Low-temperature Catalytic Reduction of Nitric Oxide by Carbon Monoxide on SnO_2–CuO Gels

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Summary After thermal activation at 450°, coprecipitated SnO_2–CuO gels, particularly those having a Cu:Sn atomic ratio of between 0·5:1 and 0·6:1, show high activity and high selectivity for N_2 formation at low temperature (150°) in the catalytic reduction of NO with CO compared with a commercial barium-promoted copper chromite catalyst (Girdler G-22).

The low-temperature catalytic reduction of NO to N_2O and, more importantly, N_2 has been extensively studied with a view to automobile exhaust purification. Comparative studies[1,2] of laboratory-prepared and commercial catalysts, including promoted and supported oxides and supported metals (*e.g.* Ni, Pt, Ru, Rh) have shown commercial barium-promoted copper chromite (Girdler Catalyst G-22, Chemetron Corp.) to be the most active catalyst at low temperatures (100—200°). Coprecipitated SnO_2–CuO gels, which we have previously shown to be active low-temperature CO-oxidation catalysts,[3] are now shown to be very active catalysts at 150° for the NO–CO reaction, and to exhibit high N_2 selectivity at this temperature.

The Table shows a comparison of the catalytic activities of various batches of SnO_2–CuO gels,[3] similarly prepared Al_2O_3–CuO gels, SnO_2 gel,[4] and commercial barium-promoted copper chromite (granulated Girdler G-22 pellets, nominal composition 23·3% Cr, 32·6% Cu, 9·6% Ba) for the CO–NO reaction at 150°. Each catalyst was pre-activated at 450°, first in air for 3 h, then in argon for 16 h. The product gases were separated and analysed on a Molecular Sieve type 5A column (Perkin-Elmer F 11 gas chromatograph, hot wire detectors, and He carrier gas) at 100° (N_2, NO, and CO) and 350° (N_2O and CO_2). NO conversion data quoted in the Table refer to the reaction after 6 h (essentially steady state), and the quoted specific surface areas refer to the used catalysts.

Table. Reduction, at 150°, of 12—14% NO in CO at flow rate of 30 cm^3 min^{-1} through 36—72 B.S.S. mesh catalysts activated at 450°.

Catalyst	Weight (g)	S^{N}_{BET} (m^2g^{-1})	% NO conversion to N_2	to N_2O	Total
SnO_2,0·51-CuO	0·5	109	39	32	71
SnO_2,0·52-CuO	1·0	90	68	24	92
SnO_2,0·55-CuO	0·5	112	42	30	72
Girdler G-22	1·0	40	<1	17	17
Girdler G-22[a]	1·0	65	14	22	36
SnO_2	1·0	30	0	0	0
Al_2O_3,0·20-CuO	1·0	250	0	0	0
Al_2O_3,0·73-CuO	1·0	104	0	0	0

[a] Pre-reduced in CO at 450° for 16 h.

The inactivity of the SnO_2 and Al_2O_3–CuO gels at 150° illustrates the synergistic effect on catalytic activity of coprecipitating Sn^{IV} and Cu^{II} oxides, previously observed for CO oxidation on SnO_2–CuO gels[3] and subsequently to be described in more detail.[5] As has been previously reported[1] pre-reduction of Girdler Catalyst G-22 was found to enhance its activity, particularly for N_2 selectivity, but this is at least partly accounted for by an increase in specific surface area on reduction. It is apparent from the Table that, on both a unit surface area and a unit weight basis, the SnO_2–CuO catalysts have superior activity for the NO–CO reaction and, in particular, a much higher selectivity for reduction to N_2 compared with the Girdler G-22 catalyst.

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