SURFACTANT-ENHANCED CATALYST DISPERSION ON CARBONACEOUS MATERIALS

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Introduction

Catalyst loading and activity are dependent on the surface properties of coals and carbons. For this reason, several techniques (1,2) have been applied in an effort to improve catalyst loading and dispersion in these solids. Although surfactants have been applied to improve the dispersion and stabilities of coal-water slurries (3), their effects on catalyst loading and dispersion on carbonaceous solids have not been investigated. The purpose of this study is to enhance catalyst dispersion in carbons and coal prior to conversion by pretreatment with surfactants. This technique will be compared to catalyst loading using the incipient wetness method, ion-exchange and physical mixing of the catalyst. Results on the effects of coal pretreatment with surfactants followed by catalyst adsorption and char gasification are also presented.

Experimental

A Darco activated carbon (20-40 mesh size) was loaded with iron using ion-exchange and the incipient wetness techniques and by physically mixing the iron nitrate catalyst precursor with the carbon. For the ion-exchange method, 50 mL of 0.1 mol/L iron (as the metal) solution were introduced into 250 mL flasks containing 2 g of the carbon and the pHs were adjusted to about 2, 6 and 10 to obtain different levels of metal ion-exchange onto the carbon. After shaking the samples for 24 h to effect metal loading, the pHs of the samples were redetermined and the samples were filtered. The carbons were chemically analyzed for iron by Galbraith Laboratories, Knoxville, TN.

Results and Discussion

The gasification results for the surfactant-treated coals in Figure 1 show that pretreatment of the coal with surfactant reduced the carbon burn-off rates compared to that of the unloaded coal. These results are surprising since it was expected that the surfactants will increase catalyst loading and dispersion and enhance the char gasification activity.

The gasification of the carbon and its iron-containing samples are shown in Figures 2, 3 and 4 for catalyst addition using the ion-exchange, the incipient wetness and the physical mixing techniques, respectively. As shown in these figures, the samples containing iron are more reactive. In addition, the char burn-off increased with increase in the catalyst content of the carbons. Comparison of Figures 3 and 4 shows that at similar catalyst contents of 1, 5 or 10 wt% iron, the specimen that was loaded using the incipient wetness technique was more reactive at comparable catalyst loadings than those that were added by physical mixing. For instance, the carbon burn-off at 10 wt% iron was about 75 wt% for the former and 67 wt% for the latter. Similar levels of char reactivities were obtained for the catalysts that were ion-exchanged. However, it should be noted that the catalyst content of the ion-exchanged samples were 0.2, 0.8 and 8 wt% Fe compared to 1, 5 and 10 wt% Fe for physical mixing of the metal with the carbon.

In summary, the results of char gasification in CO_2 at 850°C show that, compared to catalyst addition using the ion-exchange and physical mixing methods, higher gasification rates were obtained when iron was loaded onto carbon by the incipient wetness technique. This implies that higher catalyst dispersion may occur in these samples. Catalyst dispersion studies will confirm this hypothesis. Further studies involving surfactants are in progress to gain better understanding of the effects of surfactants on catalyst loading and gasification activity.

Acknowledgments

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References

1. McCormick, R. L., Jha, M. C., *Energy & Fuels*, 1995, 9, 1043.
2. Nishiyama, Y., *Fuel Proc. Tech.*, 1991, 29, 31.
3. Fuerstenau, D. W., Rosenbaum, J. M., Laskowski, J., *J. Coll. Surf.*, 1983, 8, 137.

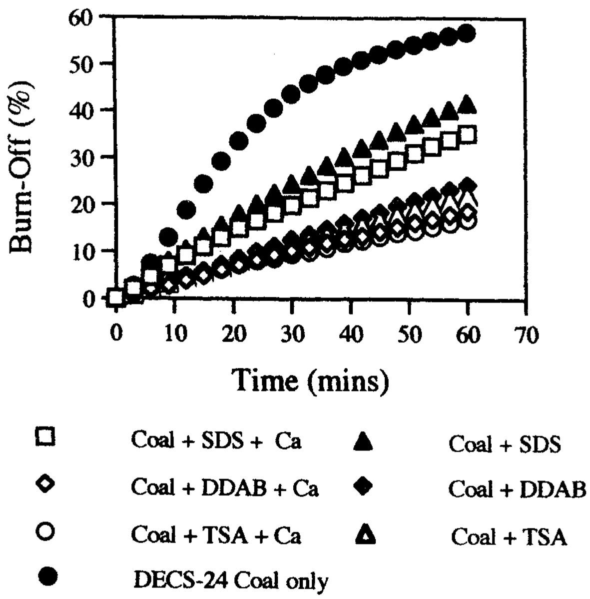

Figure 1. Gasification of Illinois No. 6 coal and its samples after surfactant and calcium adsorption.

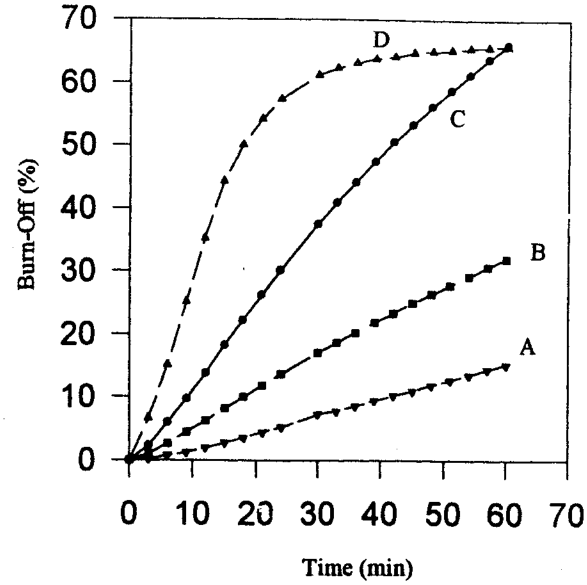

Figure 2. CO_2 conversion of chars containing iron loaded by the ion-exchange technique. A = 0, B = 0.2, C = 0.8, D = 8 wt. % Fe.

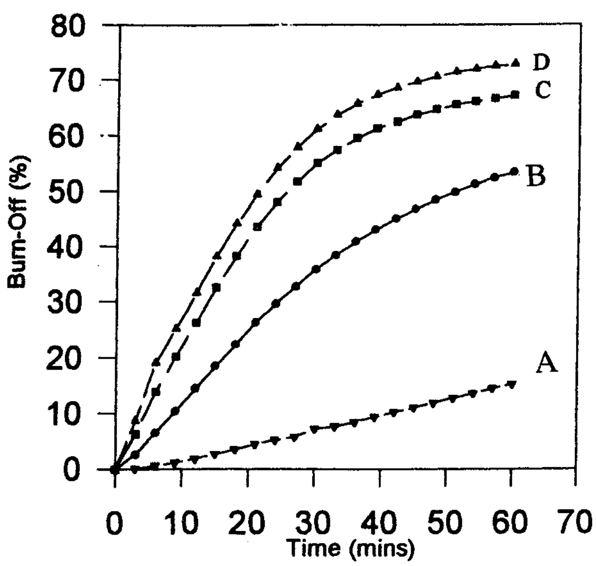

Figure 3. Gasification of chars containing iron loaded by the incipient wetness method. A = 0, B = 1, C = 5, D = 10 wt. % Fe.

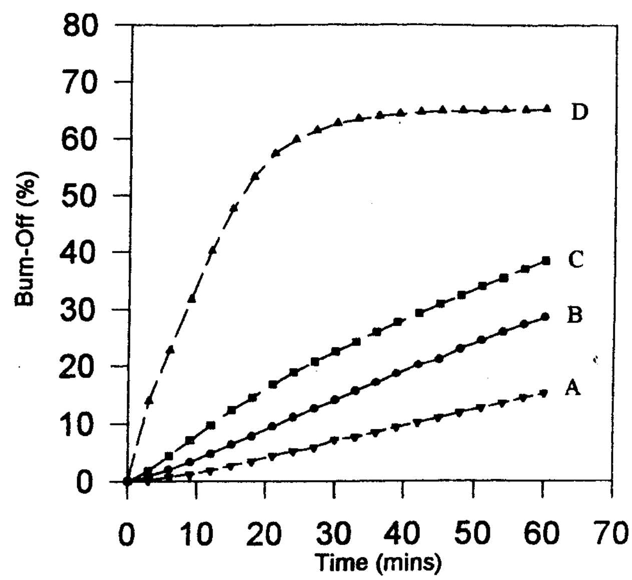

Figure 4. Gasification of carbon chars containing iron loaded by physically mixing iron catalyst precursor with the carbon. A = 0, B = 1, C = 5, D =10 wt. % Fe.