Wastewater Purging. Case Study

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Abstract: *The treatment of the used water is a vital component in any industrial process, because it provides the necessary conditions so that the water can be reused under optimal conditions. In addition to traditional methods and procedures, more and more advanced methods are being sought to complete these processes, making them more efficient and faster, but with lower costs. Of these methods, an effective one is adsorption which has a good efficiency, although it cannot remove pollutants in very small or very high concentrations. Among the most commonly used adsorption treatment methods are the one with active carbon and the one by ion exchange on cations.*
One of the concrete solutions found is the use of pure oxygen in the decanting technique. This is exemplified by the BASF decanting facility in Ludwigshafen care using pure oxygen for nitrification through Messer gaskets.
Another concrete case for the depollution of waste water refers to those arising from the processes of manufacturing smoke-free powders by adsorption on activated carbon. In this case, the materials used were Nano carbon powders and activated carbon obtained from charcoal grinded beech wood.

Keywords: *Adsorbents, adsorption, pollutant, water depollution*

1. Introduction

In modern era, it was reached the step in which it utilizes the water, the key element of life on Earth, more and more, this way reaching an irrational and inadequate consumption that made this resource become polluted.
In our country, around 31% of utilized waters are evacuated without being purged, 41% are insufficiently purged and 28% are purged correctly.
Water pollution represents the alteration of physical, chemical and biological water qualities, made directly or indirectly, in a natural or anthropogenic way, that can happen continuously or discontinuously, temporary or accidentally.
Water purging represents the decrease of pollutant concentrations at enough low concentrations not to pollute reception waters. It is realized with the help of numerous machinery that make up the purging stations from which result purged waters and sludges, that can be used as fertilizers in agriculture. The EU legislation and policy impose that the pressure impact on water should be decreased significantly.

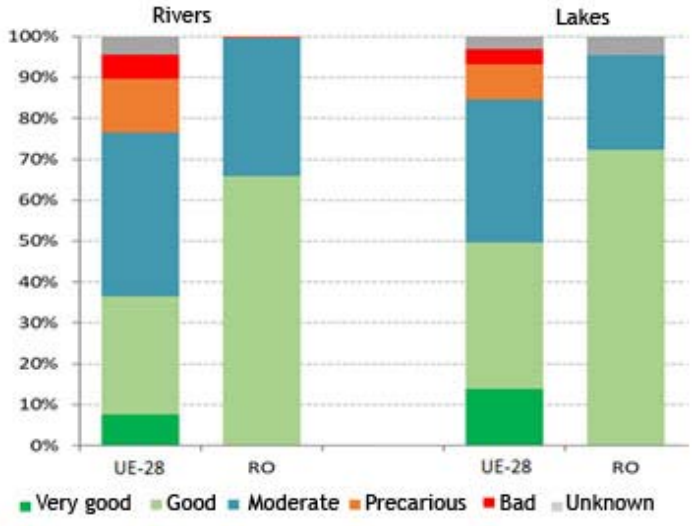

Fig. 1. The ecological status or potential of surface water bodies in Romania [8].

2. Processes and methods of depollution of industrial wastewater

Purging processes are of physical-mechanical, chemical and biological nature. They have the role to obtain an yield as high as possible of impurities elimination that exist in wastewaters, with the goal of giving them back to the surface water circuit at normal parameters in terms of legal norms.
In every purging station exist three stages:

- Primary stage (mechanical) with role of retaining coarse substances with the help of grills, sieves and decanters.
- Secondary stage (biological) where remaining organic matter break down using microorganisms.
- Third stage (biological, mechanical or chemical) that doesn't exist all the time and where mineral and organic non-biodegradable substances are eliminated using neutralization, precipitation, coagulation and flocculation reactions.

More and more are utilized modern wastewater depollution methods such as:

- Intensification of the electrochemical processes for the treatment of the residual sludge,
- Elaboration and utilization of coagulants
- Utilization of membranous matter

When normal functioning of the purging station is not affected it is recommended to purge in the same time the industrial wastewater and the sewage, because they have some advantages, such as: [2]

- Optimal development of the purging process, due to the nutritive substances contained by the industrial wastewater
- The existence of one wastewater treatment plant, in which both types of wastewater are treated, can reduce the purification costs and increase the cooperation between industry and populated center for water purification
- The existence of only one plant responsible for the purification of the entire water in the populated center, giving an increased efficiency of exploitation.

3. Advanced wastewater treatment methods through adsorption

Advanced purification consists of supplementary processes meant to remove substances in suspension and the dissolved ones that remained after the two conventional purification stages. It can be incorporated in the biological process or removed after the secondary stage.
The principal wastewater pollution removal processes are: [3]

- Biodegradation- low-cost technology that requires optimal environment conditions
- Coagulation- simple technology that produces high quantities of waste that are hard to remove
- Membrane separation- allows the removal of a wide range of pollutants, but allows the treatment of a big volume of wastewater
- Processes based on biomass- cheap but slow processes
- Absorption- big efficiency but doesn't remove pollutants in very small or very big concentrations
- Ion exchange- has limitations regarding the species that can be purified
- Oxidation- fast and efficient process but with a high cost
- Advanced oxidation processes- don't produce waste, are efficient, but in some cases appear toxic by-products

3.1. Purification through absorption with active carbon

Adsorption is a surface phenomenon. After absorption, the grade of pollutants in solutions decreases but doesn't disappear completely. When the quantity of unpurified pollutant is small, it is carried downstream in the emissary. Absorption is much utilized because of its variety of absorbents and the possibility of reutilization in multiple absorption-desorption cycles. Adsorbents can be capillary systems or powders in suspension. From all the adsorbent materials the most common are the vegetal, artificial or animal active carbons, the clays, the synthetic resins, the polymers etc.
Active carbon is utilized on a large scale for wastewater purification. It has the specific surface extremely big, because of the pores, being able to reach hundreds of m^2/gram.

Another important feature of active charcoals is the affinity for various types of pollutants. They have medium efficiency in removing heavy metals, which can be increased through the optimization of the period in which the wastewater comes in contact with the adsorbent.
After some researches it was revealed that the utilization of active charcoal in industrial wastewater purification disolves partially or totally solid impurities according to the quantities and requires a big capacity of oxygen, as shown in figure 2.
Active charcoal can be reutilized by heating it at 900 ^{o}C, temperature at which it was created and when all the impurities that were adsorbed are released.

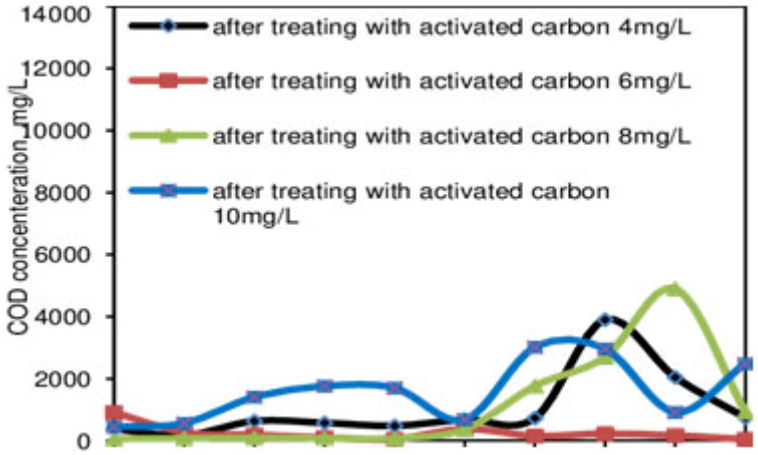

Fig. 2. Chemical concentration of oxygen depending on the amount of activated carbon [4]

In figure 3 it is shown a simplified model of the interaction of the 4 A factors (active charcoal, dissolved oxygen, microorganisms and pollutants). The reaction between the active charcoal and pollutants is the adsorption effect of the active charcoal, and the reaction depends of their characteristics.

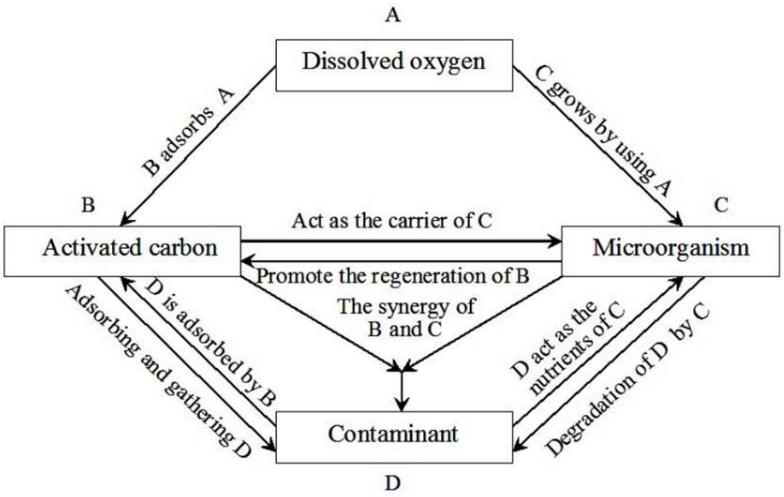

Fig. 3. Simplified interaction model of factors in BAC process [5]

3.2. Ion exchange adsorption on cationites

Ion exchange adsorption refers to the replacement of some ions from the solution with the adsorbents ions.
Very important for this method is the fact that some ions retained on the exchanger can be put back into the solution and the regenerated exchanger can be reutilized. [6]
An ionic species situated into an aqueous electrolyte solution interacts with an adsorbent solid material.

4. Case studies

4.1. Pure oxygen utilization in the decanting technique

Pure oxygen is the concentrated oxygen without nitrogen ballast that can be released into the water fast and at low costs.
Such a supply of pure oxygen has numerous advantages, including the economic one if it is being used through an adequate installation technology, taking into consideration the utilization and local conditions (ex. Special evacuation installations with hose, injectors and oxidizers) as it is represented in figure 4. To fix a problem that shows up when at the decantation installation appears oxygen shortage, serious odor problems, an Emscher decantation installation was introduced, with spillage and an additional supply of pure oxygen.

Fig. 4. The charging procedure developed by Messer for pure oxygen: gas hose (left), injectors (center), oxidizer (right) [7]

In the biological stage, the traditional aeration was supplemented with oxygen in order to eliminate the nitrogen, figure 5, and lifting the biological mass in the system.

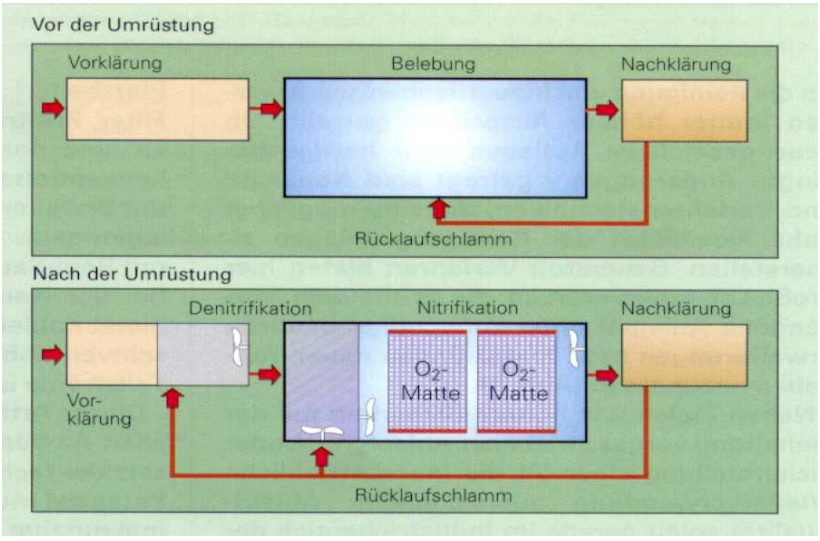

Fig. 5. Schematic representation of the conversion of a clearing installation for the Biox®-N procedure [7]

For low stabile leakage values the biofiltration procedures are utilized, at which the continuous vertical filter uses the quartz sand as a filtering medium.
These are some of the applications in which the oxygen is successfully used in effective purification of industrial wastewater.

4.2. The depollution of waste water from the processing of smoke-free powders and the recovery of ethyl alcohol from them using adsorption / desorption processes on activated carbon

This method is based on the adsorption of ethylic alcohol on two types of materials, carbonic adsorbents, the active charcoal obtained out of ground beech wood charcoal and the Nano carbonaceous powder obtained through laser pyrolysis, followed by its recovery by desorption, which is realized by taking the steam through active charcoal and collecting it in special recipients.
From the experimental data resulted the following:

- Ethanol adsorption on active charcoal is net superior to the adsorption on carbonic Nano powders.
- carbonic Nano powders have different adsorbent capacities compared to ethanol
- The chosen method for the determination of adsorbed capacities is advantageous because all the determinations can be made without the need to open the thermostat enclosure and to expose the samples in the atmosphere outside the enclosure. [1]

The process is important because: the toxic substances from the waste water, which can be recycled, are eliminated, the recovered ethanol is reintroduced into the technological process, and the activated carbon is regenerated and reused. The use of this process at industrial level leads to lower costs of producing smoke-free powders and implicitly to the protection of the environment.

5. Conclusions

The biggest problem of pollution is the disposal of industrial waste water in natural water resources due to non-compliance with the legislation in force and insufficient treatment resources.
In the few industrial enterprises that our country still has wastewater treatment should be carried out through a combination of complex biological, chemical and physical procedures.
To eliminate these problems, that are quite serious, Romania should invest much larger amounts for the introduction of wastewater treatment plants from different industrial fields in order to ensure the discharge of clean water in the rivers that cross our country.
Another solution would be the reopening of research institutes, which could find modern and inexpensive solutions designed to help purify industrial wastewater.
Perhaps the most important thing that could be done in Romania would be for all citizens to be aware of the consequences of water pollution and to try by any means to help stop this.

References

[1] Petrea, Nicoleta. *Ecological depollution of industrial wastewater containing toxic substances / Depoluarea ecologică a unor ape uzate industriale conţinând substanţe toxice*. PhD Thesis, Technical University of Civil Engineering of Bucharest, 2012.
[2] Vișan, S., A. Angelescu, and C. Alpopi. *The environment. Pollution and protection / Mediul înconjurător. Poluare şi protecţie*. Bucharest, Economic Publishing House, 2000.
[3] Baciu, D. *Water pollution. Depollution technologies*. Cluj-Napoca, Risoprint Publishing House, 2003.
[4]https://www.researchgate.net/publication/315552769_Industrial_Wastewater_Treatment_Improvements_Using_Activated_Carbon.
[5]https://www.intechopen.com/books/biomass-now-cultivation-and-utilization/biological-activated-carbon-treatment-process-for-advanced-water-and-wastewater-treatment.
[6]http://www.amac.md/Biblioteca/data/17/08/Romania/78-Analize-Fizico-chimice-Si-Metode-Avansate-de-Epurare-a-Apelor-Uzate.pdf.
[7]http://www.messer.ro/Aplicatii/Protectia_mediului_si_reciclarea_deseurilor/Purificarea_apelor_uzate/Epurarea.pdf.
[8] Report_en_en.pdf, AEM, WISE indicator table.