

Mr. Lang's opinions on this point appear to be incorrect; and as he states that coke may be added up to 12 to 15 per cent without interfering with the process, we could wish that he had specified more explicitly the conditions obtaining when he made the observations.

He observes that iron has a greater affinity for oxygen than sulphur has, while Mr. L. F. Wright notes that the presence of 12 per cent SO<sub>2</sub> is sufficient to check the combustion of sulphur; Mr. Lang quite justly asserts that the oxidation of iron is the main source of the heat not provided by carbon, either in the furnace or as hot blast. As regards the question of sulphur, Mr. C. Palmer (p. 233) says that but little free sulphur is found in the fine dust—a fact which, however, does not prove much, inasmuch as we know that some free sulphur is evolved from the furnace charge by simple decomposition of pyrites into ferrous sulphide and sulphur. In pyritic smelting the addition of excess coke might be prejudicial by reducing iron from the slag, giving a tendency both to form sows of infusible sub-sulphide matte and also a too silicious infusible slag. Dr. Peters and Mr. Lang are, however, in direct conflict on this question of the coke; Dr. Peters (p. 145) says that excess coke induces freezing; Mr. Lang says it does not. The writer of this review certainly considers that any condition tending to produce a too silicious slag—and excess of coke with a slag already silicious—is such a condition, in virtue of the reduction of iron from slag by carbon—must tend to stop the working of the furnace; indeed, it is an axiom of pyritic smelting that, as the coke is diminished, the silica should be increased.

4. A little copper in the charge—about 1 $\frac{1}{2}$  per cent—usually gives slags cleaner in gold and silver, though Mr. E. P. Mathewson asserts that copper is not necessary, which is also Mr. Nutting's opinion when speaking of non-zincy charges. As Dr. Peters says, the absence of copper may not matter under special conditions, such as the presence of traces of tellurium, bismuth, arsenic, antimony, etc., which may act as collectors for the precious metals. The presence of sub-sulphide (free iron in the matte) may also induce better collection of the gold and silver. Mr. Bretherton notes that more copper is needed to collect the gold and silver (we should like to add, especially the silver) if zinc is present. Dr. Peters, on page 166, says that the free iron in iron mattes is produced thus:  $FeS + 2 FeO = 3 Fe + SO_2$ , which is, to say the least of it, doubtful. The writer believes it to be produced by direct reduction of FeO (in slag) by carbon.

5. With regard to lime, the opinions are very diverse. Mr. R. Lloyd depends upon other bases, and says that clean slags can be got with purely metallic bases, which is perfectly correct. Lane, however, lowers the specific gravity of a slag and gives a better separation of slag and matte. Also calcium goes further in slag forming than iron, not only because of its smaller atomic weight with the same atomicity, but because, whilst a mono-silicate of iron is produced, a bi-silicate of lime is the normal product. On the other hand, as Carpenter says, lime increases the amount of slag.

With regard to zinc there is some divergence of opinion as to the amount which may be present, though there is unanimity in the opinion that a charge works better without it. About 10 per cent of zinc would seem to be the limit. ZnS has a more evil effect on a slag than ZnO, and for this reason, where concentration is low, it would be better to roast the ore before smelting when there is more than a few per cent of zinc as sulphide. Zinc seems to have a particularly bad effect in the presence of alumina. Where there is a high degree of concentration, roasting is unnecessary, as the ZnS gets oxidised in the blast furnace. Some of the authorities quoted do not see any particular virtue in an iron slag as a flux for zinc, the fact is, however, undoubted, and may possibly be explained by the greater fusibility of a compound of ferrous oxide and zinc oxide (where the ZnO acts as an acid oxide) over zinc silicate. The increased volatilisation losses of silver, in presence of zinc, are referred to by Mr. Nutting.

7. The consensus of opinion is that, in practice, 60—80 per cent of the sulphur may be eliminated. The average desulphurisation is 75 per cent. As noticed by Mr. Lang, the joint presence of arsenic and sulphur in a charge may result in the volatilisation of arsenic sulphide, this involving the possibility of high matte concentration with but little oxidising action.

8. The possibilities as to capacity of furnace vary with the conditions prevailing, but the capacity is as a rule greater with hot blast.

9. Limitation of the process.—The presence of sulphides, and especially those of iron, is necessary, and the process is inapplicable in presence of much lead or zinc. However, as previously pointed out, by using the hot blast we are enabled to smelt pyritically charges much poorer in sulphides than we could smelt with cold blast, with the same degree of concentration.

10. The process is very cheap, and comparable with cyaniding or chlorination as a silver gold recovery.

Summarising with regard to heavy pyritic ores, Dr. Peters gives, as advantages of the pyrite process, the following:—

1. No roasting required (saving in plant, in costs, in losses of metal, in time).
2. Great saving in coke.
3. More silica can be used in the charge.
4. More complete elimination of Pb, As, and Sb.
5. Heavy spar less objectionable than in ordinary smelting.

The drawbacks of the process are:—

1. Heavier blast required.
2. Exceptional care and skill.
3. Shorter campaigns.
4. Possible reconcentration of matte.
5. Zinc more injurious than with a roasted charge.
6. Sulphur fumes are wasted.

Local conditions must decide on which side the balance of profit lies, as Dr. Peters says.

Mr. Rickard deserves the best thanks of all interested in metallurgy for reprinting the subject matter of the discussion in a book, in which form it becomes accessible to a much larger public than when scattered through several numbers of a periodical.

#### BOOKS, ETC., RECEIVED

*Department of Mines, New Zealand—Papers and Reports Relating to Minerals and Mining.* Comprising (1) Statement by the Minister of Mines; (2) Report on the Goldfields; (3) Report on Coal-Mines; (4) State Coal Mines. A comprehensive review of the mining industry of New Zealand, and matters connected therewith, for the year 1904. With many tables, plans, half-tones, etc.

*California State Mining Bureau—California Mines and Minerals; Bulletin No. 41.* Compiled by Chas. G. Yale, State Mineralogist. An illustrated survey of the mining industry of California, giving (1) Quantity and Value of Mineral Products of California 1904; (2) County Mineral Products and Value—1904; lithographed Maps of Individual Counties with References showing Locations of Companies, Railroads, Stage-lines, etc. Obtainable from Lewis E. Aubrey, State Mineralogist, Ferry Building, San Francisco, California.

*United States Geological Survey—Geology and Underground Water Conditions of the Jornada Del Muerto, New Mexico.* By Charles Rollin Keyes. Pages 39; illustrated by half-tones and maps.

*Field Measurements of Rate of Movement of Underground Waters.* By Charles S. Slichter. Pages 119; illustrated by numerous half-tones and diagrams.

*Field Assay of Water.*—By Marshall O. Leighton. Pages 76; illustrated by half-tones and diagrams.

*A Review of Latest Forbidding Pollution of Inland Waters in the United States, Second Edition.*—By Edwin B. Goodell. Pages 144.