

The Catalytic Hydrogenation of Indoles

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INDOLES are usually reduced to indolines by chemical methods or by catalytic hydrogenation at high temperatures and pressures. For 2,3-disubstituted indoles the equilibrium between

indole and indoline is unfavourable to catalytic hydrogenation¹ and chemical methods are often inconvenient. Booth *et al.*² reduced 1,2,3,4-tetrahydrocarbazole to the hexahydro-derivative using Raney nickel and copper chromite catalysts at 120 atm. pressure. Their yields, however, did not exceed 20%.

We have investigated the catalytic hydrogenation of several indoles, including substituted

about 1:1 ethanol-aqueous fluoroboric acid. The catalyst used was platinum oxide. Experimental details and results are given in the table.

Reaction products were analysed by vapour-phase chromatography. The only products giving more than one peak were the reduction products of indole and 3-methylindole where the major impurity was the unreduced indole. Major products were identified by their infrared spectra and

TABLE

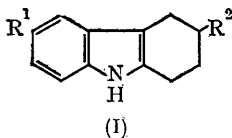
Hydrogenation of System

(I) Indole* R ¹ R ²		Vol. HBF ₄	Vol. EtOH	Reaction† Time (mins)	Extent of Reduction to Indoline (by v.p.c.)	m.p./b.p. of Product
H	H	20	15	45	quantitative	m.p. 95—96°
Me	H	15	10	42	„	m.p. 30—31°
H	Me	15	10	65	„	m.p. 54—56°
Me ₃ C	H	15	15	50	„	m.p. 64—65°
H	Me ₃ C	15	10	375	„	m.p. 75—77°
	Indole	12	10	255	>85%	b.p. 100°/0.5 mm.
	3-Methylindole	15	15	300	>95%	picrate m.p. 154°

* Weight of indole hydrogenated, 1.0 g.; weight of catalyst, 0.01—0.05 g.

† For uptake of 1 mole. equivalent of hydrogen.

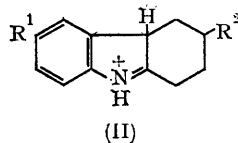
tetrahydrocarbazoles (I), and have devised an experimental procedure which leads to complete and rapid hydrogenation. It is important that either the indole to be reduced is stable in strongly acidic solutions, or that the rate of hydrogenation is rapid relative to the rate of polymerisation. Indole itself can be reduced by our method.



The hydrogenations were carried out in a conventional glass apparatus at atmospheric pressure and room temperature. The base was dissolved in ethanol and fluoroboric acid solution (42% w/w) added. In our experiments the final solution was

physical properties. All new compounds gave correct analyses.

It is noteworthy that the 3-substituted hexahydrocarbazoles prepared were sharply-melting compounds giving only one peak upon vapour-phase chromatography. This suggests that only one of the possible stereoisomers is formed. The reduction of 3-methyltetrahydrocarbazole with tin and hydrochloric acid yielded a product identical with that obtained by catalytic hydrogenation. Indoles protonate at the 3-position and it is probable that we are observing hydrogenation of the C=N in the indolenine system (II).



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¹ H. Adkins and R. E. Burks, Jr., *J. Amer. Chem. Soc.*, 1948, **70**, 4174.

² H. Booth, F. E. King, and J. Parrick, *J. Chem. Soc.*, 1958, 2302.