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# The State of Rhenium in Pt/Re/Alumina Catalyst

Webb (*1*) has presented strong evidence that in an oxidized catalyst consisting of 3.5% Re supported on alumina, the rhenium is completely converted to metal upon treatment with hydrogen at 400–450°C. In contrast, Johnson and LeRoy (*2*) reported that rhenium in catalysts containing up to 1.18% Re is not reduced below the $Re^{4+}$ state.

There are at least two factors to be considered in this apparent contradiction—the rhenium content, and dryness of the system during reduction. Oxides such as rhenium on supports such as alumina often interact with these supports. As a result, reduction of the supported oxide to metal becomes more difficult, because of the lowered free energy of the oxide-support system. For a given system, there must be a composition above which the chemical behavior of the oxide is more like that of bulk oxide than of the supported oxide. It is not unexpected, then, that metallic rhenium would be produced by reduction of a catalyst containing more than 1.2% rhenium, on alumina.

This explanation does not, however, account for Webb's finding that *all* of the rhenium interacts with 7 equiv of hydrogen in the reduction process. Thermodynamic considerations also suggest that in a particular temperature range, 400–482°C in this instance, a change in water partial pressure can alter the degree to which supported rhenium oxide can reduce to metal. Webb's observations can be explained in this light. However, there is not necessarily any contradiction of the Johnson and LeRoy finding that the active state of rhenium, at concentration levels generally used in reforming catalysts, and under conditions which are not extraordinarily dry, is the $Re^{4+}$ state.

## REFERENCES

1. Webb, A., *J. Catal.* **39**, 485–487 (1975).
2. Johnson, M. F. L., and LeRoy, V. M., *J. Catal.* **35**, 434 (1974).

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