Press of Parallelepiped-Shaped Briquettes

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Abstract: *The article analyses the basic elements necessary for the design of a press on which one can make medium-sized parallelepiped briquettes (150/60/60). First, the qualities of the raw material, the forest sawdust, the need and utility of making and using briquettes, as well as comparative elements with firewood are highlighted. The article presents a hydraulic solution of a medium sawdust briquette press and not only, of medium size (226kgf h), for which an indicative hydraulic scheme and an overall drawing are given, which is the basis of a future manufacturing.*

Keywords: *Press, briquettes, electrohydraulic, driving*

1. Introduction

1.1 The usefulness of sawdust

In recent years, it has been found that specialists around the world are facing the problem of diversifying energy sources while reducing the consumption of fossil fuels and forest wood. One of the resources that is easy to turn into energy is sawdust and other forest waste, or even straw waste resulting from the harvesting of cereal crops. The circular economy rule on the "zero waste" requirement is very successfully applied in both forestry and agriculture. Next, we will talk with priority about the processing of forest sawdust, which is easier to control and possible to extend the results to other types of raw materials from waste [1]. In our country there is a lot of sawdust, as waste at furniture factories, sawmills, wood cutting in forests, wood cutting in households, etc. On average, the density of the sawdust is 300 kg/m^3 even at a humidity of 55%. The most sought-after type of sawdust is beech. The density of the sawdust is usually estimated at 0.21 g /cm^3 or 210 kg/ m^3. Sawdust has some extremely dangerous characteristics, in addition to the ecological ones of environmental pollution and especially of the waters of mountain rivers. Among the most serious are those related to its danger as a carcinogen, but also as an element that attacks the skin, eyes and respiration. All these elements have contributed to finding technological solutions that highlight the qualities of a component for agricultural improvers, but especially those of fuel.

1.2 Useful items for the briquettes manufacturer and user

Briquettes are a solid fuel formed by pressing forest sawdust or straw vegetable, but also by pressing coal dust. In the process of burning, the briquettes increase their volume, so pay attention to the loading of the stoves, and consume more air than firewood. 95% of sawdust briquettes burn. In the end very little embers and very little ash result. There are rectangular briquettes on the market which, in addition to the forest sawdust, also include wood chips and which finally reach a calorific value of approx. 18.63 MJ/kg. The calorific value of the sawdust is 4,200-5,500 kcal/kg, wood used for fire, 1,600-2,800 kcal/kg. The professor from Brașov, Dragomir Peneș, once said that "a 1 Gcal gas power plant consumes twice as much as a similar power plant that uses sawdust briquettes".

1.3 The advantages of using sawdust briquettes [2]

Briquettes have already entered in our lives as a variant of replacing wood from the heating process with an equivalent, processed, obtained from forest or cereal vegetable waste, such as sawdust and chips. Does this solution have advantages or only disadvantages compared to wood?

The first advantage is that the moisture content of the sawdust, which is important in the heating process, is lower than that of wood. Forest sawdust briquettes have an approximate humidity of 5% to 10% compared to firewood which has a relative humidity of over 35% taking into account that wood fibre usually stores this amount of water in the atmosphere.
The second advantage is the calorific value of briquettes, which is 2-3 times higher than firewood.
The third advantage is that the briquettes burn longer, the burning being slower, very little ash remains, which in turn is a fertilizer. Finally, one of the intentions of the circular economy is fulfilled, that of carrying out processes that do not result in waste.
The fourth advantage is a complex, economical one, which results from the acceptable price, the ease of transport, the reduction of storage space and for many people the advantage of getting rid of cutting and cracking activities that require time, money and effort.
The fifth advantage is the ecological one, both by the fact that it takes an extremely aggressive raw material for the environment, but also by the fact that the combustion process is non-polluting.
The sixth advantage is that it succeeds in replacing coal, coke and natural gas, fossil fuels, non-renewable and with limited world reserves.
The comparative tests made by some specialists, regarding various fuels, showed that 10 kg of briquettes represent the equivalent of 5.5 l of oil, that 1 kg of briquettes has a calorific value of 4769 cal/kg or 19.97 MJ/kg and that a ton of briquettes is equal to 4 m^3 of firewood.

2. Constructively functional press solutions for the manufacture of sawdust briquettes

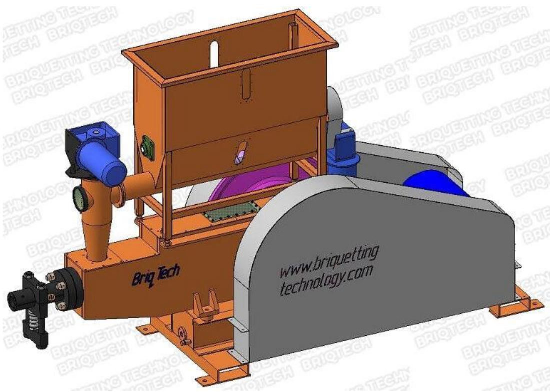
Briquetting is the technological process, which transforms the sawdust into briquettes, meaning presses it until the total evacuation of the contained air. Although, theoretically, briquettes can be made mechanically by plasticizing wood chips and then heat sintering them, or by mixing the sawdust with a chemical binder, the most used and almost the only solution used is by which the sawdust is pressed without introducing binders or other substances. In the case of a larger production of briquettes, a technological line consisting of a waste sorter, a thermal power plant, a sawdust dryer, a briquetting machine and auxiliary transport elements between machines is used. As the temperature at which the briquettes are removed is even 100 °C, they are often introduced into the technological and cooling line to reduce both manufacturing defects and the risk of fire.

2.1 Existing solutions on the press market

Several briquetting press solutions are currently known in various sizes and with a wide variety of functional and efficient features. An example is the Winter BP 60 briquetting press (https://www.winter-holztechnik.de/winter-maschinen/winter-brikettpresse-bp-60.html) which is hydraulically driven with a 5.5 kW motor having a productivity of 15-70 kg / h. Haba Hallenbausatz also produces a hydraulically operated press with a 7.5 kW motor, which has a productivity of 100 kg / h (https://habapellet.de.tl/Prese-bricheti.htm).

PRODECO Winter BP 60

Haba Hallenbausatz



AGROBI BRICHET

Company: PRODECO - Italy produces a 4kW electrohydraulic press variant (NANO 55), but with a reduced productivity of only 15-50 kg/h, having only 7 cycles per minute (https://www.lemnsupermarket.ro/prese -de-briquetting-PRODECO-2298). The company AGROBI BRICHET produces electromechanical briquetting press BT-050-200 (https://agrobiobrichet.ro/presa-brichetat-mecanica-bt-050-200.html) with a capacity of 150-250 kg / h with main drive motor of 18.5 kW to which are added two other secondary motors under 3kW. Some manufacturers of briquetting presses out of a desire to display low energy consumption underestimate the installed power with the risk of achieving specific pressing forces in the mould at the limit, below 300 kgf /cm^2, resulting in insufficiently compacted, "elastic" briquettes that crumble in time. Another problem is that the technological process requires adjustments of forces and working speeds depending on the raw material used. Most of these presses use fixed flow hydraulic pumps, and for speed adjustment they use hydraulic throttles that are high energy consuming and heat the oil in the tank for cooling which is consumed again.

2.2 The chosen solution

The technical problem solved by the press for manufacturing parallelepiped briquettes, proposed, consists in the realization of a new solution of briquetting press with six parallelepiped moulds, located on a rotating plate, which are used simultaneously in the work process. Thus, the main cylinder on the pressing stroke also evacuates the previously pressed briquette, at the same time three mould nests are filled by the free fall of the raw material from the tank into the wells, and in the mould to be pressed, the material is prepressed with a screw, also placed in the tank which creates pressure on the material in the mould and constantly ensures the amount of raw material to achieve an approximately equal length of briquettes [3]. Thus, an increased productivity can be obtained by superimposing the working times on the phases preparatory to the final pressing. Practically the whole working process takes place at the same time as the final pressing, so the productivity is that regulated by the working frequency of the main cylinder plus the indexing time without other waiting times for filling moulds, prepressing and evacuation.

Figure 1 shows the realization of the hydraulic press of parallelepiped briquettes. It consists of a pressing cylinder **1**, which has mounted on the rod a double pressing and discharge punch **2**, a cylinder for indexing the moulded plate **3**, a raw material tank **4**, a prepress screw **5**, the frame **6**, a briquettes tray **7**, rotating plate with six parallelepiped dies **8**, and hydraulic station **9**.

Cylinder **3** rotates the mould plate **8** by actuating a ratchet mechanism in a fixed working position. Three of the six parallelepiped dies are located in front of the raw material tank **4** and are filled by its free fall during three work cycles until each of them reaches the pre-pressing station. The mould to be inserted on the pressing station is next to a screw **5**, which makes the pre-pressing and ensures an approximately equal volume of material for the final pressing. The material in the die on the pressing station is pressed by the cylinder **1**, which at the same time discharges the previously pressed briquette by means of the pressing / evacuation punch **2**. The cycle is resumed by a new indexing in a fixed position of work

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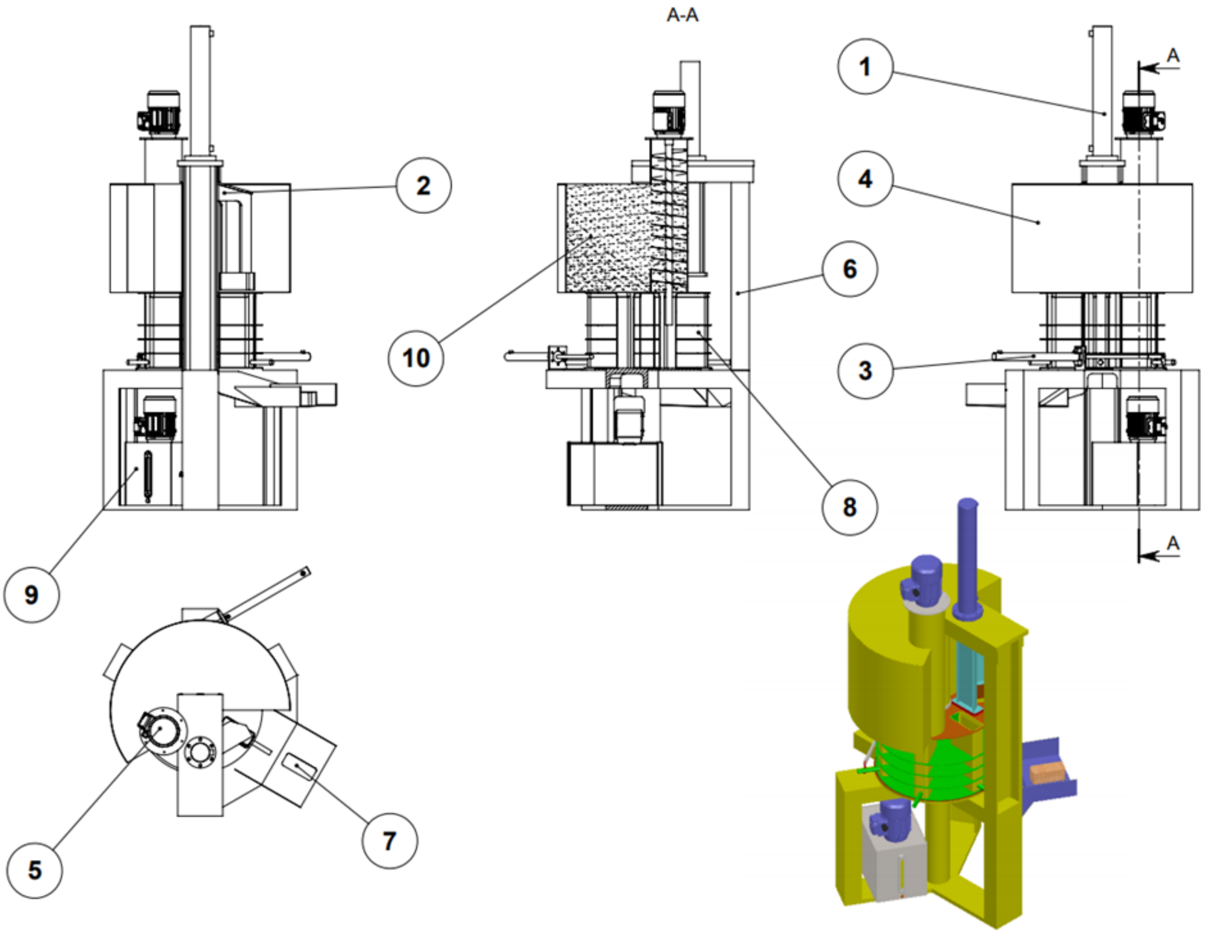


Fig. 1. Example of making the hydraulic press of parallelepiped-shaped briquettes

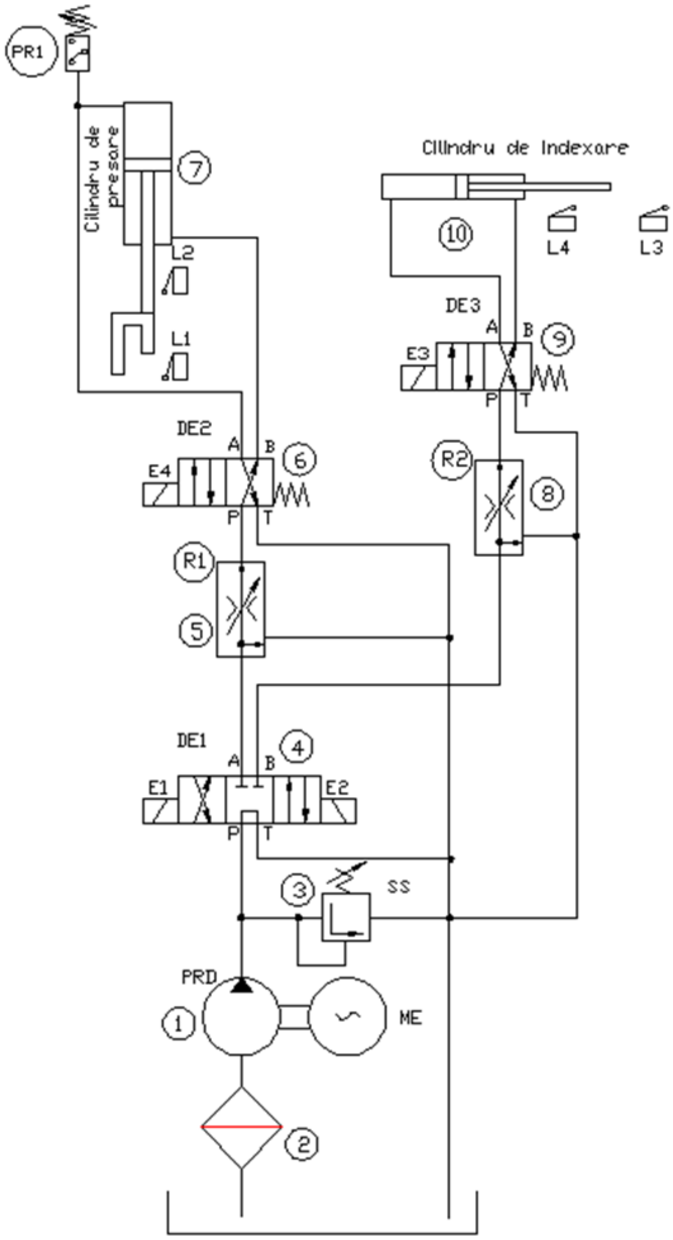
Component elements:

1. Pressing cylinder
2. Press / discharge punch
3. Indexing cylinder
4. Raw material tank
5. Prepress screw
6. Frame
7. Briquette tray
8. Rotating plate with parallelepiped dies
9. Hydraulic station

2.3 Hydraulic schematic diagram

The hydraulic scheme allows the adjustment of the working speed for the pressing and indexing cylinder by means of three-way flow regulators, which in the construction are not energy consuming, the excess flow being discharged to the basin at very low pressure [1].
Figure 2 shows the hydraulic scheme diagram for operating the hydraulic press of parallelepiped-shaped briquettes.
The hydraulic scheme diagram consists of electric pump **1,** which absorbs oil through the filter **2** and sends to the installation a fixed flow at the pressure set at valve **3**. The directional control valve **4** when is in the centre position allows the discharge of the flow to the tank without pressure, thus protecting the pump at start and energy saving in case of short work breaks. The same directional

control valve **4** alternates the pressing phase with the moulding plate indexing phase. The working speed for the pressing cylinder is adjustable with the flow regulator **5**, and by switching the directional control valve **6** the rod of the pressing cylinder is raised or lowered between the limiters L1 and L2. If accidentally the cylinder does not reach the limiter **L2** (for example too much material in the mould), although the compaction was done at the set pressure, the pressure switch **PR1** gives the command to continue the work cycle. The indexing cylinder **10** has the preferred position retracted and makes a return stroke by indexing the mould plate **3** by a ratchet mechanism in the next working position. The advance and retraction of the indexing cylinder rod is done through the directional control valve **9** between the limiters **L3** and **L4**. The indexing operating speed is adjustable with the flow controller **8**.



Hydraulic scheme structure

1. Electro pump
2. Suction filter
3. Pressure valve
4. Hydraulic press / index selection directional control valve
5. Three-way flow regulator
6. Hydraulic directional control valve for lifting / lowering press cylinder rod
7. Press / discharge cylinder
8. Three-way flow regulator
9. Hydraulic directional control valve for indexing cylinder control
10. Hydraulic cylinder for indexing

Fig. 2. Hydraulic scheme diagram for operating the hydraulic press of parallelepiped-shaped briquettes

3. Calculation elements for the sawdust briquetting press

The hydraulic system produces a specific pressing force of 700kg/cm^2 and a check is made at 900 kg/cm^2 during the briquetting process, thus ensuring a high quality of the briquette even in operating conditions at a fairly sufficient rate or with poor quality raw material on moisture, wood type or granulation.

Calculation starting elements [4]:
- Briquette size L-1-h (mm) 150 -60-60
- Press productivity 7 briquettes / min
- Density of R_{ob} briquette1000 kg/m^3 or 1 kg/dm^3 or 1g / cm^3
- Density of sawdust R_{or} 0.2 kg / dm^3
- Working pressure of the hydraulic installation, Pc, 200kgf /cm^2

Calculation of required forces:

- Briquette volume: $V_b = 15 \cdot 6 \cdot 6 = 540\ cm^3$ (1)
- Briquette mass: $M=V_b \cdot R_{ob} = 540\ g = 0.54\ kg$ (2)
- Briquette weight: $G = 540\ gf$ (3)
- Pressing surface, in the variant with the positioning of the briquette with h = 60 mm:

$$S_a = 60 \cdot 60 = 36\ cm^2 \quad (4)$$

- The specific pressing force is adopted:

$$F_s = 700\ kgf/cm^2 \quad (5)$$

- Required total pressing force:

$$F = 36 \cdot 700 = 25200 kgf \quad (6)$$

4. Design elements for the solution of the hydraulic briquetting press

Functional performance of presses:
a. The first performance of a press, the one that orients us to purchase is the production capacity.
b. The number of cycles per minute is between 5 and 10.
c. The calorific value of briquettes is between 4000 and 5500 kcal / kg.
d. The density varies quite a lot depending on the type of wood, from which the sawdust resulted, but also on the level of pressing. The density value is between 900 and 1400 kg / m^3.
e. The pressing force is between 700kgf / cm^2 and 2000 kgf / cm^2.
f. The burning temperature of the briquette is between 900 and 1200 °C.
g. The ash resulting from normal combustion is between 1.5% and 10% of the amount of briquettes used.

5. Conclusions

5.1 Briquettes from forest sawdust or from any other material is a useful and important fuel for a country's economy, with an energy value of more than 4400kcal / kg.
5.2 The burning of briquettes is not polluting as the manufacturing process excludes the use of additives of any kind.
5.3 The use of briquettes can save up to 30% compared to any other fuel.
5.4 The briquetting presses are complex equipment, hydraulically operated most of the time, and have capacities from 30kg/h to 250kg/h, and if they are organized in complex production lines, they can have much higher productivity.

Acknowledgments

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