Carbon Monoxide Oxidation Rates Computed for Automobile Thermal Reactor Conditions

Carbon monoxide oxidation rates have been computed by integrating differential equations for a system of 29 reversible chemical reactions. At temperatures above 1030°K (1394°F), oxidation is rapid and is complete in one-fourth of the residence time in thermal reactors for exhaust manifolds.

The reactors are noncatalytic replacements for conventional exhaust manifolds and are a system for reducing carbon monoxide and hydrocarbons in automobile exhausts. Secondary air is injected at the cylinder exhaust ports and reacts with pollutants in a well-insulated container which replaces the usual exhaust manifold. The thermal reactor provides volume both for mixing the added air with the exhaust gas and for the subsequent reaction.

Concentrations of the various chemical species as a function of time were determined by summing the extent of reaction of a large number of simultaneous and competing chemical reactions. In these, the individual rates are dependent on concentration and temperature; temperature, in turn, depends on changes in composition. Solution for temperature and composition requires the integration of a set of first order, nonlinear differential equations. The system was assumed to be adiabatic and to obey the ideal gas law. Carbon monoxide and hydrogen are the major combustibles in the untreated exhaust gas and may amount to several percent by volume. Hydrocarbon concentrations are considerably smaller amounting to several hundred parts per million.

Carbon monoxide oxidation rates for various initial temperatures are shown in the figure. The residence time in a typical thermal reactor is about 20 milliseconds; whereas, at temperatures somewhat above 1100°K (1520°F), oxidation is substantially complete in 5 milliseconds. Thus, excess air definitely promotes the final cleanup of the last traces of carbon monoxide.

(continued overleaf)
Notes:
1. With the rate limiting process identified, a more rational design of the thermal reactor should be possible.

2. The following documentation may be obtained from:
   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)


3. Technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: TSP72-10137

Patent status:
No patent action is contemplated by NASA.

Source: R. S. Brokaw and D. A. Bittker of Lewis Research Center (LEW-11638)