Granulated Activated Carbon Adsorption / Bio-Filtration

Granulated Activated Carbon Absorption / Bio-Filtration (GACBF) Systems are becoming the low cost solution for VOC and Odor control from industrial, agricultural, energy and municipal sources of air emissions. Bio-Filtration is currently being used to bio-oxidize toxic and other volatiles in industrial effluents present in higher concentration amounts.

However, the market for abatement technology based solely on bio-filtration has been a fraction when compared to more traditional abatement control technologies such as; thermal oxidizers, regenerative thermal oxidizers, catalytic thermal oxidizers.

Granulated Activated Carbon Absorption / Bio-Filtration Introduction

A frequent cited example is the overall emission control efficiencies of 98% percent or slightly above conditions that exist within the United States, the United States industry has preferred the use of abatement control technologies such as incinerators i.e. thermal oxidizers which actively reach destruction efficiencies of 98%+ and are more conventional in nature. GACBF in the U.S. have to compete against these control technologies that have been widely accepted and used, and whose performance has been well understood for decades.

Currently, second and third generation GACBF systems are capable of achieving much higher destructions 99%+ and are equal to or often surpass many of the more conventional destruction methods, such as thermal oxidizer systems, these newer systems adopted a granulated carbon adsorption bed and are achieving documented destruction efficiencies above 98 percent.

The reality that most European countries have odor standards that may help to explain why there are more solely bio-filtration systems that exist in European countries. The objective in the European case is overcoming, the odor nuisance rather than meeting specific destruction efficiency as adopted by most U.S. State and Federal Agencies. After analysis you will find that *there are no real obstructions that exist preventing the total widespread use of the combination granulated carbon absorption/bio-filtration system* as a very clean and viable pollution control technology within the United States.

Legislative Approach

The Clean Air Act (CAA) has an important impact on the United States environmental regulations, and many regulatory aspects are contained in its provisions. Directed by various provisions dealing with metropolitan air pollution, the U.S. Environmental Protection Agency has issued regulations and State instruction documents to control many pollutants to include ground level Ozone, nitrogen oxides (NOx), and sulfur compounds that include hydrogen sulfide (H2S), sulfur dioxide (SO2) and sulfur trioxide (S03).

Volatile organic compounds (VOCs) are restricted because they are a significant contributor to the formation of ozone with many of the compounds contributing hundreds of times that of carbon dioxide (CO2) per pound. To reduce, VOCs, the EPA and State agencies have

developed regulations to minimize levels of emission that have been identified in their State Implementation Plans. Most often the level of VOC control is based on those presented in a Control Techniques Guidelines (CTG) issued by the United States Environmental Protection Agency for a particular source category.

Control Techniques Guidelines provides an overview of the various emission points with industry and the typical cost of using reasonably available technology (RACT) to reduce emissions from the relevant emission points at an existing facility. Emission points differ and may be a stack, collection system, bag house, ventilation area, boiler or other operational unit.

Often VOCs are considered toxic or a Hazardous Air Pollutant (HAPs). Today there are some 188 listed toxic pollutants. Listed within the toxic list are chemicals such as benzene, Xylene, and toluene.

The United States Environmental Protection Agency is mandated to develop rules based on maximum achievable control technology, referred to as MACT. The level of MACT for new sources must be based on the best-controlled similar source, for existing sources with more than 30 facilities. The level of MACT must be based on the average of the best performing 12 percent of the existing sources.

MACT Standards focus on cancer and irreversible health effects, whereas RACT focuses on reducing ground level ozone reduction because of its effect on human health and welfare. Hence, it should not be unexpected to find MACT levels of control for reducing a compound such as benzene, a more restrictive control level.

The Pollution Prevention Act in 1990, United States Environmental Protection Agency has been working to promote pollution prevention (P2), mainly through source reduction. However, there is little evidence that issuance of the P2 Act has resulted in regulations that have precluded any use of control technologies for meeting emission limits. However, P2 is now offered as a competing alternative to control technology.

Accessibility of Control Information

It was a difficult assignment in the past for an owner or operations manager to select a pure bio-filtration system to reduce waste or off-gas emissions as a means of compliance. Unlike in the case of microbial treatment of VOCs in wastewater, vapor phase GACBF systems have mostly been used in the United States for treating odor and far less for treating VOCs, SO2 or toxics in air. This is not because the pollutants in air are more complex than in waste water. In fact, the off-gas waste streams can be easily analyzed using conventional flame ionization techniques.

There are numerous publications describing what granulated carbon absorption systems offer as a control technology and the use of bio-filters as a digestion system. Most of these articles described only bio-filtration units or granulated carbon absorption systems, it has been understood that in an aerobic environment, degradation (bio-oxidation) of the pollutants

occurred in the bio-film, and the bio-film was attached around the carbon particles, which make up the granulated carbon bed. The oxidation reacted bi-products are carbon dioxide, water.

The parameters that were needed to characterize the size and estimate the cost of building a GACBF unit are well understood. If we adopt the presently used representation of the design parameters, they included the empty bed residence time (EBRT) in seconds, which is calculated as the volume of the space occupied by the packing material (assuming no void volume) divided by the air-flow rate.

Efforts to model the performance (microbial pollutant removal) of bio-filtration are abundant and very specific, as most modeling work is.

In 1997 OAQPS hosted the 1997 Air Bio-filtration or reactor Meeting. The purpose of the meeting was to bring together the wood furniture industry, academic institutions, and manufacturers. Thus United States Environmental Protection Agency would have a better understanding of the state of the technology and would learn more about the information that EPA needs to consider such a technology as an industrial control option.

GACBF systems were discussed during the later 1997 meeting. Among the latest of designs presented was the patented rotating drum called the Filtercobe® GACBF system, which used a granulated activated carbon bed and was offering a self carbon cleaning system that produced no bio-mass waste.

GACBF System

In the Filtercrobe® granulated activated carbon is housed within a stainless steel rotating drum (or wheel) which is used to capture (absorb) the pollutants in the waste or off-gas process stream. During the rotation of the drum the pollutants are trapped within the granulated carbon and leached into a bath of oxygenated water, it is here that the micro-organisms reside and destruction of the hazardous pollutants occurs. The hazardous pollutants are leached to the microbial water bath during the drum rotation. Rotation of the drum will cause turbulence at the water surface and the trapped pollutants detaches from the granulated activated carbon into the water. A working system is in operation in the United States and is being used for the bio-oxidation of emissions from a fiberglass boat manufacturing facility.

The GACBF system as discussed is able to control the emissions of pollutants from the waste gas process stream, to a specific designed level capable of reaching 99%+ destruction efficiency. Various microbial and structural systems may be addressed based on the pollutant type and if they contain halogenated hydrocarbons.

The combination granulated activated carbon/bio-filtration system such as the Filtercrobe® produce no biomass during the bio-oxidation reaction, which would have to be disposed of. Particulate matter should be limited within the process stream as this matter may be released during the submersion of the bio-filter reactor bed and cause the production of bio mass to occur. Water must also periodically be drained from system, but requires no down time as the granulated activated carbon absorbs the pollutants until the system is re-filled with water and

microbes. The amounts and quantity of the drain will depend on the type emissions and operation of a system, but are usually between 1 and 12 months. The bio oxidation reaction creates by-products which are carbon dioxide and water vapor. The microbes are natural occurring and as such periodically need to be replaced. Disposition of the natural occurring microbes may be completed by normal waste water treatment.

Sizing And Cost Of A Bio-Filtration Systems

The installed cost of a specific type Filtercrobe ® GACBF system depends on the amount and pollutant being degraded. There are also variations within a type of system and across types. For a medium sized closed bed system where input and output streams can be readily monitored medium-sized, the Filtercrobe® system, designed for destruction of styrene, Type 4a (activated carbon), the costs are around $230 per month, and will vary with the cost of electricity. The pre-installation cost is estimated to be approximately ($14-18/cfm). The actual cost of a system and cost of operation may vary with size and loading capabilities.

Discussions And Conclusions

Bio-filtration systems, especially the open bed systems, were widely used in the early 1990s in Europe, because odor standards were in place, which required controlling nuisance from species in amounts less than less than 50 ppmv. However, in the U.S. the focus was to destroy VOCs and HAPs. The GACBF technology for higher level VOCs and HAPs has recently proven as a viable system for industrial emission control. This may more accurately explain why bio-filtration technology has gained a much smaller share of the U.S. market than more traditional control technologies.

To date one such system the Filtercrobe® system has been controlling VOC and HAPs emissions. Many of the prior systems have been designed for odor control, where this technology is said to be both reliable and economic, great advances have been made using the Filtercrobe® GACBF system for emission control. Odor treatment currently remains the largest market for the pure bio-filtration technology which includes odors from waste water treatment, such as sludge treatment, pulp and paper production, tobacco production, and bakery operations. However, GACBF applications involving SO2, NOx from coal fired power plants and combinations of complex hydrocarbons involving hazardous waste are currently under discussions for large scale applications.

The Filtercrobe® GACBF system is designed to meet performance requirements as required in United States Environmental Protection Agency regulations and is presently competing against more traditional control devices, such as regenerative thermal oxidizers, catalytic thermal oxidizer, direct fired thermal oxidizers.

For more information about the Filtercrobe® or specific destruction efficiencies as it may relate to your specific emissions, please contact American Environmental Fabrication & Supply at www.american-environmental.us or call +1 918 708-1253. Representatives will be happy to discuss conversion of older technologies or new system applications.