

In reviewing this book the London *Mining Journal* deals with it at considerable length, as follows:

It is almost impossible within the limits of an ordinary review to do full justice to a book such as this one, which, dealing with a comparatively modern branch of metallurgical practice, and containing a mass of facts and up-to-date expert opinion in relation thereto, will probably take rank as a metallurgical classic.

The oxidising smelting of raw sulphide ores in the blast furnace has been variously spoken of as matte smelting, raw sulphide smelting, pyritic smelting, and pyrite smelting, which latter term is considered by the editor of the book, Mr. T. A. Rickard, to be the one most correctly descriptive of the process. Whilst uniformity of nomenclature is much to be desired, it is seldom in any branch of knowledge attained on logical grounds, but is more generally the result of usage. The term "matte smelting" is certainly misleading, since it connotes processes other than the one under consideration; and the same objection applies, though in a lesser degree, to the term "raw sulphide smelting"; whether we use the expression "pyrite smelting" or "pyritic smelting" is of very little import, but we might observe that, although the termination "ic," as here applied, is not quite logically correct, as Mr. Rickard indicates, yet it is more euphonious and is sufficiently descriptive.

Speaking generally, the objects of "pyrite smelting" are, firstly, the concentration of the copper contents of a charge into as rich a matte as possible, and sometimes into a matte sufficiently rich for direct conversion into blister copper or for reverberatory smelting; and secondly, the recovery of the gold and silver by concentration in as rich a matte as possible, consistent with clean slags, and in as few operations as possible. Sometimes one of these objects is of more importance than another, sometimes both are aimed at equally. Incidentally the place of carbon as a fuel is in part taken up by the iron and sulphur existing in combination in the pyritic ores smelted, with a consequent saving of fuel; this is important, as the *raison d'être* of the process is mainly economic.

Briefly, the advantages of pyrite smelting are the efficient and economical concentration of copper into a matte even from low grade pyrites, and the recovery of gold and silver from low grade silicious and pyritic ores at a cost which compares favourably with that of stamp milling and cyaniding or chlorination: the economy of the process consisting in the saving of the cost of roasting and of the upkeep of roasting plant, and the saving of carbonaceous fuel used in the blast furnace.

With a view of thoroughly ventilating the subject of pyrite smelting, a series of ten questions was sent out by the then editor of the *Engineering and Mining Journal* (Mr. T. A. Rickard), and these questions formed the basis of a discussion which ran through that periodical between October, 1903, and February, 1905. The various contributions which then appeared have been revised by the respective authors, and, together with a most interesting introductory article by the editor, and one or two others bearing more or less on the subject, have been collected into the present volume. The replies to the ten questions, received during the course of the discussion, were at its close ably reviewed by Dr. E. Peters, and his review is, of course, included in the book.

The questions sent out were as follows:—

1. What types of ore are suited to the process?
2. Is hot blast advisable?
3. To what extent can fuel be eliminated?
4. What amount of copper is required for the collection of the precious metals?
5. What percentage of lime is necessary to clean slag?
6. What percentage of zinc in the charge can be treated profitably?
7. What is the degree of desulphurisation attainable?
8. What are the possibilities as to capacity of furnace?
9. What are the limitations of the process?
10. What is the relative economy as compared to rival processes?

The substance of the answers received was as follows:—

1. The best ore mixture is one of iron and copper sulphides with silicious fluxing ores, though ores containing lead, antimony, and arsenic may be used if they do not hold enough lead to pay for lead smelting. The presence of much fine pyrites in the charge increases the difficulty of working. Pure iron pyrites only pays to smelt when smelted with silicious ores (of gold and silver) which are themselves fluxes. The process is particularly good for pyrites and pyrrhotite ores poor in gold and silver, and with sufficient copper to give a good matte. In pyrite smelting the slag made must be silicious, otherwise the matte concentration is low—a fact which, as far as it goes, seems to fit in well with Mr. Herbert Lang's views as to the nature of the reactions taking place in pyrite smelting (p. 214). According to Mr. Hixon, pyritic smelting is inapplicable to nickel copper sulphides on account of nickel matte being more infusible. We might add, further, that the oxidisability of nickel unfits it for concentration in an oxidising smelting, nickel being more oxidisable than iron.

2. Opinion is pretty nearly unanimous as to the efficacy of hot blast in pyritic smelting, and it is certain that, with very many ore mixtures it is absolutely necessary to heat the blast. Moreover, and this is a point upon which insufficient stress is laid, the use of heated blast renders it possible to attain results such as high degree of matte concentration, which the mere addition of coke in the furnace as an apparent alternative not only will not bring about, but absolutely retards. In some cases a high pressure cold blast may be as effective as a hot blast, but increasing the pressure also increases the flue dust losses.

3. With regard to the elimination of coke the opinions vary, as this depends so largely on the nature of the charge; but it would appear that the coke used can be brought down to about 3 per cent as a practical limit, though Mr. F. R. Carpenter says that it can all be eliminated.

As the carbonaceous fuel is diminished, more iron and sulphur are oxidised and more silicious flux is needed.

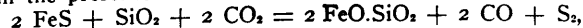
Not only can coke be so largely eliminated, but for successful pyrite smelting—that is, for a high matte concentration, it must be eliminated; any extra heat which is required by virtue of low pyrite contents, of insufficient iron and sulphur, must be added in the form of hot blast, which is thus seen to be specially advantageous on charges low in pyrites and with a heavy silicious charge.

A mixture of metallic oxides and silica with but little pyritic material can be pyritically smelted with the aid of hot blast.

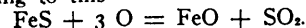
Dr. Peters says that the addition of excess coke in the furnace simply causes the matte to run down and leaves a silicious skeleton behind, with ultimate freezing up. Mr. H. Lang, however, says that excess coke does not induce freezing; in his view the matte concentration and heat production are brought about according to the two following equations:



and in the presence of extra coke—



and not according to this—



According to Mr. Lang's view, the presence of free oxygen, as demanded by the last equation, is not necessary; yet even on his own theory, the first equation he gives clearly shows that in pyritic smelting the oxidation of the iron is effected by free oxygen; whilst in the second equation the amount of oxygen consumed is evidently increased by just the amount necessary to convert the extra carbon into CO, which means increasing the blast to that extent. But, as Dr. Peters indicates, even this would be no good, since the matte would simply run away so much more easily without being "held back" sufficiently to get oxidised and allow of concentration. Whatever the nature of the reactions, the addition of carbon must in general result in the rapid fusion of unoxidised matte, with a lower concentration, owing both to the increased heat and to the shortage of oxygen; and it must also tend to give stiffening of the slag and freezing of the charge in many cases. We must confess that, to us,