

METALLURGY

Hydrogen Reduction Characteristics of Natural and Artificial Hæmatites

PUBLISHED data on the rate and mechanism of the reduction process in iron oxides are frequently discordant. This lack of agreement is exemplified by two recent studies^{1,2}. McKewan¹, for example, has reported the rate of reduction of hæmatite spheres in the size range 0.6-2.5 cm. to increase continuously from 400 to 1,050° C. I found³, however, that hæmatite particles in the size range 0.002-0.008 cm. showed a rate maximum at about 550° C. and a pronounced rate minimum at 700° C. approximately.

Since this difference in behaviour could be due to a particle-size effect, an apparatus-effect or to different physical properties of the materials, it was decided to repeat the work eliminating the first two of these variables, and using hæmatites similar to those employed in the two investigations in question^{1,2}.

For one series, approximately spherical particles of artificial hæmatite, 0.03 cm. diameter, were prepared by rolling pigment grade ferric oxide (as used by McKewan) in a jar for 1 hr. A screened fraction of this material was fired, in a platinum boat, for 2 hr. in an atmosphere of oxygen at 1,370° C. and then cooled slowly in oxygen to room temperature.

For the other parallel experiments, particles similar in size and shape to the artificial hæmatite were obtained by screening a washed natural hæmatite from Yampi Sound, Western Australia. Part of this

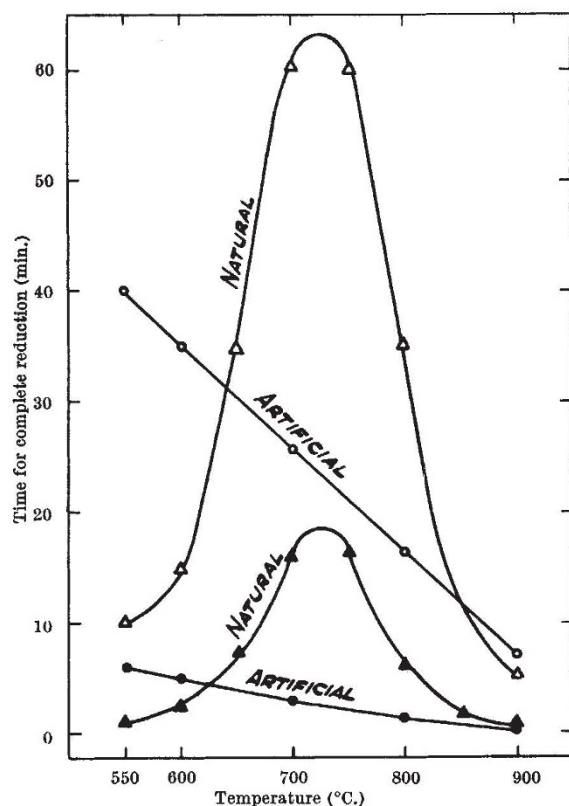


Fig. 1. Dependence on temperature of hydrogen reduction-rate for natural and artificial hæmatites. Δ , 0.03 cm. natural hæmatite, fired at 1,370° C. or dried at 110° C.; \blacktriangle , 0.008 cm. natural hæmatite dried at 110° C.; \circ , 0.03 cm. artificial hæmatite fired at 1,370° C.; \bullet , 0.008 cm. artificial hæmatite dried at 110° C.

material was subjected to the same treatment as the artificial hæmatite and another portion was dried in air at 110° C.

Particles of both artificial and natural hæmatite, approximately 0.003 cm. diameter, were also prepared from screened fractions of the raw materials and dried in air at 110° C. Using a procedure described in ref. 2, 100-mgm. samples of the various materials were reduced in a stream of hydrogen flowing at 2,000 ml./min. The distinctly different results given by the natural and artificial hæmatites are shown in Fig. 1.

In Table 1 some physical properties of the two hæmatites are shown. Both materials are weakly magnetic, and heating them to 500°, 700° and 900° C. respectively, in nitrogen, and quenching, did not alter significantly the lattice parameters shown in Table 1. The only significant differences found so far in the two hæmatites are that, under reflected polarized light, the artificial material shows a pronounced 'sub-structure', while the natural hæmatite shows none and the small amount of gangue material (mainly silica and alumina minerals) present in the natural hæmatite occurs as separate particles, whereas in the artificial material it is present with ferric oxide as composite particles.

Table 1. PHYSICAL PROPERTIES OF HÆMATITES

Property	Hæmatite	
	Natural	Artificial
Fe ₂ O ₃ content (weight per cent)	99.1	99.5
Density (gm./cm. ³)	5.20	5.10
Hexagonal parameters (Å.)	5.085	5.083
	13.75	13.75
Crystallinity*	Monocrystalline	Polycrystalline

* Reflected polarized light examination.

It has been clearly demonstrated that the origin of a hæmatite may influence markedly the dependence on temperature of its hydrogen reduction-rate. Until the reasons for this differing behaviour are discovered, it is apparent that care must be exercised in interpreting or comparing reduction data for hæmatites from different sources.

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¹ McKewan, W. M., *Trans. Amer. Inst. Min. (Metall.) Eng.*, **218**, 2 (1960).

² Henderson, J., *Amer. Inst. Min. (Metall.) Eng., Metall. Soc. Conf.*, **8**, Phys. Chem. of Process Metallurgy, 671 (New York: Interscience, 1961).

ENGINEERING

Power Requirements and Scale-up in Flotation

As part of a systematic programme for correlating mineral engineering process variables^{1,2}, flotation machines are now being investigated. There is no need to stress the engineering importance of the flotation process. First applied more than fifty years ago for the recovery of fine sulphide minerals from Australian gravity plant tailings, to-day it is the