JOURNAL OF CATALYSIS 48, 447–448 (1977)

Answer to Comments from Professor Selwood

In a letter to the editors Selwood (*1*) expressed the opinion that Van Meerten *et al.* (*2*) have confused the symbols ϵ and α used by Selwood (*3*) and Martin *et al.* (*4*), respectively, and that they have misquoted Martin's equation.

We acknowledge that our use of symbols may cause confusion. We were conscious of the fact that Martin *et al.* (*4*) expressed their α per *molecule* of hydrogen: in the second paragraph of (*2*) we also used an α, but with the value 0.7. So ϵ(Selwood) $= \frac{1}{2}\alpha$(Martin) $= \alpha$(Van Meerten). ϵ and α are defined as the change in magnetic moment of the adsorbent caused by the chemisorption of hydrogen *related to absolute zero.*

According to Martin *et al.* (*4*) at other temperatures the change in magnetic moment, α_{mes}, is less, following the relation

$$\alpha = \alpha_{\mathrm{mes}} \frac{M_0}{M_s}, \tag{1}$$

with M_0 the saturation magnetization extrapolated to absolute zero, and M_s the saturation magnetization at any temperature. To be in line with the text following in the paper (*2*) we wrote after rearrangement of Martin's relation

$$\epsilon(T) = \frac{I_{\mathrm{sp}}(T°\mathrm{K})}{I_{\mathrm{sp}}(0°\mathrm{K})}, \tag{2}$$

where $\epsilon(T) = \frac{1}{2}\alpha_{\mathrm{mes}}$ (Martin), α(Van Meerten) $= \frac{1}{2}\alpha$(Martin), I_{sp} the spontaneous magnetization and the quotient $I_{\mathrm{sp}}(T)/I_{\mathrm{sp}}(0) = M_s/M_0$. On the contrary in low-field magnetization measurements Selwood (*5*) found that in his relation for the fractional loss of magnetization

$$\frac{\Delta M}{M} = \frac{2N_{\mathrm{H}}\epsilon\beta}{I_{\mathrm{sp}}V}, \tag{3}$$

where N_{H} is the number of hydrogen atoms adsorbed on the sample and V is the volume of ferromagnetic adsorbent, β the Bohr magneton, the only temperature dependence was located in the spontaneous magnetization. ϵ proved equal at −78 and 206°C.

Following Geus and Nobel (*6*) and Martin *et al.* (*4*) we introduced in Eq. (3) a temperature dependent $\epsilon(T)$ according to Eq. (2) so that the fractional loss of magnetization became temperature independent,

$$\frac{\Delta M}{M} = \frac{2N_{\mathrm{H}}\epsilon(T)\beta}{I_{\mathrm{sp}}(T)V} = \frac{2N_{\mathrm{H}}\alpha\beta}{I_{\mathrm{sp}}(0°\mathrm{K})V}. \tag{4}$$

Admittedly some of the results reported by us in (*2*) confirm findings by others reported in earlier publications. However, one should recognize that significant differences do exist between different nickel on silica catalysts, so that we felt that verification of these findings for our catalyst was not superfluous.

Our attention in (*2*) was especially directed to measurements under reaction conditions. This paper (*2*) is the third in a series of four papers on benzene hydrogenation on Ni/SiO_2. The important new facts reported in (*2*) are:

i. Adsorption of hydrogen is not homogeneously distributed over the nickel crystallite size distribution.

ISSN 0021-9517

ii. The hydrogen active in hydrogenation does not compete with benzene on the surface of our catalyst.

iii. Only a small fraction of the nickel surface plays an active part in the reaction.

iv. A weakly bound form of dissociatively adsorbed hydrogen reacts with benzene during the flow of hydrogen and benzene over the catalyst.

REFERENCES

1. Selwood, P. W., *J. Catal.* **48**, 445 (1977).
2. Van Meerten, R. Z. C., De Graaf, T. F. M., and Coenen, J. W. E., *J. Catal.* **46**, 1 (1977).
3. Selwood, P. W., "Adsorption and Collective Paramagnetism" Academic Press, New York, 1962.
4. Martin, G. A., De Montgolfier, P., and Imelik, B., *Surface Sci.* **36**, 675 (1973).
5. Selwood, P. W., "Adsorption and Collective Paramagnetism," p. 107. Academic Press, New York, 1962.
6. Geus, J., and Nobel, A. P. P., *J. Catal.* **6**, 108 (1966).

R. Z. C. van Meerten
J. W. E. Coenen

Department of Catalysis
Faculteit der Wiskunde en Natuurwetenschappen
University of Nijmegen
Toernooiveld, Nijmegen, The Netherlands

Received March 16, 1977