RECOVERING DICHLOROMETHANE, CHLOROFORM, TETRA CHLOROMETHANE FROM CHLOROMETHANE MIXTURES BY ACTIVATED CARBON FIBER

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Introduction

Activated carbon fibers have received an increasing attention in recent years as they have unique characteristics compared with granular activated carbons[1,2]. ACF exhibit much faster adsorption kinetics and more complete desorption as compared to granular adsorbents. The application of ACF may lead to smaller adsorption units and more effective recovery of components [3].

This work described the preliminary experimental inspection of an industry process, which comprised the procedures as follows: adsorbing monochloromethane, dichloromethane, chloroform and tetrachloromethane from mixture gases by ACF; desorbing the ACF by using steam and recovering dichloromethane, chloroform and tetra-chloromethane desorbed.

An interesting phenomenon observed was the displacement of previously adsorbed monochloromethane by dichloromethane, which is accompanied by the rise of the temperature of the ACF bed.

Experimental

The adsorbent (ACF- 1500, Liaoyuan Chemical Materials Company was characterised by the nitrogen adsorption isotherm at 77K. The adsorbate is chloromethane mixture. Thermocouple is inserted into the end of the fixed bed to measure temperature changes of the adsorption process. The breakthrough concentrations are analysed by HP6890 GC with HP prapac Q packed column and FID detector. Steam is used to desorb the chloromethane mixtures from the activated carbon fiber bed. The liquid CH_2Cl_2, $CHCl_3$ and CCl_4 are collected from the effluent.

Results and discussion

The effective adsorption capacity, namely, the amount adsorbed when the breakthrough concentration of CH_2Cl_2 is up to 1.37% (according to the industrial requirements) was examined. The effective adsorption capacity is 98.6%, which is very close to the saturate adsorption capacity 104%. It is significant that the temperature rises as the adsorption goes on from the temperature record of the ACF bed. There are two maximum points. The time to arrive at the first maximum temperature is the same as the breakthrough time of CH_3Cl, the second one is the same as the breakthrough time of CH_2Cl_2. This phenomenon is very interesting and useful to the industrial process, which means that the measurement of the temperature change of the tail part of the ACF bed can be used to predict the breakthrough of CH_2Cl_2 if analysis instrument is unavailable. It will be more time and money saving.

At the same time, the displacement between CH_3Cl and CH_2Cl_2 is also observed. For more details see reference [4]. Because dichloromethane has stronger adsorbabilities than mono-chloromethane, it has more power to occupy the adsorption sites, it pushes the mono chloromethane out from the adsorption site and finally make all mono chloromethane move from ACF bed. For the industrial purpose of this research, this displacement phenomenon is helpful to separate chloromethane mixtures.

Desorption for recovering dichloro-methane, chloroform and tetra chloromethane is examined too. The desorption rate is equal to the mass of the liquid mixture of dichloromethane, chloroform and tetra chloromethane collected divided by the effective adsorption amount. Because the liquid chloromethane mixture is collected together with the condensed water, chloromethane is slight soluble in water, it is difficult to calculate the precise desorption rate. If the chloromethane dissolved in water is neglected, the desorption rate is up to 96%, which shows the desorption from the ACF is almost complete. This is also testified by the additional experiment: there is no chloromethane detectable of the tail gas when the ACF bed is dried by hot air after desorption by steam.

Conclusion

This type of activated carbon fiber is used to separate mono chloromethane from chloromethane mixtures by adsorption and recovery dichloromethane, chloroform and tetra chloromethane by desorption successfully. The displacement of mono chloromethane by dichloromethane is advantageous to separate mono chloromethane from the mixtures. The temperature curve of the ACF bed can be used to indicate the breakthrough of mono chloromethane and dichloromethane, the adsorption process can be switched to the desorption process when temperature of the ACF bed rises once more. The liquid dichloromethane, chloroform and tetra chloromethane are recovered from the desorption effluent. The recovery rate is greater than 96%, which shows the desorption is almost complete.

References

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