

INFLUENCE OF NICKEL PLATING ON HYDROGEN CHLORIDE REMOVAL OF ACFs

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Introduction

The Industrial Revolution in Europe in the 19th century saw the beginning of air pollution as we know it today, which has gradually become a global problem. Air pollution has been aggravated by four developments: increasing traffic, urban growth, rapid economic development, and industrialization. Air pollution threatens the health of human beings and other living on our planet [1]. The acidic gases such as NO_x, SO_x, and HCl as by-products of incineration processes are major contributors of atmospheric pollution. Most of the well-known techniques for NO_x, SO_x, and HCl removal are the selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR). However, they tend to require large capital investment and devices [2,3]. In order to solve these problems, many researchers have studied acidic gases removal using metal supported on activated carbons (ACs) or activated carbon fibers (ACFs) by metal plating, impregnation, sputtering, and so on without generating any secondary pollution problems. These researches show that the removal efficiency of NO_x and SO_x is improved [4]. The main objective of the present work is to prepare Ni-plated ACFs (Ni/ACFs) by nickel electroplating and to investigate the surface properties and pore structures of the Ni/ACFs. The HCl removal efficiency of the Ni/ACFs was analyzed, and the relationship between nickel in the Ni/ACFs and the chlorine in HCl was investigated.

Experimental

The ACFs obtained from Korea ACF Co. were used in this work. Ni-deposited ACFs were prepared by Ni electroplating at constant velocity and same electric current. Electrolytic nickel plate was used as the anode and ACFs were used as the cathode to be plated. The ACFs were plated with different times 0, 1, 2, 3, and 5 min. The samples were denoted in pristine, Ni-1, Ni-2, Ni-3, and Ni-5. The surface and pore properties of Ni/ACFs were studied in AAS, XRD, and SEM measurements. N₂/77K adsorption isotherms were investigated by BET and D-R plots to characterize the specific surface areas and pore volumes, respectively. HCl removal efficiency was measured by using gas-detecting tubes of two types (GASTEC: 14L and 14M).

Results and Discussion

Figure 1 shows the content (wt%) of nickel on the ACFs as a function of electroplating time. The content of nickel on the ACFs are linearly increased with increasing the plating time, whereas the plating rate decreased gradually due to the presence of nickel on the ACF surface. Also, the surface pore structures on ACFs undergo pore-blocking phenomena owing to deposition of Ni.

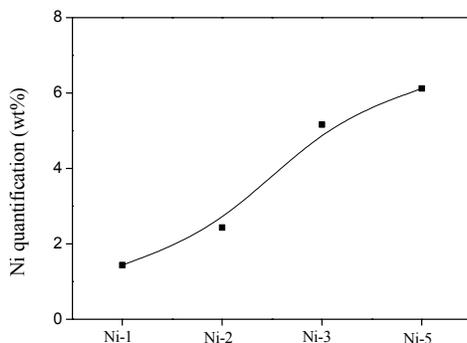


Figure 1. Nickel quantification of the Ni/ACFs

The shapes of adsorption isotherms can provide qualitative information on the adsorption process and the extent of the surface area available to the adsorbate. The results of nitrogen adsorption isotherms are shown in Figure 2. It is clear that the content of nickel has a significant influence on the porosity development.

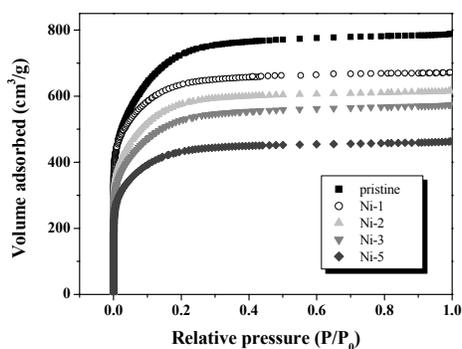


Figure 2. Adsorption isotherms of nitrogen at 77K on the Ni/ACFs

In Figure 2, all of the specimens are the Type I isotherms having well-developed micropores. It is evident that most of the pore volumes of the specimens are filled at low relative pressure, indicating that these ACFs are highly microporous. And specific surface areas and total pore volumes are decreased with increasing the plating time. It

can be seen that Ni-plating shows pore blocking owing to deposition of nickel metal on ACF surface.

The average bulk structure of carbon materials can be revealed using X-ray diffraction. Figure 3 shows the XRD patterns of the Ni/ACFs. As a result, the intensity of the carbon peak in the Ni/ACFs decreased, whereas nickel peaks and crystallinity in the Ni/ACFs are strengthened with increasing the plating time.

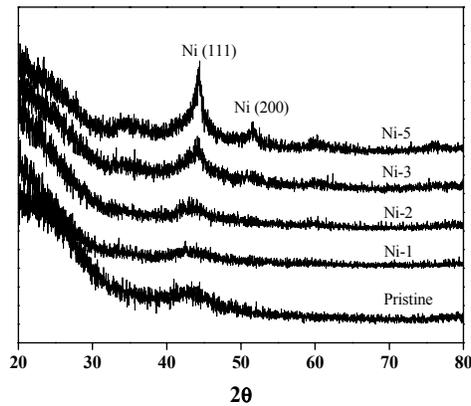


Figure 3. XRD profiles of the Ni/ACFs

The activities of Ni/ACFs for HCl removal are shown in Figure 4. The electrolytic Ni-plated ACFs show much higher removal efficiency than that of non-treated ACFs. And Ni-3 sample shows the highest removal efficiency. It is considered that the removal efficiency is depended on Ni content and the specific surface areas.

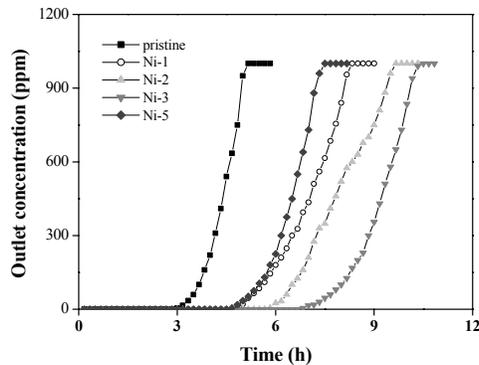


Figure 4. HCl removal efficiency of the Ni/ACFs

Conclusions

In this work, the effects of the surface properties and pore structures of Ni-plated ACFs on HCl removal were investigated. As a result, HCl removal efficiency of Ni/ACFs shows

higher values than non-treated ACFs. It was indicated that the presence of Ni on the ACFs strongly led to an increase of HCl removal efficiency, in spite of the decrease in specific surface areas and total pore volumes. It could be concluded that HCl removal efficiency was basically affected by adsorption properties and the catalytic reactions of Ni on the ACFs. Also, nickel electroplating treatment on ACFs is a useful technique for the removal of noxious gases from the aspect of highly functional metallic catalytic systems.

References

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