THE KINETICS OF THE REDUCTION OF LEAD MONOXIDE
BY HYDROGEN

by

I.G. Matthew, B.Sc., B.E.

of the

Department of Mining, Metallurgical and Chemical Engineering

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ABSTRACT

The kinetics of the reduction of yellow lead monoxide by hydrogen according to the reaction

\[ \text{PbO (s) + H}_2(\text{g}) \rightarrow \text{Pb (l) + H}_2\text{O (g)} \]

have been investigated. The reaction rates have been measured by one of two different experimental techniques, depending upon the composition of the gaseous reductants. Particles of various sizes lying with the limits 5 to 52 B.S.S. have been reduced with pure hydrogen, hydrogen-nitrogen, and hydrogen-water vapour mixtures.

The reaction rate is increased markedly by an increase in the temperature, being approximately proportional to the twenty-second power of the absolute temperature. The activation energy is 40 ± 4 kcal/g-mole. The reaction rate is approximately directly proportional to the hydrogen partial pressure for reduction with hydrogen-nitrogen mixtures, but with hydrogen-water vapour mixtures the reaction rate is depressed to a greater extent than with nitrogen. The correlation \( R = x/(Ax + B) \), where \( R \) is the reaction rate, \( x \) is the percentage of lead monoxide unreduced, and \( A \) and \( B \) are constants, applies for most conditions, but only for values of \( x \) between 0 and 90.

The reaction exhibits none of the characteristics of mass transfer control and accordingly the chemical reaction must be rate controlling. By fitting the experimental data to rate equations derived using the concepts of the extended Langmuir-
Hinshelwood theory, it is demonstrated that the adsorption of hydrogen, either as a dissociated or an undissociated molecule, is the indicated rate controlling step.

Microscopic examination reveals that the zones of metallization are irregularly distributed throughout the particles of lead monoxide.