perature must be used. To avoid fusion under the greater heat, and to keep the charge in the desired pasty condition, slacked lime is added; while, to accelerate the chemical reactions, powdered coal or charcoal may be mingled with the charge.

II.—EFFECT OF ORE IMPURITIES.

This process of reverberatory smelting, of which the details appear sufficiently simple, may in practice be much complicated by the ore impurities. The influence of some of these impurities is described: A small quantity of iron oxide is advantageous, in so far as it helps to stiffen the charge. A slight proportion of iron pyrites also is favourable, as it promotes oxidation, and when itself reduced to ferric oxide, renders the charge less fusible. If, however, the proportion of pyrites rises to 10 per cent. or 12 per cent. it is injurious, since it is likely to combine the lead sulphide, and thus prevent reduction of the latter. The presence of 35 per cent. to 40 per cent. of iron pyrites renders the ore unfit for treatment in a reverberatory furnace. Spathic iron ore, in the presence of silica, forms a fluid slag, and is to be avoided in reverberatory lead smelting. In the case of copper pyrites most of the copper combines with sulphur to form subsulphide, but some is likely to enter the lead and may be sufficient to need subsequent separation. Blende, in quantities of 4 per cent. to 5 per cent., assists the roasting of the charge, but 10 per cent. to 12 per cent. both prolongs the roast and diminishes the lead extraction. With 20 per cent. to 24 per cent. of zinc very little lead is extracted, and with 35 per cent. to 40 per cent. the reverberatory method cannot be employed. Antimony, even to the amount of 2 per cent. to 3 per cent. is very prejudicial, as it not only promotes caking and fusing of the charge, but carries lead into the slag, and itself mixing with the lead, injures the quality. It also increases the volatilization losses. Next to antimony, arsenic is the most deleterious impurity, producing results similar to those of antimony. The gangue constituents also have considerable influence on the process of smelting. Limestone, more especially dolemite, stiffens and hinders fusion of the charge; but a large quantity will prevent the various lead compounds coming into contact, and thus, by impeding reduction, will reduce the yield of lead. The highest permissible percentage of limestone for a reverberatory charge is 12 per cent. Silica combines to form lead silicates. These not only react with the oxide, sulphate, and sulphide of lead; but, in consequence of their low fusion point, easily melt, and, coating the particles of the charge, check all reaction. For successful reverberatory work, therefore, the lead ore charge must not contain more than 4 per cent. to 5 per cent. of silica. Barytes and fluorspar, if seperate, have no effect; but if both are present, they may increase the fusibility of the charge by combining with lead sulphade.

III.—ADVANTAGES AND DISADVANTAGES OF REVERBERATORY SMELTING.

These may be deduced from the observations made in the foregoing paragraphs. Briefly enumerated, the advantages of reverberatory smelting are: First, raw ore can be smelted. That is to say, no preliminary or independent calcination of the ore is required, because the ore roasting is done in the furnace itself. Secondly, raw fuel can be used. The use of cheaper combustibles, such as coal, wood, etc., is possible, because very high temperature is not needed. The operation, as we have seen, does not aim at gangue fusion, except in the last stage; and, even then, as much refractory material, such as lime, silica, etc., cannot be present in the charge, no great heat is necessary. Thirdly, the volatilization losses of silver and lead are small; an advantage due to the low furnace temperature. Fourthly, the slag losses are strictly moderate. For, though the slags themselves are rich, their quantity, owing to the purity of the ore employed, is small; and thus the net loss in the operation is reduced. Fifthly, unbricked fines can be smelted without excessive loss in flue dust, since the necessary temperature can be attained without the use of a blast. Sixthly, extraction is easy, and the yield is pure; this results from the high grade and purity of the ores used. Lastly, the plant is cheaply erected. As offset to these advantages, there are the following defects: As intimate contact of the metallic particles is necessary, only rich sulphides, or mixtures of sulphide and carbonates, containing, say, 58 per cent. to 70 per cent. of lead are suitable for reverberatory smelting. For the same reason, the ores must be fairly pure. Blende, iron pyrites, chalcopyrite, calcspar, barytes, silica, lime, magnesia, etc., must not, therefore, be present in larger quantities than already indicated. Other defects are the comparative slowness of the operation, the heavy fuel consumption, usually about 45 per cent. of the charge, the necessity for a good deal of skilled labour, and lastly the richness of slags, which necessitates their re-treatment.

IV.—VARIOUS FORMS OF REVERBERATORY SMELTING.

Those that merit attention are the Carinthian, the English and the Silesian.

The Carinthian method, now almost obsolete, is adapted to treat small charges of pure rich ores, containing 60 per cent. to 75 per cent. of lead, at a low temperature. On account of this low temperature, the Carinthian are more durable than the English furnaces. Instances of such furnaces are the Raibl at Carinthia, the modified Raibl at Egnis, Belgium, and the American air furnaces in the Mississippi valley. The Carinthian method gives a high extraction, but is attended with the disadvantages of a small output and heavy cost of fuel and labour.

The English method aims at dealing with large charges at a high temperature. The extraction is quicker but lower, and, in consequence, the charge residues have to be re-smelted in the blast furnace. The volatilization losses naturally are higher.

The Silesian is a modified English method, the furnace, etc., being correspondingly arranged. This method follows the English in dealing with large charges, but the Carinthian in employing a low temperature. The result is a larger output of purer lead than the English furnace product. The volatilization losses also are lower. The charge residues are sent to the blast furnace.

The reasons for the above difference in practice are sufficiently obvious. A slow roast at a low temperature, without charge fusion, favours the extraction of a comparatively large percentage of pure lead, with low volatilization losses. Hence the suitability of the Carinthian method for treating small quantities of pure and richly argentiferous, high grade lead ores. But the majority of lead ores are not pure, and their complete reduction, therefore, requires a higher temperature. The Silesian method is designed to deal with these by extracting, with the least lead and silver volatilization losses, as much lead as possible at