INDUSTRIAL GAS PURIFICATION USE OF BIOFILTERS

Lecturer Irina Ramona **PECINGINĂ,** University „Constantin Brâncuşi" of Tg-Jiu, irina@utgjiu.ro

Abstract. *Biological filtration systems is one of the current alternatives to remove residual volatile components of the air through biological means, without affecting the natural environment. Biofilters have a technology that uses microorganisms (bacteria) to treat emissions, in a secure economic and environmental quality. Biofilters consist of porous filters, which is distributed flue gas stream.*

Key words: biofilters, biofilm, microorganisms

1. Introduction

Air pollutants may be alien substances present in atmospheric composition or substance, depending on their concentration and time of action, have a harmful effect on health and environment, by default, man.

Biological filtration systems is one of the current alternatives to remove residual volatile components of the air through biological means, without affecting the natural environment.

Due to the metabolic capacity of aerobic species to degrade different volatile organic substances, they are subject to microbial oxidation processes in the presence of atmospheric oxygen after prior solubilization in aqueous medium, so that any gas to be completely free of any compounds residual.

Biofilters have a technology that uses microorganisms (bacteria) to treat emissions, in a secure economic and environmental quality. Biofilters consist of porous filters, which is distributed flue gas stream.

Organisms that eat the waste gas are attached to the porous substrate. Biofiltration process is similar to the conventional treatment of the precipitate obtained, in which microorganisms are used to completely oxidize organic compounds in the form of CO_2 and water. Biofilters are useful for controlling emissions from composting operations, the waste gas recovery processes in food, petrochemical, metallurgy, etc.

2. Biofiltration process description

Biofilters are technological facilities, such as fixed-film biological reactors that use microorganisms attached to the substrate material. These substrates can be made of: compost, peat, bark, soil or inert materials to convert waste products organic or inorganic CO_2 and water. Substrate provides structural support and nutrients essential for growth and multiplication of microorganisms. Porous structure of the substrate provides an optimal surface at a reasonable pressure drop of gas.

As the gases are passed through the reactor, the pollutants diffuse into the biofilm. Pollutants are then decomposed by aerobic biodegradation process. Biofilters are economical when applied to gas streams with low concentrations (<1000 ppm), rich in oxygen. Decomposition efficiency greater than 90% can be achieved only if the water-soluble organic substances such as alcohol, aldehydes and amines, or of the inorganic high solubility in water, such as H_2S and NH_3.

The main stages of the biofilter are shown schematically in figure 1 and consists of the following technological operations:

- collection of the raw waste gas production or processing;
- transportation of gas by pipeline network, with a special pumping device;
- waste gas pretreatment to remove dust and particles of impurity;
- optimal temperature adjustment;
- adjusting the relative humidity until saturated, filtering particles and/or temperature adjustments are often combined with equipment adjustment gas moisture content.
- decomposition of pollutants by microorganisms fixed on biofilter

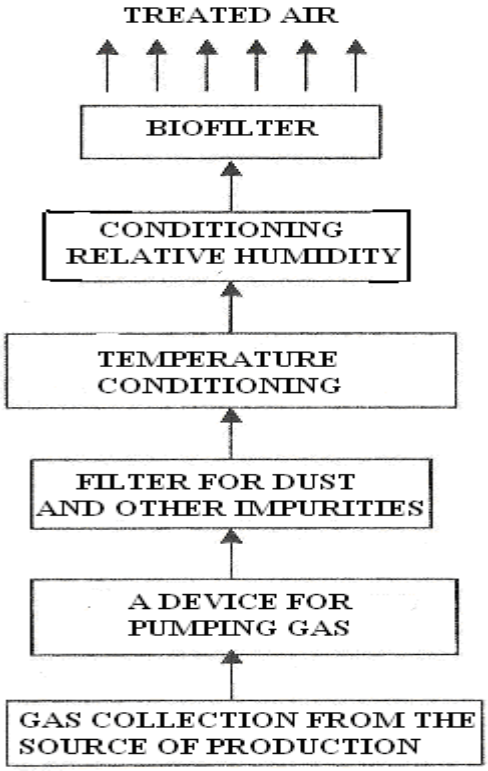

***Fig.1**. Schematic representation of a biofiltration system*

Biofilter efficiency is directly proportional to the quality of filter material and the conditions in which the biofiltration process (tun uniform air distribution, degree of humidification, drainage system). Since the composition of bacterial species are used as biofilter media biofilters, they must be properly prepared and fertilized in accordance with specific nutritional requirements of such microorganisms.

Broths are made from high quality raw materials that can guarantee the efficiency of these bacteria supply nutrients for a long time. Correct structure of the material creates the optimal conditions for development of low pressure and, therefore, to obtain as reduced operating costs. The finished product of biological decomposition, in the ideal case, carbon dioxide, water and bacterial biomass.

The pollutants are absorbed on the surface of the filter is then decomposed by microorganisms present in an aqueous solution trickles down the filter constant. This method is suitable mainly for water-soluble solvents.

Composition and activity of microorganisms are provided, optimally, only when the filter layer and the design and construction biofilters certain conditions are met:

- ***Design and construction***. Capacity and efficiency of biofilter operation are directly proportional to the active surface, the vacuum space of the filter efficiency in achieving the targets, types of gas and gas loading. A proper design of the biofilter principal components is very important to ensure a viable and efficient operation in terms of cost.

- ***Raw gas composition.*** First, the raw gas amount to be determined under biofiltration. To ensure both a reasonable extraction efficiency and a reasonable life of microorganisms, raw gas flow must include: an oxygen concentration equal to the ambient gas concentrations below lethal to the microorganisms used and types of microorganisms and bacteria lethal gas should be in the raw gas stream.

- ***Transportation of raw gas.*** The gas is collected from the processing and transport by pipeline, and fans using pressure boosting, the preconditioning equipment.
- ***Preconditioning raw gas***. To ensure destruction efficiency and lifespan biofilter, raw gas stream must be adjusted before the gas is introduced into the biofilter safe to come in preselected particle load, temperature and humidity.
- ***Preconditioning particles***. Loading strong with heavy particles (dust, grease, oil and other aerosols) of gas, may be critical to the filter bed porous structure, resulting from this increase in pressure loss. Oils and heavy metals are deposited on the filter bed can be poisonous to living organisms in the biofilm .
- ***Temperature.*** Temperature operation of a biofilter is controlled primarily by temperature gas treatment subject. Average operating temperature recommended for destruction efficiency is between 20 to 40 C°, with optimum temperature of 37 C°. At low temperatures, bacterial growth will be limited and extremely low temperatures, the bacteria will be destroyed. Above average recommended bacterial activity is also reduced. extremely high temperatures will kill bacteria in the filter bed. If gas flow is at a very high temperature (above 100 C°), the cost of cooling gas can be stored so high, that may be more effective odor control some conventional methods such as thermal oxidation.
- ***Humidification.*** Inhabited by organisms that digest pollutants in a thin layer of water, called biofilm, which encircles the filter substrate. Insufficient humidity may damage the filter, resulting in reduction of surface active and untreated gas leak. Insufficient moisture can also lead to breaking compression filter media, which would reduce the active area and the untreated exhaust gases. Humidification of the gas flow is the preferred method of transport, which is kept moist filter bed. Humidity is usually added gas flow after fitrare stage, spraying water or steam. It is recommended to add moisture directly above the filter bed to maintain moisture, because it could cause local drying of the substrate. Also, the addition of hot water may reduce the activity of microorganisms until water temperature reaches the final status of filtration bed.
- ***Gas distribution system***. Gas distribution system mission is to ensure an even distribution of gas flow, preconditioned in all areas of filter bed. In models of flow biofilter upstream gas distribution system provides: drainage environments, collecting,

transporting excess water inside the filter bed, surrounding soil prevents potential contamination, leak from the filter, a structural basis for the filter bed environment. Gas distribution system may be composed of a network of perforated pipes, cracked or a concrete block exits or metal bars. When there are limitations of space, is used to filter one level. In areas where space is limited using multistage filters. If treated inorganic components will be used building materials resistant to corrosion due to acidic reaction bioproduct

- ***Filter array***. Desire to preserve the effectiveness of cleaning the filter is the material-support to ensure a sufficient supply of nutrients for the microorganisms most frequently used biofilters beds today are: soil or compost, leaves, peat forest, bark, wood chips, paper or other organic material. These materials are arranged in the form of layers through which the waste gas stream. Longer work because the microorganisms, the filter material is gradually transformed as compost. For this reason, it can lead to clogging and failure of the biofilter, which increases the loss of gas pressure in the filter layer. To maintain efficiency filter material filter should be replaced every 3 to 5 years. Are allowed inactivity period of several weeks, during which organic filter material serves as a nutrient for microorganisms.

  The filter selection should consider the following:

  - Particle size and porosity of the filter environment, because efficient operation is directly related to the biofilm surface area available;
  - Filter medium must be a source of inorganic nutrients for microorganisms, and for the duration of operations, these may be added periodically inorganic nutriments in bed;
  - Sealing of the filter bed will lead to the formation of gas channels and increase pressure loss;
  - eed good characteristics of the bed drained to ensure that reaction products are easily removed by the filter medium;
  - Any flow are generally recycled through the process of humidification to reduce wastewater flow;
  - Filter medium must have buffering capacity to maintain the pH at least 3, particularly when necessary to reduce the inorganic components;
  - Filter medium must be composed of materials with irritant odor.

Before entering the biofilters of waste gas containing pollutants, it shall be, in each case, a preliminary treatment. Reinstatement in service to the biofilter must be taken into account, where applicable, between the populations of microorganisms to adapt to new conditions of existence. This method is used for organic compounds that are soluble in water and can be decomposed microbiologically. Natural microorganisms used in biofilters are the same fungal and bacterial species that are used routinely in activated sludge wastewater treatment. Also were obtained and genetically modified organisms through genetic engineering techniques that are designed decomposition of aromatic organic compounds by chemical synthesis (xylene and styrene). Among the various research in progress, trying to widening the number of chemicals that can be biodegraded, which will contribute to lowering the cost and size of filter beds, currently used by reducing the time necessary for digestion.

The most common species of microorganisms are presented in table 1.

***Table.1**. Species of microorganisms used in biofiltration*

Bacteria	**Fungi**
Actinomyces sp.	*Penicillium notatum*
Micrococcus sp.	*Cephalosporium sp.*
Bacillus cereus	*Mucor mucedo*
Streptomyces sp	*Aspergillus niger*

3. Conclusions

- Biological filtration systems is one of the current alternatives to remove residual volatile components of the air through biological means, without affecting the natural environment.

- Biofilters are technological facilities, such as fixed-film biological reactors that use microorganisms attached to the substrate material. These substrates can be made of: compost, peat, bark, soil or inert materials to convert waste products organic or inorganic CO_2 and water.

- This method is suitable mainly for water-soluble solvents

References

[1] Pecingină I.R., *Environmental Biotechnology*, Ed C.T.E.A., Bucharest, 2010, p.171-185
[2] Petre, M., Teodorescu A., *Environmental Biotechnology*, Vol. I, Ed. CD Press, Bucharest, 2009
[2] Petre, M., Teodorescu A., *Environmental Biotechnology*, Vol. II, Ed. CD Press, Bucharest, 2008