'74— S 684

622.341.11-188.5: 669.162.263.23

(44) REDUCTION STRENGTH OF SUPERFLUXED PELLETS MADE FROM RICH MAGNETITE CONCENTRATE

LKAB, Sweden Gunnar Thaning

Superfluxed pellets with an addition of limestone often show very good metallurgical properties according to conventional tests carried out isothermally at high reduction temperatures, 1000–1100°C. In such tests these pellets have shown favourable swelling results, good reduction strength and very high reducibility. It became apparent, however, that if the reduction is carried out at a low reduction temperature (500–600°C) and at a low reduction potential, i. e. under conditions similar to those in the upper part of the blast furnace stack, heavy disintegration of the same pellets occurs, Fig. 1 (left section). Low-temperature breakdown, usually measured in the LTB-test (1), takes place in the very first phase of the reduction, when the magnetite starts to form. At a low temperature, the magnetite formed is microporous which creates conditions for a weakening of the iron oxide bonds and cracking at the grain boundaries, Fig. 2. If the slag bond is not sufficiently strong, the pellets disintegrate when subjected to the slightest handling. At a high reduction temperature the reduction mechanisms are changed. The initially formed magnetite acquires a different and often quite dense structure and the conditions for disintegration are therefore eliminated at this stage of reduction.

Superfluxed pellets with lime addition contain such slag phases as calcium ferrites, the binding ability of which is weakened due to the fact that they start to be reduced early in the course of reduction. Owing to the stresses caused by the hematite-to-magnetite transition the ferrite phase therefore cracks. On the other hand, the binding phase in acid pellets is not affected by the reduction at this stage. The acid binding phase remains intact and has sufficient mechanical strength to hold the structure in the porous magnetite stage together. Providing a sufficient amount of slag phase is present, disintegration will be insignificant in the case of acid pellets during low-temperature reduction.

The experiments showed that superfluxed pellets disintegrated to a much lesser extent during low-temperature reduction when limestone was replaced by dolomite, Fig. 1 (right section). The binding phase in the "dolomite pellets" contains magnesioferrite which is more stable and is not affected by the reduction during the hematite-to-magnetite transition.

However, it is important that the addition of dolomite is made in such a way that the lime coefficient, CaO/SiO_2, of the pellets is kept between fixed limits, Fig. 3. As in acid pellets superfluxed pellets also contain a silicate phase, which controls the high-temperature strength during reduction. At a low CaO/SiO_2 ratio a vitreous silicate slag is formed and in the case of pellets made from rich magnetite concentrate abnormal swelling caused by growth of iron whiskers occurs when a vitreous slag is present, Fig. 4. The abnormal swelling causes high pressure drops in the Burghardt-Grebe test (1), PHT in Fig. 3.

An increase of the lime coefficient makes the vitreous slag crystallise and this occurs together with a sudden drop from abnormal swelling to normal swelling (2). If the CaO/SiO_2 ratio is raised too much, calcium ferrite is formed in the magnesioferrite, destroying the binding ability of the latter during reduction and again the pellets are exposed to the risk of low temperature disintegration, Fig. 3.

References

1. B Björkvall and G Thaning, Test methods for pellets used in research and production at LKAB, Sweden. Trans. SME/AIME 254 (1973) pp 152–160
2. L Gränse, The influence of slagforming additions on the swelling. Proceedings ICSTIS, Suppl. Trans. ISIJ, 11 (1971) pp 45–51

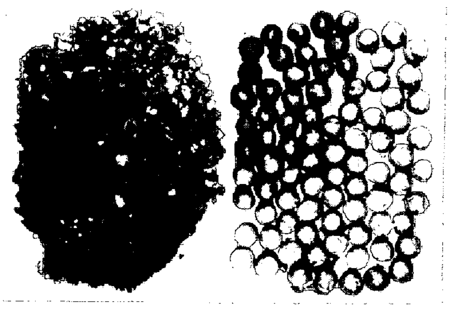

Fig. 1 Superfluxed pellets with lime addition (left) and dolomite addition (wright) after low-temperature breakdown test (LTB)

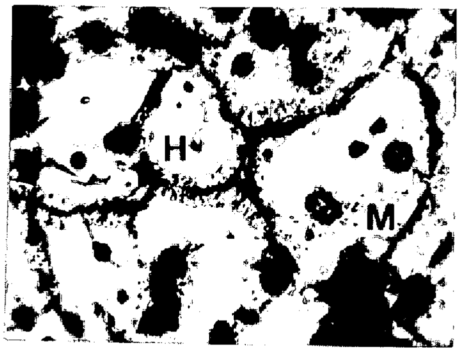

Fig. 2 Cracking at the grain boundaries during the transition of hematite to microporous magnetite. Static reduction at 550°C in 24/16/60 % $CO/CO_2/N_2$. H = hematite, M = magnetite (x 450)

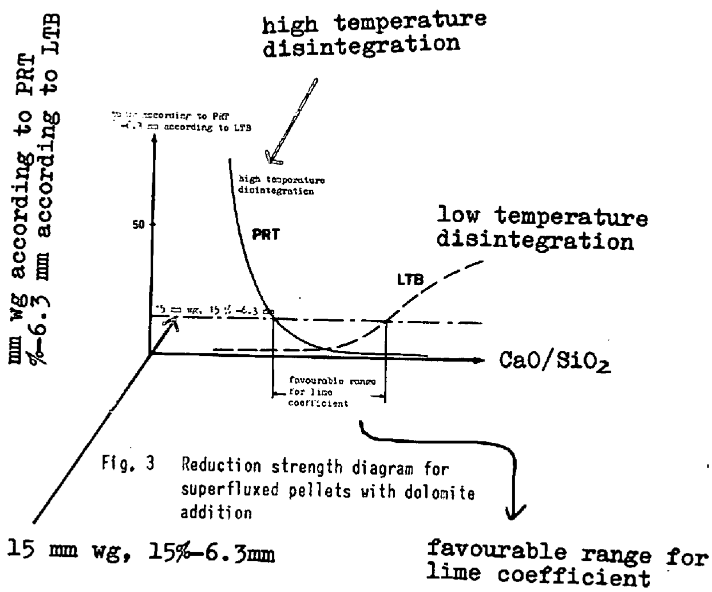

Fig. 3 Reduction strength diagram for superfluxed pellets with dolomite addition

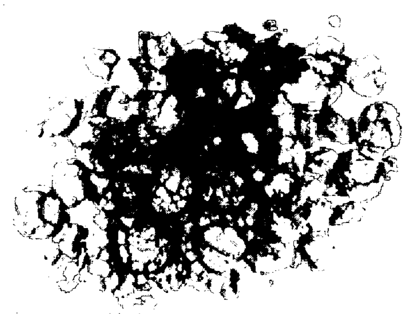

Fig. 4 Dolomite pellets with too low CaO/SiO_2 ratio reduced at 1000°C in 40/60 % CO/N_2