

# Research on the High-Efficiency Complex Bio-Filter Technology and the Cognitive Circuit-Based Management Technology for VOCs Reduction

## 1. Summary

### ■ Purpose of and Need for Research

- Volatile Organic Compounds(VOCs) are hydro-carbon compounds that volatilize in the atmosphere and generate bad odor and ozone, and they contain many carcinogens such as formaldehyde, benzene, acetaldehyde, and chloroform.
- They may cause nervous system disorder through skin contact or inhalation.
- VOCs cause bad odor even at low concentrations, and as compounds themselves, they are directly harmful to the environment and human body, or participate in photo-chemical reactions in the atmosphere and generate secondary pollutants such as photo-chemical oxides.
- VOCs occur mainly in the majority of industrial processes throughout the industry, including manufacturing and storage processes for petro-chemical, refinery, paint, and coating plants, building materials such as paints and adhesives, and storage tanks for gas stations.
- Today, VOC emissions are increasing by more than 10% annually, and are widely emitted from various environmental infrastructures to various industrial facilities.
- The toxicity of these VOCs is becoming increasingly serious in the impacts on the health of human body and environment, and the factories that generate waste gas such as VOCs including bad odors are widely distributed around our lives.
- Therefore, it is urgent to prepare measures for the future including identification of current VOC emissions including bad odors generated in various industrial sites.
- Currently, continuous complaints caused by the spread of bad odor substances including VOCs generated from the industrial complex are occurring but there are limitations in establishing concrete measures to resolve bad odor complaints and to reduce bad odor due to the limitation of research conditions.
- Today, VOC emissions are increasing by more than 10% every year, and the impacts on the health of human body and environment are also becoming increasingly

serious.

- The prevention system for treating such VOCs is very vulnerable to abrupt changes in concentration and flow rate, which limits the effective removal of VOCs.
- As the rapid changes of concentration and flow rate are converted to the same concentration and flow rate and the VOC removal is done effectively when the electro-thermal concentration control module is used, in this research, we want stable treatment and various field applications by using electro-thermal concentration control module, enriching VOCs, converting to the condition of the same concentration and flow rate, and applying to cylinder rotation type bio-filter which is a microbial treatment technology.

#### ■ Contents and Scope of the Research

- Through exhaust emission property research on a local factory, the emission status of VOC and bad odor substances generated in the workplace was closely examined by PID continuous measurement and GC/MS analysis.
- As a result, rapid changes in concentration and flow rate of various types of VOCs and odorous substances were observed.
- Connecting to these characteristics, research was conducted to remove adverse effects of media micro-organisms according to the changes of external loads and flow rates.
- We have researched and developed a pilot-scale concentration system that enriches low concentration VOCs and odorous substances and enriches them in a stable state at a high concentration, and have developed and operated as a treatment system linked to a cylinder rotation type bio-filter.
- A program related to the operation of the electro-thermal concentration control module to automate the operation of developed processing system has been developed.
- In addition, we applied the system based on the electro-thermal concentration control module to a local factory in Korea, and conducted observation and analysis.
- Based on the results of the research, we have continuously improved the defects in the process of operating the electro-thermal concentration control module program, solved problems, and applied them to the local factory.
- In addition, we have researched the improvement of functionality including development of an alternative bio-filter media including organic media, and application of it to a cylinder rotation type bio-filter.

- In addition, the research on the miniaturization of the treatment system through the concentration of VOCs and on the improvement of the economical efficiency such as the scale reduction of the processing facilities through the miniaturization was conducted.
- In addition, we have continued the optimization research of the program and constructed the cylinder rotation type bio-filter system based on the electro-thermal concentration control module through the optimization of operating parameters and the limiting factors to automate the operation of the pretreatment system and to maximize the processing efficiency.

## 2. Research Results

### ■ Results of Research and Development

- As the results of the operation measurements based on the ACF desorption target concentration of 1000ppm, the highest concentration was 1063.8ppm and the lowest was 860.1ppm.
- The average concentration was 973.5ppm, and the VOC concentration ratio was identified to be 10.4 times compared to the average concentration.
- The variation range between the maximum and the minimum concentration entering from the coating booth was 483.5ppm, and the variation range in the ACF desorption rate was 52.1ppm.
- Based on the average concentration, the variation rate was 5.1 and 0.5, and the average concentration-based variation of the incoming VOC and ACF desorption operation was 0.10, achieving the equalization target of 75%.
- As the results of the operation measurements based on the ACF desorption target concentration of 1000ppm, the average concentration of VOCs entering the bio-filter was measured as 973.2ppm and the average concentration of VOC which was removed and going out was measured as 37.7ppm.
- The removal rate of 96% fulfilled the target of 90% of the pilot-scale bio-filter VOC removal rate.
- The Labview (Laboratory Virtual Instrument Engineering Workbench) program used in this project can program the execution order of VIs and functions using the flow of data passing through the node in the block diagram but in this project, using Labview, we have developed a program to control and implement a model made similar to the installation model of the pilot plant that is actually manufactured and

operated.

■ **Plans to Utilize the Results of Research and Development**

- VOCs and odorous substances generated from various industrial sites and environmental infrastructures in Korea are very diverse, and the treatment methods may need to be changed according to the generated substances.
- Therefore, various types of optimization will be carried out by installing a pollutant disposal system for representative domestic sites generating VOCs and odor.
- Supply of a prevention system to process VOCs emitted from a small ship block factory
- Supply of a disposal and prevention system of pollutants for a food waste composting facility
- Development of a bad odor removal device for sewage treatment plants, livestock wastewater treatment plants, and merged septic tanks
- Multi-purpose installation and operation for the treatment of VOCs generated in various industrial sites
- Commercialization plan (domestic and overseas sales, technology export, etc.)

Source: National Scientific & Technological Information Center