

dependent on the kind of solvent used, but other factors must be operating: their nature will only be revealed by further work.

### Other Reactions

Sokol'skii and his associates report (3) for the hydrogenation of olefins (cyclohexene and 1-heptene) using ruthenium-platinum catalysts that maximum rates occur at 45 and 88 atomic per cent ruthenium. We originally showed the existence of a maximum rate for the hydrogenation of maleic acid in methanol at about 30 atomic per cent ruthenium and have since found a maximum at about the same concentration in glacial acetic acid.

One of the interesting features of our earlier work was that, with acetylenic substances such as methylbutynol, maximum rates occurred with very low concentrations of ruthenium: the Engelhard group report (4) a similar observation (almost the only point of agreement between us) but their maximum rate is only about 20 per cent greater than for PtO<sub>2</sub> whereas we found a maximum rate about 2.2 times greater.

### Other Catalysts

Comparison of our results with those of the Engelhard group for rhodium-platinum catalysts again demonstrates the existence of a large solvent effect. With this system glacial acetic acid is a much better solvent than methanol for nitrobenzene hydrogenation: with methanol we find rates which vary somewhat erratically with catalyst composition, the maximum rate (at 39 atomic per cent rhodium) being only about 50 per cent greater than for PtO<sub>2</sub>. However, with glacial acetic acid as solvent the maximum rate occurs at the same composition but is four times greater than for PtO<sub>2</sub>. Rylander reports the factor to be about 2.5. Again we cannot compare absolute rates for the reasons given.

### Conclusions

Substantial and inexplicable differences are shown between the results of the various groups which have worked on mixed platinum

group metal catalysts. Solvent effects are partly responsible, but the precise method of preparing the mixed oxides and differences in experimental procedure are other possible factors which may account for the discrepancies.

Ruthenium-platinum oxide catalysts, their preparation and use, are covered by British Patent Nos 1,099,406 and 1,016,058 and U.S. Patent No. 3,305,402, and are the subject of pending patent applications in a number of other countries.

### References

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## Complexes of Substituted Olefins with Salts of the Platinum Metals

One of the small but intriguing parts of organometallic chemistry concerns the complexes formed between salts of the transition metals—more particularly those of the platinum metals—and substituted olefins. The discovery of this class of compound has not only advanced our knowledge of chemistry and of chemical bonding, but has stimulated our understanding of catalytic processes both in solution and at solid surfaces. A recent review by Richard Jones of the ICI Petrochemical and Polymer Laboratory (*Chem. Rev.*, 1968, **68**, 785) provides a thorough survey of this field. Among the type of substituents discussed are halogens, where perfluoro-olefins behave in some respects quite differently from simple olefins, and amine and cyanide groups, both of which may also chelate to the central metal atom. Complexes of this type provide an increased range of stabilities by comparison with their unsubstituted analogues, and may well find industrial uses in the tailor-making of catalysts of specific activity.