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Turbulent Adsorption of VOC in Zeolite Doped Metal Foam

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Extended Abstract

The flow through random cellular structures can lead to efficient mixing to increase system efficiency. Especially, the adsorption process through filtration is greatly influenced by the physical shape of the cellular structures [1]. In this paper, mass transfer due to structural complexity in metal foam structure is evaluated through VOCs removal rate measurement. VOCs refer to liquids or gases containing organic carbon, and generally have a characteristic of being a pollutant that diffuses very quickly. Most of the VOCs are often generated from small nonpoint pollution sources such as automobile exhaust gas and overall occurrence in factory plants [2]. Zeolite is microporous with uniform and small pores, is adsorbed by type according to pore size, has ion exchange, and high heat resistance [3]. In general, when coating the surface of complex structures such as porous media, a coating method by dipping is used. However, when the zeolite used in this study is coated with the dipping method, the organic solvent fills the micro-pores of the zeolite and reducing the adsorption power. Therefore, in this study, a new zeolite coating method using graphene ink was used to prevent the decrease in adsorption power.

Ethylene gas was used as VOCs, and air was added together for ppm control. In order to make the concentration of ethylene injected into the VOCs removal device constant, the mixed gas is introduced through a mixing chamber manufactured by itself. The area flowmeter was used to control the amount of mixed gas input was used in the range of 1-10 l/min. To measure the VOCs concentration, a photoionization VOCs monitor (NEO-181) was used. The measuring range of the VOCs monitor is 0.01 ppm-5,000 ppm, and the accuracy is $\pm$3%. The VOCs monitor has its own pump built in, so it sucks at 400cc/min, and the measured value is saved directly to the computer using its own software. For the experiment, five copper foams with a size of 90 mm x 100 mm and a thickness of 20 mm were connected in series so that the mixed gas passed through a total of 500 mm of the metal foam layer. Therefore, based on the flow rate of 5 l/min, the gas residence time of the metal foam layer (T_r) is 10.13 sec [4].

Experiments were conducted under the conditions of 10 l/min or less. In the case of 20PPI and 40PPI, all removal rate values were more than 10%, and the trend according to the ethylene concentration was also confirmed. However, the high PPI metal-foam increases the pressure drop and the difficulty of the zeolite coating process. Except for the initial concentration condition of 120 ppm, the removal rate of 80% or more can be confirmed up to 2.2 Tr, and it can be seen that the removal rate decreases rapidly under all initial concentration conditions from 2.4 times the residence time of the metal foam. It confirmed that the higher the input concentration, the larger the change in the emission concentration with time at the end of the adsorption section. The higher the partial pressure of the polluting gas, the faster the adsorption rate and the larger the adsorption amount. On the other hand, the fluctuation generated by the random structures evenly contacts the surface of the metal foam with high partial pressure, leading to more efficient adsorption.

References

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