CONCENTRATION OF MOLYBDENITE ORES BY FLOTATION.

By F. W. Horton.

Molybdenite has the property, common in varying degree to most metallic sulphides, such as chalcopyrite, sphalerite, galena, pyrite, and pyrrhotite, of not being wetted readily by water, and, when dry and in small particles, of floating on a water surface. Moreover, like those sulphides, it is easily wetted by most oils. Further, in a pulp of crushed ore and water, oils have a preferential wetting action for particles of molybdenite as against particles of gangue minerals such as quartz, and this selective wetting action is decidedly increased if the water is slightly acidified. Particles of molybdenite so wetted with oil are covered with a buoyant water-repelling coating that materially assists their flotation. As the reasons for many of these phenomena—for example, the selective wetting action of oils and the increase of this selective action by acids—are not clearly understood, and as even an elementary discussion of the accepted theories of mineral flotation would be out of place here, the reader who wishes further information on the subject is referred to a clear and concise exposition by Hoover** and to an excellent paper by Mickle.† It suffices here to say that the phenomena mentioned above are the basis on which all flotation processes depend. In many processes the area of the effective surface of flotation is increased by the liberation of bubbles of gas or air in the liquid, the surface of each bubble acting in the same way as the horizontal surface of a liquid at rest. These bubbles may be of air and may be produced by violent agitation of the pulp or by release of air from solution in the liquid by a reduction of pressure, or they may be of carbonic-acid gas formed by the action of sulphuric acid on limestone or other carbonates or by other means.

Water-Flotation Processes.

Water flotation for the concentration of molybdenite depends solely on the fact that small dry particles of the mineral float readily on water, whereas the usual gangue material is easily wetted and sinks. They do not of necessity involve the use of oil, acid, or gas, and their application is extremely simple. The concentrators, which are of various types, consist essentially of a device for feeding the crushed ore in as thin a sheet and at as uniform a rate as possible onto a moving water surface in a tank and an arrangement, either by an overflow or a revolving belt of canvas or other suitable material, for discharging the floating film of concentrates into another tank. The tailings are usually drawn off from a spigot in the bottom of the first tank. In some types of apparatus the ore from the feeder is allowed to slide down an inclined plane or concave, over which a film of water is passed and from which the ore is discharged approximately in the plane of the water surface in the tank. In other apparatus the ore from the feeder falls on top of an almost submerged corrugated or canvas roller, the revolution of which carries the ore forward to the flotation surface. The object of all these devices is to place the ore on the water in a sheet only one mineral particle in depth with as little disturbance of the water surface as possible and with the majority of the particles of gangue already wetted.

Even with the best of feeding devices some particles of gangue fall on the floating film of concentrates or are otherwise mechanically entrained by it. Various methods of cleaning the film, such as allowing it to flow down an incline into a second tank, picking it up on a roller or belt and again discharging it to a flotation surface and dividing it into a large number of parts and agitating it by causing it to flow through the teeth of a comblike obstruction, are used.

No description of any particular water-flotation concentrator is attempted here, as detailed information both as to the design and the operation of a number of different types of machines is given in papers published elsewhere.

To be concentrated successfully by water flotation, a molybdenite ore should be such as to require only medium-fine crushing to liberate the molybdenite, and the gaugue should be one in which the individual particles are readily wetted. Further, if a high-grade concentrate is to be obtained the ore must be practically free from other sulphides such as pyrite, pyrrhotite, and chalcopyrite, which would be concentrated with the molybdenite. Proper treatment of the ore previous to flotation is of great importance. It should be reduced to approximately 10-mesh, or as much finer as may be necessary to liberate the mineral from the gangue, by crushing in rolls in such a manner as to make the quantity of fines as small as possible. Then if it is at all damp it should be thoroughly dried. Mechanical difficulties in the proper feeding of fine ore, and the great reduction in the capacity of the concentrators when fine material is treated exclusively, render advantageous in most instances the treating of the ore without sizing, although the capacity of the concentrators and the grade of concentrates made are considerably increased when coarse material that has been sized is treated.

The capacity of water-flotation machines varies with their type and with the character of the ore treated, and depends directly on the size to which the ore is crushed, the amount of fines made, the nature of the gangue, and the ratio of concentrates to tailings. In speaking of a particular type of concentrator, Wood says:

"A standard machine treating a 20-mesh quartz ore, using a 3-ft. width of feed and having a 4-ft. take-off belt, will vary in capacity from 1,000 to 2,000 pounds per hour, unless the ratio of concentration is low, in which case the capacity will be smaller. Some ores that possess an easily wetted gangue and call for a high concentration ratio can be fed rapidly at 20-mesh, 30-mesh, or 40-mesh. For instance, a 1 or 2 per cent. molybdenite ore in a quartz gangue will give a clean concentrate, even if the ore is fed several times faster than an ordinary sulphide ore."

The writer thinks that the capacities stated above could be had only at a sacrifice of either the recovery or the grade of concentrates obtained, and that a machine with a feed 3 ft. wide, handling 300 to 500 lb. per hour of ore crushed to pass a 20-mesh screen would be treating about the maximum quantity of material that it could separate efficiently. No figures as to cost of operation can be given, but they are presumably small as the concentrators require only moderate quantities of water and little power.

The accompanying table shows the results obtained by Wood in 10 concentration tests of five different molybdenite ores. In every test except the last, in which the ore had been slightly roasted, the recoveries were good, averaging nearly 90 per cent. In general, however, the grade of concentrates was low to medium, averaging less than 60 per cent. MoS_2. Test No. 3 is

* Extracts from Bulletin No. 111, U. S. Bureau of Mines.

** Hoover, T. J., Concentrating ores by flotation, 1912, 221 pp.

† Mickle, K. A., Flotation of minerals: Proc. Royal Soc. Victoria, vol. 23, pt. 2, 1911, pp. 555-585, abstracted by Eng. and Min. Jour. vol. 92, 1911, pp. 307-310, and vol. 94, 1912, pp. 71-76.