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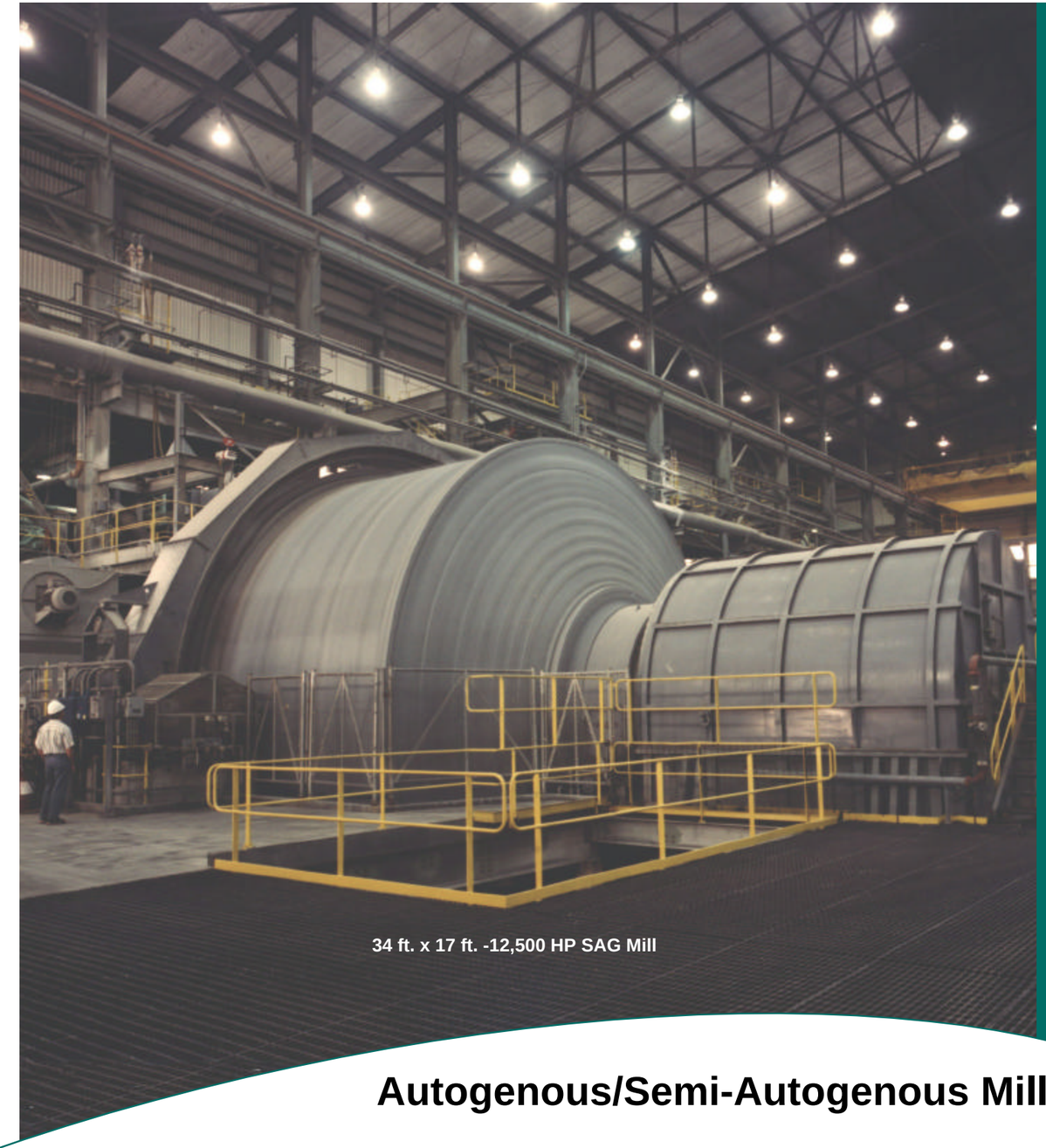

34 ft. x 17 ft. -12,500 HP SAG Mill

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Autogenous/Semi-Autogenous Mills

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34 ft. diameter-14,000 HP SAG Mill

The sights and sounds of large grinding mills in operation are impressive to even the most seasoned mill operator. Grinding systems are a symbol of the application of brute force to extract mineral wealth from nature and are a major and critical part of any mineral processing facility.

Autogenous (AG) grinding is the size reduction of material in a tumbling mill utilizing the feed material itself as grinding media. Semi-Autogenous (SAG) grinding is the size reduction of material in a grinding mill, utilizing the feed plus supplementary grinding media. The most common supplementary medium is steel balls.

Metso's experience with Autogenous and Semi-Autogenous grinding dates back to the 1930s with the development of the Hardinge Cascade Mill. The first commercial high length-to-diameter ratio Autogenous Mill was a 10 ft. x 5 ft. 100 HP machine sold to a gold mine in 1940.

In 1959, the first large commercial autogenous milling plant was ordered including twelve 18 ft. x 5 ft. – 600 HP Autogenous Mills for a Canadian iron ore concentrator. In 1966, the first 32 ft. diameter Autogenous Mills were sold. One of these mills had the capacity of the twelve mills sold just 7 years earlier.

During the 1970s and 1980s Allis Chalmers and Dominion Engineering competed with Hardinge (then Koppers) to obtain near equal shares of the large mill market. Marcy was a later entry into that market and supplied several good medium sized mills during the 1980s. Now, Hardinge, Allis Chalmers, Dominion Engineering, and Marcy are combined under Metso Minerals Grinding. Our combined reference list represents a very high percentage of the total worldwide installations of all AG/SAG mills. A last review, Metso's AG/SAG milling installations totaled over 1,100,000 installed HP.

Application

AG/SAG mills are normally used to grind run-off-mine ore or primary crusher product. Feed size to the mill is limited to that size which can be practically conveyed and introduced into the mill. The mill product can either be finished size ready for processing, or an intermediate size ready for final grinding in a ball mill, pebble mill, or VERTIMILL™. Wet grinding is accomplished in a slurry of 50 to 80 percent solids.

AG/SAG mills can accomplish the same size reduction work as two or three stages of crushing and screening, a rod mill, and some or all of the work of a ball mill. Because of the range of mill sizes available, AG/SAG milling can often be accomplished with fewer lines than in a conventional rod mill-ball circuit. All of the above contributes to lower capital cost and lower maintenance cost for an AG/SAG mill circuit and accounts for the current popularity of this type of size reduction in modern mineral processing plants.

In some ore bodies, due to moisture and clay content, crushing and screening is considered to be difficult, if not impossible. The elimination of the process step with the use of AG/SAG milling is most advantageous.

Testing of the Ore

It is essential that the ore be tested to determine its amenability to AG/SAG milling, the grinding power requirements, optimum milling conditions, and grinding circuit arrangement. These are conducted on a representative sample of ore at the Metso Minerals Test Plant in York, PA. For most ores, small samples (about 100 pounds) are adequate to judge the suitability of AG/SAG milling and to make a preliminary estimate of grinding power requirements. A second level of testing (using a 1,000 pound sample), conducted in a 6 ft. batch mill, can be conclusive if the ore resembles ore previously tested. The third, and most precise, level of testing involves continuous milling in a 6 ft. x 2 ft. AG/SAG mill. Up to 50 ton samples are required for each ore type to be tested. The results of this test provide accurate information for the optimum mill sizing and circuit design for a commercial installation.

Grinding Circuit Design

AG/SAG milling can be accomplished with a variety of flowsheets. The optimum flowsheet should be established during the testing of the ore. Common flowsheets include:

- AG-Single Stage
- AG in a closed circuit with a crusher
- AG with a crusher + ball mill
- SAG-Single Stage
- SAG with ball/VERTIMILL™

Metso Minerals process engineers welcome the opportunity to assist you with circuit and circuit control design as well as start-up, operation, and optimization of the milling plant.

Our engineers can specify or supply computer control systems for the sophisticated circuits. The cost of computer hardware decreases almost daily, making these controls feasible for smaller installations. It is possible with automatic operation to save power, grinding media, and liner wear, while increasing capacity. Software can be developed to suit the most complicated circuits and complex ores. Development of the software is often unique to a specific ore and concentrator and is time-consuming to develop, but is ultimately rewarding.

Productive grinding systems are the result of the efforts of disciplines ranging from mechanical design and metallurgy of materials to process engineering and instrument application. Desired grinding results are achieved only through careful and skillful attention to detail.

Experiences from the past have been carefully considered in the development of the Metso AG/SAG mills which are presented in this bulletin. All equipment adheres to the applicable standards set by ASTM, NEMA, AGMA, AWS, and ANSI. Metso mills are equipped with all normally required safety features. Designs to meet other codes and local or state safety regulations will be quoted on request.