

EXPERIMENTAL STUDY ON THE REOMOVAL OF SULFUR COMPOUNDS AND SILOXANES FROM BIOGAS

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Biogas is a renewable energy source, which can be produced by anaerobic digestion with anaerobic organisms from agriculture waste, manure, municipal waste, sewage, food waste, etc. The biogas consists primarily of methane and carbon dioxide, but also smaller amounts of nitrogen, oxygen, hydrogen and volatile organic compounds including sulfur compounds, halogenated compounds and organic silicon compounds may be present. Here, methane which is the main component in the biogas may be used as a fuel in many applications such as heating, combined heat and power systems, fuel cells, etc. For the implementation of methane, therefore, the biogas needs purification to improve its quality in most cases by removing impurities from the biogas, resulting in no corrosion and scaling problems in the applications.

In the present work, a hybrid biogas purification process, consisting of a physicochemical process with an adsorption for the removal of sulfur compounds and siloxanes and a membrane separation process for the removal of carbon dioxide, has been proposed. The main focus of this study is to examine the physical properties and adsorption characteristics of adsorbents being used to remove sulfur compounds and siloxanes from the biogas. Indeed, recent studies are on the desulfurization and siloxane removal process using an activated carbon and impregnated activated carbon. However, there are many different types of sulfur compounds and siloxanes in the biogas and each may have a different reaction rate and adsorption capacity. In this study, therefore, several commercially-available adsorbents are selected to analyze their removal capacities for the main components (methane) and major impurities in the biogas. The main impurities considered in this work are hydrogen sulfide (H_2S), carbonyl sulfide (COS), carbon disulfide (CS_2), Octamethylcyclotetrasiloxane (D_4) and Decamethylcyclopentasiloxane (D_5), based on the measurements from the on-site sewage treatment plant in Incheon, Korea. In the bench-scale adsorption experiments, iron oxide, activated carbon, impregnated activated carbon and inorganic adsorbents such as zeolite and silica gel are used as adsorbents for the removal of impurities from synthetic biogas and their physical properties are analyzed with XRF, SEM and BET analyses. The experimental results show that the adsorption capacity of hydrogen sulfide in the iron oxide (IO) is superior to those of the activated carbon (AC) and impregnated activated carbon (IAC) with a relatively good adsorption capacity (Figure 1). In addition, the removal efficiency of carbonyl sulfide and carbon disulfide with the activated carbon is more effective than using the iron oxide having a very poor adsorption capacity (Figure 2). It is also shown that both activated carbon and zeolite exhibit a high adsorption capacity of siloxanes D_4 and D_5 . Especially, in case of siloxane D_5 , the zeolite has a better adsorption capacity than the activated carbon (Figure 3). More detailed results will be presented at the conference.

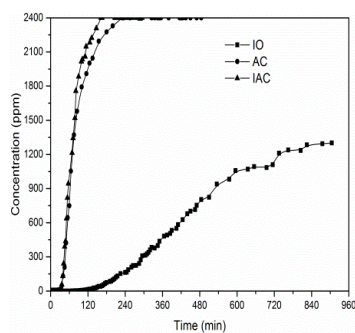


Figure 1 – Adsorption curve of H_2S by IO, AC and IAC

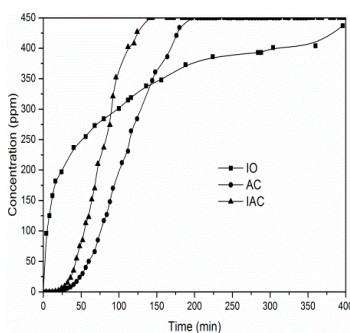


Figure 2 – Adsorption curve of COS by IO, AC and IAC

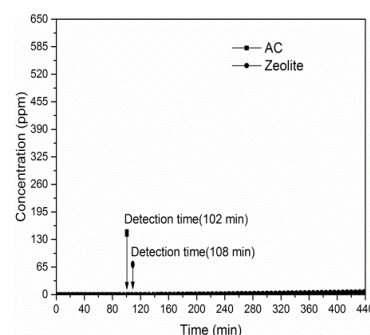


Figure 3 – Adsorption curve of siloxane D_5 by AC and Zeolite