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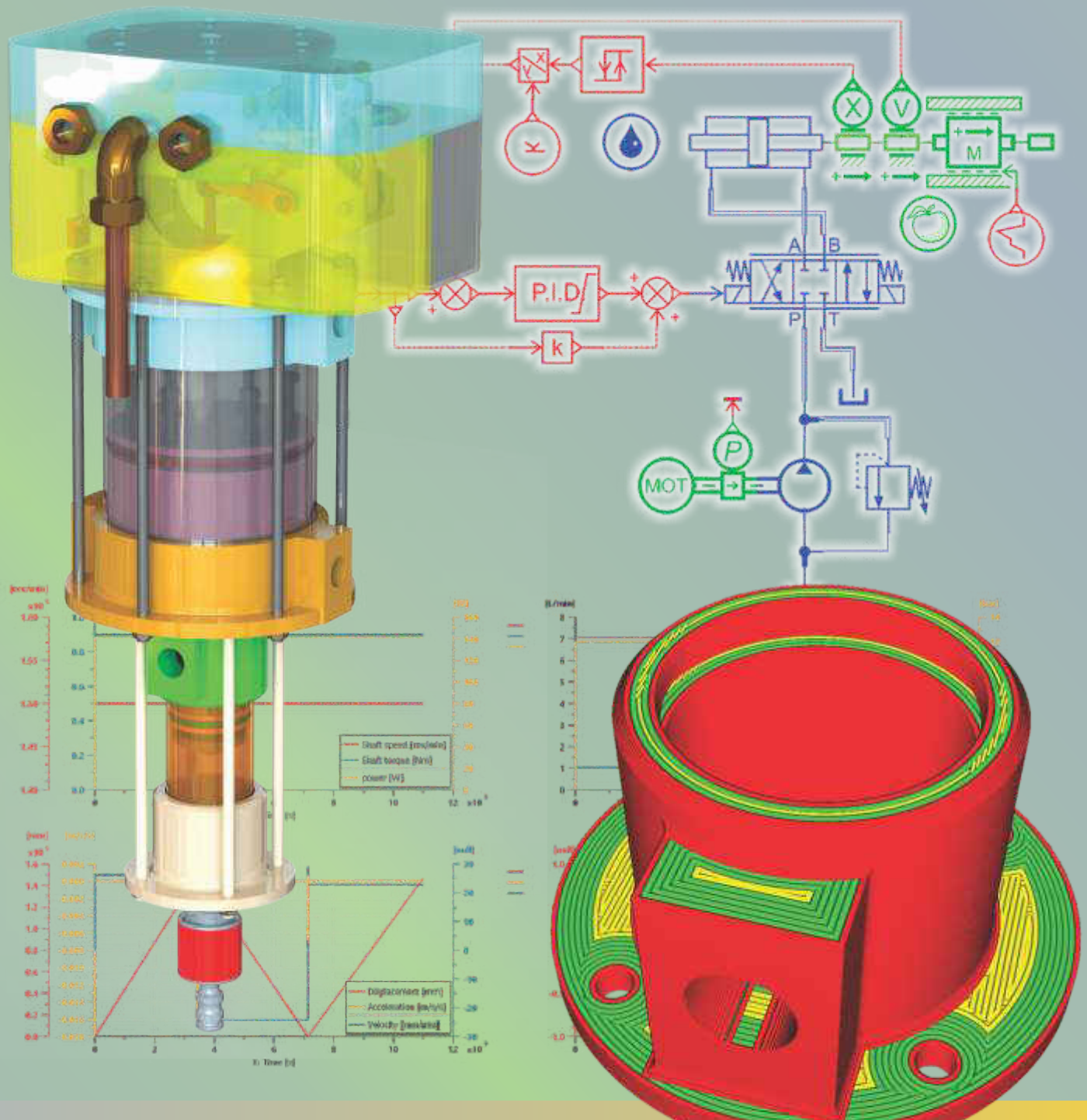

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EDITORIAL

Hidraulica în vremea pandemiei

Dr. Ing. Petrin DRUMEA
DIRECTOR PUBLICAȚIE

La întrebarea multor lucrători din domeniu privind viitorul hidraulicii în actualele condiții, încerc un răspuns scurt și sper că și clar.

Vremurile tulburi, complexe, dar și ciudate pe care le trăim nu au blocat și nici nu par să blocheze progresele din hidraulică. Deși știu că din previziunile făcute în decursul timpului nu s-au adeverit nici măcar jumătate, o să risc câteva previziuni pe termen mediu pentru domeniul nostru, tocmai în aceasta perioadă dominată de pandemie.

Înainte de alegerea direcțiilor de dezvoltare, încep cu o observație generală, și anume că studiile teoretice vor depăși, ca preocupare și efort asumat, studiile experimentale și fabricația, chiar dacă realizările nu vor fi pe măsura așteptărilor.

Probabil va crește numărul de metode de simulare, numărul de proiecte noi nefinalizate și chiar numărul de brevete neaplicate. Se vor studia intens noi proiecte de pompe și motoare hidrostatice, de utilizare a soluțiilor de load sensing, dar mai ales sistemele de transmisie hibride având la bază hidrostatica. Este posibil să se demonstreze utilitatea fiabilității, a siguranței în funcționare, a mentenanței și a diagnozei pe baza prognozei. Sigur se va dezvolta subdomeniul digitalizării sistemelor hidraulice, iar domeniul acționărilor hidrostatice în ansamblu va deveni inteligent.

Cred că rolul hidraulicii în domeniile energiilor regenerabile și al roboticii nu va crește la nivelul așteptărilor, deși teleoperarea hidraulică va deveni un fapt, poate și pentru că nivelul învățământului de specialitate va scădea.

Speranțele domeniului vor fi determinate de introducerea în fabricație a noutăților ultimilor ani, cum ar fi, de exemplu, utilizarea materialelor și fluidelor inteligente, hidraulica digitală, sistemele de acționare utilizatoare de circuite regenerative, optimizarea energetică a circuitelor hidraulice. De asemenea, un rol benefic îl vor avea și noutățile din domeniile adiacente, cum sunt cele din senzorică, din electronică, din electrică și din informatică. Chiar și numai din aceste dezvoltări, acceptând ideea că lucrurile nu se vor deteriora dramatic, se poate constata că pentru domeniu va fi o perioadă normală, fără motive serioase de îngrijorare.

Multă sănătate!

EDITORIAL

Hydraulics during the pandemic

Ph.D.Eng. Petrin DRUMEA
MANAGING EDITOR

To the question of many workers in the field regarding the future of hydraulics in the current conditions, I try a short – and hopefully clear - answer.

The turbulent, complex, but also strange times we live in have not blocked and do not seem to block the progress in hydraulics. Although I know that not even half of the forecasts made over time have come true, I will risk a few medium-term forecasts for our field, precisely in this period dominated by the pandemic.

Before choosing the development directions, I start with a general observation, namely that theoretical studies will exceed, as a concern and effort, experimental studies and manufacturing, even if the achievements will not live up to expectations.

The number of simulation methods, the number of unfinished new projects and even the number of unapplied patents will probably increase. New projects for hydrostatic pumps and motors, projects for the use of load sensing solutions, but especially for hydrostatic-based hybrid transmission systems will be intensively studied. The usefulness of reliability, operational safety, maintenance and diagnosis may be demonstrated based on the forecast. The subdomain of hydraulic systems digitalization will surely develop, and the field of hydrostatic drives as a whole will become intelligent.

I believe that the role of hydraulics in the fields of renewable energy and robotics will not increase up to the level of expectations, although hydraulic remote operation will become a fact, perhaps also because the level of specialized education will decrease.

The hopes of the field will be determined by the introduction into the manufacturing of the novelties of the last years, such as, for example, the use of intelligent materials and fluids, digital hydraulics, drive systems using regenerative circuits, energy optimization of hydraulic circuits. In addition, a beneficial role will be played by the news in the adjacent fields, such as sensorics, electronics, electrical and computer science. Even from these developments alone, accepting the idea that things will not degenerate dramatically, one can see that it will be a normal period for the field, without any serious cause for concern.

I wish you all good health.

Dynamic Modeling and Simulation of Working Regime of the Hydraulic Driven of Auger Bucket for Loader Using Matlab/SimHydraulics

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Abstract: *The paper focuses on modelling and simulation of the working operation with the auger bucket (0.7 m^3 capacity) from skid steer loader, with hydraulic acting, using Matlab/SimHydraulics environment. It was highlighted the dynamic behaviour of pressure, flow fluid, resistant torque and angular speed at shaft of hydraulic motor, subjected to the random loads that can appear when mixing concrete.*

Keywords: *Auger mixing bucket, hydraulic drive, working regime, Matlab/SimHydraulics*

1. Introduction

At present, increasing the efficiency of earthmoving machines, especially excavators and hydraulic loaders (as multi-function basic machines), is a desideratum. Starting from this aspect, for example, the efficiency of the operation of the loaders depends on their equipment with a lot of work accessories [1], one of them being the bucket with auger mixing system that can be built with different working capacities depending on the type and size of the basic machine on which it is mounted. Auger mixing is the most widely used technique of in-situ materials mixing and is especially useful for particular applications. Usually, execution of construction works consisting in concrete, mortar, cement or other granular mixtures pouring process (often used on sites) is done with its specialized equipment, such as concrete mixers or multifunctional base machine equipped with auger mixing bucket (see Figure 1).

Fig. 1. Working principle of the mixing bucket for loader [2]

It must remark main advantages of using of this equipment, as: eliminating the backbreaking labor of mixing, transporting and dispensing wildlife feed, sand, asphalt, agricultural grains and washed gravel (3/4 inch maximum). In addition, the auger buckets have a quick-attach frame on either side to control the discharge from the left or right and come complete with a chutes, hoses and couplers.

2. Conceptual design for auger bucket

Equipment design focuses on the basic conceptual principles taking into account by actual desideratum: to perform its working specific requirements with maximum economy and efficiency. Thus, the objective of this purpose were accomplishing the following engineering aspects: fast production, easy maintenance and control, minimum complexity of the mechanical parts, standard parts use, health harmless material, and mechanical safety [3, 4]. In above context and based on common solutions developed by manufacturers worldwide, a virtual prototype of auger bucket (with 0.7 m^3 capacity), it was drawn in Figure 2.

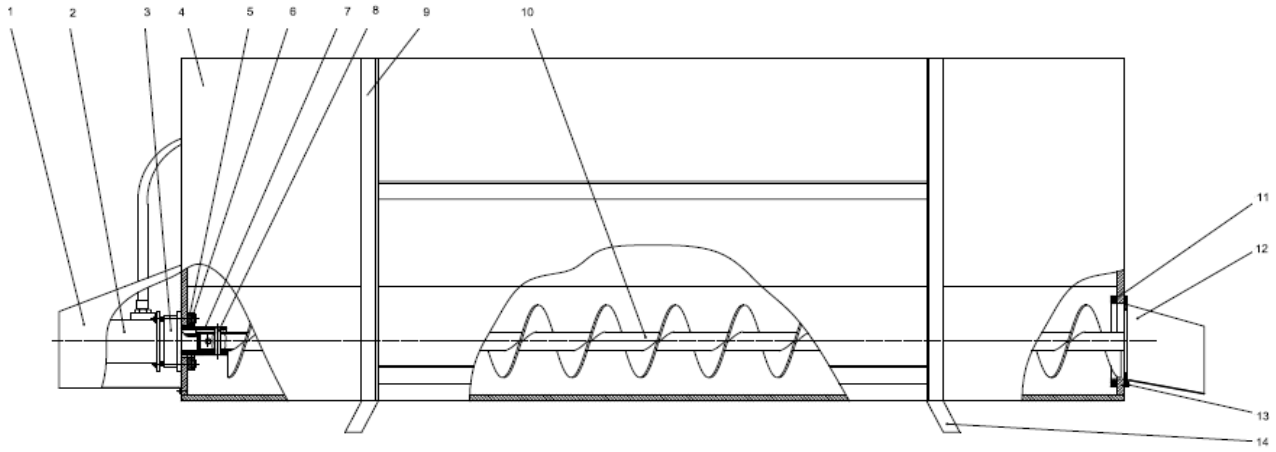


Fig. 2. Drawing in 2D CAD of the concrete mixing bucket for skid loader (rear view):
1. recessed cavity; 2. hydraulic motor; 3. bearing; 4. bucket; 5. protective flange; 6. protection fixing flange; 7. coupling; 8. coupling fixing bolt; 9. bucket support frame; 10. mixer shaft; 11. mixing ring guide ring; 12. unloading chute; 13. auger; 14. bucket support frame leg.

To operate the auger bucket, must need to be a skid steer loader (as base machine) able to provide a minimum flow of 2 m^3/h and always operate the bucket at idle speed. In this way, the hydraulic motor on auger bucket provide plenty of power to operate the auger, mix and feed product continuously without interruption. At adding heavier materials is necessary to increase the speed so the auger will not stall. Operating the auger in reverse will mix the materials and after obtained the desired consistency, the auger is stopped. The skid steer loader is driven by an engine with power P_m = 45 HP and angular speed n_m = 2400 rpm. The author will consider the higher density of the material (ρ = 2200 kg/m^3) that corresponds to the mixing of a mixture consisting of cement mortar or fresh concrete. The mixing bucket operates in two working modes: slow (for ready-processed materials) and fast (for on-site preparation of different mixtures). Thus, the mass productivity of the bucket of Q_m = 4.5 t/h corresponds to the operation in the fast regime and, respectively, Q_m = 1.26 t/h to the operation in the slow regime. Next, it will be considered the most intense case for the drive system, adopting the highest value of mass productivity.

3. Mathematical modelling of working regime for auger bucket

Mathematical modelling focuses on research related to the response of mixing equipment subjected to the random loads that can appear during working operation. Thus, the author has built a mathematical model for mechanical-hydraulic co-simulation of the auger mixing bucket, based on:
- the equilibrium equation of the fluid flow rate from hydraulic circuit;
- the equilibrium equation of the torque at drive-shaft of the hydraulic transmission of the auger.

Firstly, a database is set up with details about each component of the hydraulic system, according to constructive characteristics of equipment and base machine (e.g. pump, proportional distributor, command device, hydraulic motor etc.).The instantaneous flow of the pump (Q_p), by neglecting losses, will be given by the formula (1):

$$Q_p = \frac{V_0 p}{2\pi} \cdot \omega_p \,, \tag{1}$$

where: V_0 – pump specific volume of the fluid; p – pressure; ω_p - pump angular speed.
Fundamental equation for the hydraulic driveline will be derived by using the generalized Newton's second law of motion. The equilibrium equation between the input and output torque of the hydraulic driveline is obtained the formula (2) given below:

$$T_m - T_l = J_{eq}\dot{\omega}_m \,, \tag{2}$$

where: T_m – motor torque; T_l – load torque; J_e – equivalent moment of inertia; ω_m – motor speed.
Using these equations, it is possible to choose a proper software environment for virtual simulation

of dynamic behavior of hydraulic drive system of auger mixing bucket, among the most used by engineers being Matlab environment (with specialized modules, such as: Simulink, SimHydraulics, SimMechanics etc.) [5, 6, 7, 8, 9].

4. Simulation of working regimes of auger mixing bucket

To simulate the behavior of the hydrostatic driven mixer system, a scheme has been performed using the Matlab/SimHydraulics environment (Figure 3). It was implemented a simplified model of a closed circuit for auger acting from a hydrostatic motor with fixed-displacement volume. The global scheme contains the following blocks, namely: the main pump of the circuit subsystem with its mechanical driven subsystem, the pressure loss compensation subsystem for fluid pressure circuit, the hydrostatic motor subsystem, auxiliary equipment (directional valves, protection valves, pipelines), the controller block subsystem of the circuit, and the sensor blocks subsystems for instantaneous monitoring of the hydraulic parameters (input and output pressures, fluid rate flow). Visual representation of the main blocks has been marked separately, in different colors, for better understanding of functional components of the hydraulic scheme.

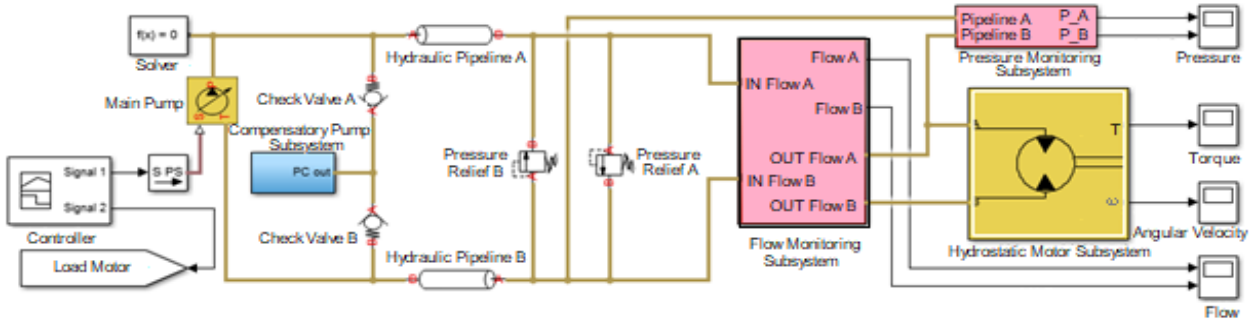


Fig. 3. Schematic of hydraulic circuit implemented in Matlab/SimHydraulics environment

The parameters that customize main blocks of the scheme in figure 3 are centralized in tables 1-3.

Table 1: Block parameters of hydraulic fluid

Parameter	Value
Type	MIL-F-5606
Density	847.4 kg/m^3
Viscosity	12.15 cSt
Flow discharge coefficient	0.7

Table 2: Block parameters of hydraulic motor

Parameter	Value
Motor displacement	8.5x10^{-4} m^3/rad
Nominal angular velocity	6 rad/s
Volumetric efficiency	0.92

Table 3: Block parameters of 4-way directional valve

Parameter	Value
Leakage area	10^{-12} m^2
Valve passage maximum area	5x10^{-5} m^2
Valve maximum opening	0.01 m

The model of pump with constant parameters will be assumed, functioning at 200 bar pressure. The control of the constant flow pump is provided by the controller, by inserting a generic signal

conditioning block in the physical signal. The pressure / flow loss compensation circuit in the scheme has the principle diagram shown in Figure 4. This module was included a volume pump with constant displacement, mechanically putting into working regime by a constant rotational speed source. The discharge valve acts as a protection of the circuit when the maximum value of the working pressure is exceeded (preset to 180 bar). The block with the parameters of the hydraulic fluid used was also added to the scheme.

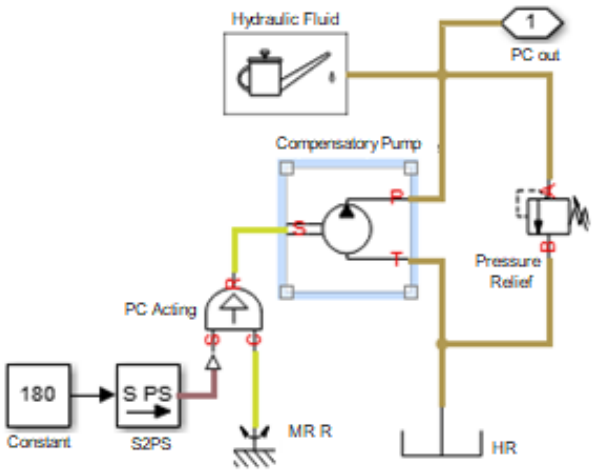


Fig. 4. Compensation circuit subsystem

Generally, knowledge of the dynamic behavior of rotational loads driven by hydrostatic system is mathematic modeled using equivalent models. In order to reduce the whole mechanical system (represented by auger mixing bucket with its transmission) into an equivalent one, we can assume that it can be modeled as two moments of inertia, one to model the hydrostatic supply power and one to model the auger [10]. The first one includes the moment of inertia of the motor, of the clutch disks, of all the rotating parts, reduced to the engine shaft (with equivalent moment of inertia $J = J_e = 0.042$ kgm^2), while the moment of inertia of the auger loads and of are included in the second. In addition, the mathematical modelling of the mechanism of energy dissipation in mechanical systems [11] is often modeled through a damping element, in our case with $D = 0.2$ Nms/rad (see Figure 5).

The third element, denoted "Load" in Figure 5, is a constant torque signal generator. It maintains at its output a mechanical moment whose value is set by the connector, relative to a reference value which is usually zero. This block simulates the resistant torque that the auger bucket must overcome during working operation. The instantaneous value of this torque is configured in the control controller and taken directly, by means of a numerical scaling block, followed by a conversion from generic signal (Matlab/Simulink) to physical signal (mechanical moment, measured in Nm). It is specified that the hydraulic motor is reversible, with constant displacement flow.

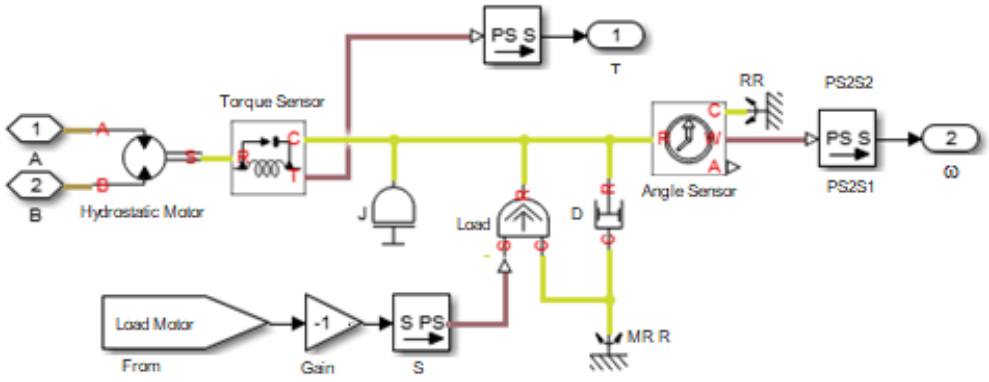
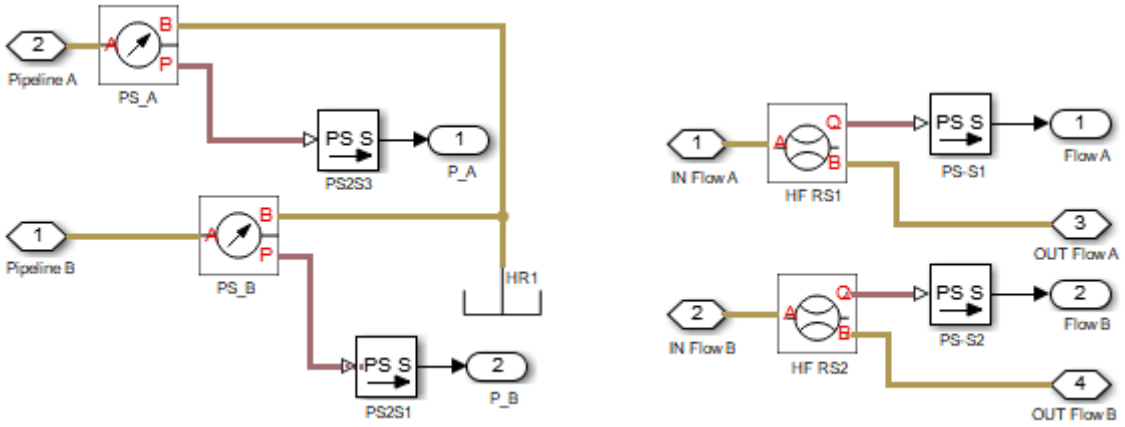


Fig. 5. Hydraulic motor subsystem

Thus, the subsystem in Figure 5 contains the all mechanical elements (above mentioned) next to the transducers specific to the monitoring of rotational motion (e.g. mechanical load of the hydrostatic motor). All these blocks help to simulate the dynamic behavior of the auger mixing bucket.
Sensors have an essential purpose in a simulated operating scheme, as in the case of this paper or physical case, in operation. Thus, it is necessary to monitor (continuously or periodically) the main parameters of the respective scheme. In this study, it is considered that the pressures and flows in the two main pipeline of the circuit constitute the set of parameters that require continuous monitoring, from the point of view of the hydraulic assembly behavior. On the other hand, from a mechanical behavior point of view, the torque resistant to the motor shaft and its angular velocity are the main parameters to be monitored. The pressure and flow sensor subsystems are shown in Figure 6, with the "mechanical" sensors being incorporated into the hydraulic motor subsystem (Figure 5).



a) b)

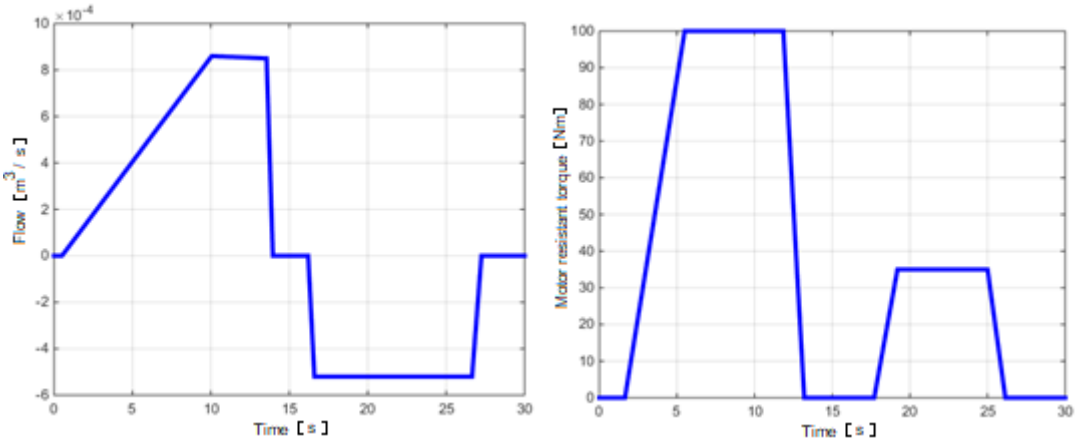
Fig. 6. Sensors diagram subsystems:
a) for pressure; b) for fluid flow.

5. Results

Simulation process is based on the model of the drive system of auger bucket (Fig. 3) that was created in Matlab/SimHydraulics environment. As numerical solver, the algorithm *ode45* (Dormand - Prince) with variable step was used. The minimum step size was set at 0.02 s, maximum step size at 0.14 s and the relative tolerance at 10^{-3}.
The simulation of the behavior of the auger bucket drive system was performed taking into account the following hypotheses, namely:

- detailed information about parameters necessary for the configuration of the hydraulic components and apparatus are provide from catalogs, and the values of the mechanical parameters for load model configuration are available from dynamic analysis;
- taking into account the variability of the dynamic working regime of the mixing bucket, the unfavorable working case corresponding to auger rotation with the maximum available rotational speed was considered (means random appearance of resistant moment reaching the maximum value resulting from equation applied to rotational motion of the auger shaft);
- the simulation was performed for 30 seconds, during which time the auger is actuated in a clockwise direction, at the maximum value of the engine torque and in the opposite direction at about 30% of its maximum capacity;
- two virtual simulation scenarios were performed corresponding to the two significant working cases in terms of auger loads appearance, such as:
    a) case I: independent simulation of the main pump control in the circuit and load on the motor shaft;
    b) case II: correlation of the two control signals so that the variations of the torque resistant are proportional to the variations of the angular speed of the motor shaft.

In this study, the pressures and flows in the two pipeline (A and B) of the circuit, respectively the torque and the angular velocity of the motor shaft, are the monitored parameters. The time evolutions of the two command parameters are shown in the diagrams in figure 7. It is mentioned that for case II the load control is performed with a signal proportional to the one for regulating the flow of the main pump, through a block of corresponding scaling of the values of the numerical function.



a) b)

Fig. 7. Command parameters for:
a) flow main pump control; b) mechanical load control at pump shaft.

Figure 8 shows the results obtained for the analysis in case I. The diagrams of the evolutions of pressures and flows in the main circuit are presented comparatively for both pipeline A and B. The behavior particularities of two parameters, in ranges where transient manifestations are present, can be observed on the details in figures 9 - 12.

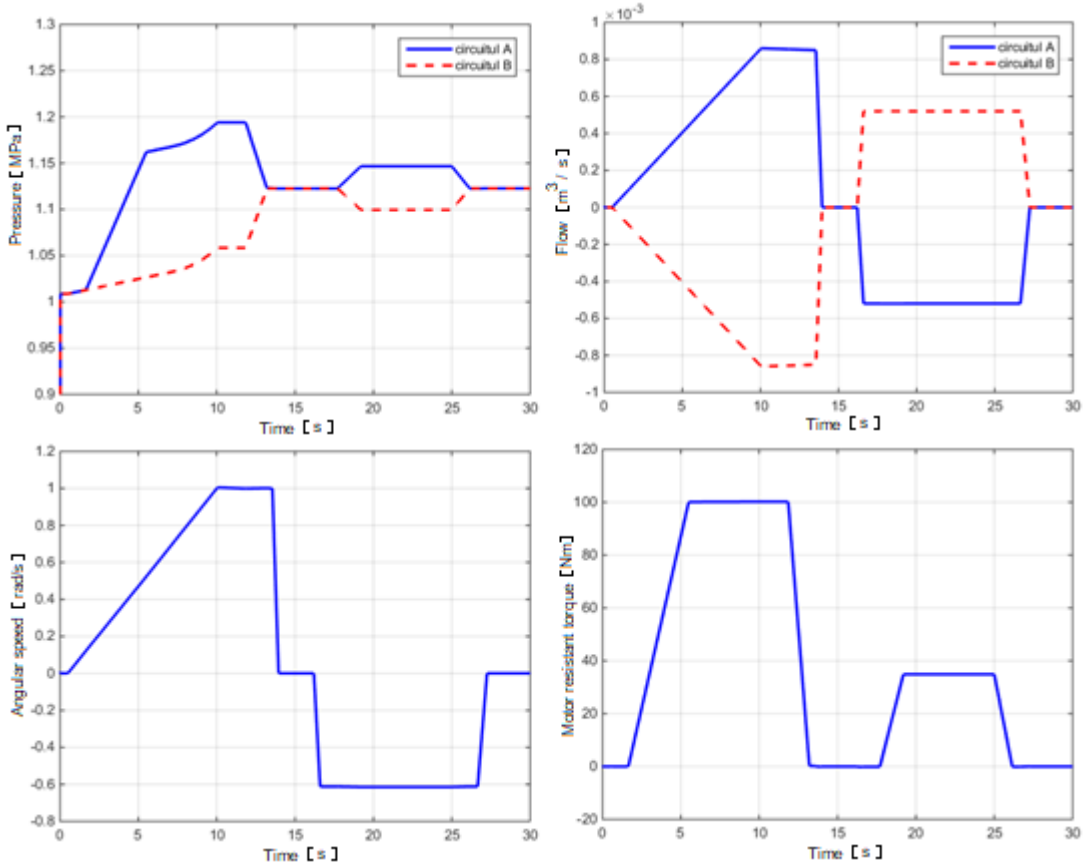


Fig. 8. Time evolutions of pressures, flow rates, angular speed and torque for the analysis in case I

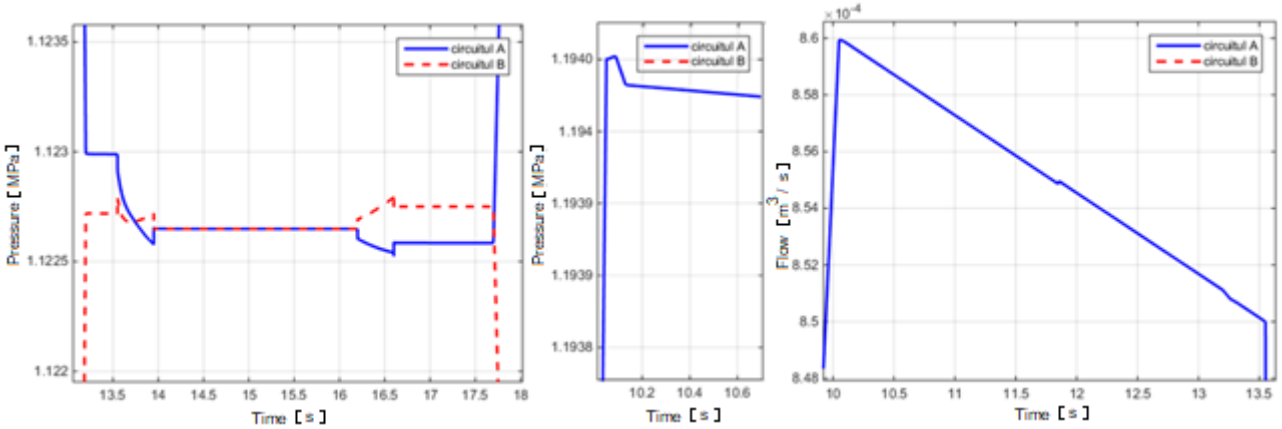


Fig. 9. Details for pressures (case I)

Fig. 10. Detail for flow (case I)

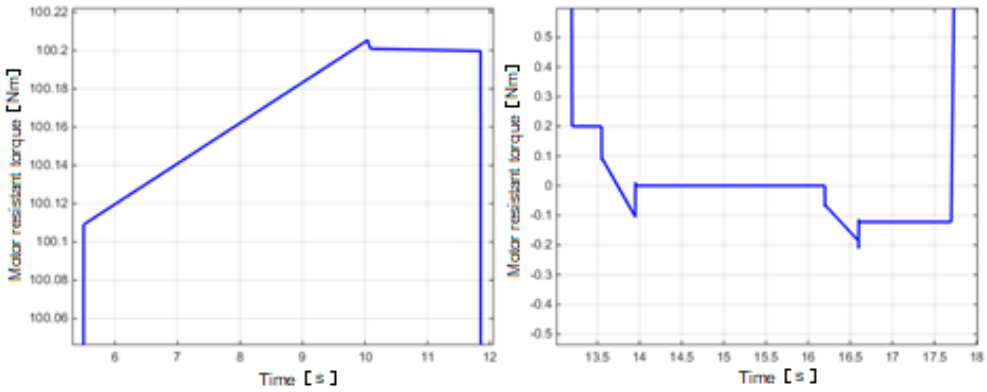


Fig. 11. Details for resistant torque (case I)

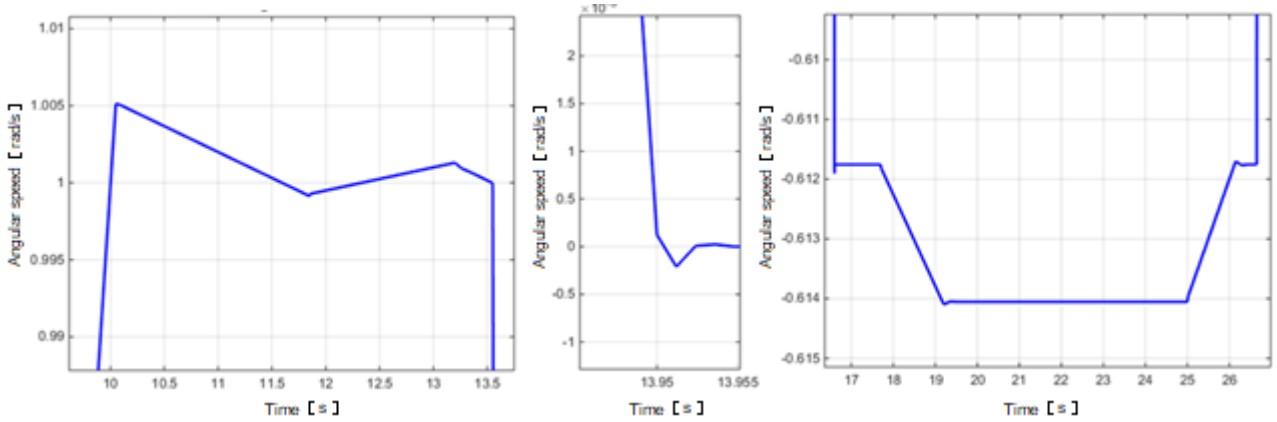


Fig. 12. Details for angular speed (case I)

After evaluating the parameters of the drive system, under the conditions of an imposed characteristic of the auger motion (case I), the control scheme is reconfigured so that the instantaneous mechanical load must be proportional with angular velocity of the motor shaft (by taking primary information on hydraulic fluid flow at the outlet of the main pump). This reconfiguration of the scheme leads to analysis in case II and the results obtained are presented in figure 13.

Similarly, to the case I, the diagrams of the evolutions of pressures and flows in the main circuit are presented comparatively for both pipeline A and B, and the behavior particularities of the monitored parameters evolutions can be seen in the details in figures 14 - 17.

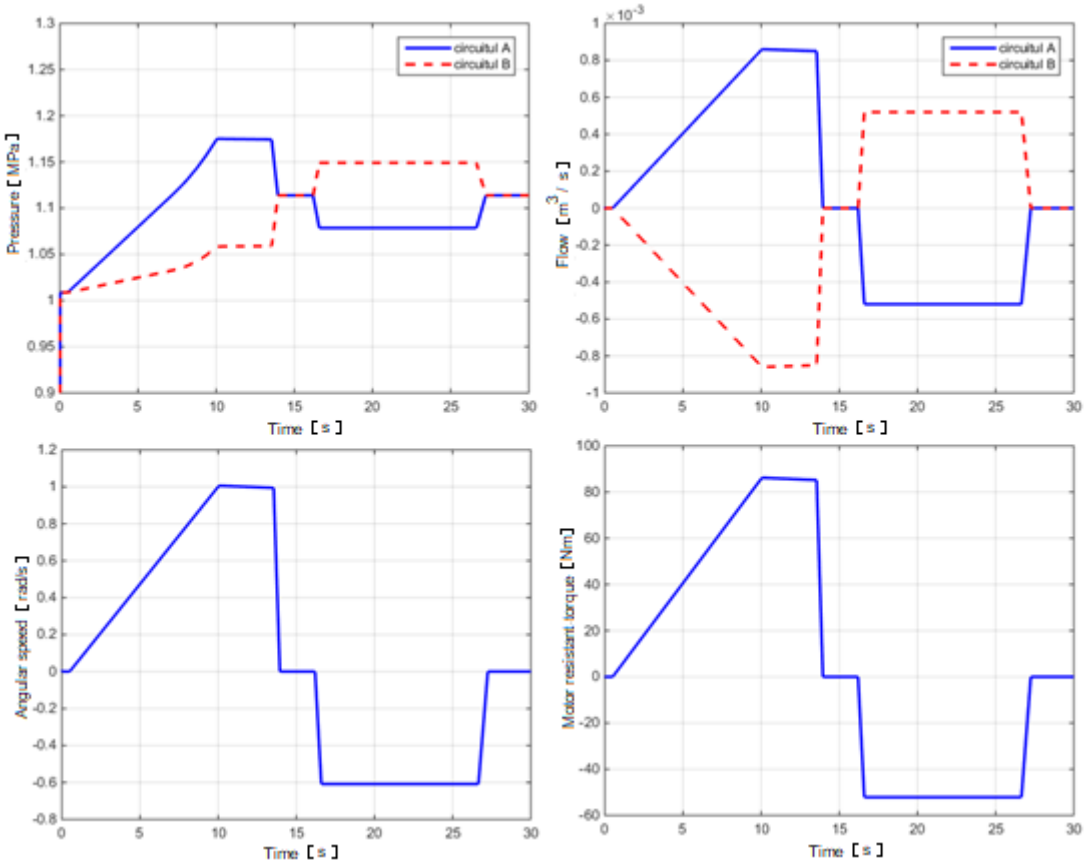


Fig. 13. Time evolutions of pressures, flow rates, angular speed and torque for the analysis in case II

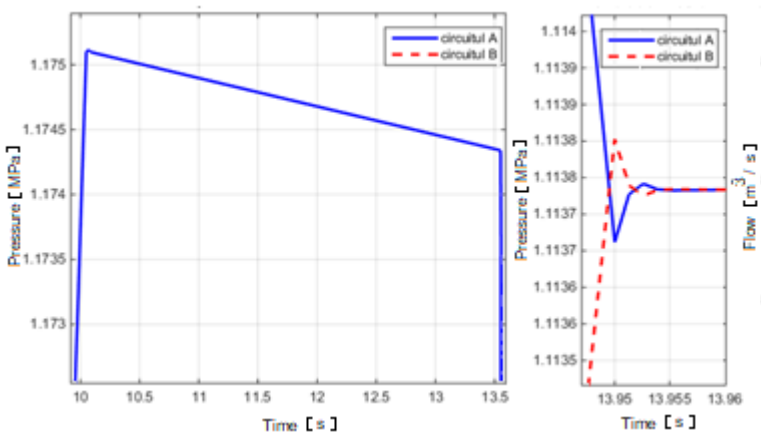


Fig. 14. Details for pressures (case II)

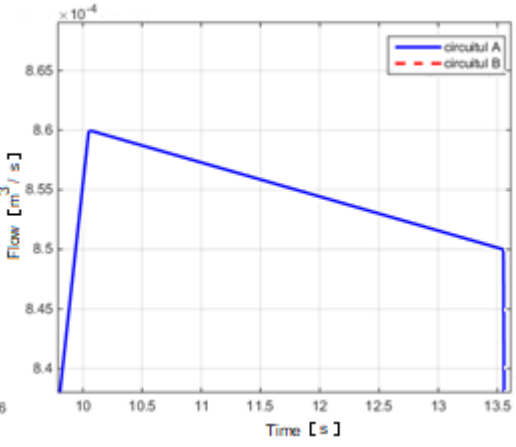


Fig. 15. Detail for fluid flow (case II)

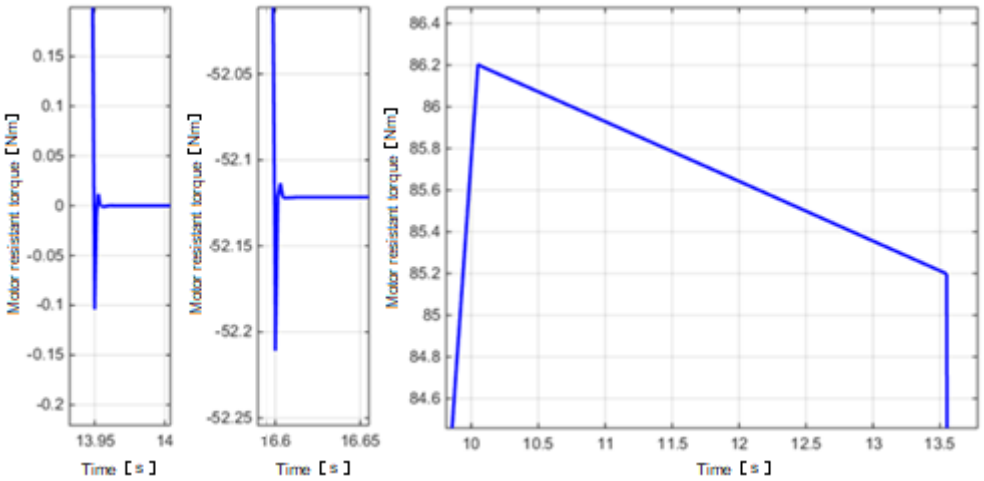


Fig. 16. Details for resistant torque (case II)

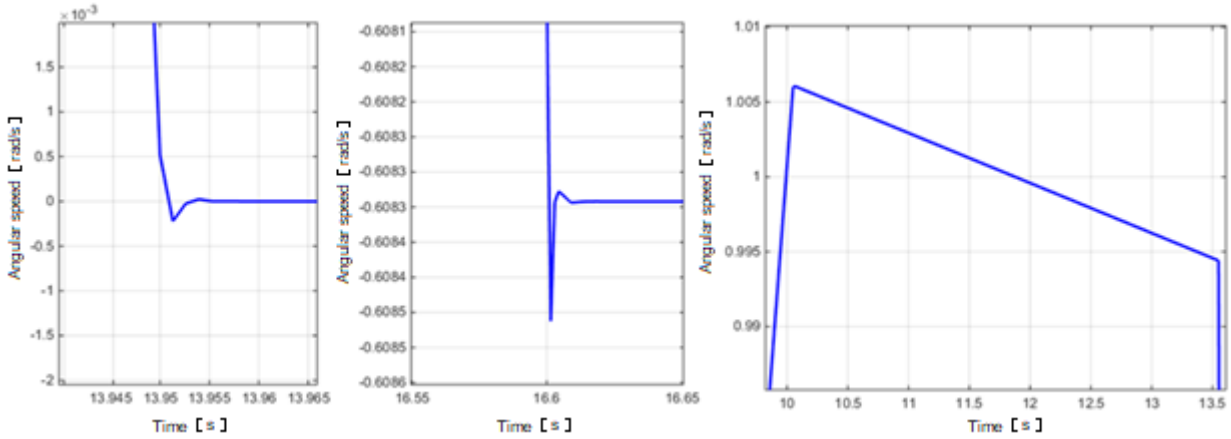


Fig. 17. Details for angular speed (case II)

It is obvious that the details presented in the paper, corresponding to the variations of the monitored parameters (both for the case I and II) must be analyzed together with the global diagrams corresponding to the evaluated parameter.
Since in case I but especially in the second, there are some manifestations of transient working regimes, which occur when the state of the drive system suddenly changes (starting, braking, auger sense changing, sudden change in the value of the mechanical load, etc.) it is a usual behavior, given that the model also includes inertial masses in rotating motion represent by the all components of the equipment ensemble.
Also, the dynamic model of hydraulic power transmission from the energy source to the auger further contributes to the appearance of transient dynamic regimes. The negligible amplitudes of these transient variations, as well as the very short time in which they are fully amortized, are the direct consequence of the determining factors, namely: very low angular speed at the axis of the hydrostatic motor and relatively high damping in the mechanical system work (reduced to the motor shaft).

6. Conclusions

The results of the aspects approached in the paper led to evidence the following conclusions:

- for this equipment (characterized by slow working regimes), without sudden or rapid transitions between working phases, the dynamic analysis approach is of secondary importance, justified mainly by the need to assess the load peaks that may occur during working cycle. This conclusion is justified by the qualitative and quantitative evolutions highlighted in the dynamics of the system analysed in this study;

- in accidental conditions (when the dynamic loads on the auger axis can reach very high values compared to the usual ones) such numerical approaches regarding the dynamic behavior of the analysed equipment are well justified, provided that the mathematical and simulation models used must take into account the whole consisting of mechanical parts of equipment and its hydraulic driven system. This conclusion is justified by the complexity of the approach of the presented study: the modeling of the drive system was made based on constructive example given in Figure 2, including all the components of such a drive scheme, as well as the determinants of the mechanical load generated by the auger simulated virtual scenarios.

In addition, using of the computer environments such as Matlab (with SimHydraulics and Simulink modules) simplifies very much the designer's efforts starting from the designing stage (conception and CAD modelling), allowing him to create the hydraulic circuit from the point of view of its, as well as to choose the functional parameters and the mechanical component parts of the equipment so as the energetic efficiency of the assembly should be as high as possible.

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Resistance and Behavior to Cavitation Erosion of Semi-Finished Aluminum Alloy 5083

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Abstract: *Among the applications of aluminum-based alloys is that in the field of hydraulic installations and equipment. Some components of their structure, such as the rotors of the cooling pumps of motor vehicles, or the blades of propellers from the engines of fishing boats, or pleasure boats, and even the radiators of motor vehicles are subject to corrosion by the cavity created during operation. Among the aluminum alloys used in the manufacture of such components is the alloy 5083. These parts can be made by casting (rotors / pump housings and steam propeller) or laminated semi-finished products, such as blades for rotors / propellers with adjustable vanes. Cavitation operation inevitably leads to damage by erosion caused by cyclic stresses of micro-jets and shock waves generated by the implosion of cavitation bubbles. As a result, the paper presents the results regarding the degradation by vibration cavitation of alloy 5083, in the form of cast and rolled semi-finished product. The curves and parameters specific to the resistance of the alloy to cavity erosion, as well as the images of eroded surfaces, show, surprisingly, that the cast semi-finished product has a higher resistance than the laminated one, due to the mechanical properties and the type of microstructure.*

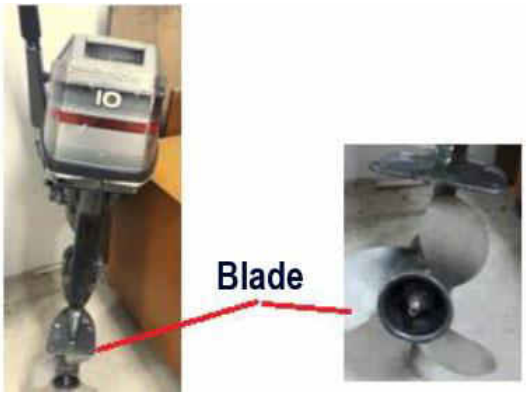
Keywords: *Cavitation erosion, semi-finished, cast, laminate, erosion rate, erosion depth, cavity resistance, mechanical properties, microstructure*

1. Introduction

Aluminum-based alloys, known as duralumin, have a very high industrial application, due to their low specific mass (less than 3 g / cm^3) and high mechanical properties. The best known are from the food, automotive, aircraft and naval industries [1, 2]. A series of components more or less mechanically, hydrodynamically or chemically stressed made from these alloys are made. For those required hydrodynamically, specialists are looking for solutions to increase the surface resistance to cyclic stresses of micro-jets and shock waves, which cause degradation by erosion. Such parts are the rotors of household well pumps, the rotors of water pumps for cooling car engines (fig.1 c and d), the stern of boats (where the cavitation vortex is manifested), the propellers of boat engines (fig.1 b) and of the pleasure boats (fig.1.a), respectively the attack board of the

aircraft wing and its warhead. Therefore, it is necessary to know the strength of the alloy, regardless of the type of semi-finished product (cast or rolled), to look for ways to increase it, by using modern or traditional heat treatment technologies, so as to increase the service life when they are operated in hydrodynamic conditions with developed cavitation. In this sense, the research on aluminum alloy 5083 (cast and rolled) is included, the results of which are presented below, whose purpose is to present the differences in strength between the two semi-finished states and to look for methods of structural modification and properties. mechanical, which increase the resistance of the surface to the hydrodynamic stresses of the cavity.

a) Boat propeller that sailed on the Danube (purchased from the Drobeta Turnu-Severin Shipyard)



b) Boat engine propellers

c) Car cooling pump

[3]

d) Tractor cooling pump

[4]

Fig. 1. Various propellers and motor vehicle cooling pumps, made of aluminum-based alloys

2. The investigated material

The aluminum alloy, whose behavior and resistance to cavity erosion has been studied, is 5083 from the 5000 series [5] (known by the symbol AlMg4.5Mn), from the Polytechnic University of Bucharest.

The research was carried out on test specimens, taken from the two forms of semi-finished product, cast and laminated, under which the alloy is used in practice [5, 6]. The samples offered for the cavitation tests (with a diameter of 15.8 mm, according to the requirements of ASTM G32-2016), as well as those from which the specimens for the mechanical tests were made, are taken from laminated and cast sheets, purchased from Color Metal [5, 6].

The laminated semi-finished product is in the H111 [7] laminated state, followed by solution hardening from 454 ° C to 399 ° C and aged at 343 ° C, followed by air cooling. The molded semi-finished product is not subjected to any heat treatment, so it is characterized by low internal stress, microstructural homogeneity and constant properties throughout the volume [6].

Table 1 shows the values of the mechanical properties, according to the standard EN AW 5083 and those determined in the Specialized Laboratory of the Polytechnic University of Bucharest.

Table 2 shows the chemical, standard and measured compositions.

Table 1: Standard and measured mechanical properties

Specimen	$R_{p0,2}$ MPa	R_m MPa	HB daN/mm²	KCV J/cm²	A5 %	Z %
5083 T (standard)	110-130	230-290	68-73	-	10-15	
5083 T (measured)	141.66	294.824	72.8	25.2	-	23.4
5083 L Standard	105-125	260-340	70-75	-	12-15	
5083 L (measured)	135.78	235.367	80.1	5.3	-	4.15

T- cast semi-finished product, L-laminated semi-finished product

The data in Table 1 show that, compared to the laminated semi-finished product (5083 L), the cast alloy 5083 T has higher values for the mechanical breaking strength Rm (by about 4%), the yield strength $Rp_{0.2}$ (by about 25%) and KCV resilience (about 4.8 times) and HB hardness lower by about 10%). These values are reflected in the destruction of the structure of the cavity surfaces, by the evolution in plan of the cavity area by increasing the number, depth and width of the caverns (see table 3).

Table 2: Standard and measured chemical compositions

Alloy	Chemical composition, [%]									
	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Other	Al
5083 (standard)	< 0.4	< 0.4	< 0.15	0.4-1.0	4-4.9	0.05-0.25	< 0.25	< 0.15	0.05	rest
5083 T (measured)	0.38	0.36	0.141	0.85	4.69	0.23	0.223	0.142	-	rest
5083 L (measured)	0.39	0.37	0.137	0.89	4.71	0.21	0.243	0.137	-	rest

The data in Table 2 show that the chemical elements, identified, are in the standard range, but with slight differences from one material to another, which, also, through compounds formed at the micro level produce their effect on the resistance of caristal bonds to collisions with micro-jets. shock waves.

3. Experimental research

3.1 Apparatus and method used

The experimental research program was carried out on the vibrating device with piezoceramic crystals, from the Cavitation Erosion Growth Laboratory within the Polytechnic University of Timișoara. The experimental procedure was with a stationary sample, in accordance with the standard procedure, described by ASTM G32-2016 [8] and according to the custom of the laboratory, in terms of total and intermediate durations of exposure to cavitation attack, how to record and process data. experimental [9-11].
Three samples were tested from each type of material.
Throughout the cavitation test, the functional parameters of the device (double vibration amplitude of 50 μm, oscillation frequency of 20 ± 0.1 KHz, electric power supply of the electronic ultrasonic generator of 500 W and distilled water temperature of 22 ± 1 °C), which determines the hydrodynamic regime of the cavitation, respectively the intensity of destruction, by the micro-jets and shock waves produced by the implosion of the cavitation bubbles, were kept at constant values, due to the fact that the whole operation program is computer software specially built for this purpose [12].

3.2 Cavitation test results. Analysis and discussions

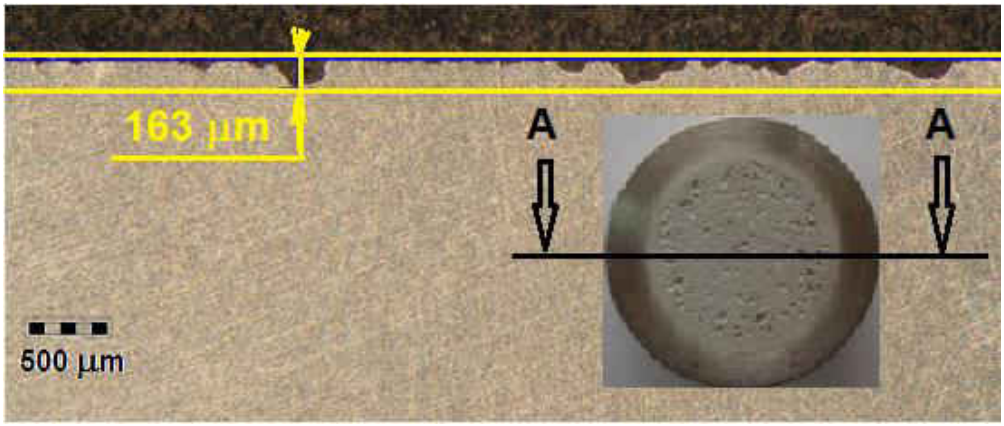
3.2.1 Destruction of the surface exposed to the vibrating cavity

Table 3 gives images of eroded surfaces, at three significant times, for one of the three samples tested in each material. The images, depending on the size of the caverns and the area in which they extend, highlight the differences in behavior and resistance to the cyclical stresses of local fatigue produced by micro-jets and shock waves.
The larger shape and dimensions of the caverns produced in the layer of laminate semi-finished product (5083 L) are observed. This is the effect of lower values of KCV resilience (property that strongly influences the absorbed energy to break the bonds between the crystalline grains), but also of the mechanical breaking strength Rm and the yield strength $Rp_{0.2.}$

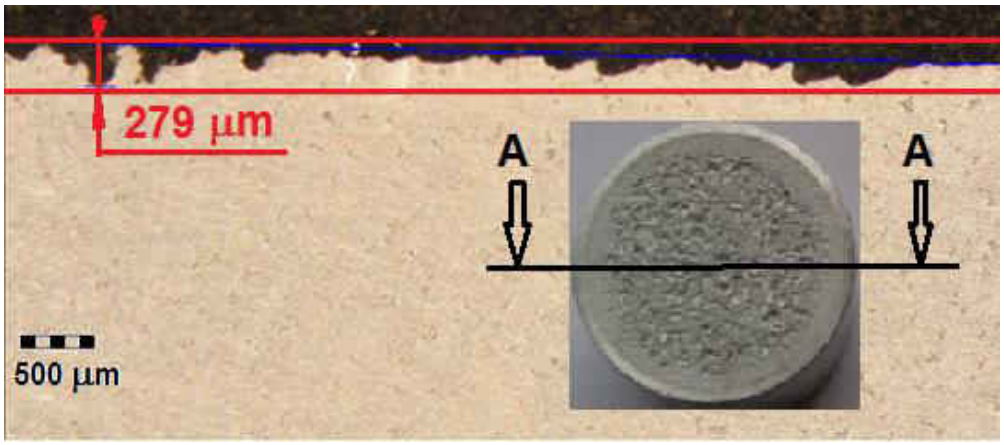
Table 3: Macro-photographed images at significant times

Material	45 min	105 min	165min
5083 T			
5083 L			

Although hardness is a property with great influence, positive, on the resistance to cavitation erosion, according to the studies of most specialists, the most cited being Bordeasu [9], Garcia ao [13], Hobbs [14], Franc ao [15], Steller [16], Sakai-Shima [17], made of various types of metals, especially ferrous and copper alloys, in this case does not help due to the low values of other mechanical properties, equally influential on the strength of stresses. cavitation fatigue.
Fig. 2 shows images under an optical microscope on sections A-A made by the cavitationally eroded surface, which highlight the maximum penetration depths of the cavitation and the dimensions of the caverns in the cavity area.



a) 5083 T



b) 5083 L

Fig. 2. Images under the metallographic optical microscope (caverns, cracks, deformations) and macrostructural images of the eroded structure in the specimens required for cavitation in the two structural states

Moreover, these images, from fig. 2, confirms the lower resistance of the 5083 L alloy compared to the 5083 T. It is observed both the differences in roughness created by erosion, but also the cavern with the greater depth at 5083 L (279 µm compared to 163 µm). At 5083 T there are fewer and deeper caverns, and at 5083 L more, wider and deeper. These developments of deformations and fractures are also related to the values of mechanical properties. The more frequent ruptures of the 5083 L alloy are also caused by the higher hardness value (80.1 HB).

3.2.2 Curves and characteristic parameters

In fig. 3 and 4 show the specific cavitation diagrams, constructed based on the mediation of the mass losses recorded at the end of each intermediate period "i" (one of 5 and 10 minutes and 10 of 15 minutes each [9]), on the three samples tested, using the relationships:

$$M_i = (1/3)\sum_{i=1}^{12}\Delta m_i \text{ - cumulative mass loss (experimental values)} \quad (1)$$

$$v_i = (1/3)\Sigma\frac{\Delta m_i}{\Delta t_i} \text{ - erosion rate (experimental values)}$$

where:

Δm_i - represents the value of mass losses in each of the 12 periods
Δt_i - duration of the intermediate period (5, 10 and 15 minutes respectively)

The approximation of the experimental values is made by analytical curves, built with the relations established in the Cavitation Erosion Research Laboratory by Bordeașu and the team [9, 18-21]:

$$M(t) = A \cdot t \cdot (1 - e^{-B \cdot t}) \tag{2}$$

$$v(t) = A \cdot (1 - e^{-B \cdot t}) + A \cdot B \cdot t \cdot e^{-B \cdot t}$$

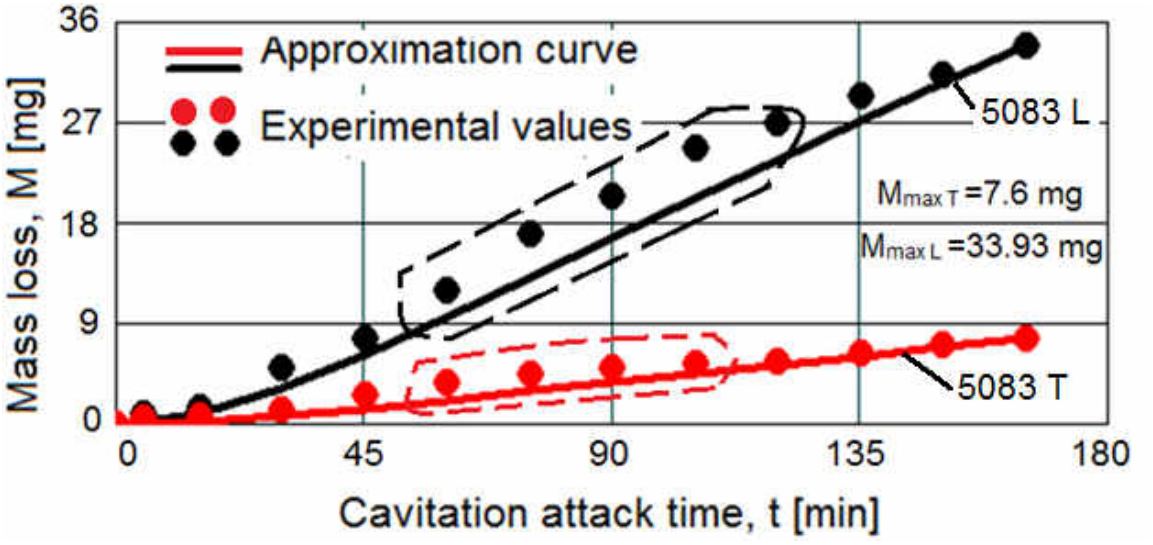


Fig. 3. Variation of mass losses with the duration of the cavitation attack

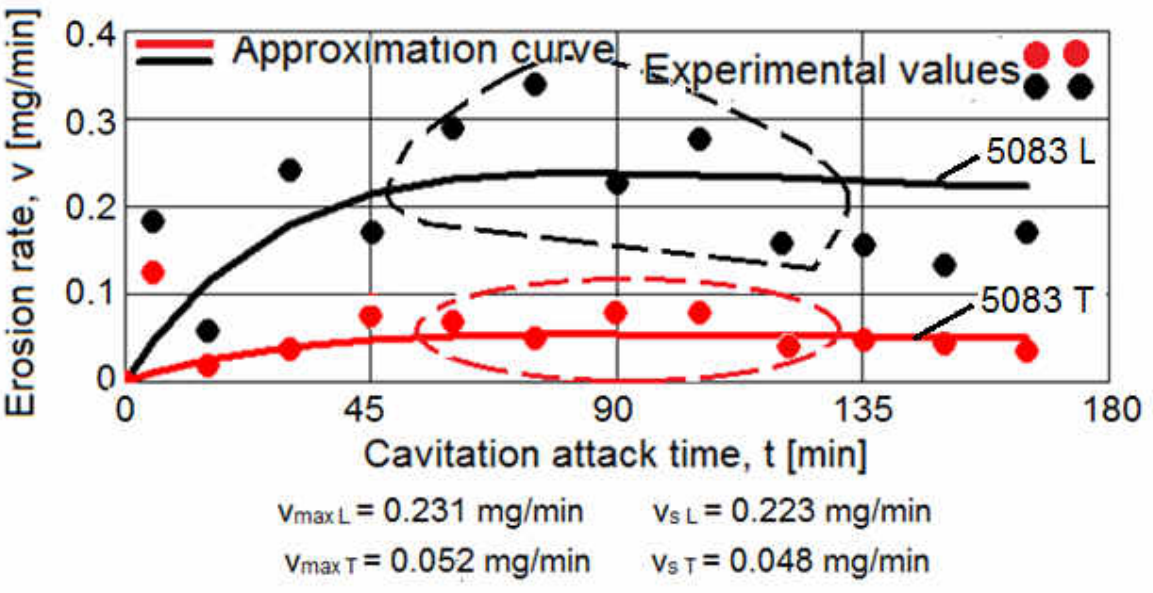


Fig. 4. Variation of the erosion speed with the duration of the cavitation attack

The dispersion of the experimental values, regardless of the diagram, M (t) or v (t), compared to the mediation curves, shows that the two materials have a similar behavior, a fact proven by the interval of 60-120 minutes. This resemblance is natural, due to the fact that they are the same material (see chemical composition in Table 2). The differences between the values of the parameters, M_{max} (total mass lost by erosion in the 165 minutes of cavitation attack), v_{max} and vs (maximum values and towards which the mediation-called and stabilization or final curve asymptotically tends - defined by the mediation curve v (t)), which express the cavitation strength are determined, in this situation, by the values of the mechanical properties (Rm, Rp0.2 and KCV),

as mentioned in paragraph 3.2.1. Thus, according to the value of M_{max}, erosion rate, vs, or cavitation resistance R_{cav} (R_{cav} = 1 / vs) the 5083 T alloy has a higher resistance than the 5083 L alloy 4.4 ... 4.6 times.

4. Conclusions

- The nature of the semi-finished aluminum alloy 5083 series 5000, from which parts are made that work in cavitation mode, influences the resistance to cyclic stresses of micro-jets and shock waves, generated by the implosion of cavitation bubbles.
- The results of this study show that hardness is not always the property that contributes to increasing the resistance of a surface to cavitation stresses, but, as studied, the values of mechanical properties, on which depends the capacity of the energy absorption structure developed by impact, to breakage and mycostructural homogeneity.
- The study calls for further research to see how the surface strengths of the two alloys change through the application of protection technologies / processes or volumetric and surface heat treatments.
- The way of destroying the structure shows that both alloys can be used for parts that work in cavitation, periodic or low intensity regimes.

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Economic Efficiency of the Pneumatic Semi-Rotary Drives

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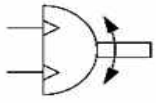
Abstract: *The paper presents the study of the economic efficiency for the semi-rotary drives. In fact, semi-rotary drives are actuators used in many technical applications. The study of the semi-rotary drives is performed in the FluidSim software from Festo. In the first part, we make a pneumatic system with a single semi-rotary drive and a pneumatic circuit with two semi-rotary drives. However, we continue with simple and complex electro-pneumatic systems that contain semi-rotary drives. Pneumatic semi-rotary drives have the potential to reliable motion characteristics with large power output to weight at low benefit–cost ratios. The performance of semi-rotary drives is deeply influenced by the way in which they are actuated. Conventional semi-rotary drives are operated by compressed air supply and controlled pressure from directional valves. Thus, the semi-rotary drives can be applied to pneumatic and electro-pneumatic schemes used in real-world applications. The costs of purchasing and maintaining of the semi-rotary actuators are low.*

Keywords*: FluidSim, pneumatic, semi-rotary, drives, actuators*

1. Introduction

The most commonly used actuators for pneumatic drives are cylinders (single acting and double acting). There are many applications that require a turning or twisting movement of up to 360 degrees. Only semi-rotary drives can be used for these pneumatic applications [1].
The semi-rotary are used in the following applications:

- Subsea ROV actuators;
- Submarine hatches;
- Car production automation systems;
- Door operation and security gates;
- Turn-over machines;
- Coal mining machines;
- Crane grabs;
- Ball and butterfly valve actuation;
- Rubber production;
- Mixing machines;
- Container spreader arms.

Symbol	Description
	The semi-rotary actuator is controlled by a reciprocal compressed air inlet from a pneumatic circuit. In the end positions, the semi-rotary can activate valves or switches.

The semi-rotary actuator is compact with high torque ratings. The force is transmitted to the drive shaft by a rotary vane. In this case, the range of angular movement is adjustable with end stops. Moreover, that angle can be adjusted between 0^0 and 180^0, [2].
The rotary vanes are separate from the adjustable stop system.
This allows force to be absorbed by the stop blocks. Only at the final positions, the impacts are cushioned by elastic cushioning rings, Fig. 1.

Fig. 1. Semi-rotary drive

The main features of a semi-rotary for an electro-pneumatic installation are:

- Cushioning angle: 43 deg.
- Swivel angle: 180 deg.
- Assembly position: any.
- Operating pressure: 0.2...1 MPa.
- Mode of operation: double-acting.
- Ambient temperature: -10...60 ^{0}C.
- Product weight: 650 g.
- Pneumatic connection: M5.

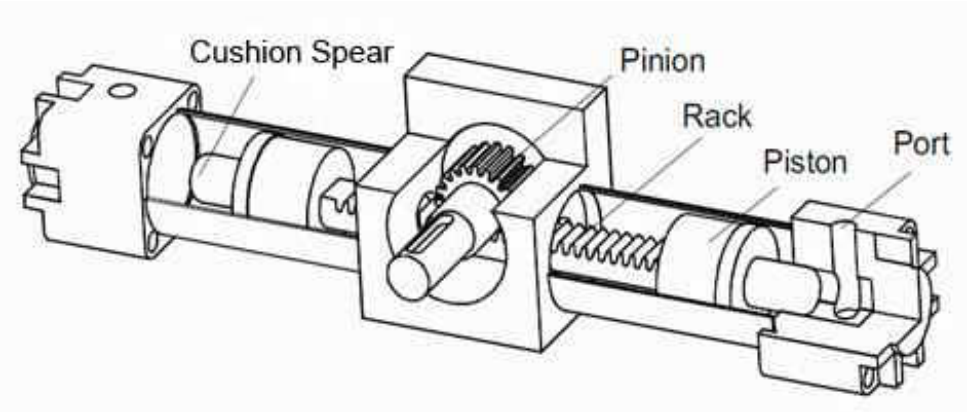


Fig. 2. Cut-away view of a semi-rotary actuator

Main components of a semi-rotary actuator are, Fig. 2:

- ❖ cushion spear;
- ❖ pinion;
- ❖ rack;
- ❖ port;
- ❖ piston.

The semi-rotary are composed of a pinion and rack constriction providing constant torque over the total rotation.
They incorporate twin rack pistons which operate on a centrally located pinion or output shaft, [3]. Pressure applied to the piston moves the rack against the pinion creating rotary movement. Regardless of shaft angular position, positive, constant, predictable constancy, mechanically balanced torque is produced in either direction.

The pinion of the actuator drives the clamping shaft, [4].
In practice, various types of semi-rotary actuators are used. Thus, the most used semi-rotary drives are:

- Semi-rotary drive with piston DRRD

	Advantages
	-cushioning options: internal and space saving or externally for maximum torque in the end position; -positions precisely and thus more reliably even with a long lever arm; -optionally for size 16 and above: end position locking and completely sealed variant.

- Semi-rotary vane drive DRVS

	Advantages
	- lightweight; - simple, compact design; - swivel angle infinitely adjustable; - sealed for reliable use in harsh environments.

The relationships describe the transformation from linear to rotational movement:

$$f_P = p \cdot A - f_F = i \cdot \tau_S \quad (1)$$

Where:

- f_P – piston force;
- p– pressure;
- A– area;
- f_F – friction forces;
- i– transmission ratio;
- τ_S – shaft torque.

$$i = \frac{2 \cdot \pi \cdot \varphi_{max}}{360^0 \cdot s_{max}} \quad (2)$$

Where:

- φ_{max} - maximum angle of rotation;
- s_{max} – maximum stroke.

$$S_p = \frac{\varphi}{i} \quad (3)$$

Where:

- S_p – piston displacement;
- φ – angle of rotation.

2. The semi-rotary actuator in pneumatic circuit

The first pneumatic circuit made in this paper is designed as a simple pneumatic scheme, Fig. 3.

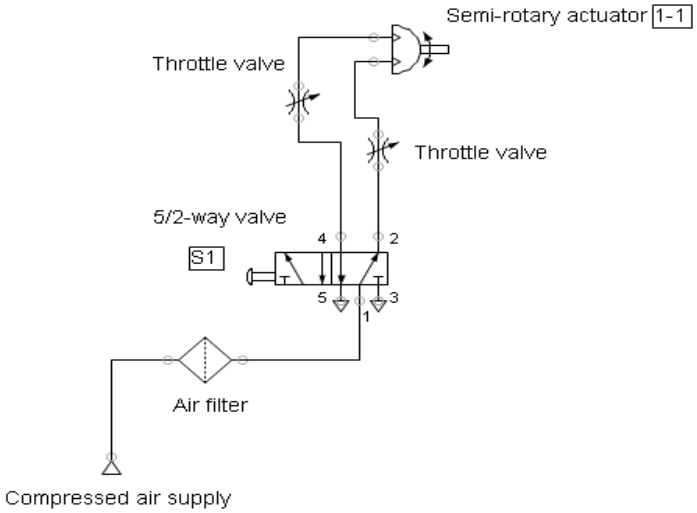


Fig. 3. Pneumatic system with a semi-rotary 1-1. Scheme 1.

Table 1: The components from scheme 1

Description	**Number of components**
Semi-rotary actuator	1
Throttle valve	2
5/2-way valve	1
Air filter	1
Compressed air supply	1

The distributor 5/2 –way valve with air filter makes the connection between compressed air supply and semi-rotary 1-1, Fig. 3.

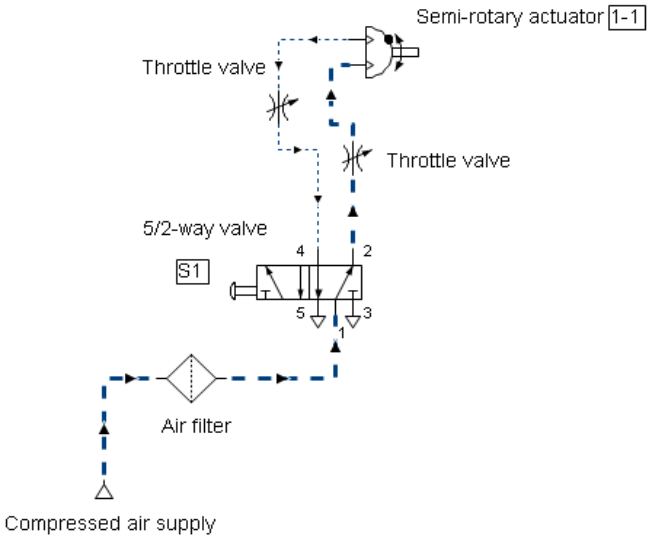


Fig. 4. Pneumatic system with a semi-rotary. Simulation

The pneumatic system with a single semi-rotary actuator opens if we press S1 button from 5/2-way valve, Fig. 4.

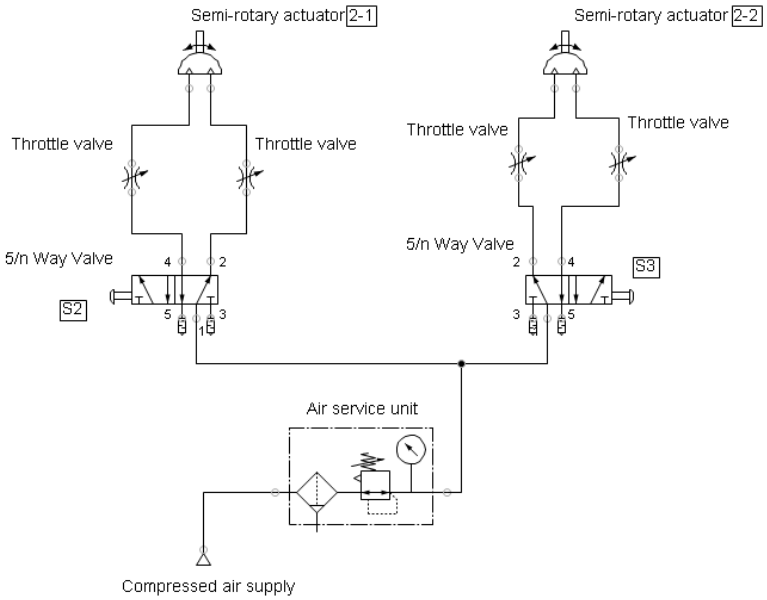


Fig. 5. Pneumatic system with two air motors. Scheme 2.

Table 2: The components from scheme 2

Description	**Number of components**
Semi-rotary actuator	2
Throttle valve	4
5/2-way valve	2
Air service unit	1
Compressed air supply	1

Those two semi-rotary actuators are independent of each other. They can start at the same time or in turn, Fig. 6.

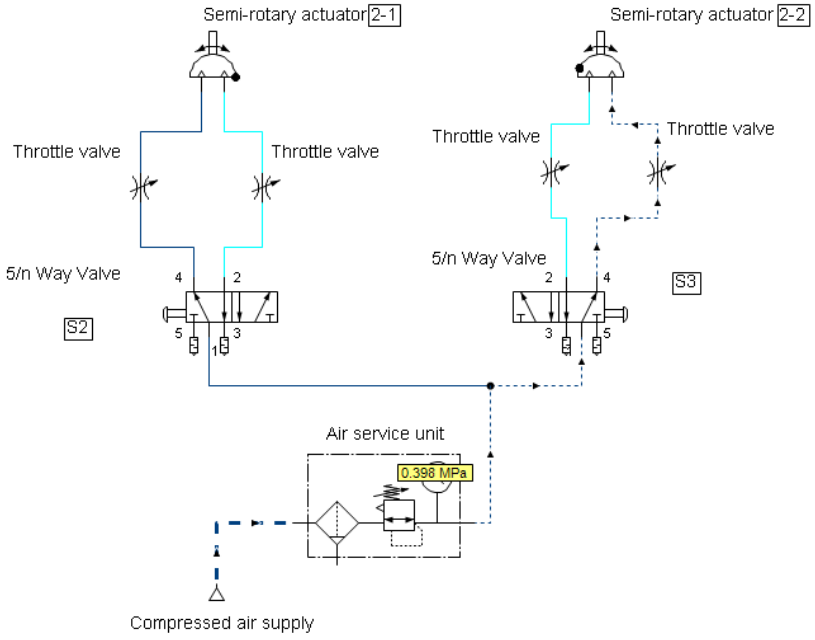


Fig. 6. Pneumatic system with two semi-rotary actuators.

3. Electro-pneumatic system using semi-rotary

Pneumatic circuit can be controlled by electric circuits. The interface between these two circuits is a solenoid valves. Solenoid valves perform the same function as normal pneumatic valves but there are operated electrically [5].

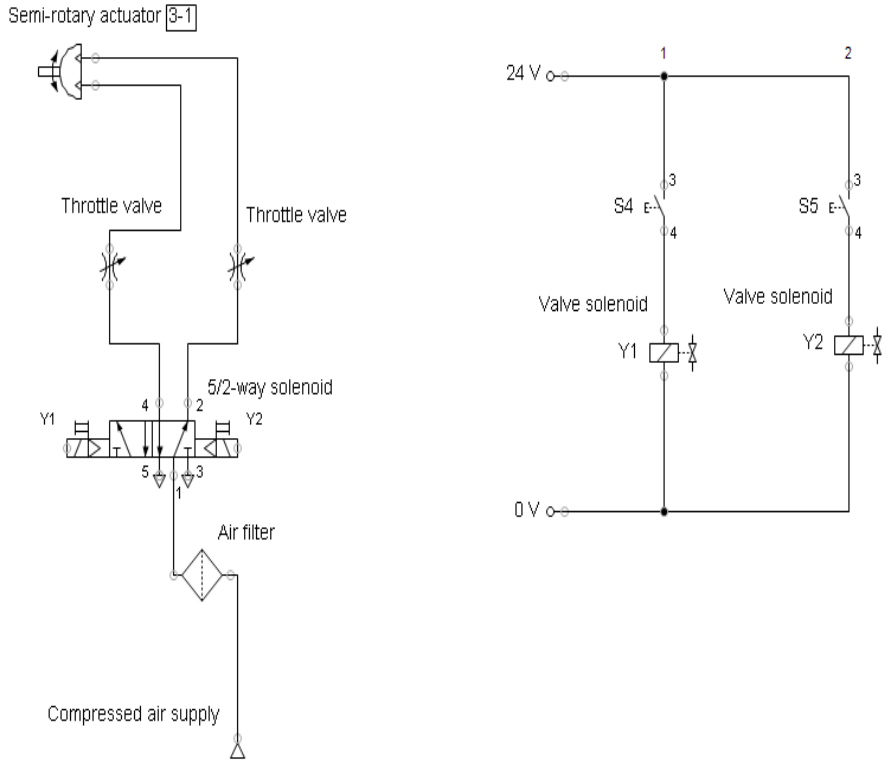


Fig. 7. Electro-pneumatic circuit with a semi-rotary actuator. Scheme 3.

The electro-pneumatic system with semi-rotary drive 3-1 has the following devices:

Table 3: The pneumatic components from scheme 3

Description	Number of components
Semi-rotary actuator	2
Throttle valve	4
5/2-way valve	2
Air filter	1
Compressed air supply	1

Table 4: The electrical components from scheme 3

Description	Number of components
Valve solenoid	2
Pushbutton	2

To start the electro-pneumatic circuit we must press the S4 button. Then the semi-rotary pinion rotates clockwise, Fig. 8.

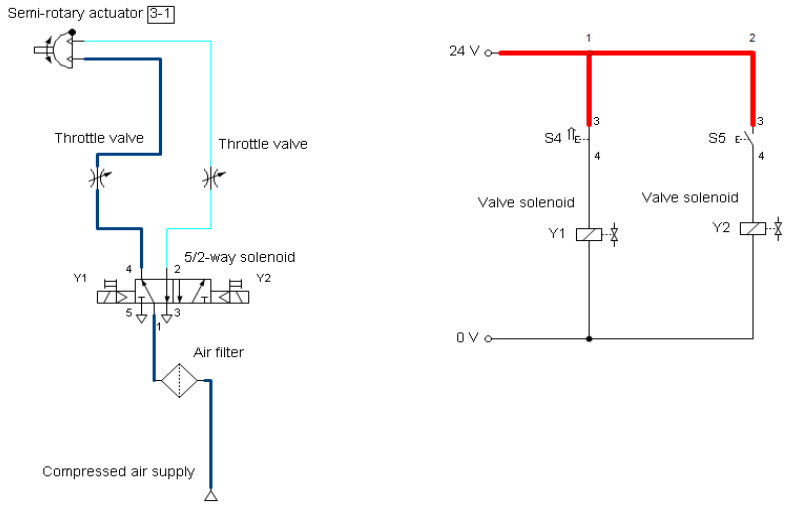


Fig. 8. Pinion clockwise rotation

After that, we press the S5 button. In this case, the pinion rotates counterclockwise, Fig. 9.

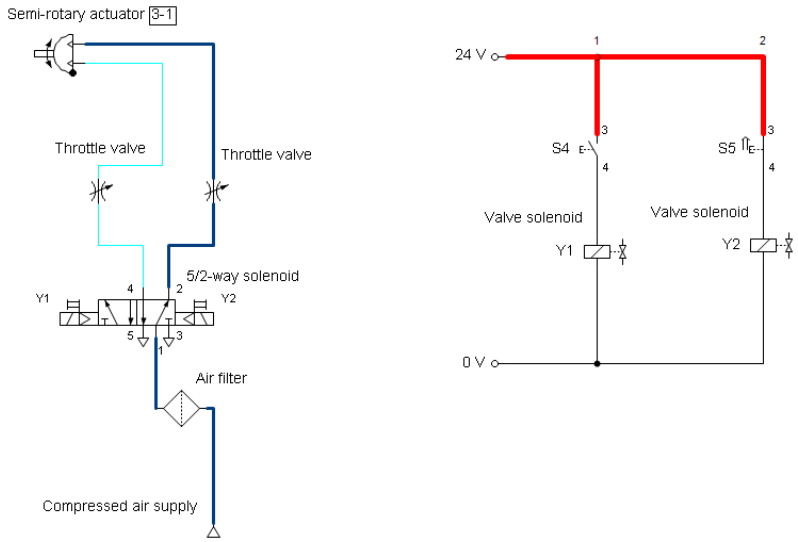


Fig. 9. Pinion counterclockwise rotation. Scheme 4.

Table 5: The pneumatic components from scheme 4

Description	Number of components
Semi-rotary actuator	1
Throttle check valve	2
5/2-way solenoid valve	1
Air service unit	1
Compressed air supply	1

Table 6: The electrical components from scheme 4

Description	Number of components
Valve solenoid	1
Pushbutton	2
Logic module	1

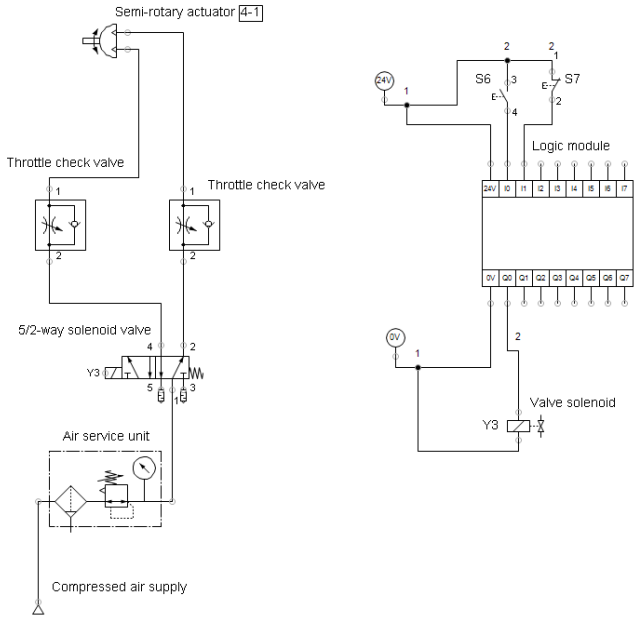


Fig. 10. Electro-pneumatic system with a semi-rotary and logic module

In logic module, there are two components in digital technology: Off delay and NOT, Fig. 11.

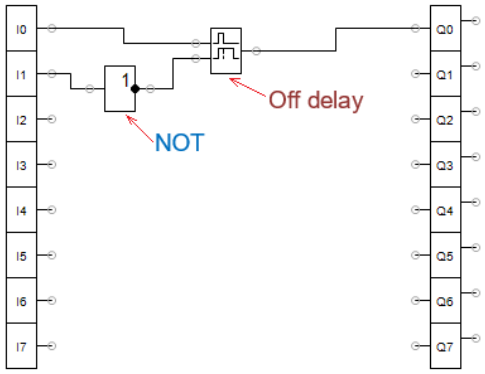


Fig. 11. Components of logic module

The electro-pneumatic system with semi-rotary 4-1 actuator starts if the S6 button is pressed. In this case, the pinion from semi-rotary 4-1 are clockwise rotation, Fig. 12.

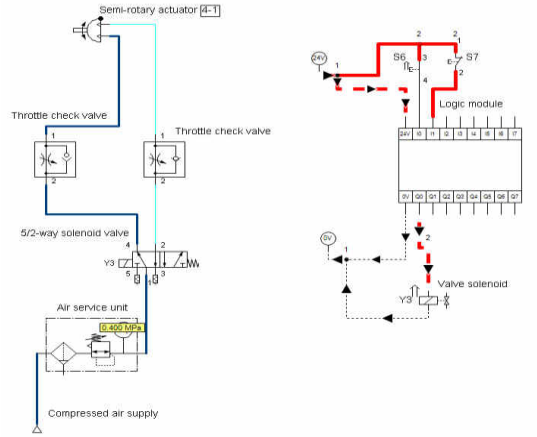


Fig. 12. Pinion clockwise rotation with logic module

However, to change the direction of rotation from semi-rotary actuator 4-1, the S7 button must be pressed in electrical circuit, Fig. 13.

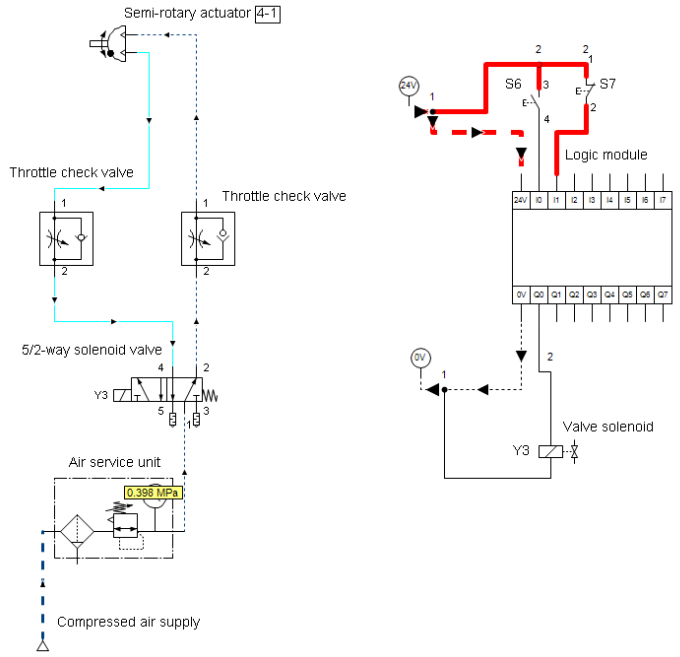


Fig. 13. Pinion counterclockwise rotation with logic module

Diagram of the semi-rotary actuator depends on rotational angle [deg], Fig. 14.

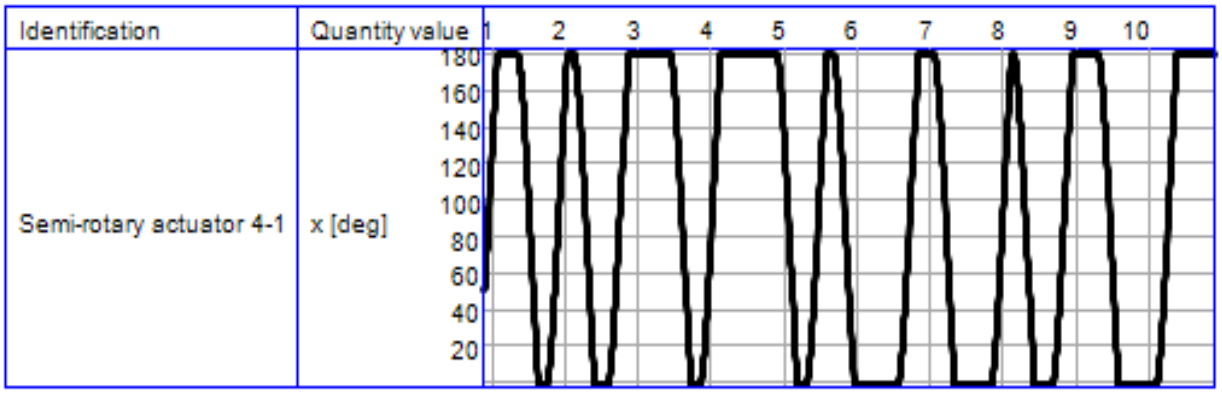


Fig. 14. Diagram of the semi-rotary actuator 4-1

3. Conclusions

The semi-rotary actuators are rugged and versatile with multiple streamlined sizes that keep operations simple and cost-effective. This actuator construction ensures the pinion bearing by each rack under pressure. The torque of pinion can be varied by adjusting the hydraulic pressure.
Cushioning from semi-rotary is available as an optional extra to slow down operation at the end of stroke. It is normally effective over the last 10 to 15 degrees of stroke in each direction.
However, the semi-rotary is more compact than a hydraulic cylinder with crank arm, more reliable than gearbox and an electric motor. These actuators rated for continuous industrial duty are ideal for continuous automation requirements, subject to speed of suitability and operation of the electro-hydraulic circuit control system and inertial loads.
In the future, electro-hydraulic circuits will be developed with semi-rotary actuators.

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Examining of Public Water Supply System

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Abstract: *Water supply systems are becoming more important in our life. The increase in population increases the demand of drinking water. A water supply system delivers water from sources to population. The water supply systems influence all our lives directly or indirectly. For the safe operation of the water supply systems, it is essential to examine the operating parameters. I my study I will present an examination of a main water pipe. My goal is to call attention to the proper way of operating water supply systems, the transient generated during operation as a harmful phenomenon.*

Keywords: *Drinking water, water supply system, burst pipe, transient*

1. Introduction

The field measurement's location was a main water pipe, which is part of the water supply system. On one end of this main water pipe, a water tower is located. The primary function of water towers is to pressurize water for distribution. In the previous period multiple pipe bursts on this section occurred. The examined pipe section consists of pipes made of different materials. The instrument was connected to the hydrant located 20m away from the water tower. Burst pipes can cause a number of different problems in the water supply systems. It is costing a great deal of money, time, effort, so water supplier must do everything in power to prevent water pipes from bursting. Water pipes burst for a range of reasons, from physical effect, to the weather, to environmental changes, and more [1-10].

Fig. 1 shows a water pipes burst in the water supply system.

Fig. 1. Burst pipe

2. Examining the water supply system

The applied measuring instrument is TSI Digital 250 DL. The TSI Digital 250 DL Flowmaster is hydrant flow and pressure test instrument. The TSI Flowmaster suitable for hydrant testing pump testing and water main condition testing. The measuring instrument provides the accurate and reliable flow and pressure measurements. It measures flow rates up to 3,000lpm and pressures up to 25 bar.

Fig. 2 shows the TSI Digital Flowmaster 250 DL.

Fig. 2. TSI Digital Flowmaster 250 DL

Table 1 shows the Technical Data for Flowmaster.

Table 1: Technical Data for Flowmaster

Item	Value
Type	Electromagnetic
Operating Range	30 to 3,000 lpm
Accuracy	30 to 750 lpm: ±15 lpm > 750 lpm: ± 2%
Operating temperature	-10 to +50 ºC
Weight	12.5kg
Dimensions	210 (H) x 240 (W) x 390 (L) mm
Housing	Solid and corrosion resistant LM25 aluminium
Sensor	Piezoresistive pressure transducer
Range	0-25bar in 0.1bar increments
Accuracy	± 1%

2.2 Presenting measurement results

I used FMSv4.5 software for evaluating the results of the measurement.

Fig. 3 shows the change of pressure value. The figure demonstrates that the phenomenon of transiency is detectable in the system. The pressures generated by transient conditions in pipe systems are frequently more times the value of normal operating pressures.

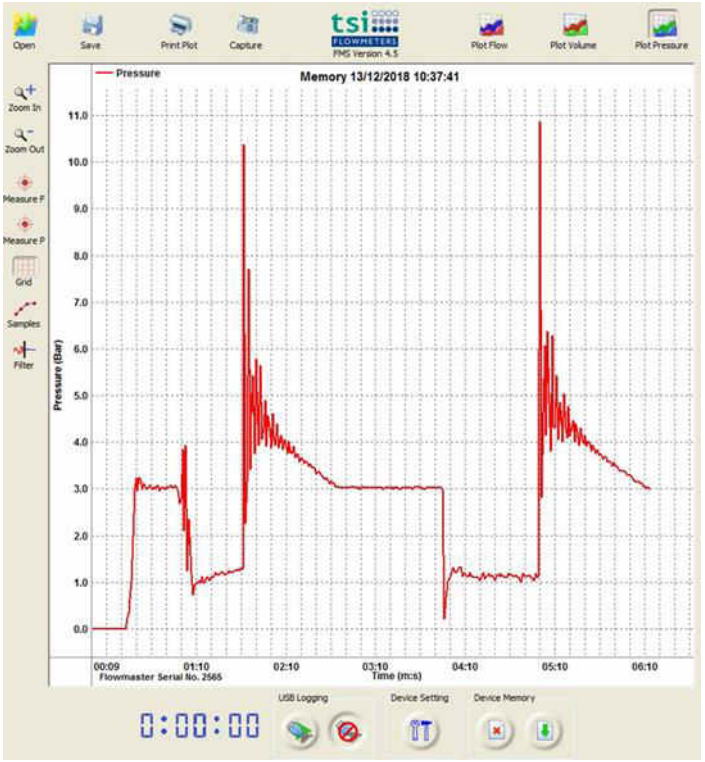

Fig. 3. The change of pressure value.

Fig. 4 shows the change of volume flow value.

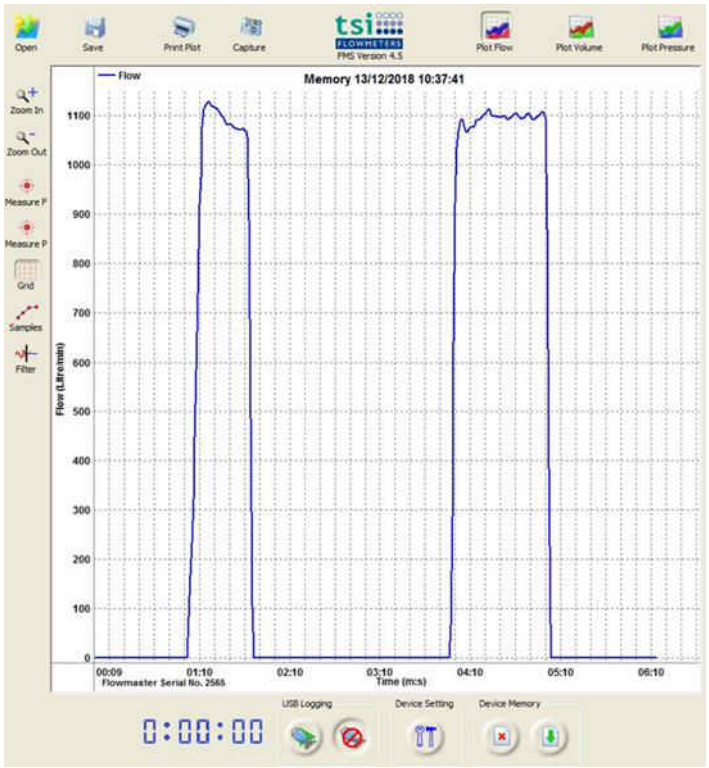

Fig. 4 The change of volume flow value

Fig. 5 shows the change of pressure and volume flow value.

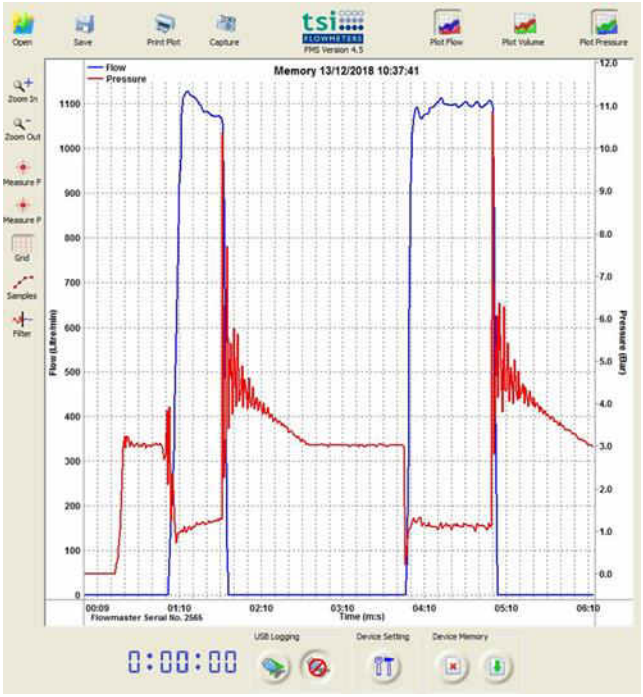

Fig. 5. The change of pressure and volume flow value

The suddenly opening and closing taps caused the significant pressure changes and the appearance of transient phenomena in the water supply system.

3. Conclusions

If the valve openings and closings are not carried out slowly enough in the systems of large water pipes, they might generate quick changes in pressure. The pressure changes may cause the appearance of transient phenomena in water supply systems. These phenomena can have harmful effects on the water pipe systems. This phenomenon often leads to pipe bursts. I would like to research the phenomenon of transient in other areas in the future [11-17].

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Numerical Modelling of a Refurbished Triple Stepped River Sector with Side Fish Passage

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Abstract: *The paper presents a 2D numerical modelling by HEC-RAS 5.07 of a restored and refurbished hydraulic arrangement on Târnava Mică River in Mureș County, Romania. The arrangement consists of a concrete triple step accompanied by a side fish passage and is considered to be transited by a high waters flow (given as a levels synthetic hydrograph of the specific discharge phenomenon from 15th -16th of April, 2000). The numerical simulation of the hydraulic phenomenon, performed on the 2D generated structure, looks to illustrate the high water flow discharge modality by establishing the unsteady hydraulic parameters. Further on, specific hydraulic aspects regarding the sanitary (ecological) flow discharge by the fish passage need to be specified.*

Keywords: *Fish passage, ecological discharge, highwaters, unsteady flow, water velocity, stream lines, computer hydraulics*

1. General information

The subjected Târnava Mică River sector (fig.1) is situated in the area of the Bălăuşeri Village, south-east of Mureş County, in the center of Transylvania Plateau, Romania. The numerical model starts as based on an existing deteriorated river triple bottom step for which a rehabilitation technical project needs to be developed [1]. Under these circumstances, the present analysis also considers the accomplishment of a fish passage as required in order to ensure the ecosystem restoration, and banks stone protection works respectively in order to longer maintain the river sector arrangement.

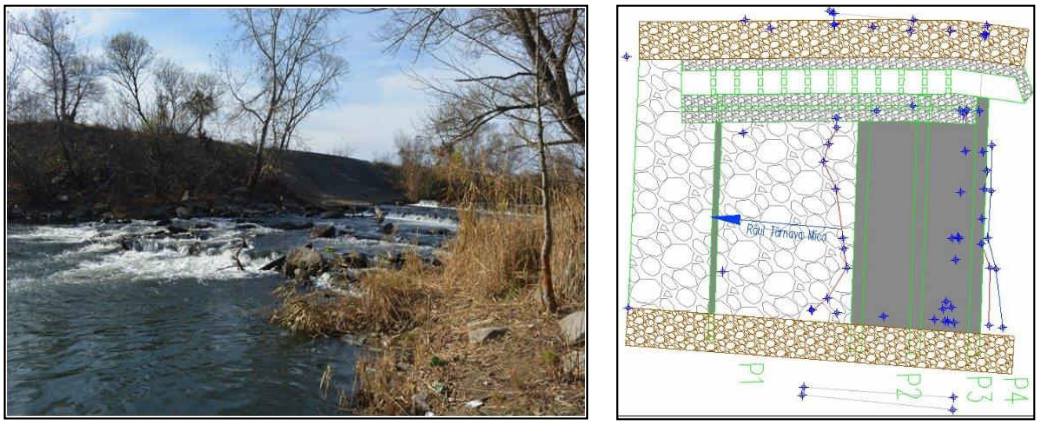

Fig. 1. Site view of the triple stepped sector on Târnava Mică River and the designed plan-view for the refurbished hydraulic arrangement with fish passage on the right bank

The site in the Bălăuşeri Village area is situated at an average level of about 328.50 mSL. The 2D geometrical modelling of Târnava Mică River valley was accomplished for a sector of about 50m. There was employed a geometry data base produced from topographical measurements ("Stereo 70", supplied by an AutoCAD file of .dxf extension) as a leveled plan-view, five river crossing profiles and one riverbed longitudinal profile. A detailed cross-view of the designed fish passage (fig.2) was also developed.

Considering all the geometrical features given by the technical design views (the fish passage channel with the 10 rows of shaped stones including) and required for defining the model mesh, the analyzed flowing paths (the three stepped river sector and the fish passage) were divided by 89 cross-sections in 88 straight segments.
By considering the AutoCAD configured plan of the existing site as background, a 1D numerical model was first developed in HEC-RASv.4.1 [2] as covering the 89 cross-sections. Further on, a 3D shape type surface (as a .shx extension file) was obtained from the attached site configuration by employing a topographic two directions (x,y) linear interpolation software.

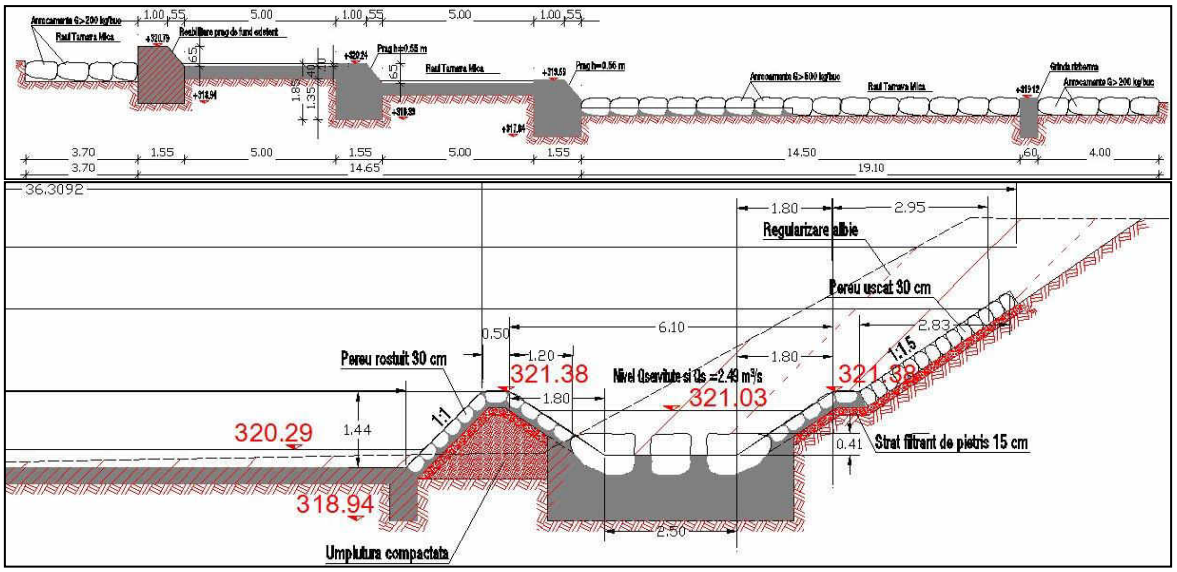

Fig. 2. Longitudinal profile by the triple step arrangement and detail cross-section by the first concrete casted three-stone row on the fish passage

The 3D surface contour was defined by the topographic supplied coordinates (x, y and z - ground level) of four corner points, i.e. P_{left_down}(477214.92,544796.27,320.434), P_{left_up}(477214.92,544832.96,320.437), P_{right_down}(477257.64,544796.27,321.436) and P_{right_up}(477257.64,544832.96,321.436). This space sloped surface was then uploaded by ArcMAP9.3 [3] and meshed by triangular discrete elemental surfaces, obtaining the final 3D discrete surface of **T**riangulated **I**rregular **N**etwork type. In order to be compatible to RAS Mapper graphical processing module in HEC-RASv.5.07 [4], the TIN surface needed to be converted into a **D**igital **T**errain **M**odel grid type file.

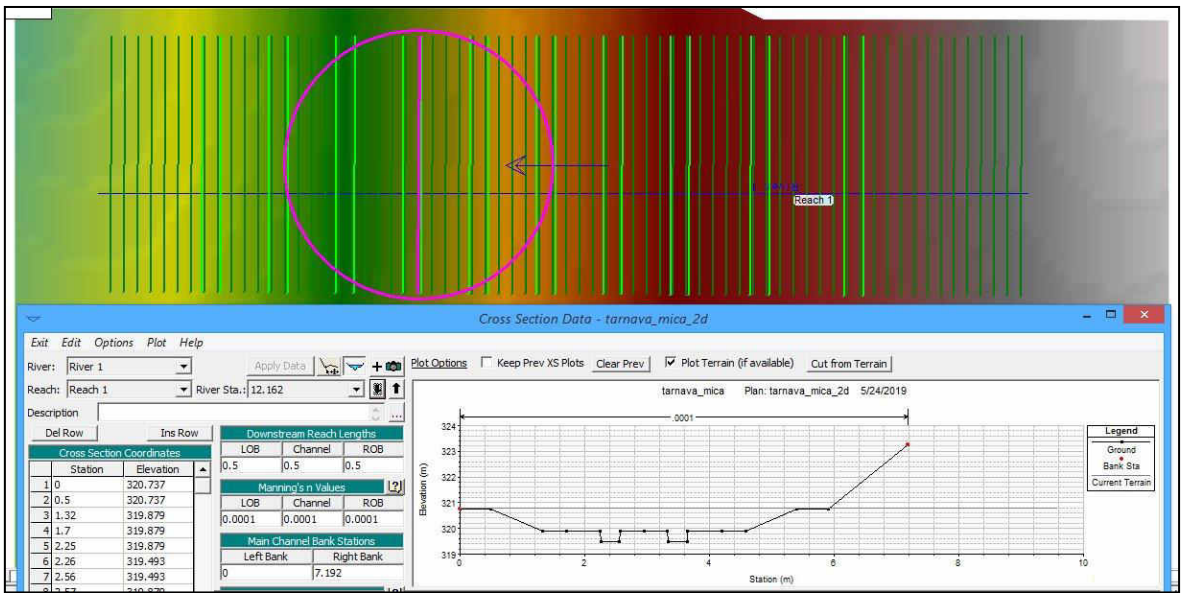

Fig. 3. Accomplishment of the prior 1D fish passage path with the cross-sections editing

Several other specific numerical modelling operations were then followed within HEC-RASv5.07 software package [5,6,7] in order to properly consider the right side designed fish passage (fig.3 and 4) and the restored concrete steps river sector with the corresponding left bank. The final modelled domain of the hydraulic arrangement is illustrated by figure 5.

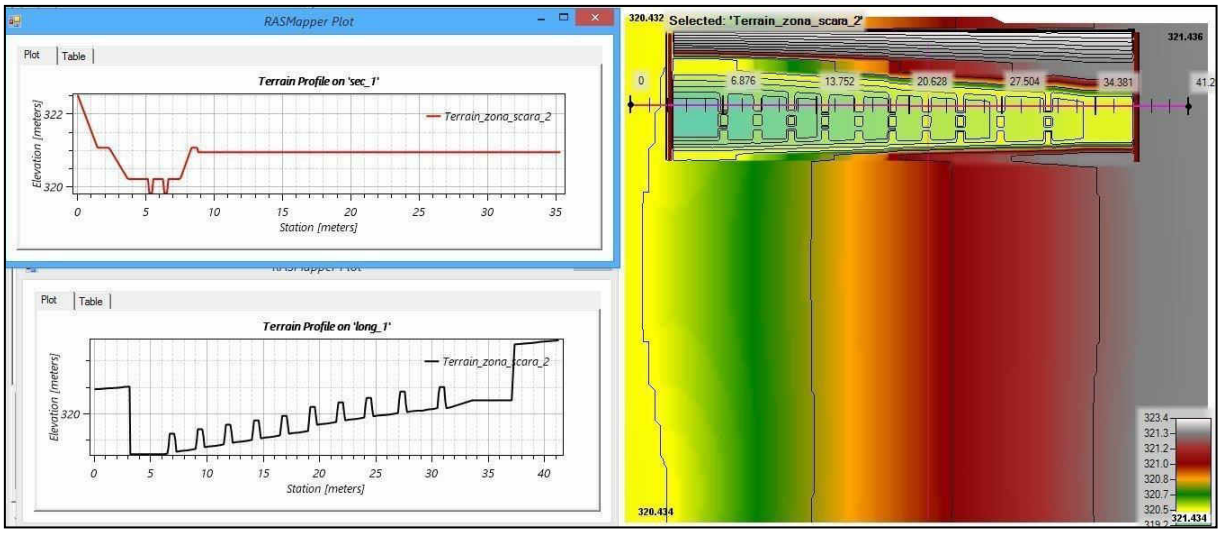

Fig. 4. Level lines of the fish passage updated area, together with a cross-section and a longitudinal profile by the designed structure

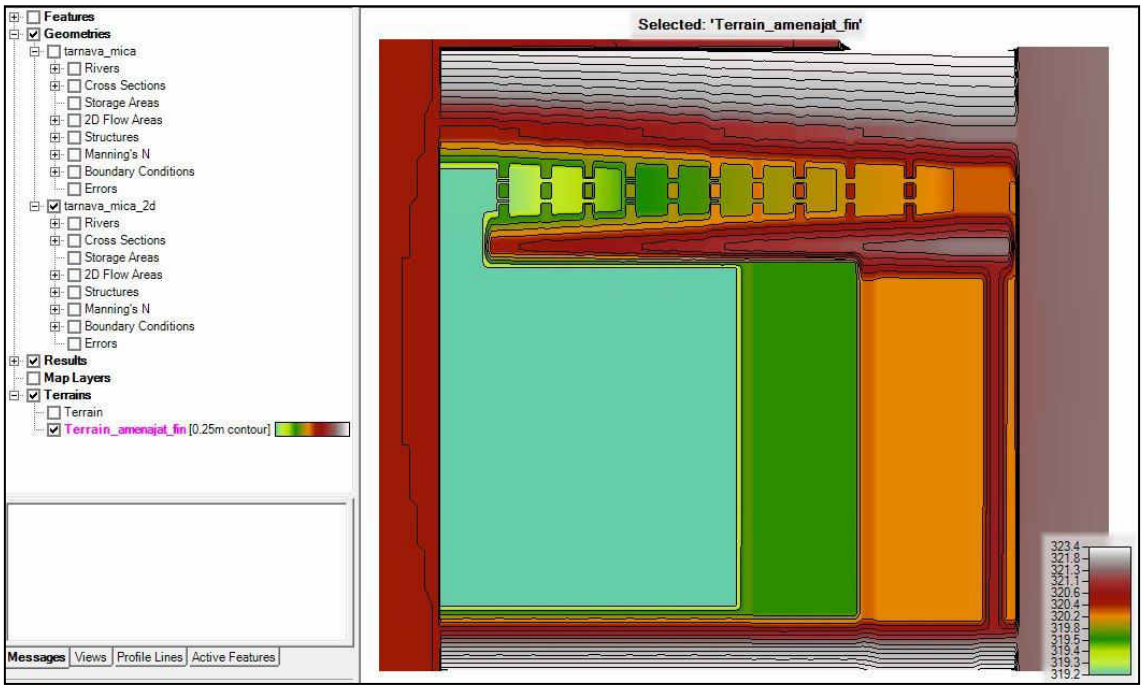

Fig. 5. Updated ground view with level lines (of 0.25m step in elevation) of the modelled hydraulic arrangement

The concerned river sector maximum values of water flows with the two overcoming probabilities of 5% and 1%, as corresponding to the hydraulic arrangement importance class, were supplied by the water authority: $Q_{5\%}$ = 245 m^3/s and $Q_{1\%}$ = 430 m^3/s. At the same time, one has to consider the enforced sanitary flow to be discharged by the triple stepped sector with side fish passage at a value of about 2.49 m^3/s. The employed river-bed roughness coefficient of 0.065 was estimated by considering the foreseen natural constitution.

2. Numerical modelling of the hydraulic phenomenon

The discrete numerical model developed by HEC-RAS 5.0.7 [4] considers the originally existing 3D site surface as obtained by bi-dimensional interpolation of the arranged sector on Târnava Mică River. As built on this surface, the analysis model of the designed hydraulic arrangement was generated (fig.5). By considering the 2D Flow Areas facility in the explorer type window, the contour S2D of the analysis domain was drawn (fig.6). The 2D mesh spacing was set at 0.50m on both horizontal directions. After defining the structural points connected to the mesh (*Generate Computations Points*), their property data tables can be generated (*Compute Property Points*).
In order to employ a condense mesh in the area of the 10 rows of shaped stones in the fish passage, break lines were defined by engaging *Geometric Data* from main menu. The editing size of cells in the area of all breaking lines was set in-between 0.05m minimum and 0.25m maximum.

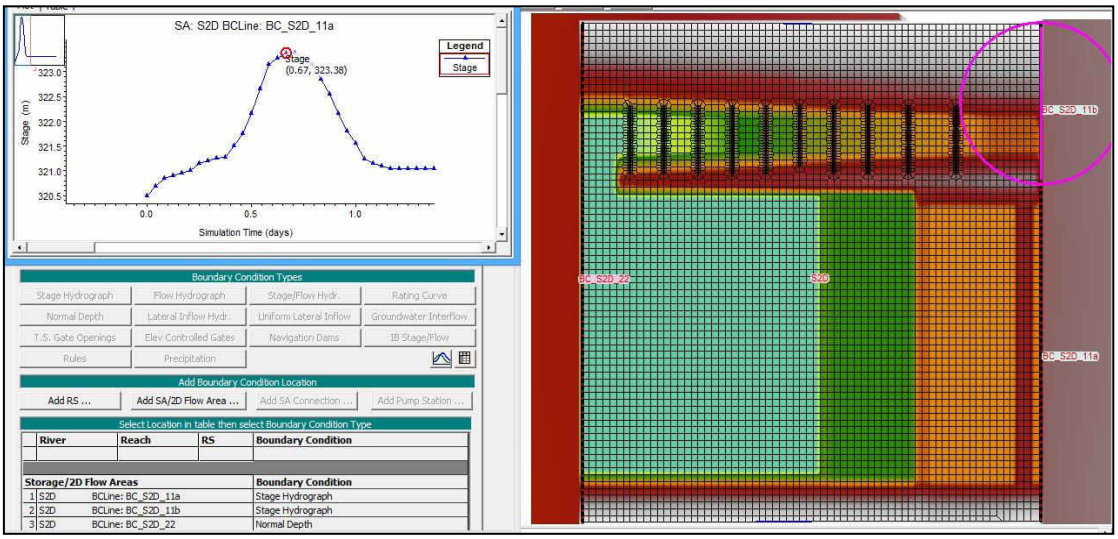

Fig. 6. 2D discrete numerical model of the hydraulic arrangement on Târnava Mică River, with two discharging paths (three stepped river sector and fish passage), and the boundary condition represented by the accidental flow hydrograph

As about the boundary conditions of the model, they are defined by *Geometric Data* in main menu as BC Line type, so by considering the *SA/2D Area BC Lines* option. Three boundaries were defined for the present S2D domain: two at the upstream entering edge, *BC_S2D_11b* as corresponding to the fish passage flow path and *BC_S2D_11a* as corresponding to the three stepped river sector, and one at the downstream outgoing edge, *BC_S2D_22*. An accidental flow hydrograph of 408.50 m^3/s maximum discharge (given from a measured phenomenon) as corresponding to the maximum level of about 323.38 mSL was attached to each of the two upstream boundary lines and the river hydrodynamic gradient of 0.0085 was assigned to the downstream boundary line.
The actual flow discharging numerical simulation was set to develop over the specific period of time from 01:00 on April 15th to 05:00 on April 16th, 2000, as corresponding to the most significant measured high waters phenomenon on the concerned sector of Târnava Mică River.
The analysis was set to run with a time step of 0.1s and a mapping interval of 10s, while the time interval of results storage was fixed to 5 minutes.

3. Flow numerical simulation and results presentation

Following the run of the actual numerical simulation of the discharging phenomenon, the specific developing parameters – water levels, discharges and velocities – were obtained over the entire S2D modelled domain of Târnava Mică River sector.
The main analysis output, after performing the results post-processing graphic operations on the 2D model, is further on presented. So, the following 7 and 8 highlight the flow development – particles trajectories, water depths (m) and longitudinal / transverse water surface profiles – by the two paths at the significant moment 01:04.18 when the sanitary discharge of about 2.48m^3/s

passes the hydraulic arrangement. Further on, figure 9 shows the particles trajectories as overlaid to water velocity spectrum (m/s), accompanied by a longitudinal and a transverse velocity profiles, for the same specific moment.
The next four figures, 10, 11, 12 and 13, present also the main characteristics of the flow phenomenon by the modelled hydraulic arrangement – particles trajectories, water depths (m), water velocities (m/s), longitudinal / transverse water surface and velocity profiles, but for the moment 17:05 when the maximum discharge of 408.50m^3/s passes the structure.

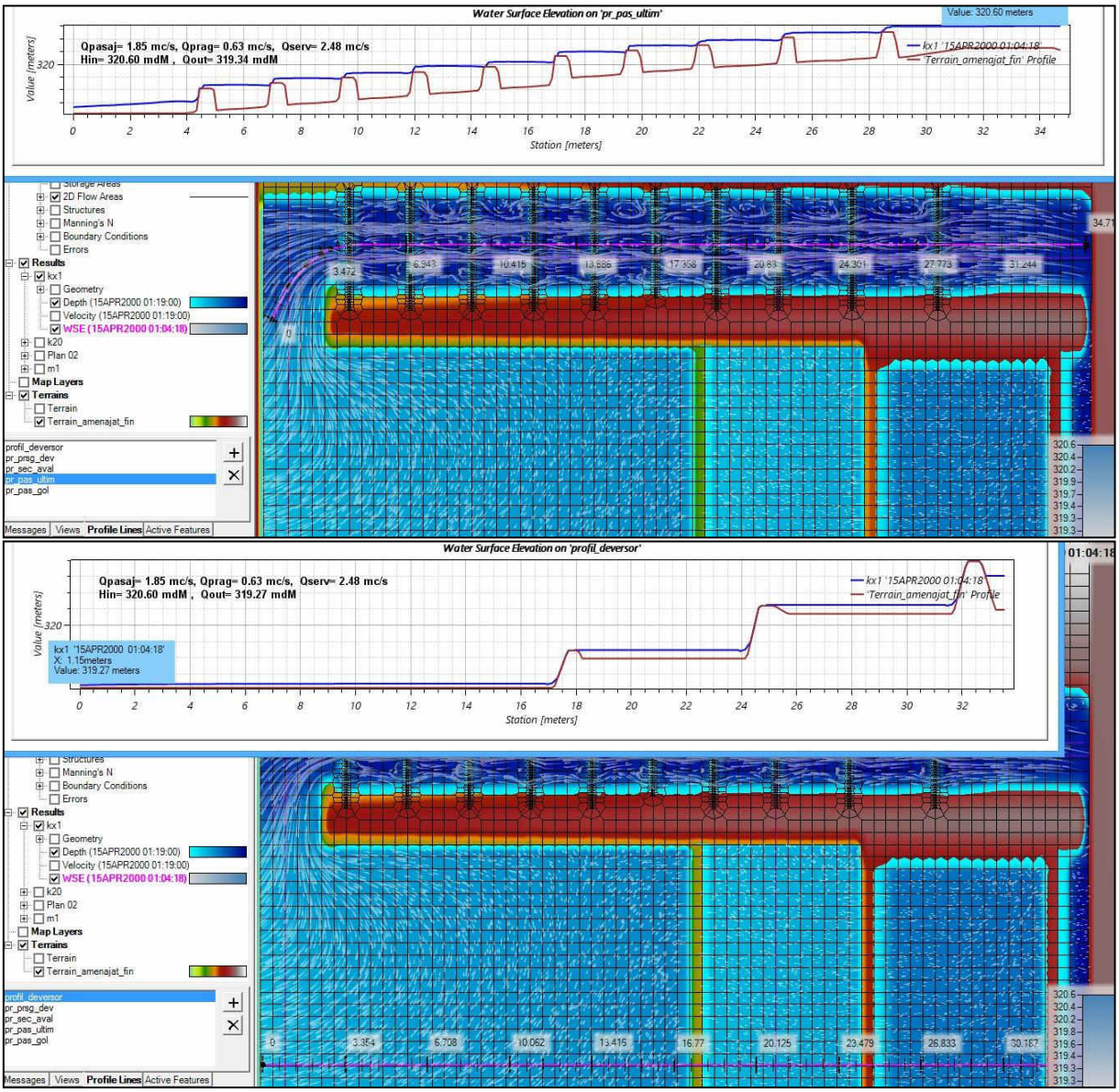

Fig. 7. Particles trajectories overlaid to water depth together with water surface longitudinal profiles by the middle lines of fish passage (over the 10 rows central stones) and of stepped river sector, at the specific moment when the sanitary flow (2.48m^3/s) is discharged

The last figure, 14, brings out the water flow and piezometric line time development correlation for the fish passage upstream entrance border (BC_s2s_11b) and the arrangement downstream outgoing border (BC_s2s_22).

4. Conclusions

The discrete numerical model represents a river hydraulic structure composed from a triple stepped sector with a side fish passage, arrangement transited by an accidental high water flow

defined by a representative recorded water levels hydrograph, allowing the possibility of considering a fragmented assignment of entering boundary conditions.

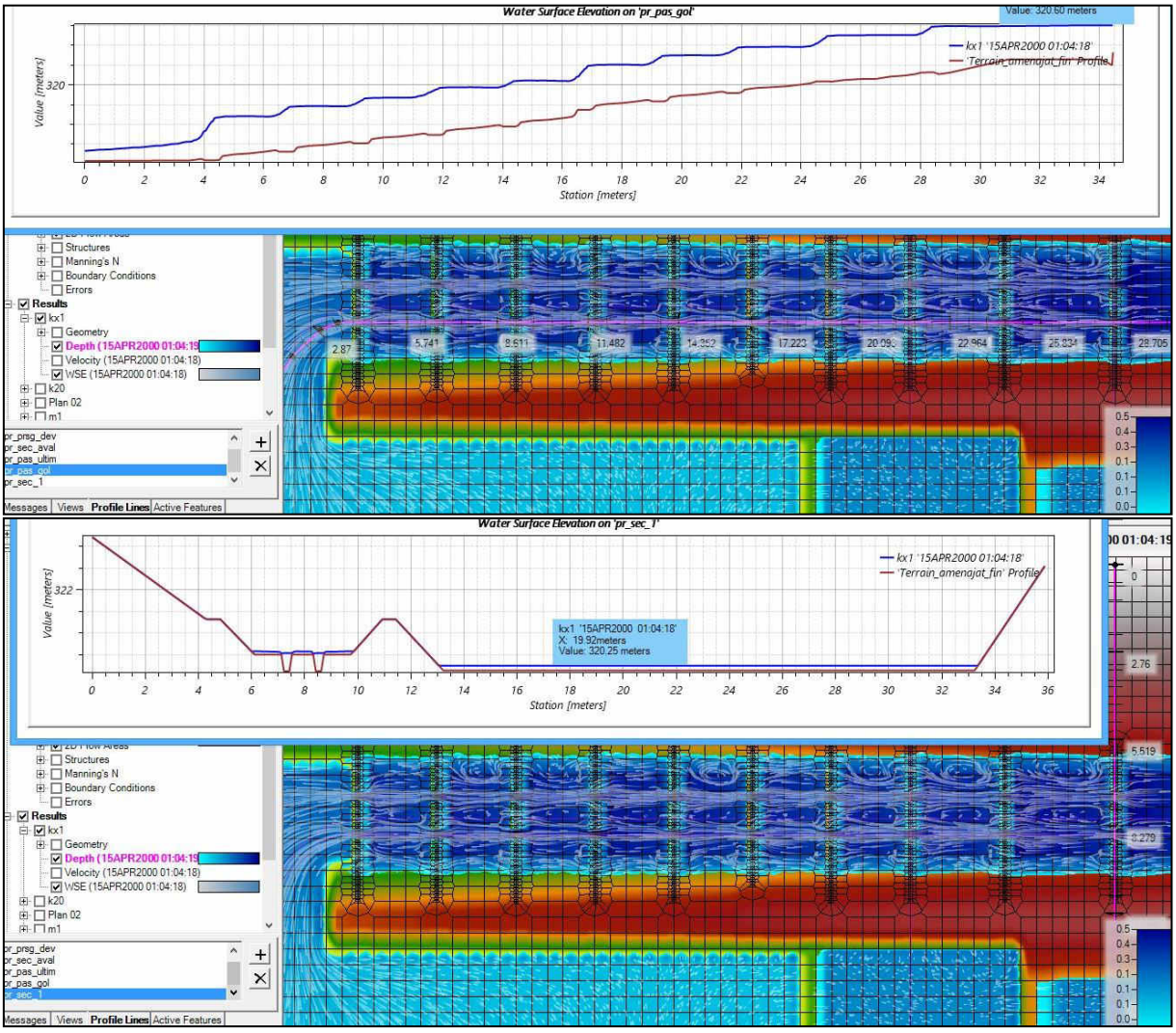

Fig. 8. Particles trajectories overlaid to water depth together with water surface longitudinal unfolding by the fish passage rows gaps and transverse profile by the first upstream three stones row of the side passage, at the specific moment when the sanitary flow (2.48m^3/s) is discharged

The specific hydraulic parameters reached by the actual numerical simulation of the flow passing phenomenon lead to a distinct appraisal of discharged values by the triple stepped sector and fish passage paths, at the considered output storing time interval.

By analyzing the graphically presented output (fig.7 and 8), one can witness the total sanitary flow of about 2.48m^3/s discharging mainly by the fish passage (at about 1.85m^3/s) and also by the triple stepped sector (at about 0.63m^3/s). The corresponding water levels for this specific moment came out about 320.60mSL upstream and about 319.34mSL downstream.

One can also notice that the water velocity values spectrum (fig.9) goes about from 0.05 to 0.93m/s by the fish passage flowing path, and from 0.05 to 0.50m/s by the three stepped river sector.

So, one may assume that the analyzed restored and enhanced hydraulic arrangement could be in general conformable for the ichthyofaunal requirement under sanitary flow discharging conditions also, complying so with ecological and environmental protection general necessities.

As from graphical output concerning the fulfilment of maximum flow value of about 408.50m^3/s (fig.10 and 11), by observing the stream lines one can also visualize the discharging modality under extreme conditions. The maximum velocity values for this special situation (fig.12 and 13)

reach at about 7.19m/s, at the first stones row in the fish passage entering area, while in the downstream area of this flowing path drops to about 3.94m/s.

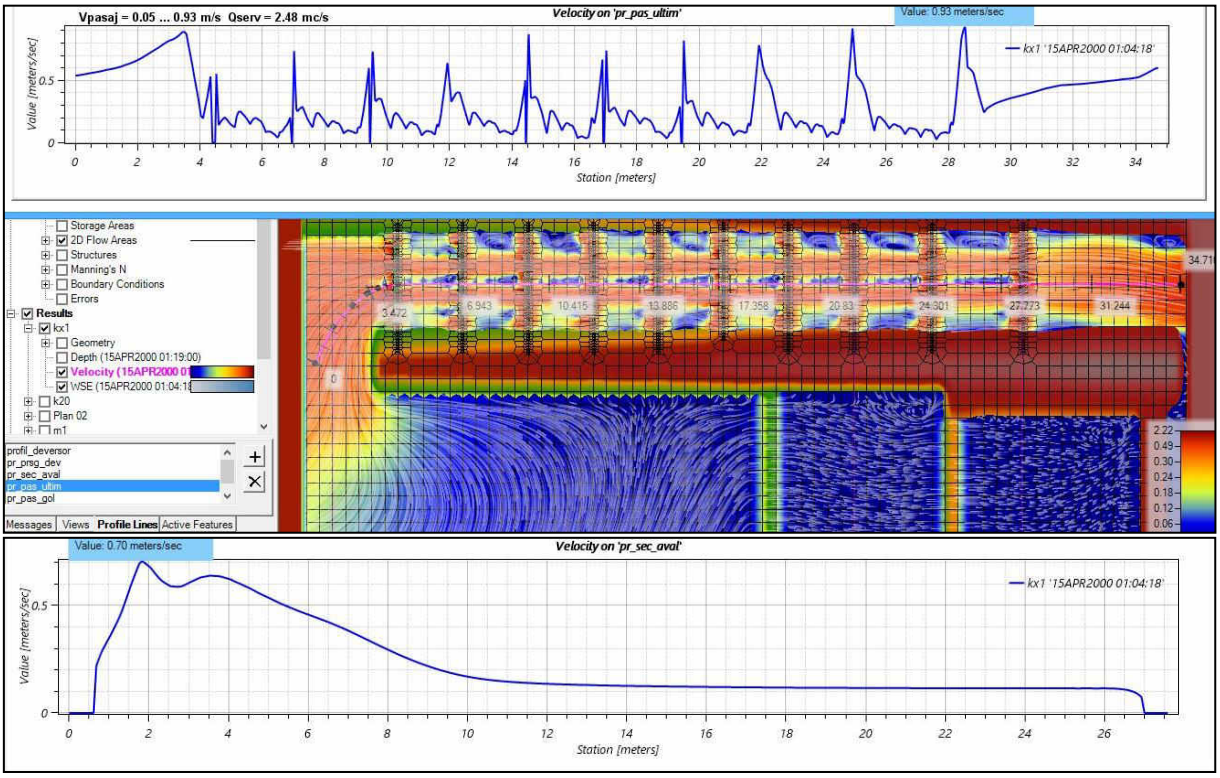

Fig. 9. Particles trajectories overlaid to water velocity spectrum together with longitudinal (by the fish passage middle line) and transverse (downstream area) velocity profiles, at the specific moment when the sanitary flow (2.48m^3/s) is discharged

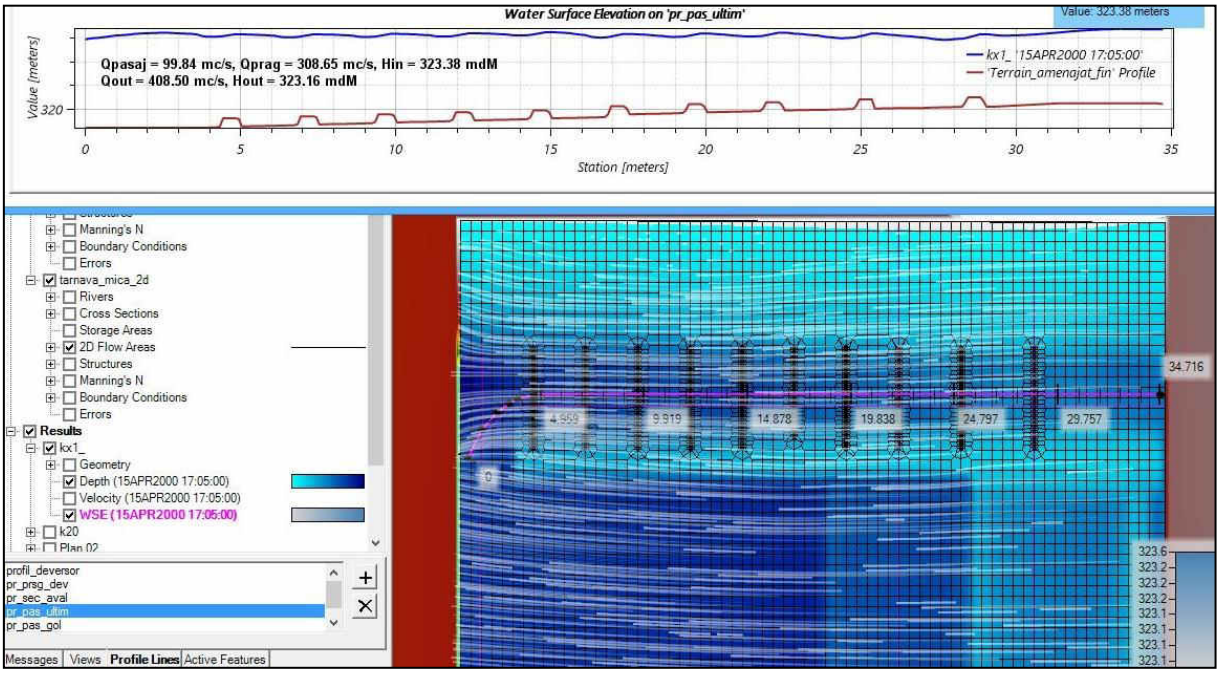

Fig. 10. Particles trajectories overlaid to water depth spectrum together with water surface longitudinal unfolding by the fish passage middle line, at the specific moment when the maximum flow (408.50m^3/s) is discharged

The maximum water levels along the high waters flow phenomenon rise to about 323.38mSL in the model upstream entering edge and to about 323.16mSL in the downstream outgoing edge (fig.14). These extreme levels are to be considered with respect to the two Târnava Mică River sector side banks, which according to the supplied ground plan run at an average level of about 323.80mSL.

Thus, according to the reached results under the given circumstances of the foreseen hydraulic structure, the water levels development lies below the existing side edges of the river valley.

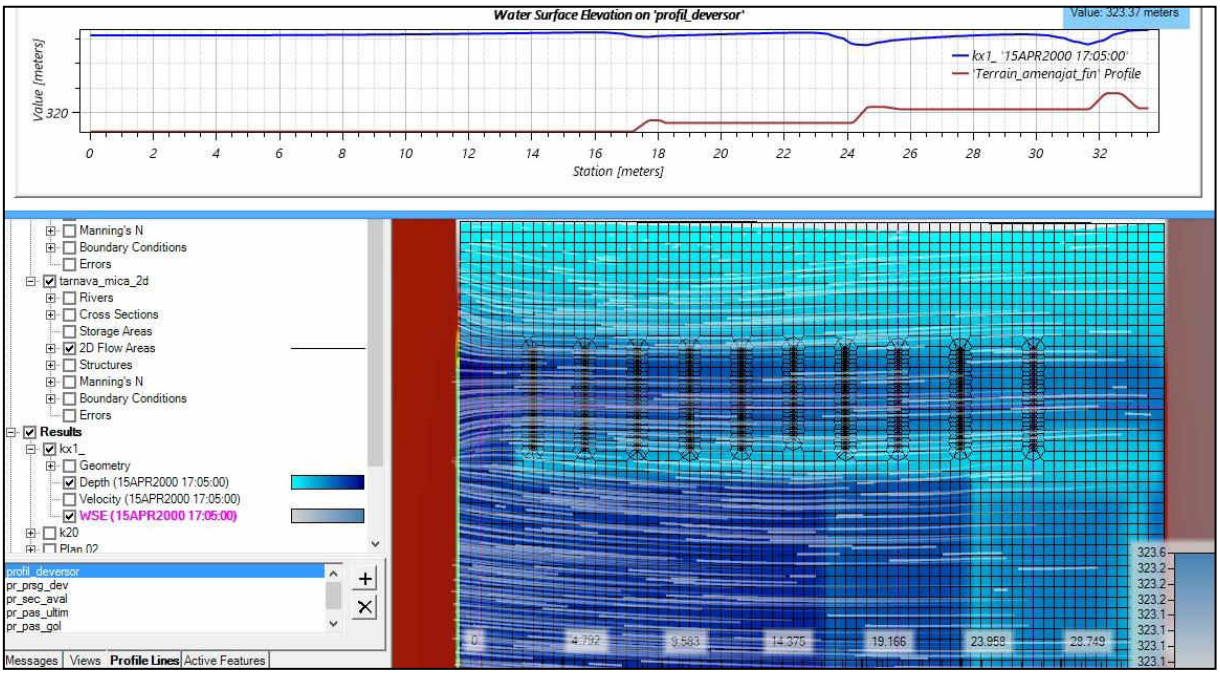

Fig. 11. Particles trajectories overlaid to water depth spectrum together with water surface longitudinal unfolding by the stepped river sector middle line, at the specific moment when the maximum flow (408.50m^3/s) is discharged

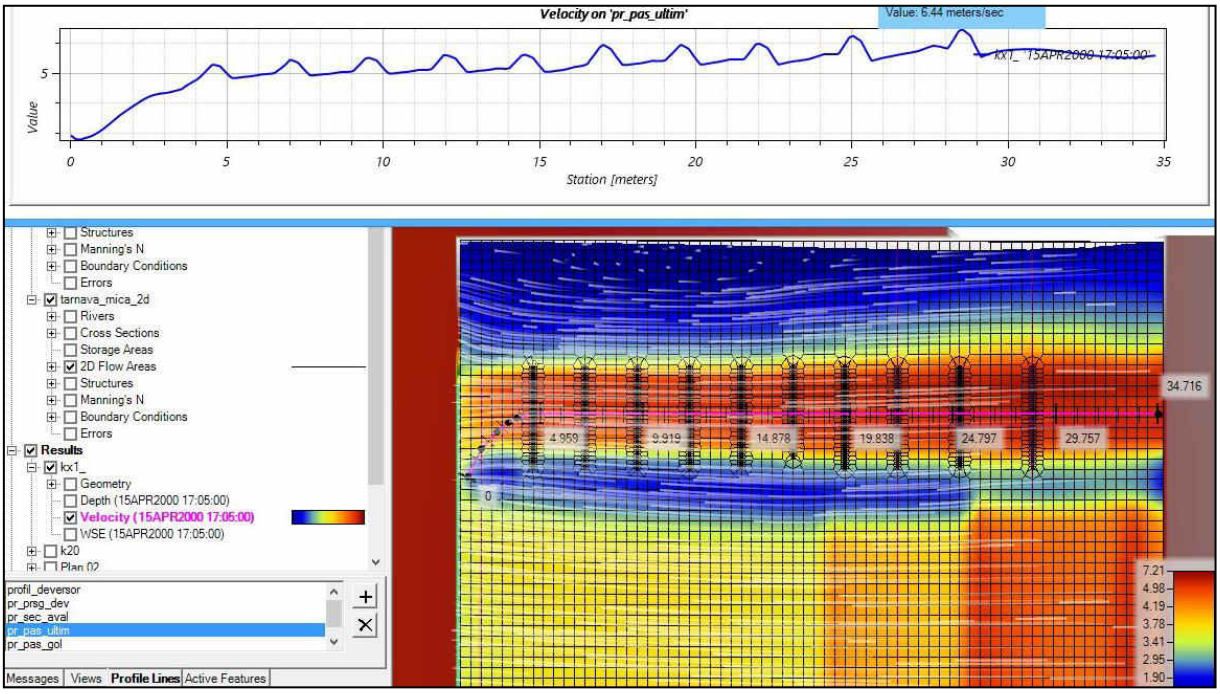

Fig. 12. Particles trajectories overlaid to water velocity spectrum together with velocity longitudinal unfolding by the fish passage middle line, at the specific moment when the maximum flow (408.50m^3/s) is discharged

At the same time, by considering the upstream entering and downstream outgoing water energy levels,

$h_{E1} = h_1 + \frac{\alpha \cdot {v_1}^2}{2g} = 323.38 + \frac{1.05 \cdot 7.19^2}{2 \cdot 9.807} = 326.15 mSL,$ $h_{E2} = h_2 + \frac{\alpha \cdot {v_2}^2}{2g} = 323.16 + \frac{1.05 \cdot 3.70^2}{2 \cdot 9.807} = 323.89 mSL$, one can estimate that the total energy drop by the modelled hydraulic arrangement [8] is about 2.16m.

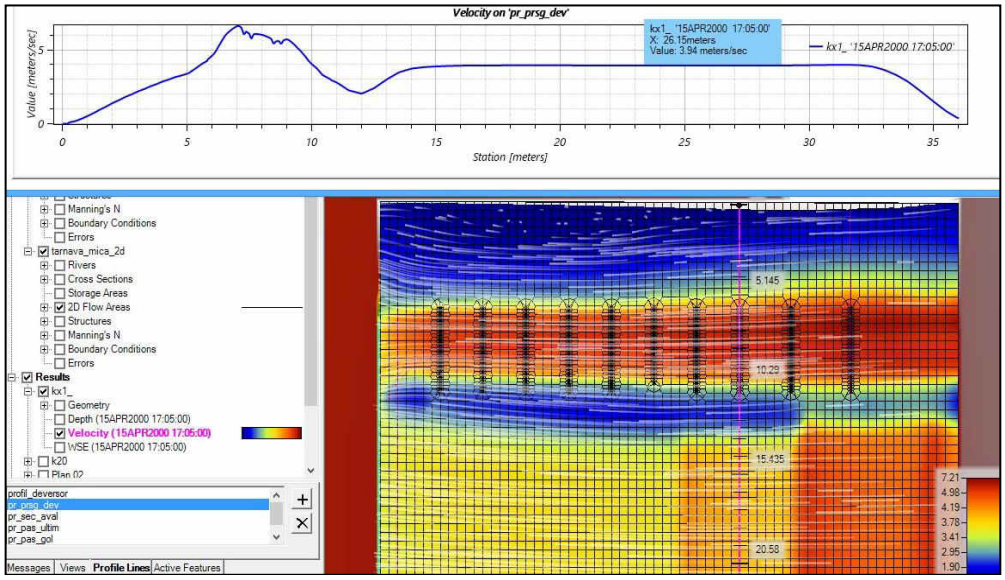

Fig. 13. Particles trajectories overlaid to water velocity spectrum together with velocity entire transverse profile by the second step, at the specific moment when the maximum flow (408.50m^3/s) is discharged

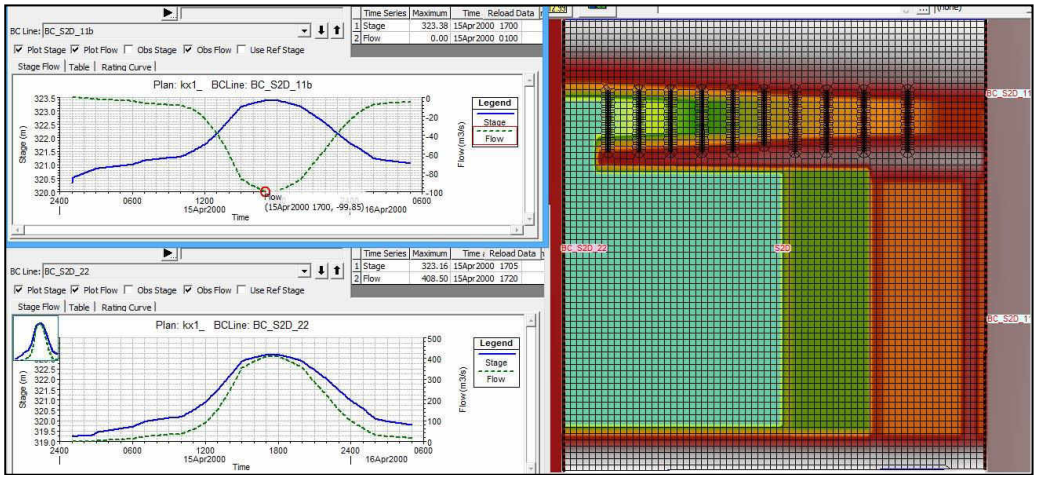

Fig. 14. Correlated water flow and level time development by the fish passage entrance (above) and entire arrangement outgoing borders of the Târnava Mică River modeled sector

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Sewage Sludge Removal and Valorification from the Circular Economy's Point of View

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Abstract: *In this article, we wanted to present the theoretical notions from the specialty literature that have to do with the generation and capitalization of sewage sludge, correlating the beneficial results of the technical process with the life quality degradation consequences on the globe, highlighting the main problems that the humanity faces, but mainly Romania.*

Keywords: *Sewage sludge, capitalization, deposit*

1. Introduction

In the context of climate changes, of massive development of industry, and the increase of population, a major issue that the humanity faces is the lack of water caused by the consumption increase and its quality degradation because of pollution.
Industrial wastewater discharges that are treated improperly or untreated and the infiltrations from agricultural activities directly into the groundwater degraded the water quality in the world.
Sewage sludge's problem is a specific one because the quantity of mud is pretty large and its processing and utilization is complicated and expensive. The solution that almost all the countries have adopted is the reduction of the mud volume that has to be eliminated outside of the wastewater treatment plant.
Sewage sludge processing means considerable costs for dehydration, stabilization and disinfection. After 2015, when the package of measures for the transition to a "circular economy" has been adopted with the purpose to minimalize the quantity of waste and to increase recycling, Romania established a package of measures [1].

- Increasing the recycling rate;
- Increasing the quality of recycled materials;
- Reducing the impact on the environment
- Implementing the concept of "life cycle analysis" in the waste management policy
- Encouraging the production of energy from waste, etc.

According to FAO's AQUASTAT database, 56% of the freshwater catchments at global scale are released in the environment as wastewater (through the form of industrial effluents and agricultural drainage water) and the rest of 44% are consumed for the irrigation of farmland [2].

2. The Formation of MUD

According to [3], mud is a complex colloidal system resulted from a surface water treatment process or wastewater treatment, with heterogeneous composition, containing water and particles in suspension, colloids, minerals and organics etc., in which are contained products of metabolic activities and/or raw materials, intermediary products and finished products of some industrial activities. When wastewater goes through treatment plants results besides clean water some technological biphasic muds, considered secondary products, that contain the pollutants eliminated from the wastewater. This thing can represent a major danger for the environment.
It comes from the primary treatment, physic and/or chemical, secondary treatment, biological and tertiary, added to the secondary, many times to remove nutrients.

In the wastewater treatment, with the purpose of removing in the natural receptors or of recirculation, muds are formed that contain the impurities from the raw waters and also the ones from the treatment processes.
The technological schemes applied to the industrial and urban wastewaters, following which muds are resulted, are grouped into two categories: the ones regarding the mechanical-chemical treatment, respectively mechanical-biological treatment. The main sources of sludge from these schemes are presented in figures 1 and 2.

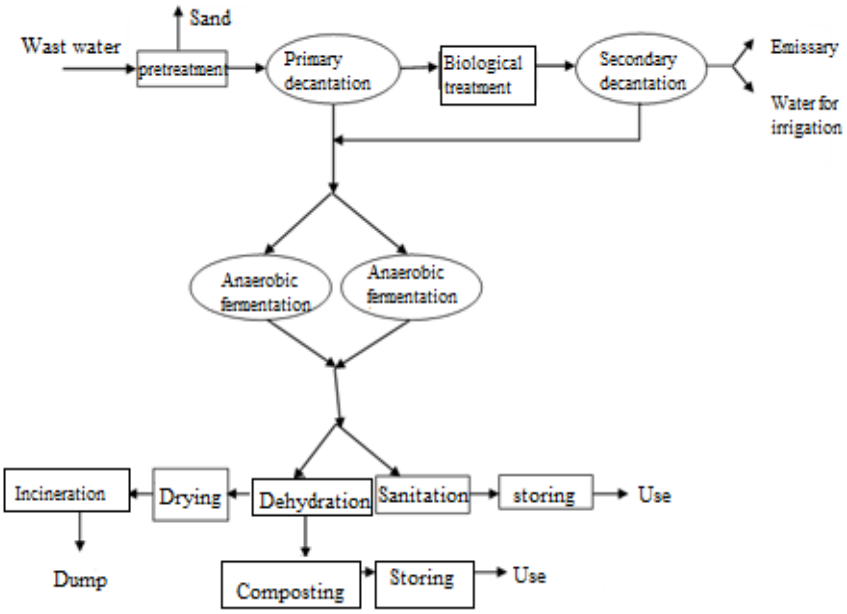

Fig. 1. Sources of sludge from the mechanical-biological treatment plant [4, 5]

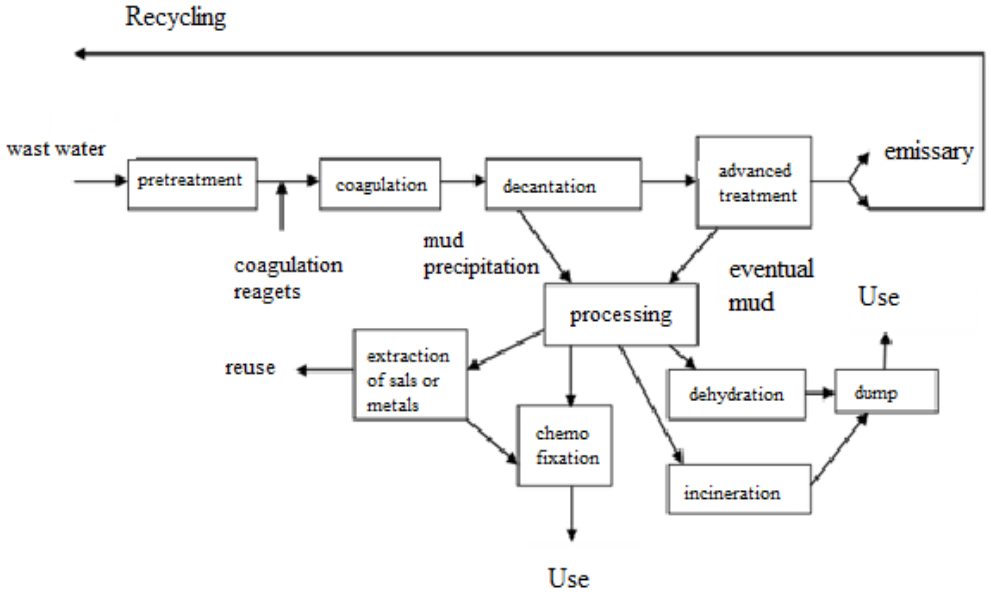

Fig. 2. Sources of sludge from the mechanical-chemical treatment plant [4, 5]

Following this process of water treatment, the main substances that are inducing the pollution are being removed [6]:

- the particles decant naturally or following the physical-chemical treatment
- the excess of micro-organisms that come from the dissolved organic matter
- not biodegradable mineral substances

Those products, together with the water that remained in the treatment basins, forms the mix called sludge.

3. The Elimination and Capitalization of Sewage Sludge from the Perspective of Circular Economy

Sewage sludge, if they respect OM 95/ 2005 and if they are dehydrated (humidity <65%) can be deposited.
The temporary depositing is realized at the generation place of the sludge, from where it is transported to the treatment, elimination and reutilization places. The maximum capacity admitted for the depositing of sludge, that will be treated, is three years, and for the one that is going to be incinerated, one year.
At present, the most used methods and with guaranteed results (figure 3) of eliminating the sludge that comes from the treatment stations, directly into the environment, are the application on the farmland and utilization of compost as fertilizer in horticulture and as nutrient in agriculture [7].

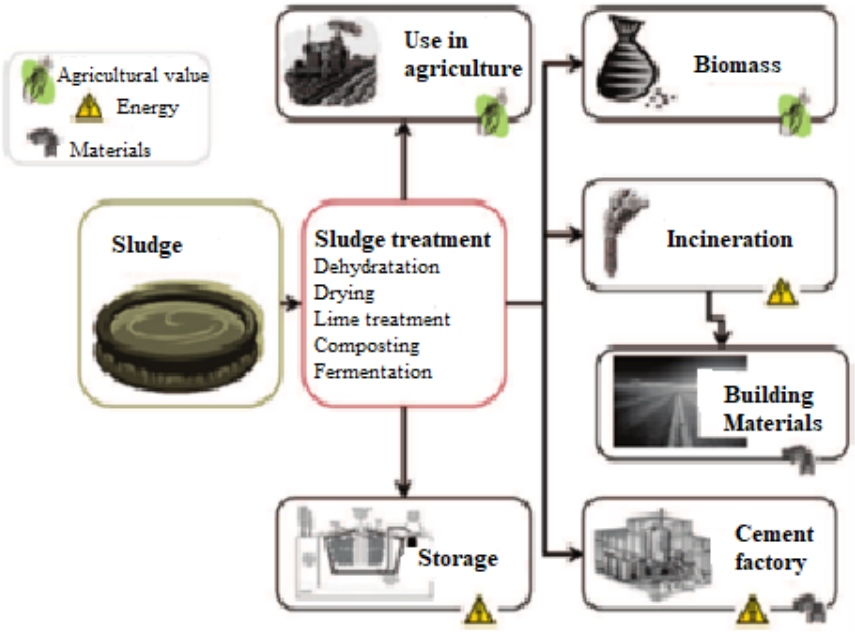

Fig. 3. Ways in which the sludge is finally eliminated [7]

Now, in Romania, around 91% of the resulted sludge is deposited at WTP (Wastewater Treatment Plant), 9% goes into a waste deposit and approximatively 0.2% is utilized in agriculture.
There are more solutions for the elimination and capitalization of the sewage sludge, such as [4, 6]:

- ***Material Capitalization of waste***
  - ✓ Utilization in agriculture, forestry and horticulture;
  - ✓ Making compost;
  - ✓ Degraded soils reconditioning;
  - ✓ Elimination at the waste deposit;
  - ✓ Fabrication of ceramics or aggregates for constructions.
- ***Energetic capitalization:***
  - ✓ Incineration ;
  - ✓ Anaerobic fermentation;
  - ✓ Co-Incineration
  - ✓ Pyrolysis;
  - ✓ Gasification;
  - ✓ Wet Oxidation;
  - ✓ Biofuel Production;
  - ✓ Direct electrical energy production in combustion cells.
- ***The depositing of residual waste*** is applied in the case of ash resulted from the energy capitalization.

The alternatives for the utilization and elimination of sludge from Romania are [4]:

- In agriculture – stabilized mud, preferably dry;
- In forestry – stabilized mud, dry;
- *Land improvements* – stabilized mud, dry;
- *Burning* (cement factories) –drying at WTP or at the cement factory;
- *Energy production* - dry mud , not now;
- *Waste deposits* – stabilized, dry, not now.

As an example of the obtained quantity of mud in a county from Romania, figure 4 shows the sewage sludge production from 2010 until 2018 and expected in 2040 in Harghita County. Overall, the production for the entire county is [8]:

- 2,115 t DS/year in 2010
- 3,862 t DS/year in 2013
- 5, 852 t DS/year in 2018
- 5,300 t DS/year is expected inn 2040.

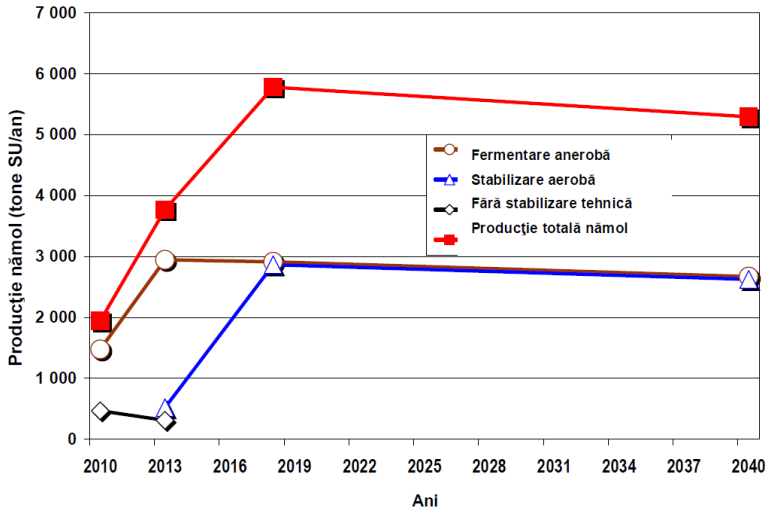

Fig. 4. Sewage sludge production until now and expected in 2040 at the level of Harghita County [8]

3.1 Agricultural Capitalization

Because of its composition, which is rich in nitrogen and phosphorus, sewage sludge can be utilized as a fertilizer for the agricultural soils. Besides its benefits, sewage sludge also contain variable quantities of heavy metals, depending on the industry from which he comes, which, if they exceed the admitted values can become dangerous for the plants but also for the animals and humans. Because of its high content of organic material, sludge can improve clay soils and also the structure of sandy soils.

At European level, there is directive 80/278/EEC, which has as purpose protecting the humans and soils by the pollution with harmful substances that imposes sewage sludge to be treated in advance, making sure that it respects the admitted parameters for heavy metals and other harmful substances. The seven heavy metals that can be toxic for humans and plants are: cadmium, copper, nickel, lead, zinc, mercury and chromium. The maximum allowable quantities are specified in table 1.

Table 1: Maximum allowable values and annual averages of heavy metals added in 10 years [6]

Heavy Metal	Zn	Cu	Ni	Cd	Pb	Hg	Cr
Kg/ha year	15	7.5	3	0.15	15	0.1	15
Romania ppm	2000	500	100	10	300	-	500

In Romania OM no. 49/2004 has been approved, which stipulates the technical environment and soil protection, when sewage sludge is used. The reuse requirements in agriculture are that the mud has to have a drying level of >90% in order not to ferment and to be deposited in silos until usage.
In order to reduce the pollution effect of the mud that is going to be used on the farmlands and for the best capitalization of the nutritive elements, it is mandatory to use adequate treatment processes for the stabilization and for the reduction of the pathogens (table 2) [9].

Table 2: Efficient sludge treatment processes for its utilization in agriculture [10]

Process	Description
Pasteurized mud	Minimum 30 minutes at 70°C or 4 minutes at 55°C followed by mesophilic anaerobic digestion
Mesophilic anaerobic digestion	Primary digestion at least 12 minutes at 35°C or 20 days at 25°C followed by a secondary period of depositing of at least 14 days
Thermophilic anaerobic digestion	Storage period in the digestor of at least 7 days followed by 4 hours at 55°C
Composting	40°C at least 5 days, 4 hours at minimum 55°C inside the reactor, followed by a maturation for the complete reduction of compost
Liquid mud stabilization with lime	Lime is added to increase the pH level at 12 for 12 hours

Mud fertilization value depends, mainly, on the treatment stage, respectively its origin. Unfermented mud contains pathogens and, from this point of view sanitary protection measures must be taken for its use, but has fertilization value bigger than the fermented mud (fermented mud contains 40-50% less nitrogen than fresh mud). After the mud dispersion on the farmlands, those have to be plowed, and their usage being prohibited for plants that their leaves and roots are being consumed raw. From the sanitary point of view, muds dehydrated through thermic treatment and wet oxidation are less dangerous [11].
Used mud can be under different forms [10]:

- liquid;
- mud cakes (25% solid, dry);
- dry mud beads (95% solid, dry).

At a national level, only a few part (4.2%) of the farmlands are suitable for the application of sludge and will use the entire quantity of produced mud. At regional level, differences exist because of topography, types of soils and climate regarding the type of agriculture and the feasibility of mud utilization. This thing assumes that mud can be utilized at maximum in some regions but is restricted in others (especially in NW, Centre and Bucuresti-Ilfov). Variations at county level are more pronounced and in some counties the necessary surface of land for the application of the entire quantity of sludge exceeds the suitable surface (>100%) [12].
Sewage sludge can be also used for energetic plants plantations, like "energy willow Salis viminalis energo" cultivated on large surfaces in Sweden, Poland, Austria and Hungary, because of its fast growth (3-3.5 cm/day) and produces biomass with caloric power superior to beech and oak, approximatively 4900 Kcal/Kg. For its utilization as fertilizer on forest plantations, those muds have to respect the stipulations from Order 344/2004 [4].

3.2. Composting

Composting consists of the sludge mixing with a filling material to obtain a mix that can be aerated in order to realize an accelerated aerobic degradation process. For the aeration of the material, it is necessary a big quantity of energy and the final product must be eliminated on a good quality soil because of the low nutritive composition.
Optimal conditions for composting are: humidity approximatively 50%, carbon-nitrogen report approximatively 25-30, and the temperature 55 °C. For the sludge that results from water treatment the C:N report is very small, of 5-10, and the humidity is very high. For the quantity adjustment dry sawdust can be added with large C:N report, approximatively 500, waste from the garden, forest waste or chopped newspapers.

At sludge composting dry matters should be added that the air flow through the compost layers. For this reason it is usually used a sludge mix of 0.5 m^3 and 75 kg of peat. A much better mix is obtained by adding household waste to the mud, so that humidity is 40-50%. The waste offers the mix a favorable proportion of carbon and nitrogen of around 15:1, offering the missing carbon [11].
Naturally, composting is realized in storage piles, at a temperature of 70^{o}C, during ferment water decreases and the germs are eliminated.
Artificially, composting is realized in a drum stabilizer, in which the mud stays for a day at 120^{o}C. The resulted product is chopped, placed in piles of 1.5m height, left at anaerobic fermentation for a few days and after that used as fertilizer [11].
According to DE 86/278/CEE, composting is realized near ecological waste deposits, thing that cannot be realized in Romania, because it requires large surfaces, machinery and high costs.

3.3. Energy Capitalization

The most used process of energy recovery during the sludge treatment process is anaerobic fermentation (digestion) that has as purpose the extraction of methane, 60-65%, that generates heat, 37-40 ^{o}C and energy, but for a short time, around 6 hours [13].
According to the circular economy's principle, fermented sludge from the biogas tanks can be capitalized through:

- Reutilization on farmlands;
- Co-processing in cement factories;
- Incineration / co-incineration.

If the muds resulted from the treatment of industrial wastewater contain organic compounds and/or inorganic, toxic, that are not allowing the agricultural capitalization, depositing on soil or the application of useful substances recovery procedures, Incineration is being appealed as the only acceptable alternative. During this process, the organic compounds are totally oxidized, and the mineral ones are transformed in metallic oxides. For incineration the prior reduction of raw mud humidity is recommended and also the avoidance of aerobic stabilization or anaerobic fermentation, that diminishes the caloric power of the material that is supposed to be incinerated. Mud preliminary processing should lead to combustion. If the humidity is larger than 50% or the temperature over 750 ^{o}C, additional fuel must be utilized to avoid unpleasant smells.
Incineration has the biggest mud treatment/elimination costs, because of the required fuel and of the air pollution control, made through the gas burning.
The resulted ash is stocked in a waste deposit, and the gas is pre-heated before the evacuation.
In Romania's national energy development strategy, the use of biomass is considered priority. Sadly, in Romania there aren't mud incineration facilities.
Energy recovery from sewage sludge – technologies:
1. Biogas. One of the most efficient, having the possibility to be utilized at electrical energy production, heat, steam etc.
2. Energy from biofuel. Hydrogen is one of the gas fuels recovered from the sewage sludge that in combination with CO^2 forms syngas, an alternative for fossil fuels, in the production of electrical energy and in the production of liquid fuels [13].
3. Microbial combustion cell (MCC). This technology is a solution for the water energetic crisis and for the excessive mud. It can be utilized in order to generate energy on both technological lines, both on the water side, and also on the sludge's one [14].
In Romania there are seven cement factories placed in every region of the country (two in the south region), with the exception of the South-West region and Bucuresti-Ilfov, as it follows [13]:

- Bicaz- Neamț County;
- Medgidia – Constanța County;
- Fieni – Prahova County;
- Câmpulung – Argeș County;
- Deva – Hunedoara County;
- Alesd – Bihor County;
- Hoghiz – Brașov County;

Mud can be utilized as an energy source in cement factories, because the heavy metals that it contains will be blocked in cement, and the large quantity of water from the dehydrated mud has a

minimum effect. The problem of ash inside the factory can be solved with its implementation in cement, without damaging its structural properties.

3.4. Technological Capitalization

Muds and sands resulted from the urban and industrial wastewater treatment plants can be utilized in constructions along with base raw material in order to reduce energy and to produce a material that responds to circular economy's requirements [7].
In addition, it can be capitalized as construction material (bricks and plaster material). To obtain bricks, it is mixed through centrifugation 45% cement with 55% mud, for 15 minutes, until a homogenous paste that is extracted from a form is obtained and is let to dry up for 24 hours. To increase its resistance, after it is extracted from the form, it is let outside for 3-4 days. Final product (figure 5) is considered inert waste, according to the actual environment legislation (Law 211/2011, HG 856/2002, Order 95/2005) [14].

Fig. 5. Brick obtained from mud and cement [14]

3.5. Mud Depositing

The elimination of dangerous waste in ecologic deposits is the last option in every mud management strategy because it is a waste of a very useful resource for fields' fertilization and also for energy recovery; it is also against politics and the legislation for the reduction of biodegradable waste.
Muds that cannot be capitalized must be deposited in appropriate environment protection conditions. For this reason, mud ponds are being used, special storage dumps, underground, discharge into the sea at big distances from the shore and a certain depth.
Sewage sludge is deposited in homogenous deposits (mono-deposits) only for mud, or in mixt deposits together with other municipal deposits.
For homogenous deposits, mud should be hydrated in advance and dried. A perfect correlation should exist between deposit's organization, transport vehicles manipulation and mud manipulation inside the deposit [15].
For mixt deposits, the international norms foresee a mud quantity of 20-25% out of the deposited waste, while national norms limit this ratio to 10%. To be able to deposit the mud a bed of approximatively 3m of solid waste is required, while the layers should be alternated. Romanian legislation foresees a content of at least 35% solid substance [15].

4. Conclusions

As the population grows and the industry develops, an imbalance is being created between human and environment, thing that generates major and irreversible implications from an ecologic point of view and great economic implications with very important financial losses.
Depositing, recycling or utilizing such materials represents a difficult problem mainly for large urban agglomerations. In the developed European countries, sewage sludge resulted from wastewater treatment plants is processed with the help of the most evolved technologies and machinery, so as it can be utilized as organic fertilizer and for soils restoration.

If those muds go through a well-defined cycle: formation, stabilization, dehydration and complete removal from the circuit, are no longer listed as waste. The final process is obtained through three methods: incineration, stocking in special deposits and utilization as organic fertilizer.
Choosing the capitalization/elimination method has to take in consideration the impact on environment and the farmers' acceptance (for utilization in agriculture). The knowledge regarding the optimal deployment conditions of the processes is absolutely necessary, being able to decrease the presented disadvantages using the mud processing and elimination methods.
Every capitalization solution presented in this paper has advantages and disadvantages, but there is the possibility to apply some alternative methods, depending on the activity and area particularities.

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Stand for Experimental Verification of Components in the Structure of Hydraulic Drive Systems

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Abstract: *For the experimental verification of the components in the structure of hydraulic drive systems, stands dedicated to a single category of components are used: stands for pumps, stands for hydraulic cylinders, stands for hydraulic devices (directional control valves, other valves, etc.). The article presents a stand on which one can be perform the experimental verification of almost all the components of a hydraulic drive system: pumps, rotary motors, hydraulic cylinders, devices (directional control valves, other valves, etc.).*

Keywords: *Experimental verification, stand, hydraulic drive systems*

1. Introduction

In the structure of a hydraulic drive system, there are three large groups of components: *hydraulic pumps* that convert the energy received at the shaft into hydraulic energy, *hydraulic motors* that convert the hydraulic energy received into mechanical work, which is further supplied to the driven mechanisms, *devices* that regulate and control working fluid parameters (pressure, flow, temperature, etc.). For the experimental verification of the components in the structure of the hydraulic drive systems stands dedicated to a single category of components are used: for pumps, motors, or hydraulic devices. With the stand presented in this article, one can check almost all the components of a hydraulic drive system: pumps, rotary hydraulic motors, linear hydraulic motors and various devices (directional control valves, other valves, etc.). The equipment of the stand allows the following tests and verifications: functional static tests with didactic character within the teaching line "Hydraulic drives" in the curriculum of technical universities, dynamic tests for investigating the components in the structure of hydraulic drive systems, functional verifications (type or batch tests) of hydraulic devices and components at the request of economic operators. The stand can also be used for practical training at any level (workers, technicians, engineers) of persons who specialize and / or improve in the field of hydraulic drives.

2. Technical characteristics

2.1. Technical parameters

• Main electric pump:
- electric motor: 45 kW; 1450 rpm;
- pump capacity, v_g: 70 cm^3 / rev;
- maximum pressure: 320 bar;
- maximum flow: 100 l / min at 225 bar;
- maximum flow: 75 l / min at 320 bar.
• Electric pump controls:
- electric motor: 4 kW; 1460 rpm;
- pump capacity, v_g: 6 cm^3 / rev;
- maximum pressure: 250 bar.

2.2. Measuring devices for:
- pressure: pressure gauges and pressure transducers;
- flow: turbine flow transducers;
- torque and speed: torque and speed transducer;

- oil temperature: temperature transducer;
- force: force transducer.

3. Structure and operation of the test stand [1, 2, 3, 4]

Fig. 1 shows the hydraulic diagram and the structure of the test stand, SAH - 0.

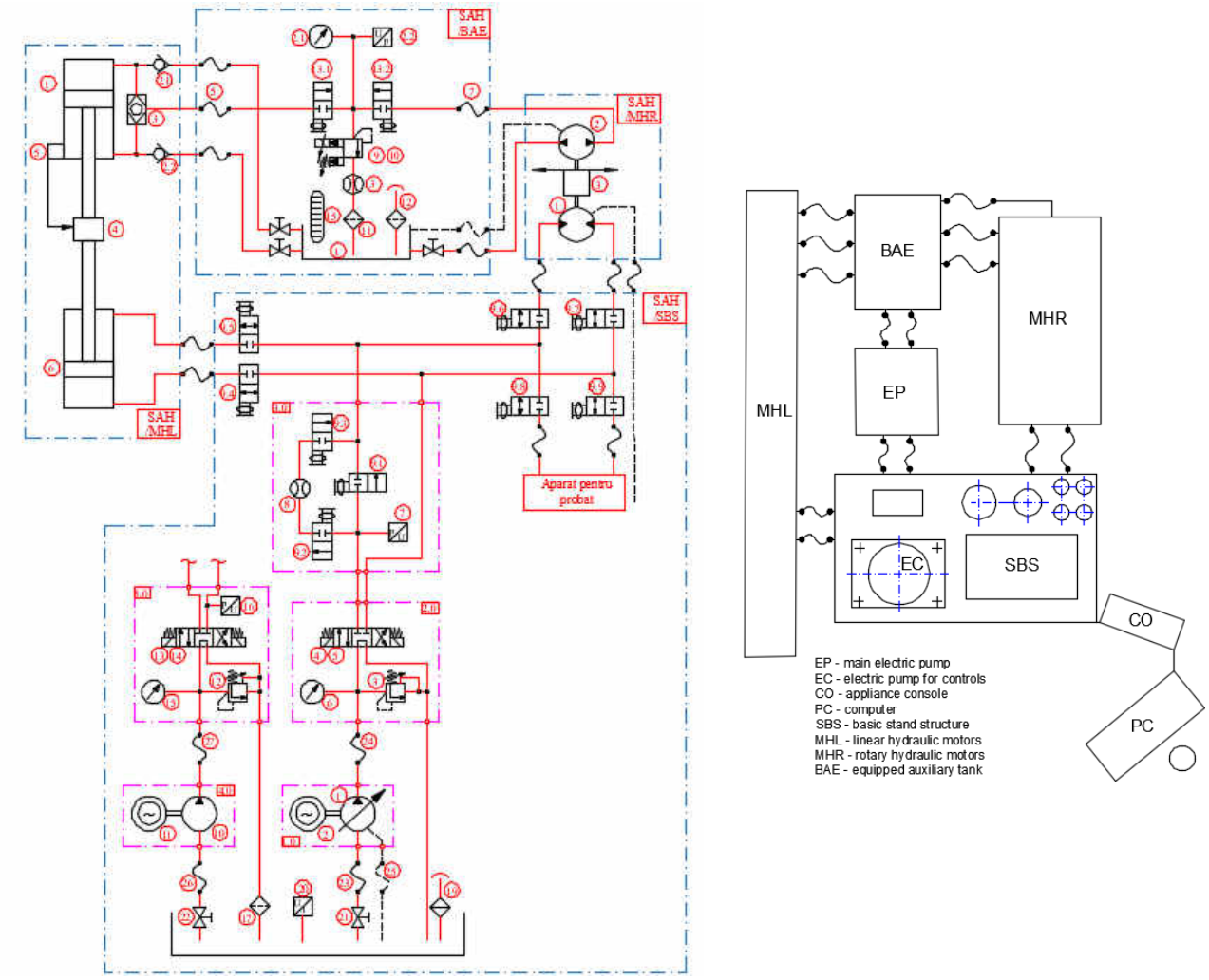

Fig. 1. The hydraulic diagram and the structure of the test stand

The SAH hydraulic drive test stand consists of four subassemblies:
• SBS - the basic structure of the stand;
• MHL - subassembly for linear hydraulic motors;
• MHR - subassembly for rotary hydraulic motors;
• BAE - equipped auxiliary tank.

3.1. The basic structure of the stand - SAH / SBS

It is the subassembly that generates the hydraulic energy necessary for the operation of the stand. Its hydraulic diagram is shown in fig. 2.
The basic structure of the stand consists of six subassemblies:
• *Main electric pump: SAH / SBS - 1.0.*
It consists of variable flow pump *1* and electric motor *2*. Axial piston pump *2* is equipped with a flow and pressure regulator. Both the flow and the pressure are remotely adjusted electrically proportionally.

• *Block with devices A: SAH / SBS - 2.0.*
It is associated with the main electric pump and consists of safety valve *3*, which limits the pressure in the discharge circuit of main pump *1*, directional control valve *4*, which directs the flow of main pump *1* to the consumers, and pressure gauge *6*.

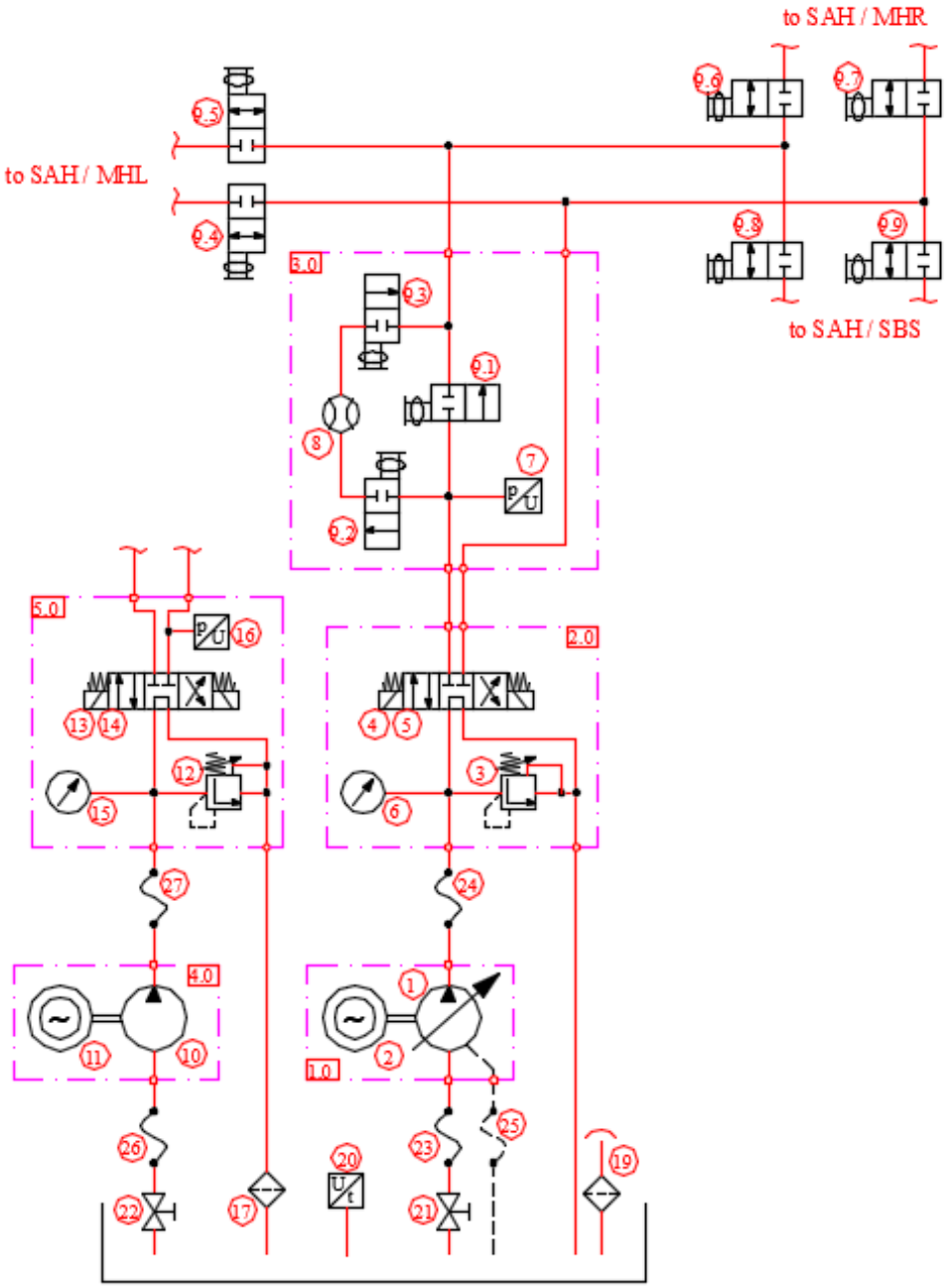

Fig. 2. The hydraulic diagram of the test stand

• *Measuring subassembly p - Q: SAH / SBS - 3.0.*
It consists of turbine flow transducer *8* and pressure transducer *7*. Valves *9.2* and *9.3* isolate flow transducer *8* when no flow measurement is required.
• *Filter and control electric pump: SAH / SBS - 4.0.*
It consists of gear pump *10* and electric motor *11*, and alternately performs two functions: oil filtration and, where appropriate, ensures the pressure required for the operation of the hydraulic devices that are being tested.

• *Block with devices B: SAH / SBS - 5.0.*
This hydraulic block with devices is associated with the filter and control electric pump and consists of safety valve *12*, directional control valve *13*, pressure gauge *15*, and pressure transducer *16*. Pressure valve *12* regulates / limits the pressure on the discharge circuit of pump *10*. Directional control valve 13 directs the flow of pump *10* to return filter *17* when not electrically controlled or to the testing apparatus which needs hydraulic control pressure when supplied with electricity.

• *Oil basin: SAH / SBS - 6.0.*
The working fluid required for the operation of the stand is in oil tank *18*. Pump *1* and pump *10* suck oil from tank *18* through valves *21* and *22* and flexible connections *23* and *26*. On tank *18* cover there are located: return filter *17*, filling and ventilation filter *19*; oil temperature indicator *20*, and T-channel bench to which the device (directional control valve, other valve, etc.) to be tested is fixed. Valves *9.4* ... *9.9* close / open depending on the equipment under tests: hydraulic cylinders, rotary hydraulic motors or hydraulic devices.

3.2. The subassembly of rotary hydraulic motors SAH / MHR

This assembly is intended for testing rotary hydraulic pumps and motors. The constructive solution for its physical development is presented in fig. 3. Supports *2* are fixed to the ends of U-profiles of frame *1* with screws *5*. On one of the supports the pump is fixed, and on the other - the hydraulic motor. Between them, there is subassembly *4* at the ends of which there are the bearings of the torque and speed transducer. The rotational motion is transmitted from the motor to the pump by means of couplings *3*. The hydraulic motor *MH* receives hydraulic energy (flow x pressure) from the basic structure of the stand *SBS* and transforms it into mechanical energy (torque x speed), which it transmits through the flow and speed transducer *TDT* to the pump *PH* shaft. The pump *PH* suctions oil from the auxiliary tank *BAE* and discharges it into the *BAE* as well. The pressure on the discharge circuit of the pump *PH* is regulated by means of a piloted proportional valve. This is how the "load" is achieved on the motor *MH* shaft with the help of the pump *PH*.

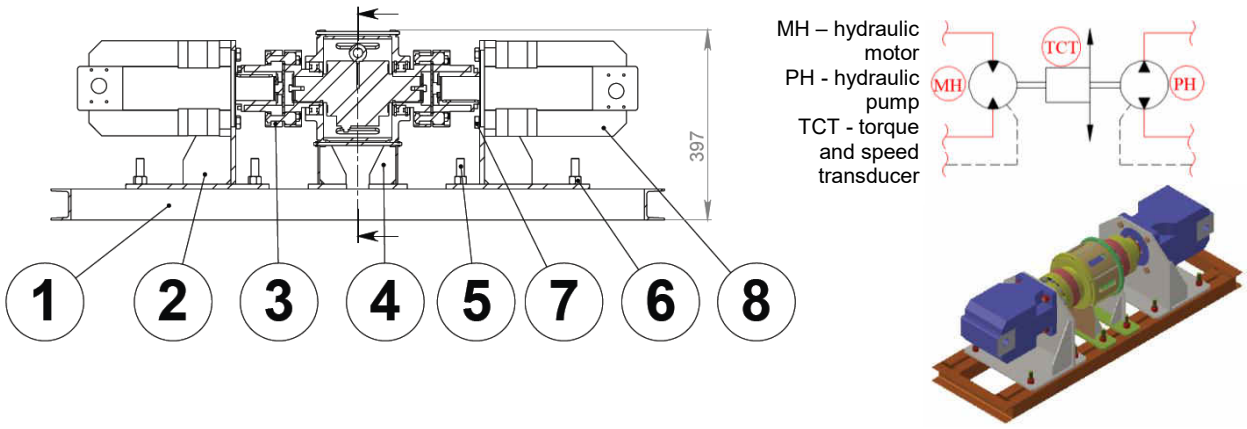

Fig. 3. Subassembly of rotary hydraulic motors

3.3. The assembly for testing linear hydraulic motors: SAH / MHL

This assembly is intended for testing hydraulic cylinders. The constructive solution for its physical development is presented in fig. 4.
On to the ends of frame *1*, hydraulic cylinder to be tested *20* and load cylinder *19* are fixed by means of supports *2* and *3*. Force transducer *13* is placed between the rods of the two cylinders. On support *2* of load cylinder, wire stroke transducers *21* are fastened with the help of screws *16*. The movable element of stroke transducer *21* is attached to plug *5* of load piston rod *19*. The hydraulic cylinder to be tested *CHP* is supplied with hydraulic energy (flow x pressure) from the basic structure of the stand *SBS*, and converts it into mechanical energy (force x displacement) which it transmits through the force transducer *TF* to the rod of the load cylinder *CHS*. The load

cylinder sucks oil from the auxiliary tank *BAE* through the one-way valves *SU*, and discharges it into the tank *BAE* as well through the selection valve *SS*. Pressure on the discharge circuit of the load cylinder *CHS* is achieved by means of a piloted proportional pressure valve. From a functional point of view, the load cylinder *CHS* is a pumping element that sucks and discharges oil from the basin *BAE*.

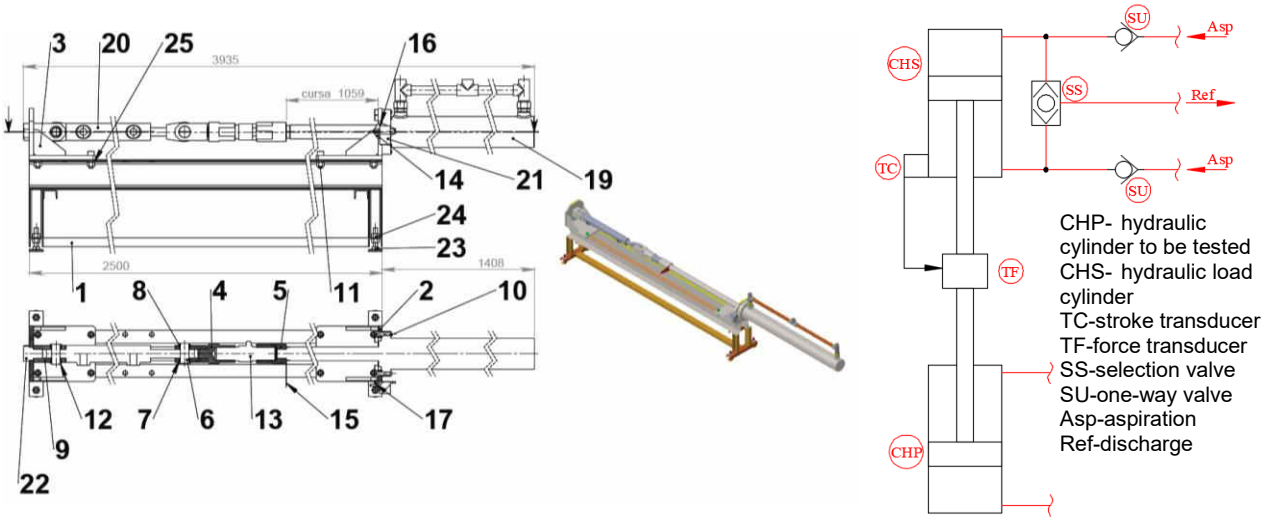

Fig. 4. Assembly for testing linear hydraulic motors

3.4. The equipped auxiliary tank: SAH / BAE

The equipped auxiliary tank *BAE* (fig. 5) is associated with the assembly for testing rotary hydraulic motors *MHR* and the assembly for testing linear hydraulic motors *MHL*.

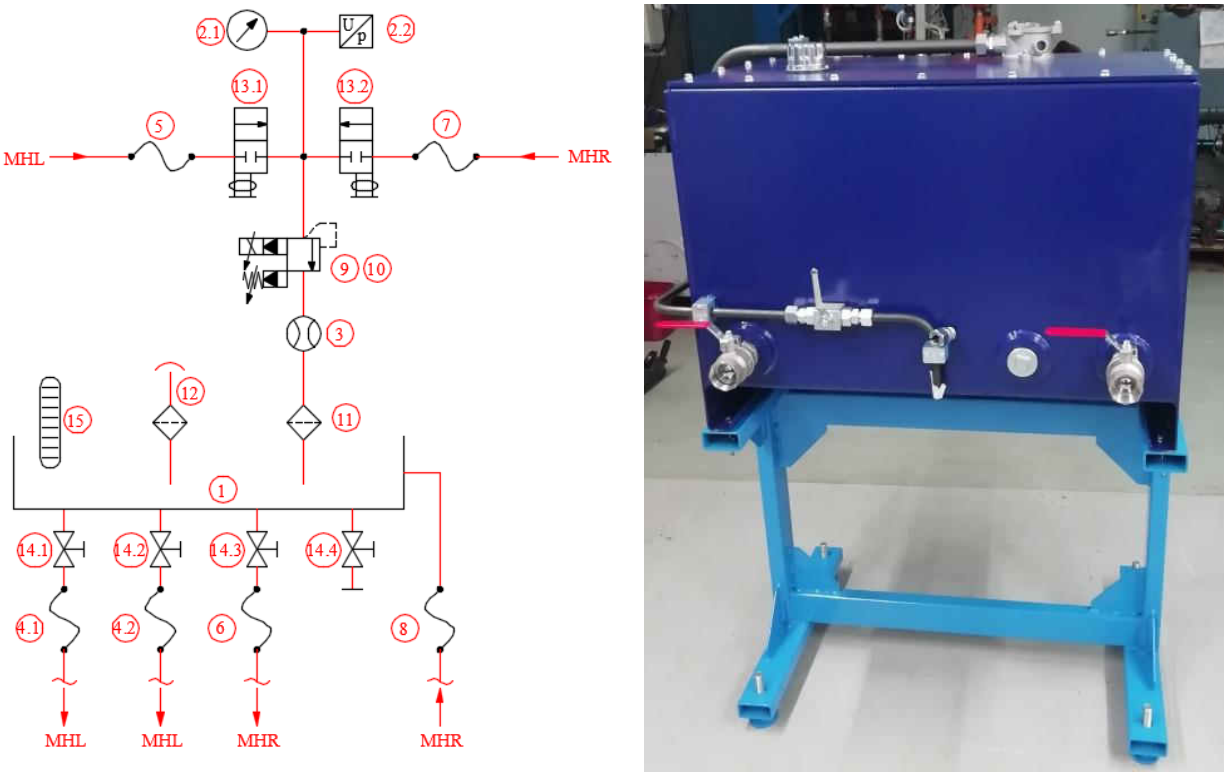

Fig. 5. Equipped auxiliary tank of the stand

The load cylinder sucks oil from the tank through valves *14.1* and *14.2* and flexible connections *4.1* and *4.2*, and discharges it through flexible connection *5*, valve *13.1*, proportional pressure valve *9*, flow transducer *3*, and return filter *11*. The pump in the subassembly for tests on rotary hydraulic machines *MHR* sucks oil from the tank through valve *14.3* and flexible connection *6*, and discharges it through flexible connection *7*, valve *13.2*, proportional valve *9*, turbine flow meter *3*, and filter *11*. The two discharge circuits operate alternately by closing / opening valves *13.1* and *13.2*. Pressure gauge *2.1* and pressure transducer *2.2* both serve discharge circuits.

4. Control, monitoring and data acquisition [3, 5, 6, 7]

The control, monitoring and data acquisition system of the multifunctional stand for testing hydraulic equipment, hereinafter referred to as SCADA (Supervisory Control and Data Acquisition), implements the electrical control of the stand equipment such as the asynchronous electric motor which operates the hydraulic pump, the hydraulic pump with variable flow valve electrically controlled, proportional pressure valve that controls the value of the testing pressure, electrohydraulic directional control valves that determine the configuration of hydraulic circuits, etc. Another function of SCADA is the acquisition of data from the transducers on the stand: pressure, flow, torque / speed, temperature transducers. The values of the process parameters are displayed locally on the operating panel of the stand and they are transmitted, via the beneficiary's computer network, to the PC by which the stand is operated. In addition, the acquired process values are stored in a database that can run on the operating PC of the stand or on the beneficiary's server. The required software components, namely the PC stand console and the process data database management programs, can be ordered by the beneficiary to run under Windows or Linux.

5. Conclusions

The test stand shown in the above allows the experimental verification of all the components of a hydraulic drive system: pumps, rotary hydraulic motors, linear hydraulic motors, hydraulic devices such as check valves, directional control valves, throttles, flow / pressure regulators, etc.
The stand presented can be used for:
- functional static tests with didactic character within the teaching line "Hydraulic drives" in the curriculum of technical universities;
- dynamic tests for the investigation of the components in the structure of hydraulic drive systems;
- functional tests (type or batch tests) of hydraulic devices and components at the request of economic operators;
- practical training at any level (workers, technicians, engineers) of persons who specialize and / or improve in the field of hydraulic drives.

Acknowledgments

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Air Quality Measurement in Buildings

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Abstract: *Air quality measurement is an essential component of quality of life, since the proper functioning of ventilation (air exchange) (e.g. in passive houses) has a fundamental influence on the indoor air composition. It is very important to be able to take measurements quickly and cost-effectively. Where appropriate, it may be useful to have such a facility available to building services engineers. The sensors presented here can be used to design and build an easy-to-use measuring device.*

Keywords: *Air quality, air quality measurement, air quality sensors*

1. Introduction

Indoor air quality is important for quality of life and health [1]. Its perception is therefore very important in the field of engineering.
Key features that are important for us:

- indoor temperature,
- indoor pressure,
- humidity,
- carbon dioxide concentration,
- volatile organic compounds (VOC-s).

To a large extent, our sense of thermal comfort depends on:

- air temperature (this is usually controlled),
- relative humidity (which indicates the water vapour content in the air and should be between 40-60%),
- air composition (of which the percentage of oxygen and carbon dioxide is of greatest biophysical importance).

The concentration of these two gases changes very rapidly in indoor spaces. A change in the CO_2 content of the air we breathe has a greater effect on the human body than a comparable change in the oxygen content. **Consequently, monitoring carbon dioxide level is an essential element of air composition monitoring.**
To maintain good air quality and reduce CO_2 concentration, the building should be ventilated continuously. **However, ventilation is an energy intensive process**.
At the same time, the increased CO_2 content in the air we breathe causes adverse reactions in the human body:

- reduces attention and
- causes drowsiness.
- When the concentration of carbon dioxide reaches a fraction comparable to that of oxygen (around 20%), it might even be life-threatening.
- If the CO_2 content in the air ones breathe rises above 1000 parts per million (ppm), one will not only feel drowsy and lose concentration, but also feel short of breath and have a rapid heartbeat.

2. Legislation on indoor CO_2 concentrations

Developed countries in North America and Europe place great emphasis on air quality standards and indoor CO_2 content [2].
Mandatory standards for ventilation [3, 4, 5, 6]:

- United States of America
  - ASHRAE 62.1-2013 [3]

- Europe
  - EN-15241:2011 [4],
  - EN-15242:2009 [5] and
  - EN-13779:2008 [6].

They aim to achieve good indoor air quality.
The figure below shows how different concentrations of carbon dioxide in the air we breathe affect the human body [7].

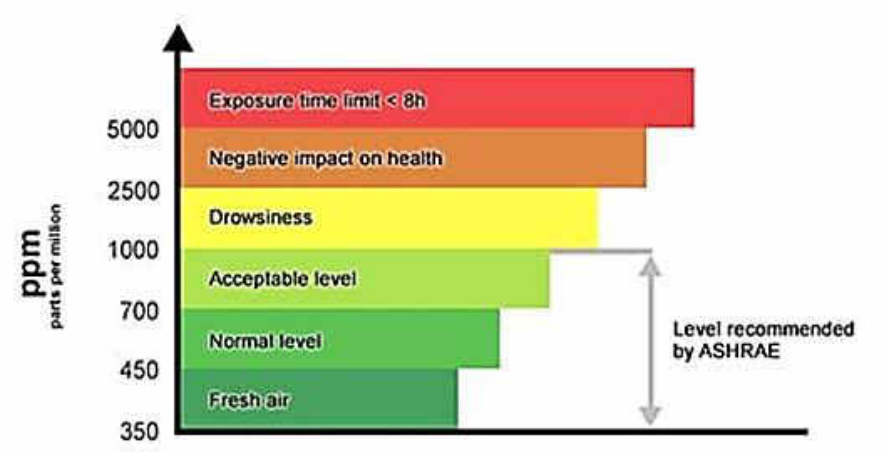

Fig. 1. Characterisation of CO_2 concentration and its effects on the human body [7]

3. Air quality sensors

Typical applications of air quality sensors:

- Indoor air quality detection,
- Home automation and control,
- Weather forecast.

3.1. BME 680 Bosch air quality sensor [8]

The BME 680 is a digital 4-in-1 sensor that measures

- gas,
- humidity,
- pressure and
- temperature.

Fig. 2. BME 680 Bosch air quality sensor [9]

3.2. Main operating characteristics of the sensor

- Operating range -40 - +85°C, 0-100% relative humidity, 300-1100 hPa
- Key parameters of the gas detector
  - Response time (τ 33-63%) <1 s (for new sensors)
  - Power consumption <0.1 mA in ultra-low power mode
  - Output data processing direct indoor air quality (IAQ) index output

- Key parameters of the humidity sensor
  - Response time (τ 0-63%) ~ 8 s
  - Accuracy tolerance ± 3% r.H.
  - Hysteresis ± 1.5% r.H.
- Key parameters of the pressure sensor
  - RMS noise 0.12 Pa, eq. up to 1.7 cm
  - Temperature coefficient ± 1.3 Pa/K, eq. ± 10.9 cm for temperature changes up to 1 °CI used FMSv4.5 software for evaluating the results of the measurement.

3.3. Using the sensor

The sensor supports low-power modes:
- sleeping and
- forced mode.

These modes can be selected using the mode control register.
After the switch-on process, the sensor automatically starts in the sleep mode. If the device is currently measuring, the execution of the mode change commands is delayed until the end of the currently running measurement period.

3.3.1. Temperature measurement

Temperature measurement can be enabled or disabled.
- If the IIR filter is enabled, the temperature resolution is 20 bits.
- If the IIR filter is disabled, the temperature resolution is 16 bits.

3.3.2. Pressure measurement

Pressure measurement can be enabled or disabled. If enabled, there are several sampling options. The resolution of the pressure data depends on the IIR filter and the oversampling settings:
- If the IIR filter is enabled, the pressure resolution is 20 bits.
- If the IIR filter is disabled, the pressure resolution is 16 bits.

3.3.3. Humidity measurement

Humidity measurement can be enabled or disabled. If enabled, there are several sampling options. The resolution of the humidity measurement is recorded on a 16-bit ADC output.

3.3.4. Read data

After reading the uncompensated values of temperature, pressure and humidity, the actual humidity, pressure, and temperature shall be calculated using the compensation parameters stored in the instrument.

3.3.5. BSEC software

The BSEC software includes intelligent algorithms that allow use cases such as indoor air quality monitoring using the BME680.
The Bosch Sensortec BSEC software is available in closed source binary form, made available through a Software License Agreement (SLA) on the Bosch Sensortec website.
The main features of the hardware-software system are:
- Calculate the ambient air temperature outside the device (e.g. telephone)
- Calculating the ambient relative humidity outside the device
- Calculating indoor air quality (IAQ) outside the appliance.

3.3.6. How the BME 680 sensor works

The BME 680 is a metal oxide-based sensor that detects VOCs by adsorption (and subsequent oxidation/reduction) on its sensitive layer.
Thus, the BME680 reacts to most volatile compounds that pollute indoor air (except for CO_2). BME680 can measure the amount of VOCs/pollutants in the ambient air. This allows the BME680 to detect e.g. fumigation from paint, furniture and/or garbage, high VOC levels due to cooking, food consumption, exhaled breath and/or perspiration.

The raw values are converted into Indoor Air Quality (IAQ) indices by intelligent algorithms within BSEC.
The IAQ scale ranges from 0 (clean air) to 500 (highly polluted air). During operation, the algorithms automatically calibrate and adapt to the typical environment in which the sensor operates (e.g. home, workplace, inside a car, etc.).
This automatic background calibration ensures that users experience consistent IAQ performance. **The calibration process takes into account the most recent measurement history (typically up to four days) to ensure that IAQ ~ 25 corresponds to "typical good" air and IAQ ~ 250 indicates "typical polluted" air.**

4. SEN-16531 - SGP30 Qwiic air quality sensor

The SparkFun SGP30 Air Quality Sensor [10] provides information about the air quality in a room or house by detecting volatile organic compounds around the sensor. The SGP30 air quality sensor can provide valid Indoor Air Quality (IAQ) values within 15 seconds of power-up.

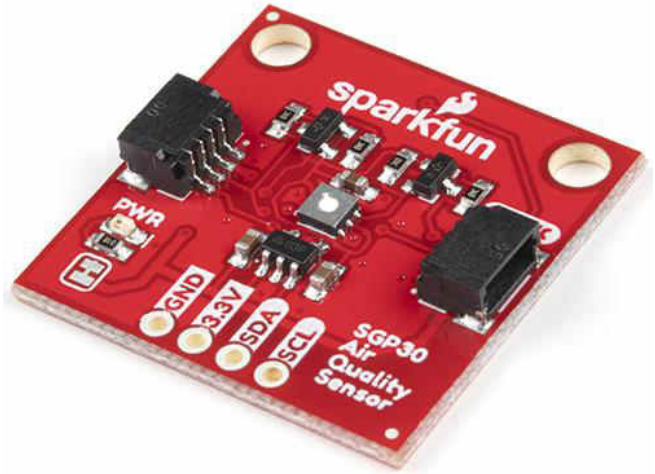

Fig. 3. SEN-16531 - SGP30 Qwiic air quality sensor [10]

Most air quality (IAQ) sensors require a start-up time of around 20 minutes. 15 seconds is considered an excellent value.
In addition to a very fast start-up time, the sensor is resistant to contamination by other gases, providing long-term stability and highly reliable results.
Output values of the SGP30 gas detector:

- VOC (TVOC),
- carbon dioxide (CO_2),
- H_2,
- ethanol.

The SparkFun Qwiic Connect System (sensor interface and system) is a system of I2C sensors, actuators, shields and cables that facilitates prototyping.
All Qwiic-compatible cards share a common 1 mm pitch and use a 4-pin JST connector. This reduces the size of the required PCB (printed circuit board) area, and the polarised connections ensure freedom from misconnectivity.
The SGP30 air quality sensor is automatically detected, scanned, configured, and logged by the Open Log Artemis data collection system.
Key features of the SEN-16531 - SGP30 Qwiic air quality sensor

- Operating voltage:
  - 1.62V - 1.98V (Typ. 1.8V)
  - When using Qwiic cable, regulated voltage: 1.8V - 3.3V
- TVOC signal:
  - Output band: 0 ppb - 60,000 ppb
  - Resolution: 13 ppb.

- CO_2 signal
  - Output band: 400 ppm - 60,000 ppm
  - Resolution: 11ppm
- Ethanol signal:
  - Measuring range: 0 ppm to 1,000 ppm
  - Resolution: 0.2% of the measured value
- H_2 signal
  - Measuring range: 0 ppm to 1,000 ppm
  - Resolution: 0.2% of the measured value
- Typical current consumption (depending on operating mode)
  - 48.2 mA (measuring mode)
  - 2μA - 10μA (sleep mode)

5. Summary

The ability to carry out a documentable energy assessment of the boundary surfaces of heated/cooled spaces as accurately and reproducibly as possible and within a shorter time is very important.
However, all this is complemented by the physical and chemical quality of the indoor air. The need therefore arises to increase the complexity of the measurement tool.
The values to be measured are VOC, CO_2, H_2, ethanol concentration, together with air humidity, pressure, and temperature.
Selected sensors:

- BME 680 Bosch air quality sensor and
- SEN-16531 - SGP30 Qwiic air quality sensor.

My goal is to create an affordable, marketable prototype tool that is labour-saving, efficient to use and cost-effective. This objective and documentable tool is expected to be most beneficial or of use for construction/civil engineering companies.
It will be suitable for a complex assessment, analysing energy aspects in synergy with indoor air quality measurements.
The benefits that come with using it:

- A cheap, easy-to-use solution for a preliminary survey
- Based on the results, the renovation technology and the exact selection of the required insulation materials, windows and ventilation systems can be planned.

Acknowledgement

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ECOVALDES Branch Choppers

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Abstract: *The article presents aspects related to the collection of biomass resulting from the annual cutting in orchards, notions of sizing of choppers and shredders, and some of the achievements resulting from the development of the ECOVALDES project in the segment of branch choppers.*

Keywords: *Biomass, secondary agricultural production, choppers, branch segmentation*

1. Introduction

Wood is the most widely used solid biofuel. The raw material can have the following shapes: logs, stumps, stems, leaves and needles from the forest, bark, sawdust, firewood and wood chips from the wood industry and wood recovered from construction. They can be used chopped when is possible directly as a fuel, or they can be processed into forms that are easier to transport, store and burn, such as: pellets, briquettes and wood dust.
In most cases of energy conversion of biomass, the potential chemical energy from biomass is converted - directly or after some preparatory biological and / or chemical processes - into heat obtained by combustion. We can say that the main form of energy conversion of biomass is its "generic combustion" and the main primary form of usable energy obtained in this way is heat.
The first operation for the use as an energy source of branches resulting from periodic cuttings in orchards and vineyards is their segmentation (chopping) [1].
One of the objectives of capitalizing on biomass is fragmentation (chopping) with the help of special equipment, in order to be used in combustion equipment for the production of thermal energy for domestic or industrial use.
The need to provide heat in the cold season but also for food preparation has been and remains a very important factor in people's lives. Also, the accessibility of the population to the fuels necessary to ensure the current energy, is becoming more and more important both from a logistical and financial point of view. That is why a first conclusion is that wood biomass in its various forms, which is a cheap source of heating and is found in abundance, can provide the energy needed for a part of the population.
The first operation of using as a source of energy the branches resulting from periodic pruning in orchards and vineyards is their segmentation (chopping).
The biomass chopper also has the role of crushing the forest residues resulting from the annual cuttings, obtaining a coarsely segmented wood mass, which will be used either for direct burning in stoves or for crushing to specific granulation for briquetting or pelletizing.
The chopping operation contributes both to the easier handling of biomass and to the creation of a compact finished product for final consumers. In order for the chopping of the branches to be carried out with optimal energy consumption in the specialized literature, there are studies and researches aimed at improving the chopping and shredding equipment, both in terms of design and in terms of fulfilment the requirements of processing of the shredded material after this stage.
The cuttings in the orchards are made in the non-vegetative period and as a result the average humidity of the cut branches is 30-35%. If we take into account a humidity of 35% of a ton of cuttings, by drying up to an average humidity of 15%, it results in 765 kg of biomass usable for the production of thermal energy. It results that a ton of cuttings has an average energy potential of 11.856 MJ or 3.3 MWhth. From a hectare of intensive orchard annually, on average, about 3000 kg of biomass is cut which has an energy potential of 35.628 GJ/ha·year.

The biomass from the cuttings is transported to the row head where it is chopped with a specialized machine at 10 ... 50 mm and stored in containers with perforated walls for a good air circulation. On average, the bulk density of the wet cut is 250 kg/m3, which leads to a need of about 12 containers per hectare of orchard. By natural drying or forced ventilation, the biomass reaches an average humidity of 15% and a bulk density of about 200 kg / m3.
From the published data, for Europe, results an average cost of gathering, chopping and transport for a ton of cuts of about 40 € /t. Taking into account a profit of 20% and VAT it results that a ton of biomass usable for thermal energy production can be sold for about 80 € /t. The specific price for the primary energy of biomass is in the case studied of 5.2 € /GJ or 18.6 € /MWhth, values much lower than those for diesel of 33.22 € /GJ or for LPG of 21.52 € /GJ [2].

2. General data on the sizing of shredding and chopping equipment

1. For shredders, the useful characteristics of shredding processes [3] should include the torque Mo (1), the grinding time t, the power of the shredder P, the energy consumed for shredding E (2):

$$M_o = r \cdot F = \frac{P}{\omega} \quad (1)$$

where: r - force radius vector (m);
F- active force (N);
ω - angular velocity of cutting parts (rad s^{-1})
and:

$$E = P \cdot t = F \cdot r \cdot \omega \cdot t \quad (2)$$

2. In the case of choppers, the cutting force varies to a very large extent depending on the structure of the wood, its length and diameter, knots, species, distribution of fibers, etc.
For sizing the chopping equipment, start with the force required for the cutting process:

$$F = K \cdot p \cdot L \cdot d \quad (3)$$

where: k - a coefficient that takes into account the angle of the knife and the state of sharpening, the species and the humidity of the wood; indicative values between 0.003 and 0.009;
p - specific resistance to cutting.
The resistance to compression parallel to the fibers has values between 30 - 90 N/mm2, depending on the essence of the wood.
L, d - length and diameter of the wood to be cut.
For the calculation, values will be chosen slightly above average.

$$F = 0.009 \cdot 70 \cdot 40 \cdot 40$$

$$F = 1008\ N = 100{,}8\ kgf$$

It is taken into account: $F_{max} = 100\ kgf$ [4]
Recent studies indicate that repair and maintenance represent about 15% of the total chopper cost [5]. As expected, maintenance cost increases over time, and the rate of increase follows approximately the same curve shape as found for most agricultural machines [6]. Normally, maintenance cost is expressed as total accumulated repair (TAR) and is referred to purchase price. In the specific case of choppers, the % ratio between TAR and purchase price has been described by [5] through the following equation (Eq. 4):

$$TAR/price = 3.408 \cdot 10^{-4} \cdot Hours^{0.83} + 8.635 \cdot 10^{-5} \cdot Hours \cdot Used \quad (4)$$

Where: Hours= total hours worked at the time of the estimate
Used = indicator variable: 0 if the chopper was bought new, 1 if the chopper was bought second-hand.

Knife cost represents the largest proportion of chopper maintenance cost.

3. Choosing the type of chopping equipment

Vegetable waste choppers can be classified according to the way the material is chopped or according to the type of machine feed. The choice will be made taking into account the material to be crushed (the thickness and hardness of the branches) and the existence or non-existence of a source of electricity. Depending on the size and position of the household in relation to the biomass, it is decided the most efficient motorization that the chopper must have. Usually, for large households, the most efficient are gasoline heat engines, because they have the ability to easily chop thicker branches and enjoy increased maneuverability, being able to be placed in any corner of the household and even apart from her. Even if the noise produced by them is more intense than that of electric motors, this type of chopper proves its efficiency in large gardens. On the other hand, the electric motor is suitable for small households because it requires a permanent power supply. Thus, if the garden benefits from the connection to a power source, then electric choppers are suitable to meet the needs of the user. In fact, there is another type of power supply suitable for branch choppers: the connection to the direct socket of the tractor. In conclusion, the garden needs a branch chopper, whether it is small or large. This machine helps to save time, money and vegetable material that we reuse in the household. You can opt for a plant that has as fuel the residues obtained by chopping the branches, or you can keep the material obtained to use it as fertilizer for the soil.

4. The choppers made in the project ECOVALDES

Under the ECOVALDES project, prototypes were made for shredding, chopping, transporting, drying, pelletizing, breaking and burning equipment. The combination of these equipment pieces can result in 26 technological lines for processing raw materials in the form of wooden logs, branches or sawdust.
In the range of branch choppers, four prototypes of equipment were made, of which, two heat-powered choppers and one electric-powered chopper and a shredder. The following are the following equipment:

4.1. Chopper driven with thermal engine of 6.5 CP

Fig. 1. Chopper driven with thermal engine of 6.5 CP

Technical specifications:
Type of drive: gasoline engine
Engine power: 6.5 CP
Average consumption: 1.5-2.3 L
Fuel type: Petrol 95
Tank capacity: 2.5 L
Number of knives: 6 pcs. (3 on each axis)
Outer dimension of the funnel: 540 × 390 mm
Ømax. green softwood: 50
Ømax. green hardwood: 45 mm
Ømax. dry hardwood: 40 mm
Length of chopped pieces of branches: 50-120 mm (not adjustable)
Productivity: max. 4 m^3 / hour

4.2. Chopper driven with thermal engine of 13 CP

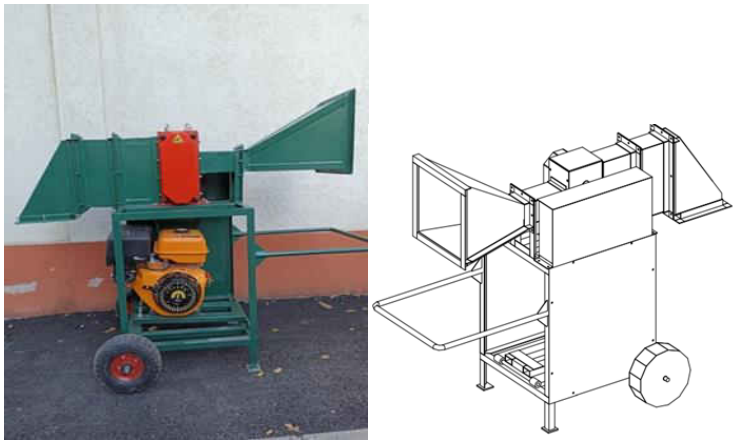


Fig. 2. Chopper driven with thermal engine of 13 CP

Technical specifications:
Type of drive: gasoline engine
Engine power: 13 CP
Average consumption: 423 g/CP*h
Fuel type: Natural 95
Tank capacity: 6.5 L
Number of knives: 6 pcs. (3 on each axis)
Outer dimension of the funnel: 540 × 390 mm
Ømax. green softwood: 60
Ømax. green hardwood: 45 mm
Ømax. dry hardwood: 40 mm
Length of chopped pieces of branches: 50-120 mm (not adjustable)
Productivity: max. 6 m^3 / hour

4.3. Chopper driven with electric engine of 2.2 kW

Fig. 3. Chopper driven with electric engine of 2.2 kW

Technical specifications:
Product type: Chopper
Type of engine: Single-phase asynchronous electric engine type
Supply voltage: 230V-240V
Engine power 2.2 kW
Maximum recommended cutting diameter:30 mm
Dimensions of the chopped material (length, thickness): 60 mm; 30 mm
Type of chopping machine: Knife with 4 double-edged blades
Working capacity of the machine: 250 kg / h

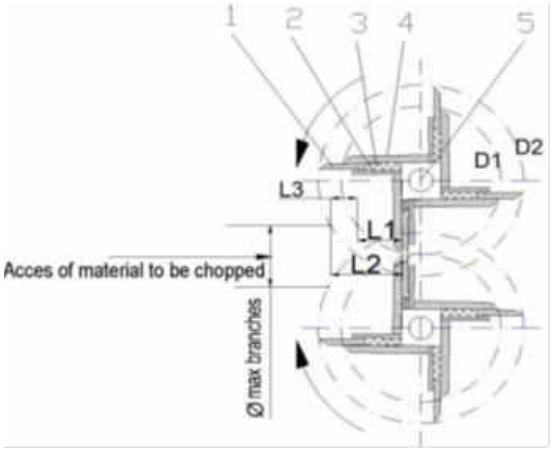
4.4. Shredder driven with electric engine of 4 kW

Fig. 4. Shredder driven with electric engine of 4 kW

Technical specifications:
Product type: Shredder
Type of engine: Single-phase asynchronous electric engine
Supply voltage: 230V-240V
Engine power 4 kW
Recommended cutting diameter:70 mm
Dimensions of the shredded material (length, thickness): 10 mm; 10 mm
Type of shredding machine: Knife with 2 cutting blades and counter-knife
Working capacity of the machine: 250 kg / h

4.5 Patent

Also in the framework of the project, a patent application was filed for a "Branch chopper with pulling knife" presented below:



1. Pulling arm
2. Pulling arm housing
3. Spring
4. Knife
5. Rotatory shaft

Fig. 5. Chopping assembly

The chopping assembly according to fig. 5 consists of two axles, one drive axle, actuated by the belt wheel and one drive axle led by a gearing with gears with transmission ratio 1. The shaft (5) is bearing at the ends and the central part is square in shape. The cutting knives (4) are screwed to each side of the square. On each cutting knife is mounted with screws a housing (2) in which the pulling arm (1) is seized which slides in the housing against a spring (3). When the chopping material is touched, the pulling arm (1) takes it and pushes it forward until the two cutting knives (4) positioned in the mirror cut the chopping material, with length L2, larger by L3 compared to the version without pulling arm L1 [7].

5. Conclusions

In general, in addition to energy recovery from waste, the aim is:
- Replacement of fossil fuels such as fuel oil, fuel gas or coke (conservation / protection of resources);
- Reducing the impact of CO2 emissions on the climate (climate protection);
- Reducing the dependence of global energy markets connected with reducing costs;
- Increasing the degree of flexibility of waste management by reducing the amount of residual waste.

Arguments in support of biomass use:
- Diversify energy supply sources
- Replaces conventional fuels with high CO2 emissions
- Contributes to waste recycling
- Protects and creates jobs in rural areas.

The advantages of chopped biomass obtained with the chopper with pulling knife are the following:
- Larger firewood segments are obtained that behave better when burning in stoves
- Can be handled more easily
- They can be stored easier and with smaller volumes
- Wood material from secondary agricultural production are used
- It creates a source of ecological energy from renewable sources.

Acknowledgments

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innovation (RD&I) to support economic competitiveness and business development, Action 1.2.3 – Partnerships for knowledge transfer, project title: Eco-innovative technologies for recovery of biomass wastes, project acronym: ECOVALDES, SMIS code: 105693-594, Financial agreement no. 129/23.09.2016.

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The Use of Biomass Can Help Save the Planet

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Abstract: *Climate change is a serious problem, so both the natural and the socio-economic system are sensitive to climate change, and the magnitude and speed projected for them will have a significant impact, which will threaten the sustainability of these systems. The motivation for action in relation to climate change must not necessarily be found in what mankind has observed so far, but in what scientific models anticipate for the near future. If the warming process continues at the rate forecast today, the world will enter a period of unprecedented climate change in human history. In this sense, we identify the categories of waste that have a major impact on the environment and we want to propose efficient alternatives for recycling also.*

Keywords: *Global warming, biomass, waste.*

1. Introduction

Mankind is facing climate change, which is increasing every year and has an impact on all aspects of life, both socially and professionally.
With globalization and massive industrialization the pace of change is very fast and also the reduction of greenhouse gases, the reduction of pollution on a large scale, recycling becomes a key factor in this fight. This phenomenon of global warming has various consequences, such as rising sea levels by melting glaciers, the restriction of certain species of flora and fauna and last but not least affects human health through sudden and very brutal climate change.
Climate change is one of the biggest threats to the environment, the social and economic environment. The warming of the climate system shown in Figure 1 is unequivocal, due to the transformations on the environment caused by global warming. Observations indicate increases in global average water and ocean temperatures, widespread melting of snow and ice, and average global sea level rise. It is very likely that, for the most part, heating could be attributed to greenhouse gas emissions from human activities.
Climate change is found in: high temperatures, changed rainfall, melting glaciers and snow, and the average sea level around the globe is rising. To a large extent, warming is most likely caused by the marked increase in atmospheric concentrations of greenhouse gases as a result of emissions from human activities. To mitigate climate change, we need to reduce or prevent these emissions [1].

Fig. 1. Global warming [1]

With the globalization and stimulation of consumerism, the resulting amount of waste has increased exponentially. Thus arose the urgent need for recycling on a global scale as well as on a small, family level.
Nowadays the amount of waste is determined directly by the standard of living and consumption. Unfortunately, the higher the standard of living, the higher the amount of waste. On the other hand, up to a certain threshold, waste can be considered as an easily accessible resource.
The development of modern society due to technological progress in recent decades brings to our attention the issue of resource use in the field of energy. The advancement of technology and science in general depends to a large extent on how energy supply and demand will be met, all with minimal impact on the environment.
In this paper, we aim to identify the categories of waste with major impact on the environment and also to be able to offer alternatives for their efficient recycling.
Alternative uses of waste for energy production could improve energy efficiency and increase the share of energy in the system by increasing flexibility, for example by producing biofuels from waste.
Renewable energy sources can be used to reduce the consumption of energy from the use of oil, coal and natural gas that are no longer regenerated [2]:

- wind energy (wind);
- direct solar energy;
- hydraulic energy of watercourses;
- wave energy;
- tidal energy;
- biomass.

2. Biomass

Biomass is the category of energy source resulting from (figure 2.): wood biomass, combustible residues from agriculture, agricultural production of sweet, starchy or cellulose substances that can be converted into petrol-substituting bio-ethanol. All of these are called biofuels [3].

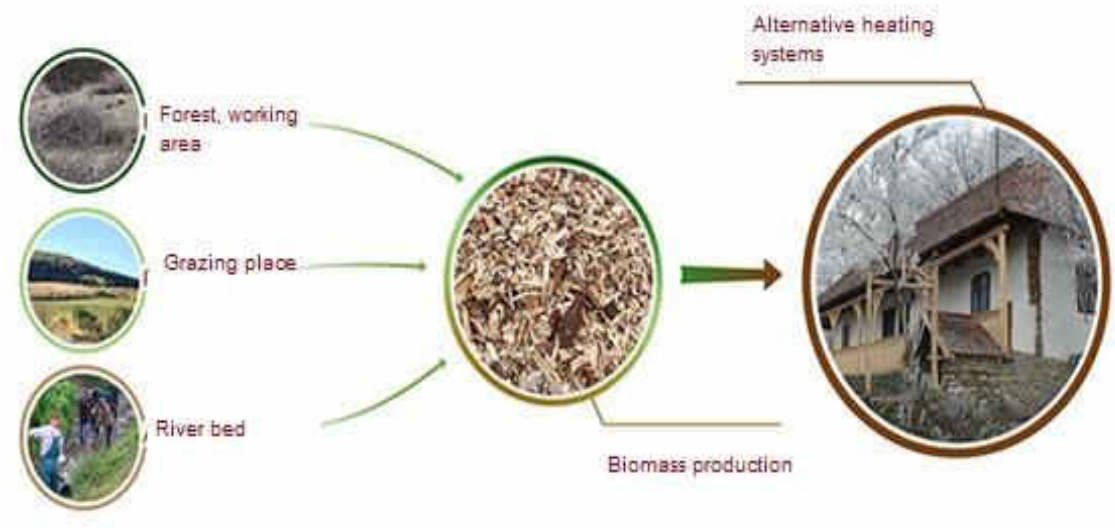

Fig. 2. Energy source [4]

Biomass is the first form of energy used by man, with the discovery of fire [3]. The energy use of biomass is based on its combustion, a process by which biomass releases thermal energy [3, 5].
The separate collection of biodegradable waste to obtain compost is a first step, useful and efficient, for the recovery and reduction of organic waste from storage (figure 3).
Composting is the way to obtain a stable product, starting from a similar oxidative biological transformation of what happens naturally in the soil [5, 6].

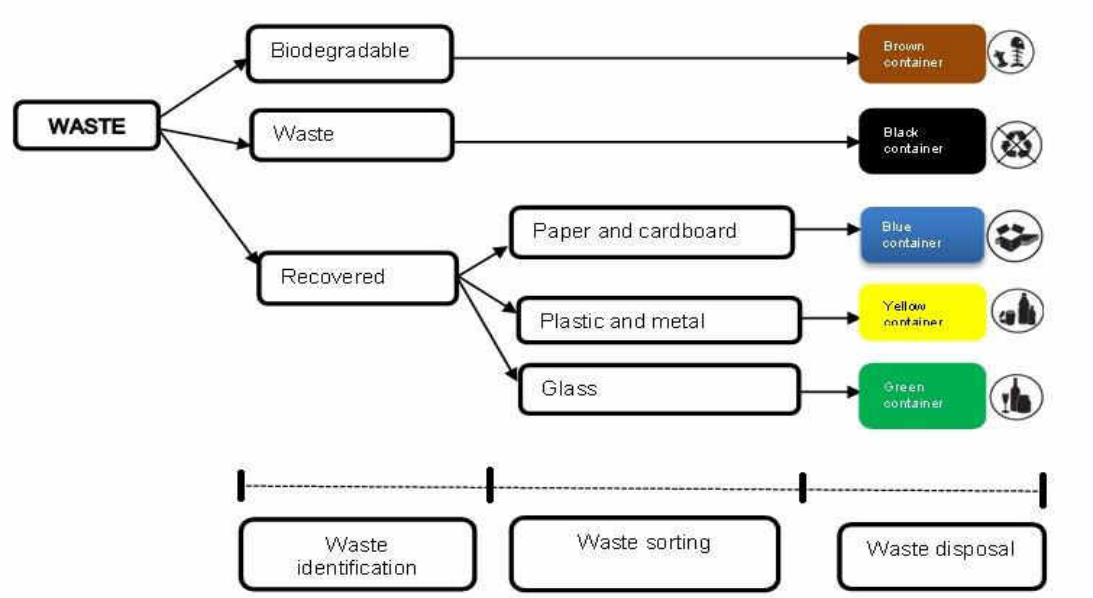

Fig. 3. Identification, sorting, disposal of waste [4]

The use of household waste as a caloric source must take into account its calorific value. Organic agricultural waste and household waste are the best source for their transformation into composts used in soil fertilization, so that the solution for recycling all organic waste is agriculture and soil because it, in addition to supporting functions and nutrient environment for plant, also has the function of accumulation and degradation of many organic substances. Natural resources are limited and cannot regenerate very quickly, over time, as the amount of waste increases to occupy large areas of land. That is why it is important to understand that almost half of the waste we throw away can be reused.
The environment is more and more polluted, by recycling waste, we try to save the environment and the earth [4, 7].
Biomass comes from different sectors, such as: agricultural sector, forestry, industrial and urban sector.
Another classification can be made by its nature: energy crops, agricultural or forestry residues and waste. The biomass represented by energy crops obviously comes from the agricultural and forestry sectors.

3. Wastes from forestry and wood industry

Waste from forestry and the wood industry is part of the biodegradable and / or combustible organic vegetable waste sector with an adverse impact on the environment. The exploitation of forest areas results in large amounts of waste (branches, stumps, roots, leaves, tree stems considered unsuitable for processing), and large quantities of raw material in the form of sawdust and bark are removed from the wood processing industry. Branches and stumps are classified as useless waste, thus losing very large amounts of potential energy sources that could be capitalized on with minimal production costs.
Technologies for recycling waste from forestry and the wood industry are classified according to how they are recovered [8, 9, 10]:

- waste recycling technologies for energy recovery;
- waste recycling technologies for composting (figure 4.).

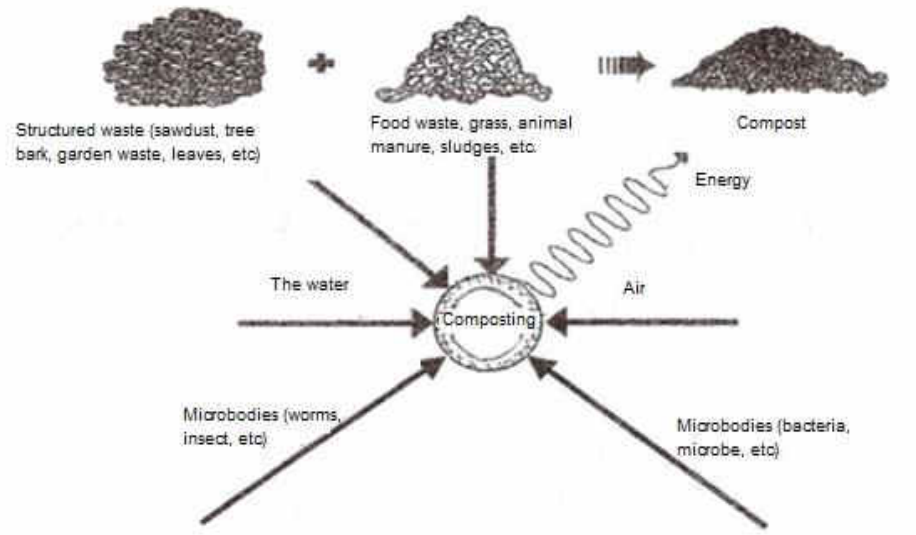

Fig. 4. Waste composting [11]

Waste recycling technologies for energy recovery are used to recover energy stored in waste and convert it by specific methods into thermal or electrical energy. Energy recovery of forest waste can be done by three methods [8, 6]:

- direct combustion;
- pyrolysis;
- gasification.

Recycling technologies for composting waste produce biogas with a high methane content, which can be used as such, for example in stoves, or in thermal power plants to produce electricity. By composting in landscaped plants the natural process of decomposition of organic matter is accelerated. Composting can take place by both aerobic and anaerobic fermentation [11, 3].
Sawdust resulting from deforestation is usually not properly treated, so it is transported by surface water to meadows and rivers, with harmful consequences for fauna and flora, by the decomposition of sawdust and the effect produced by the resulting substances.

4. Wastes from agriculture and related industries

Wastes from agriculture and related industries are residual products used for biogas production, such as [7, 10]:

- wheat straw, barley, oats, rice, rye, rapeseed;
- cobs and corn cobs;
- leaves of sugar beet or fodder beet, sunflower;
- green or dried leaves of trees;
- waste of hemp, flax, green or dried alfalfa;
- different algae;
- cane and sugar cane;
- different seeds, hazelnut shells or seeds;
- substrate from mushrooms.

All these resources can be processed taking into account different technologies (figure 5) [7, 12]:

- direct combustion (electricity / heat production, cogeneration installations);
- anaerobic digestive (cogeneration, methane-rich gas);
- fermentation (sugars for alcohol, bioethanol);
- oil extraction;
- pyrolysis (manganese, gas and oils);
- gasification (carbon monoxide).

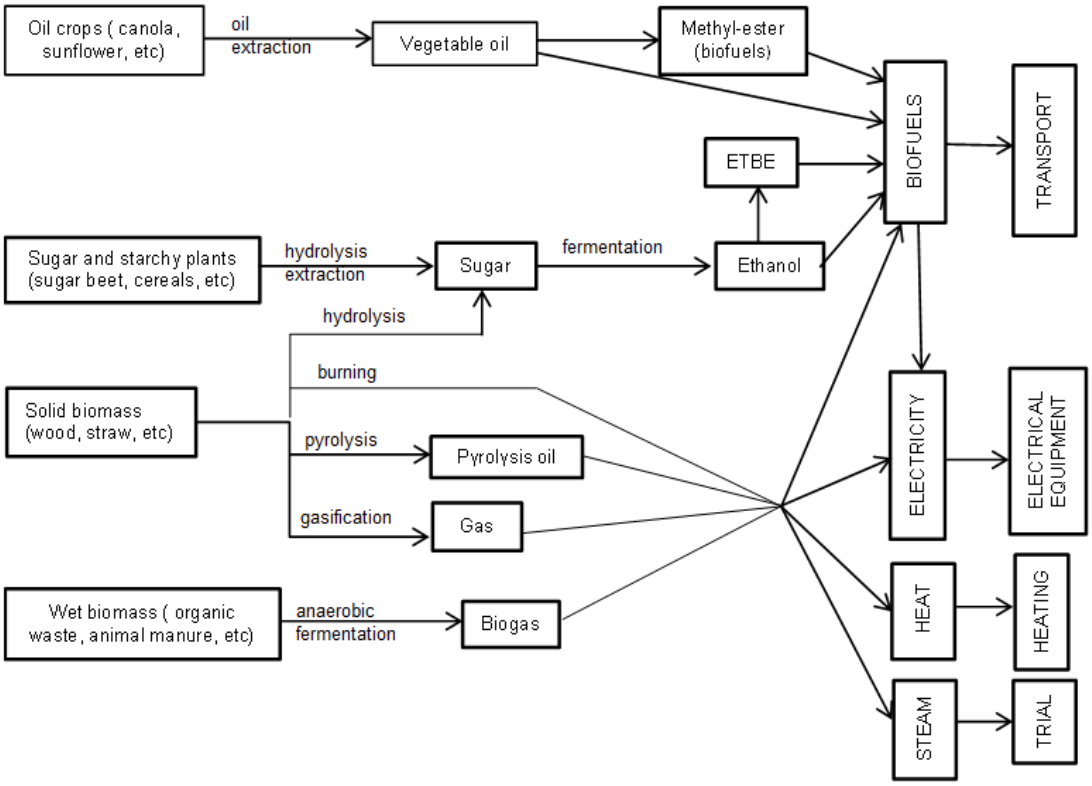

Fig. 5. Scheme of biomass technologies [12]

The technological process can be followed by a series of secondary treatments - stabilization, dehydration, refining; depending on the final products. It is important to identify the source of biomass, because some species of biomass can generate better fuel quality or energy at a lower cost.

5. Statistical data at national level and the European Union

Current estimates indicate that around a third of food produced for human consumption worldwide is wasted or lost, leading to significant economic and environmental costs [13].
Romania produces 5.8 million tons of waste per year (Table 1), with an average of 272 kilograms per year per capita and a collection rate of only 82.3%. (The Waste Atlas study shows it). Of the total waste, 56% is organic matter, 9.9% paper and cardboard, another 9.9% is plastic waste, 4% glass, 2.3% metal and 17.8% other waste (Figure 2). Romania recycles only 3%, followed by Bulgaria with a recycling rate of 0%. Romania's collection rate is 82.3%, followed by Bulgaria with 81% and Estonia with 79%.
Out of the total of 5.8 million tons of waste per year, only Bucharest is responsible for the production of 709,720 tons per year, with an average of 375 kg per capita.

Table 1: Evolution of waste generation at national level [13]

Environment of residence	**Generation indicator (kg / inhabitant / day)**				
	2015	2016	2017	2018	2019
Urban	0.66	0.66	0.65	0.65	0.64
Rural	0.31	0.31	0.30	0.30	0.29

Table 2: Quantities of municipal waste at national level [13]

Types of municipal waste	Quantity (tons / year)				
	2015	2016	2017	2018	2019
Mixed and separate household waste	3,615,166	3,598,678	3,586,583	3,506,695	3,498,851
Similar wastes collected in a mixture and separately	903,791	899,670	896,646	876,674	874,713
Waste from gardens and parks	97,400	97,400	97,400	97,400	97,400
Waste from markets	71,800	71,800	71,800	71,800	71,800
Street waste	336,800	336,800	336,800	336,800	336,800
Total municipal waste generated	5,024,957	5,004,348	4,989,229	4,889,369	4,879,563
Municipal waste generation indicators (kg / place x year)	253	253	253	248	248

Table 3: Composition of household waste and assimilation [13]

Waste type	Share (%)				
	2015	2016	2017	2018	2019
Paper and cardboard	11.9	11.9	11.9	12.0	12.2
Metals	2.7	2.7	2.7	1.8	2.0
Plastic	11.7	11.7	11.7	11.5	11.3
Glass	5.1	5.1	5.1	5.0	5.0
Wood	2.2	2.2	2.2	2.5	2.5
Biowaste	57.9	57.9	57.9	57.5	57.0
Text	0.9	0.9	0.9	1.0	1.0
Bulky	0.9	0.9	0.9	2.0	2.2
Other waste	6.7	6.7	6.7	6.7	6.8

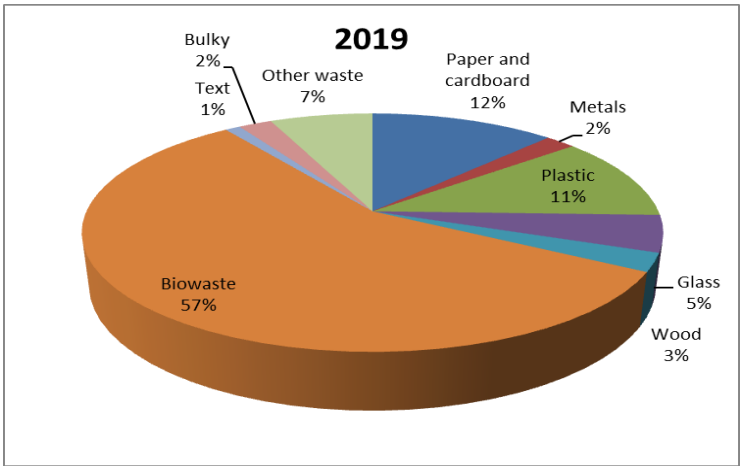

Fig. 6. Waste collection share at national level [13]

The figures on the amount of waste per capita mentioned at national level in the Waste Atlas are similar to those reported by Eurostat for 2016, of 261 kg.

The EU Member State that produces the largest amount of waste is Germany, with a figure of 50.5 million tonnes per year and 617 kg per capita. However, Germany also has the second highest recycling rate, 47%, plus a 100% collection rate.
Slovenia is the EU Member State with the highest percentage of recycled waste, 55%, plus a 100% collection rate. However, Slovenia produces only 852,075 tons of waste per year, with 414 kg per capita [14]. Sweden produces 4.3 million tons per year, or 458 kg per capita, but also has a recycling rate of 33%, plus a collection rate of 100%.
In terms of population, Denmark has the highest waste rate per capita, at 747 kg per year, totaling 4.1 million tonnes per year. At the same time, it has a collection rate of 100% and a recycling percentage of 28%.
Also worth mentioning are the United Kingdom, which has a recycling rate of 28% at a total of 30.7 million tonnes per year, the Netherlands and Austria - both with a recycling rate of 24% - or Italy with 26% [14,15].

Table 4: Amount of waste in different countries [15]

	Amount of waste produced		Recycling rate %	Collection rate %
	tons / year	Kg / inhabitant		
Germany	50.5 mil	617	47	100
Slovenia	852,075	414	55	100
Sweden	4.3 mil	458	33	100
Denmark	4.1 mil	747	28	100

In the EU, the amount of waste varies from one Member State to another according to statistics as shown in Figure 7. [16].

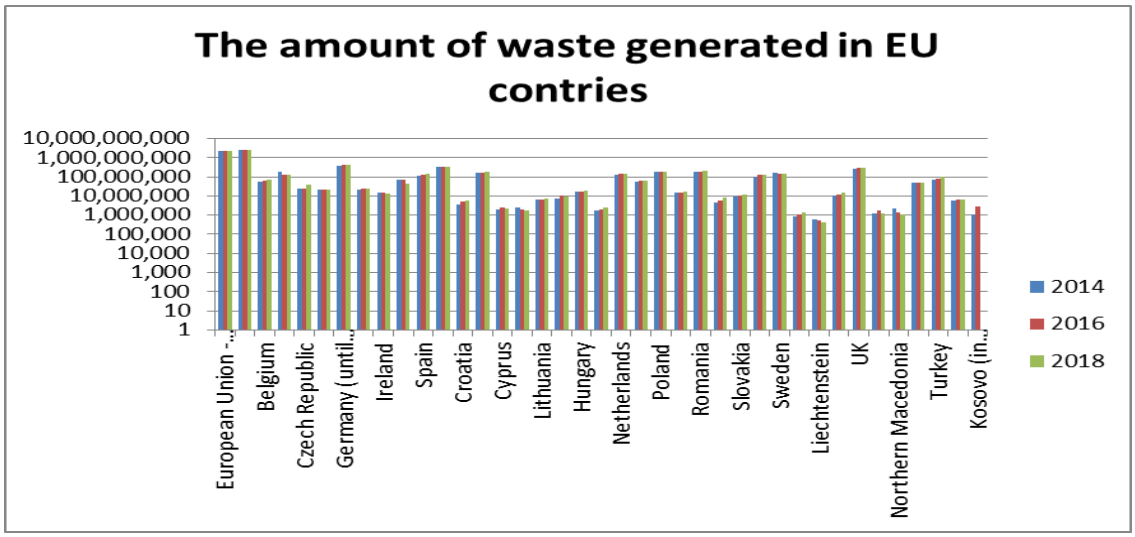

Fig. 7. Waste generated in the EU [16]

According to the study, in the European Community, the amount of municipal waste generated by each person in 2018 amounted to 492 kg, down 5% compared to the peak of 518 kg per person in 2008.
On the other hand, according to Eurostat, the amount of recycled waste reached new levels in 2018, both for the recycling of materials and for composting.

5.1. The share of renewable sources in energy consumption in the European Union

Waste from agriculture, forestry and forestry has many potential benefits, including a reduction in greenhouse gas emissions, a diversification of energy supply and a reduction in dependence on fossil fuel markets (especially the oil market and gas).

Figure 8 shows the share of renewable energy in gross domestic energy consumption at EU level [17]:

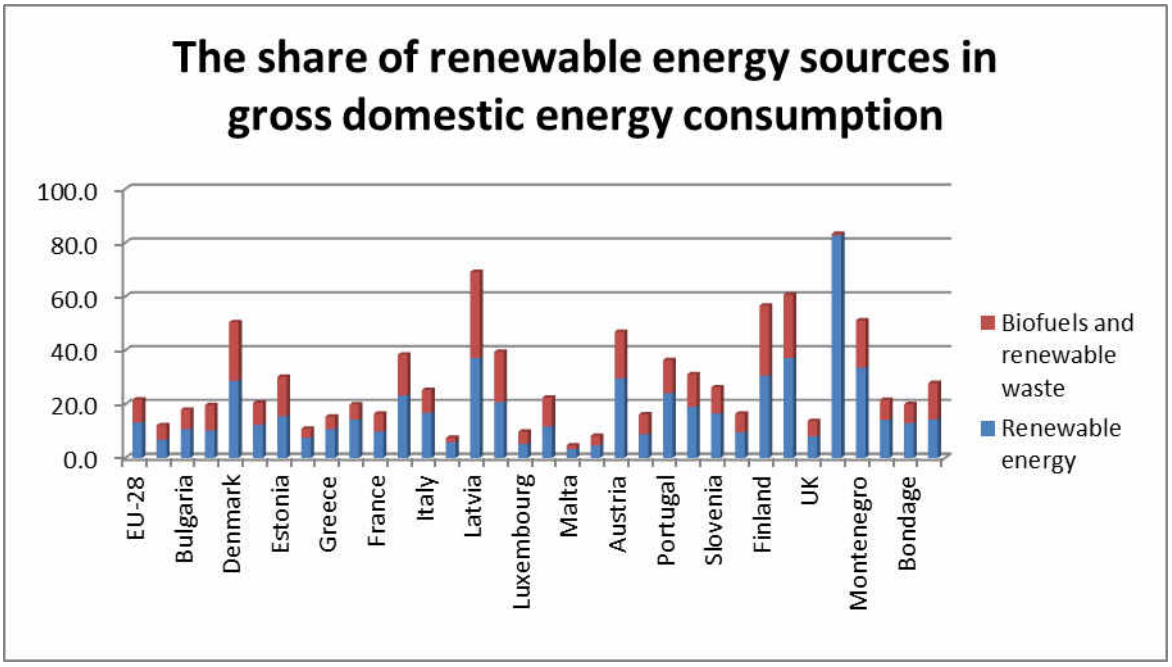

Fig. 8. Renewable energy sources in the EU [17]

The use of energy from renewable sources has many potential benefits, including a reduction in greenhouse gas emissions, diversification of energy supply and reduction of dependence on fossil fuel markets (in particular, on the oil and gas market). Figure 9 shows the primary production of energy from renewable sources at EU level.

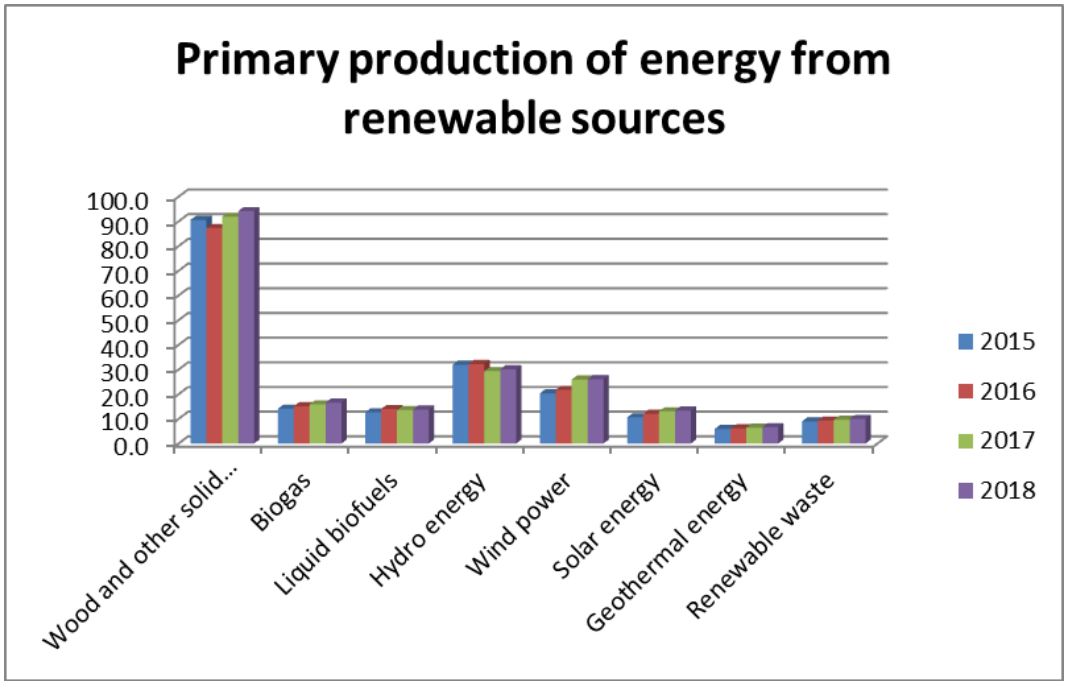

Fig. 9. Renewable energy production [17]

Renewable energy is growing more and more in recent years because it promises a clean energy future. Green energy is beginning to replace fossil fuel pests in the energy sector, providing a reduction in carbon emissions or other types of pollution. Renewable energy could provide a

solution to a major problem facing the modern world: reducing environmental contamination, which impairs the quality of life on Earth and harms human health.
Renewable energy sources (wind energy, solar energy, hydropower, ocean energy, geothermal energy, biomass and biofuels) are alternatives to fossil fuels that help reduce greenhouse gas emissions, diversify energy supply and reduce dependence on volatile and uncertain markets for fossil fuels, especially oil and gas [18].

6. Conclusions

Environmental pollution has as an effect the appearance of anthropogenic climate changes; these changes are generated by human intervention on the environment through the following activities:

- electricity and heating;
- transports, constructions;
- agriculture;
- burning of other fuels;
- industrial processes;
- deforestation and waste.

Climate change is affecting all regions of the world, with the effect of global warming manifesting itself in the following aspects:

- melting glaciers and rising sea and ocean levels;
- extreme weather phenomena;
- changing the precipitation regime;
- desertification of areas.

Our planet is heating up fast. Human activities are causing this change, and the consequences are beginning to be seen around the world. The more we disrupt the climate, the greater the risk of dangerous change, and the more difficult and costly it will be to limit future change and adapt to the inevitable impacts. The average temperature of the Earth's surface could rise by at least 4 ° C from pre-industrial levels before the end of this century if we do not take urgent measures to reduce greenhouse gas emissions.
By releasing more and more gases that keep heat in the atmosphere, we cause a very rapid rise in temperature on Earth.
Increased use of energy from renewable sources is essential to reduce both the European Union's greenhouse gas emissions and the Union's dependence on fossil fuels and energy imports, thus contributing to its security of energy supply. Moreover, energy from renewable sources can play an important role as a vector of sustainable development in rural areas.

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A Review of Psychological Assessment of Noise from Engines

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Abstract: *Noise is defined as 'unwanted sounds', while sound is a term used for sensation that the brain receives when pressure variations in the air are detected by the ear. What is sound to one person can very well be noise to somebody else, but anyone who is exposed to noise is potentially at risk. The higher the level of noise and the longer individuals are exposed to it, the more risk they have of suffering harm from it. Millions of workers worldwide are exposed to noise levels that put their hearing at risk. Excessive noise is an occupational hazard with many adverse effects, not only to the workers involved with noisy operations but also to those around them.*

Keywords: *Noise, psychological assessment*

1. Introduction

Its effects can lead to temporary or permanent hearing damage and can impair workers' efficiency. Individuals suffering from poor hearing, whether it is due to their age or illness, can have their problems made worse by exposure to higher levels of noise at work. It can also lead to accidents due to limited speech communication, misunderstanding oral instructions and masking the sounds of approaching danger or warnings.

2. Main sources of noise at work

Noise is a common hazard and is present to some extent in almost all workplaces. It is the most common health hazard in industries such as entertainment, manufacturing, agriculture, ship-building, textiles, mining and quarrying, food and drink, woodworking, metal working and construction. Some common sources of noise are:

- loud music
- the use of heavy machinery
- workplace transport
- electrical tools such as circular saws and cutter heads
- production lines
- pneumatic tools such as drills, grinders and riveting guns
- electrical motors and generators
- engineering processes such as metal fabrication
- Plant rooms where ventilation equipment has to run continuously.
- General signs of hearing loss

It is important to spot hearing loss as soon as possible because early signs can help to identify the problem quickly. Early signs of hearing loss can include:

- ringing in the ears
- inability to hear soft and high-pitched sounds
- muffling of speech and other sounds
- trouble understanding conversations at a distance or in a crowd
- listening to music or watching television with the volume higher than other people need
- difficulty hearing the telephone or doorbell
- finding it difficult to tell which direction noise is coming from
- regularly feeling tired or stressed, from having to concentrate while listening
- answering or responding inappropriately in conversations
- reading lips or more intently watching people's faces during conversations
- feeling annoyed at other people because of not understanding them
- feeling nervous about trying to hear and understand others.

Research suggests it takes 10 years from the time someone notices they have hearing loss before they do anything about it.

3. Occupational noise burden

Excessive noise is a global occupational health hazard with considerable social and physiological impacts. Exposure to loud noise from all sources accounts for about 20 per cent of adult-onset hearing loss, while 16 per cent of the disabling hearing loss in adults is attributed to occupational noise. Noise-induced hearing loss is considered the 15th most serious health problem in the world.

Noise-induced hearing loss is the most common reported occupational disease in Europe. Twenty per cent of Europe's workers have to raise their voices to be heard for at least half of the time that they are at work, while seven per cent suffer from hearing difficulties. In 2000, 29 per cent of workers in the EU15 and 35 per cent in the new member states reported being exposed to high-level noise at least one quarter of the time and 11 per cent all the time.

In the United Kingdom, it is estimated that there are more than 10 million individuals (about 1 in 6) with some degree of hearing impairment or deafness. Over one million workers are exposed to levels of noise that put their hearing at risk, with 17 per cent suffering hearing loss, tinnitus or other hearing-related conditions as a result of exposure to excessive noise at work.

4. Health effects of noise

When individuals are exposed to high levels of noise in the workplace, they can suffer from various adverse health effects. These health effects can be caused by a single exposure to a very loud noise or by exposure to raised levels of noise over a prolonged period of time.

The effects of noise on hearing depend on:

- noise intensity or sound pressure

- frequency or pitch of sound
- exposure time
- distance from source
- individual susceptibility
- other factors (life-style, age, disease, genetics and so on).

The most well-known effect of occupational noise is hearing impairment. However, it can also exacerbate other health conditions. Some individuals are more sensitive to noise than others are and will suffer harm more readily through noise exposure. The main health effects include the following:

Tinnitus

Tinnitus (ringing in the ears) is the early sign of hearing damage. Excessive exposure to noise increases the risk of tinnitus. If the noise is impulsive, the risk can rise substantially. Tinnitus can be a very distressing condition and can lead to disturbed sleep and affected speech. There is no effective cure for this condition but there is treatment available for easing the symptoms. More information on Tinnitus is available from the UK's National Health Service.

Noise-induced hearing loss

Noise-induced hearing loss occurs because excessive noise damages the delicate hearing mechanism of the inner ear. It is the most common preventable occupational health condition across the world. The level of noise that is likely to damage hearing varies depending on the individual's characteristics and the duration for which they are exposed to the noise.

Hearing loss is a common health problem that often develops with age (presbycusis). It is linked with genetic inheritance and other illnesses, and is also caused by exposure to excessive noise. Hearing loss is not always gradual: it can occur when an individual is exposed to very intense or loud noise for a short period of time such as a loud explosion. This condition is known as acoustic trauma.

Furthermore, the ear's sensitivity level decreases as a measure of protection against exposure to noise. This process is known as a shift in the threshold of hearing, meaning that only sounds louder than a certain level will be heard. The shift may be temporary or permanent. Short-term hearing loss can be experienced as a temporary threshold shift. It may occur suddenly after exposure to intense and/or loud noise, a situation most individuals have experienced at some point in their lives. Temporary threshold shift results in temporary hearing loss. However, repeated exposure to such intense or loud noise normally transforms this into a permanent loss, or permanent threshold shift.

Permanent threshold shift occurs when individuals have been regularly exposed to high levels of noise over a long period of time. It also occurs when exposed to noise repeatedly without sufficient time between exposures to allow recovery of normal hearing, resulting in permanent hearing damage. The UK's National Health Service provides more information on hearing loss.

Loss of hearing can have a huge impact on an individual's personal and work life. Once hearing has been damaged, there is currently no known cure or effective treatment.

Effect on pregnancy-Exposure of pregnant workers to high noise levels can affect the unborn child. Research suggests that prolonged exposure of the unborn child to high noise levels during

pregnancy may have an effect on a child's later hearing and that low frequencies have a greater potential for causing harm.

Physiological effects-Noise can have an effect on the cardiovascular system, resulting in an increase in blood pressure and the release of catecholamines in the blood. An increased level of catecholamines in the blood is associated with stress.

Occupational stress-Occupational stress rarely has a single cause and often arises from the interaction of several risk factors. Persistent noise in the work environment can be a stressor even at quite low levels.

An individual's performance in tasks demanding continuous attention (safety-critical tasks) may be affected by noise as it can distract them, resulting in poor judgements and decision-making process.

The noise, vibration and harness analysis of diesel engines has been an active topic of research during past few decades. This work has tried to deal with some of the important aspects of this issue. There are many key areas in which further work can be done [1].

Some of these include:

1. Quantification of various noise emissions.

A) Subjective approach -Some possible indices used for this purpose may include:

- Ranking-Various subjects may be asked to rank sound emissions from engine according to annoyance in a scale of 1to10. However, number of samples must be kept low to avoid complexity [2, 3, 4].
- Comparison in pairs-In this method various subjects may be asked to evaluate relative judgments on the basis of pairs, however this method can be exhaustive as number of pairs can be large[5, 6].

B) Objective approach-Various psychoacoustic indices that can be used for evaluation include:

I) Loudness-It is a parameter used for evaluation of noise intensity and has unit of phon or sone. Loudness level of 1 phon is SPL of a pure tone plane wave of 1kHz frequency as perceived by human ears in frontal direction [7].

II) Sharpness-A 60dB sound wave of 1kHz frequency has sharpness of 1 acum. Sharpness of a soundwave can be lowered either by adding low frequency components or by decreasing high frequency components [8].

III) Roughness-This parameter takes into account modulation of waves. Its standard unit is asper.1 asper is roughness of a tone of 1kHz frequency at 60dB which is modulated by 70Hz frequency with degree of modulation equal to unity [9].

IV) Impulsiveness- It represents the amplitude and frequency of occurrence of peaks in SPL. Its unit is Kurt and is most significant during ideal running of engines [8].

2. Motion of gudgeon pin inside pin hole

Piston pin is held inside hole either by a full floating system or by a semi floating one. For case of full floating system, both pin and connecting rod may be made of same material, whereas in case of semi floating system, piston may be made of aluminium alloy and pin of steel. Hence, a semi floating system is subjected to more noise due to differences in thermal expansion coefficients of different materials used. It has been observed that pin rotates counter clockwise inside its hole before striking the wall of piston vertically in crank angle duration 20ºBTDC- 30ºBTDC[10].Further movements of oil inside pin hole can be visualized by particle tracking velocimetry(PTV).

3. Use of gap sensors/Telemeter device to study piston secondary motion using different skirt profiles.

Frictional power losses for various skirt profiles can be evaluated using suitable motion gap sensors. Skirt profile having recess at top and bottom part of skirt has shown minimum frictional forces as it has better lubrication load bearing surface [11,12].

4. Use of AVL EXITE for modelling of piston motion.

This approach takes into account thermal distortions of liner using GUID (piston-liner guidance) and EPIL (elastic piston liner contact) approaches [13].Surface velocities may be analyzed both in time and frequency domains at thrust as well as anti-thrust side. At higher speeds, in conjunction with higher inertial forces, piston secondary motion was decreased. Hence, both approaches have shown almost same results [14].

5. Investigation into effects of bubble formations, mist and cavitation of lubrication oil during secondary motion of piston.

Formation of bubbles takes place in lubrication oil film as local pressure drops below ambient pressure particularly in convergent-divergent interfaces like contact between rings and liner [15]. It has been proved that under these conditions, Reynolds equation may yield different pressure profiles [16].

6. Use of different types of injections or use of exhaust gas recirculation (EGR)| and turbocharging.

a) Effects of post injection-specific consumption of fuel and various emissions can be controlled by use of post injection methodology. However, noise emissions were found to remain unaffected by post injection [17].

b) Effects of EGR-EGR has been found to reduce combustion noise above 300Hz range; however, excessive use of EGR may lower the thermal efficiency and increase various emissions [18].

c) Effects of turbocharging-Noise emission during transient conditions from a turbocharged diesel engine have been found to be up to 3 dBA higher as compared to steady state conditions. This has been attributed to turbocharger lag [19].

7. Use of Blind Source Separation (BSS) and Independent Component Analysis (ICA) methods for effective noise source separation.

A BSS algorithm based on least mean square method has been applied to separate piston slapping noise from other noise emissions [20]. ICA has also been used to analyze fuel injection signals, which would otherwise get suppressed by various high energy events or get corrupted by the background noise [20].

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Programul Operaţional Sectorial „Creşterea Competitivităţii Economice"
- co-finanţat prin Fondul European de Dezvoltare Regională „Investiţii pentru viitorul dumneavoastră"

Comunicat de presă

București, 10.12.2021

FINALIZARE PROIECT - Axa G

INSTITUTUL NAȚIONAL DE CERCETARE-DEZVOLTARE PENTRU OPTOELECTRONICĂ - INOE 2000, cu sediul în localitatea Măgurele, București-Ilfov, str. Atomiștilor, C.P. 077125 nr. 409, județul Ilfov, România, telefon 0214574522, fax 0314056397, anunță finalizarea, la data de 21.01.2022, a implementării proiectului **"TEHNOLOGII ECO-INOVATIVE DE VALORIFICARE A DEȘEURILOR DE BIOMASĂ / ECOVALDES"**, finanţat prin PROGRAMUL OPERAȚIONAL COMPETITIVITATE, în baza contractului de finanțare nr. 129/2016, ID: P_40_210, My SMIS 105693, încheiat cu INSTITUTUL NAȚIONAL DE CERCETARE-DEZVOLTARE PENTRU OPTOELECTRONICĂ-INOE 2000.

Valoarea totală a proiectului este de 6.958.857 lei, din care asistența financiară nerambursabilă este de 5.414.016 lei.

Proiectul s-a implementat la sediul filialei INOE 2000 – IHP, în localitatea București, sector 4, str. Cuțitul de Argint nr. 14, C.P. 040558, pe o durată de 64 luni.

Obiectivul proiectului este dezvoltarea interacțiunii INOE 2000 – IHP cu întreprinderile de producție pentru transferul de cunoștințe în subdomeniul tehnologiilor eco-inovative de valorificare a deșeurilor de biomasă. Ca obiective specifice proiectul urmărește:

a) Stimularea transferului de cunoștințe către unitățile de producție interesate în domeniul de expertiză a INOE 2000-IHP

b) Accesul întreprinderilor interesate la facilitățile, instalațiile și echipamentele de cercetare de care dispune INOE 2000- IHP.

c) Transfer de competențe de cercetare industrială pentru linii tehnologice de valorificare a deșeurilor de biomasă vegetală compuse din echipamente de tocare, presare, uscare și ardere prin procedeul TLUD.

d) Cercetare industrială în parteneriat INOE 2000 – IHP cu întreprinderi, în scopul pregătirii fabricației de echipamente mecano-hidraulice componente ale liniilor tehnologice de valorificare a deșeurilor de biomasă vegetală.

Beneficiarii actuali sunt în principal entităţi din categoria IMM-urilor, cu care INOE 2000-IHP a colaborat atât în calitate de partener în diferite proiecte şi programe de cercetare, cât şi ca furnizor de servicii directe: cercetare, proiectare, asistență tehnică, execuție modele experimentale sau prototipuri.

Rezultate realizate:

Proiectul a fost finalizat în proporție de 100%, indicatorii de realizare ai acestuia fiind: număr de societăți care cooperează cu instituțiile CO26 -9, cereri de brevet 3S7-5, Număr de societăți sprijinite – CO01 -9; Număr de societăți care beneficiază de sprijin pentru introducerea de noi produse pe piață - CO28 -4; Număr total de contracte încheiate cu întreprinderi -25; publicații științifice rezultate din proiect -15; echipamente model experimental nou create – 13; Nr de echipamente prototip nou create- 15; rapoarte de încercare /testare, metodologii de testare; Nr de combinații de echipamente din care pot rezulta linii tehnologice diferite-26; cărți tehnice, referențiale, studii tehnice, documentații complete de introducere în fabricație, proiecte tehnice ce pot fi dezvoltate, standuri realizate, workshop-uri pe teme de biomasă.

Proiect co-finanţat din Fondul European de Dezvoltare Regională prin Programul Operaţional Competitivitate 2014-2020

Detalii suplimentare puteţi obţine de la:

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