PARTICLE DYNAMICS IN VERTICAL PNEUMATIC TRANSPORT AND THEIR APPLICATION TO THE TRANSPORT REDUCTION OF NICKEL OXIDE WITH HYDROGEN

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SUMMARY

The dynamics of particles in vertical pneumatic transport have been examined both theoretically and experimentally with particular reference to the acceleration zone. A theoretical model has been proposed in which the mean particle velocity is related to the observed pressure drop in the system. The model was tested with a series of experiments using three different sizes of glass spheres (diam. range 1.15 to .64 mm) and one size of steel spheres (1.0 mm diam.) transported with air. The results of the analysis are presented in a form that can be used to determine particle residence times in a vertical pipe from pressure drop measurements. In particular the model can be used to estimate particle residence times in transport system in which a chemical reaction occurs between the transporting gas and the entrained solids.

Three size ranges of sintered nickel monoxide (viz. 35/42, 42/48, 48/60 Tyler screen mesh) have been reduced in both a fixed bed (temp. range 300 -425°C) and in a transport reactor (temp. range 500-700°C). The kinetics of the reduction for the two cases are expressed quantitatively and compared. The results showed that the reaction rates observed for the reduction in the transport reactor were much

faster than those predicted by extrapolation of the fixed bed kinetic data. The marked increase in reaction rate is attributed to a change in reaction mechanism associated with the mode of chemisorption of the hydrogen on the nickel monoxide surface.

The work indicated that both low particle residence times and high reaction temperatures can be controlled quite closely in the transport reactor. It is shown that the transport reactor is particularly suitable for carrying out chemical reactions between a gas and a particulate solid when high reaction temperatures can be used to produce fast reaction rates.