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PURIFICATION OF THE WASTEWATER FROM MEAT INDUSTRY
PREČIŠĆAVANJE OTPADNIH VODA IZ INDUSTRIJE MESA

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ABSTRACT

Meat processing industry produce highly polluted wastewater with a high concentration in organic compounds that have to be removed before reusing the treated effluent.

Wastewater (effluent) from abattoir has a high concentration about 45 % soluble and 55 % coarse suspended organics. Most of the organics are from blood and offals.

Purification of the wastewater is an efficient method for pollution decreasing. Impurities removing can be achieved by mechanical, chemical and biological methods. Effluent from slaughterhouse, meat processing and packing industries has a high concentration of suspended organics from blood and offals that can be efficiently removed by aerobic and anaerobic methods that will be comparatively studied.

Key words: *effluent, influent, wastewater, slaughterhouse, anaerobic methods.*

REZIME

Mesna industrija proizvodi veoma zagađene otpadne vode sa visokom koncentracijom organskih jedinjenja koja se moraju ukloniti pre ponovne upotrebe tretiranog efluenta. Otpadne vode (efluent) iz klanice ima visoku koncentraciju oko 45% rastvorenihi i 55% grubo suspendovanih organskih materija. Većina organskih materija potiču iz krvi i iznutrica. Prečišćavanje otpadnih voda je efikasan metod za smanjenje zagađenja. Uklanjanje nečistoća se može postići mehaničkim, hemijskim i biološkim metodama. Otpadne vode iz klanice, prerade mesa i industrije pakovanja imaju visoku koncentraciju suspendovanih organskih materija iz krvi i iznutrica koje se mogu efikasno ukloniti pomoću aerobne i anaerobne metode koje će biti prikazane u ovom radu.

Ključne reči: *efluenz, influent, otpadne vode, klanica, anaerobne metode.*

INTRODUCTION

Wastewater derived from meat industry is very harmful to the environment; effluent discharge from meat processing factories causes the deoxygenating of rivers and the contamination of the groundwater.

The pollution of meat processing factories is very high; blood one of the major pollutants in meat processing wastewater, has a chemical oxygen demand (COD) of 375000 mg/l.

A classification of wastewater from meat industry can be achieved depending on their characteristics:

- water with a high concentration with suspended organic particles;
- water with greases;
- water with blood;

Anaerobic wastewater treatment combined with proper post-treatment represents the ideal solution for environmental protection. Several advantages results from applying of anaerobic treatment. Anaerobic method is a low energy process that generates low volume of sludge, making it cheaper and simpler to operate than aerobic processes. The main advantages of anaerobic treatment such as little sludge produced, production of methane gas as a source of energy, it is a low energy process making it more environmentally friendly and has lower running costs as a result of a low energy inputs.

Anaerobic treatment and a combination of mechanical and physical/ chemical methods are recommended for pre-treatment of waste water of meat industry effluent with high organic load. Very good results were obtained by anaerobic pre-treatment followed by aerobic post-treatment.

Aerobic method has the advantages: can be used for many failing systems and is suitable in nearly soil conditions.

This paper presents some considerations about the applying the biological methods (aerobic and anaerobic) for wastewater from slaughterhouse, meat processing and packing industries.

Table 1 shows the estimated solid waste of slaughterhouse and the meat processing industry (RIVM, 1994). All the solid waste mentioned in table 1 has a potential use as fertilizer (manure) or animal feed *(Onet, 2010)*.

Table 1. Estimated solid waste in meat industry in (RIVM,1994)

Slaughter process	Unit	Value
Manure	Kg/t	5.5 carcass weight
Fat (pre-treatment wastewater)	Kg/t	1.7 product
Fat (pretreatment wastewater)	Kg/t	2 product
Fat (pretreatment wastewater)	Kg/t	2.3 product
Paunch manure	Kg/t	100 product

Effluents from slaughterhouses constitute one of the most serious causes of environmental pollution, bad odors and health hazards in almost all of the developing countries.

Some of the wastewater chemical characteristics are *(Botis, 2014)*:

- Particles in suspension (SS): effluents from the slaughterhouses have a great concentration of particles in suspension (0.28-0.34 Kg/t), most of them of organic type.
- Nitrogen (N): wastewater from slaughterhouses has a high concentration of nitrogen (N) because of the proteins of animal origin. The concentration values are between 0.23- 1.4 Kg N/t.
- Phosphor (P): The total effluent from the slaughterhouses has 0.012- 0.09 Kg P/t
- Chemical Oxygen Demand (COD) is the oxygen required for chemical oxidation of the organic matter without the help of strong chemical oxidant and it is useful in indicating the toxic condition and presence of biological resistance substances. The maximum values appear in the case of wastewater wit a high concentration of blood, heads and carcass trimmings, lungs, fats and paunch. These values can be up to 40 Kg O_2/t.

Biochemical Oxygen Demand (BOD) is defined as the amount of oxygen required by microorganism while stabilizing biological decomposable organic matter in aerobic conditions.

Table 2 presents some values of the quality of the wastewater from slaughterhouses:

Table 2. Characteristics of the wastewater from the pigs slaughterhouses (Johns, 1995)

Characteristic parameter	Unit	Value
BOD	Kg/t	2.4 carcass weight
COD	Kg/t	10
N	Kg/t	0.6
SS	Kg/t	5.6
P	Kg/t	0.05

Process and methods for wastewater treatment from meat industry

Most of the organics from the wastewater from meat industry emanate from blood, grease, offal's that are insoluble and slowly biodegradable. Because of the high percent of organic materials biological methods for purification are preferred.

a) Anaerobic methods

Anaerobic wastewater treatment is a process where bacteria digest bio-solids in the absence of oxygen. One major feature of the anaerobic digestion *(Mittal, 2008)* is the production of biogas, which can be used in generators for electricity production or in boilers for heating process.

The fact that aerobic treatment requires a method for the introduction of oxygen into the process, makes anaerobic wastewater treatment generally more cost effective *(Medhat, 2004)*.

Anaerobic systems can be classified as: anaerobic lagoons, reactors with mixing device, anaerobic contactors.

Anaerobic lagoons are applied for clarification of wastewater with suspended organics as greases, proteins, blood; the general scheme is given in Figure 1.

In a typical wastewater treatment system the influent coming into system has a high percent of organic compounds (BOD) because it hasn't been yet treated. As the influent reaches the aerated stabilization basins it enters an aerated environment where the degradation begins. The degradation of BOD is achieved through aerobic bacteria that utilize oxygen as an electron receptor in order to convert the organic material to CO_2.

Aerobic methods

Aerobic wastewater treatment is a process where bacteria use oxygen to degrade organic matter (generally quantified as biochemical oxygen demand or BOD) and other pollutants involved in various production systems.

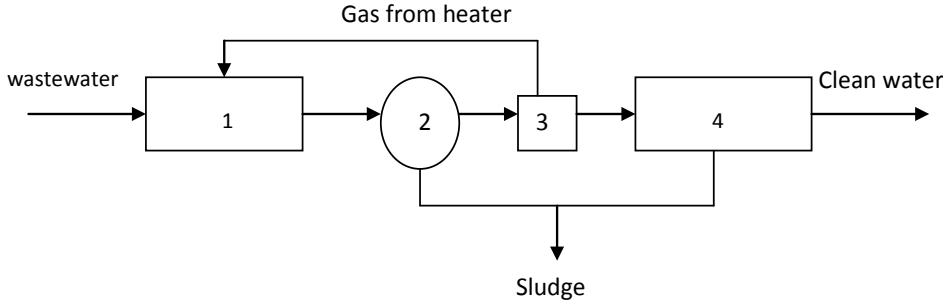

Fig. 1. Anaerobic lagoon:
1- heater; 2- contact reservoir; 3- gases remover; 4- decanter

Aerobic systems can be:

- conventional methods with active sludge
- aerobic filters
- aerobic lagoons

For wastewater from the slaughterhouses can be applied biological procedures with aerobic lagoons. In Figure 2 is presented a typical biological aerobic filter.

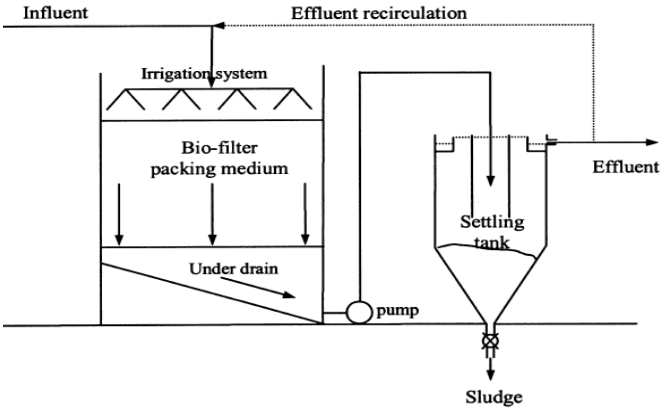

Fig. 2. Aerobic biological filter

The aerobic sludge treatment is presented in Figure 3:

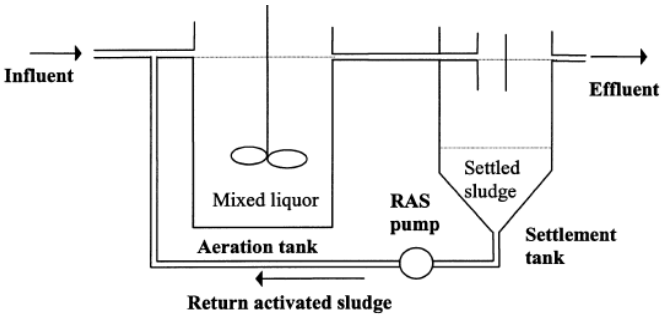

Fig. 3. Activated sludge process

Critical review of various processes for wastewater treatment from meat industry

Aerobic systems require large space, maintenance, management and energy requirement for artificial oxygenation. Primary treated abattoir waste water contains high concentration of organic carbon *(Manjunat, 2000)* which requires high aeration and sludge disposal costs if waste water is treated using an aerobic treatment.

Aerobic lagoons are large shallow earthen basins that use algae in combination with other microorganisms for waste water treatment. Oxygen is supplied naturally by the wind, through photosynthesis and by mechanical means. These lagoons are shallower than anaerobic lagoons so that the light can penetrate.

Activated sludge processes include conventional, complete mix, aeration, oxidation ditch and sequenced batch reactor. The sludge is maintained by continually recycling a fraction of the settleable solids *(Johns 1995; Mittal, 2008)* separated aeration. These settled solids contain an active microbial population, which aggregate. The

remaining sludge is removed from the system and may be stabilized using aerobic or anaerobic methods.

The aerobic filters operate as an attached growth or fixed film reactor and is a column filled with various type of media (Fig. 2).A bed of highly permeable media is used in a trickling filter with microbial flora; a distribution systems spreads wastewater over the bed surface and a drain system collects treated wastewater. Trickling filter consists of a non-submerged fixed film using rock over which wastewater is distributed continuously.

An aerobic contact reactor (Fig. 3) consists of a stirred tank reactor followed by a sludge separator. These systems are similar to the activated sludge process. Reduction in biological oxygen demand (BOD) was approximately 90 % and volatile solids reduction between 41 and 67 % *(Medhat , 2004)*.

In Figure 4 is presented a comparison between anaerobic and aerobic treatment for wastewater from meat industry:

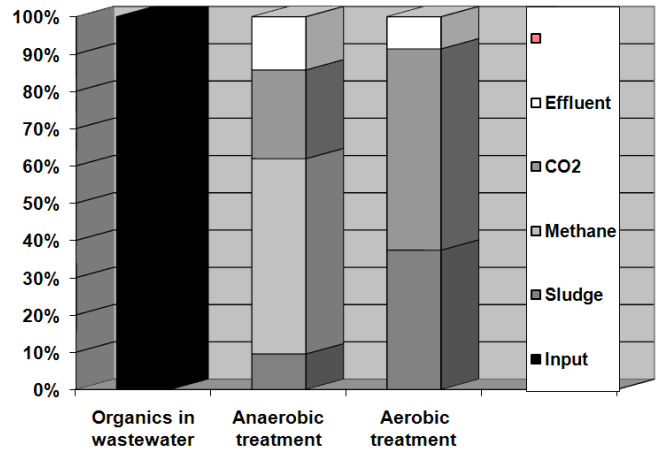

Fig. 4. Comparison between anaerobic and aerobic methods

CONCLUSION

Anaerobic wastewater treatment combined with proper post-treatment represents the ideal solution for environmental protection *(Onet, 2010)*. Several advantages results from applying of anaerobic treatment. It is a low energy process that generates low volume of sludge, making it cheaper and simpler to operate than aerobic processes. The main advantages of anaerobic treatment; small amount of produced sludge, production of methane gas as a source of energy, it is a low energy process making it more environmentally friendly, has lower running costs as a result of a low energy inputs. Anaerobic treatment *(Medhat, 2004)* and a combination of mechanical and physical/ chemical methods are recommended for wastewater pre-treatment of meat industry effluent at high organic load. Aerobic method has the advantages: can be used for many failing systems and is suitable in nearly soil conditions.

Disadvantages: are expensive to install and operate, may require more maintenance than other systems.

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