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PROCESSING PERLITE — THE TECHNOLOGIC PROBLEMS

by

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The Technologic Problems

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What influence do variations in commercial-grade perlite have upon processes used to prepare a marketable product? The problems are summarized here.

INCREASING acceptance of perlite products, chiefly in the fields of lightweight structural aggregates and thermal and acoustic insulation, has led to expanding market demands that have encouraged many new producers to enter the field. In some instances, however, the failure of these producers to anticipate the variable response of perlite to conventional processing methods has led to difficulty in establishing an economical flowsheet by which a predictable specification product could be obtained.

It is not the writer's intent to provide a solution to these problems, but rather to summarize their nature. It is to be hoped that members of the industry who have hurdled some of these obstacles will document solutions arising from their experience.

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In this treatment the term *perlite* will not be restricted to the petrographic definition but will apply to all volcanic glasses. Expansible obsidians and pitchstones are accordingly included in this broader industrial classification.

Chemical Properties: Although perlite has been reported to range in composition from that of rhyolite to that of andesite, it is probable that most of the glasses have the composition of rhyolite. When recalculated to an anhydrous basis, the five analyzed glasses from New Mexico, representing five distinct physical types from widely separated deposits, show an amazingly uniform oxide composition. Water content is the only major compositional variable; total water ranges from a low of 0.37 pct (nonexpansible obsidian) to a high of 8.95 pct (expansible pitchstone). The wide range in expansion characteristics exhibited by these samples cannot be related to significant variations in the composition of the nonvolatile fraction and has been only partially correlated with variations in water content.

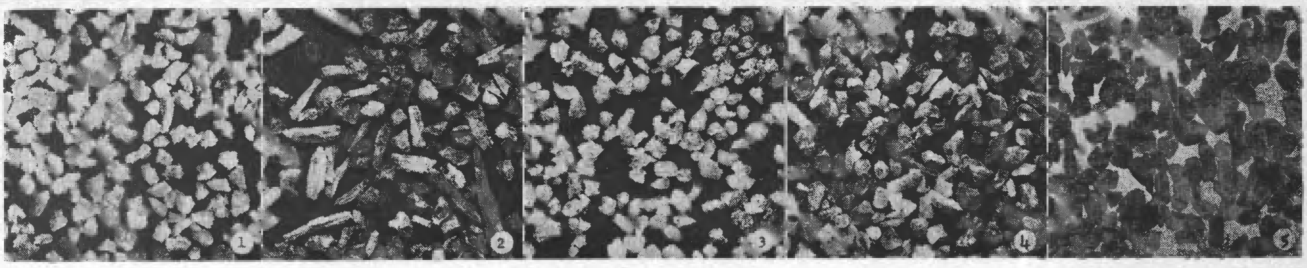


Fig. 1—The —14 + 28 fractions of crushed perlite aggregates. Variations in particle shape and texture reflect inherent differences in the physical characteristics of the crusher feed. Perlite textural types illustrated are: 1—pumiceous, non-perlitic; 2—*needle* type, prominently perlitic; 3—fine-grained, highly perlitic; 4—*onion skin* type, coarsely perlitic; and 5—pitchstone, very slightly perlitic. X4. Area reduced approximately one-half.

Physical Properties: The physical properties of perlite exhibit a wide range of variation, from massive and vitric to cellular, granular, and fragmental; many hues of color from grayish white to black; and lusters that are vitreous, pearly, pitchy, or resinous. Although they may be grouped into several distinct textural types, these types are not distinguished by sharp boundary differences but are completely intergradational. Several textural types may be closely associated in a single deposit.

Some generalized relationships are apparent between milling and expansion characteristics and the physical properties of the glass. Certain combinations of these properties, particularly texture, luster, and color, together with the water content, may aid in an approximate evaluation of the commercial potentialities of the glass. Thus fragmentation characteristics in milling and a differentiation between *lively* and *dead* glasses may be anticipated to an approximate degree. Unfortunately, the accuracy of such predictions is based upon personal experience, and some glasses will prove unpredictable.

Mining: The low unit value of perlite crude limits the scope of practicable mining methods. Deposits not amenable to open-pit exploitation have been avoided by most operators. Cost limitations have also eliminated most deposits in which variations in quality necessitate highly selective mining.

Some deposits are sufficiently fractured or friable to permit mining by use of a ripper with tractor and carryall or by bulldozer alone. Where drillhole blasting is required, care must be exercised in selecting an explosive and a blasting method that does not overbreak the ore, producing an excess of fines. Despite its hardness, most perlite drills easily and rapidly and breaks well under blast owing to its brittleness. Secondary blasting is rarely necessary.

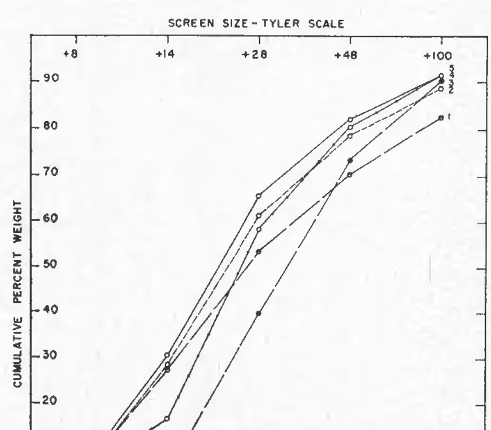
Milling: Inherent differences in the physical character of perlites from different deposits have indicated the inadvisability of selecting a crushing and sizing circuit merely because it has proved successful at another deposit. The design of a milling flowsheet requires thorough preliminary testing, beginning with laboratory evaluation and culminating in tests on a pilot mill scale.

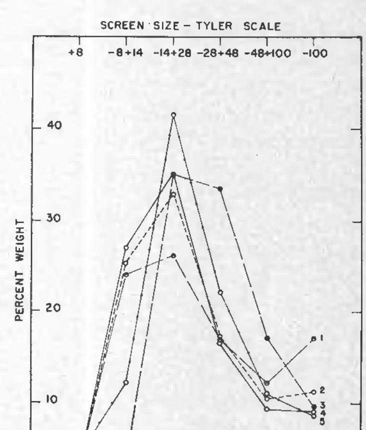
Several fundamental problems that must be resolved in this stage of processing may be stated as follows:

1—crushing to produce particles approximating a cubic shape, 2—crushing to produce the required particle size gradation, and 3—sizing to specification particle gradation.

Current crushing practice involves one-stage treatment in some plants, whereas others utilize multi-stage flowsheets. Impactors, operating at a high percentage recycle, have received widespread acceptance among users of one-stage systems. Multi-stage operations have favored jaw crushers in the primary stage. Various machines have been successfully utilized in the secondary and subsequent stages, including gyratory and cone crushers, rolls, impactors, and in at least one operation, a rod mill. Removal of the undersize by scalping screens between each stage aids in minimizing the proportion of wasted undersize produced. Dry processing is vastly preferred to wet treatment owing to the high costs incurred in drying the final product, and the difficulty of wet sizing in the finer ranges.

Although it is desirable in crushing to produce particles that approach a cubic shape, this is difficult to accomplish in commercial practice. Most perlites show tendencies to break in preferential directions along pre-existing fractures or planar structural elements. Some variations resulting from





Figs. 2 and 3—Screen analyses of five types of crushed crude perlite aggregate. Samples were prepared by passing through a laboratory jaw crusher followed by further reduction in laboratory rolls, without intermediate sizing. Dust losses were ignored. Represented perlite textural types are: 1—pumiceous, non-perlitic; 2—*needle* type, prominently perlitic; 3—fine-grained, highly perlitic; 4—*onion skin* type, coarsely perlitic; and 5—pitchstone, very slightly perlitic. It will be noted that the graphs of individual samples are divisible into two groups, each of which has a characteristic size distribution pattern. Samples 1, 2, and 4 form one group, and samples 3 and 5 form a second group.

differences in physical character are illustrated by Fig. 1. Highly perlitic types (*onion skin*) tend to break into curved spalls and rounded core kernels in the coarser fractions. Thin flakes may predominate in the finer fractions. *Needle-type* perlites, which are simply variants of the onion skin type in which the perlitic fractures have a pronounced parallel orientation in one direction, produce elongate splinters that are very difficult to size accurately. The massive, texturally non-perlitic glasses have a pronounced tendency toward conchoidal fracture that favors the production of concavo-convex chips or shards. It is therefore evident that no single scheme of crushing is equally adaptable to each of the various textural types of perlite.

Thorough sizing is essential to the production of a predeterminable expanded product owing to the multiplication of particle size resulting from expansion. Most glasses tend to yield a crushed product high in the fine fraction, a large portion of which is —100-mesh and accordingly wasted by removal from the sized product. The variation in proportion of size fractions yielded by several types of perlite is shown in Figs. 2 and 3, which represent the results of a single crushing test of each type.

Multiple deck vibrating screens are largely preferred for the sizing operations, although at least one operator has found a spiral rotary machine advantageous in securing maximum passage of undersize particles. Sizing in the finer fractions is commonly accomplished with air separators.

Dust nuisances have been reduced by the use of covered screens and the maintenance of dust producing points under vacuum, the dust fraction being collected by cyclones.

Removal of excess free moisture is usually desirable. In addition to facilitating sizing and handling operations, the dried product will permit freight cost savings in shipment to the consumer and may give better performance in the expansion process. Both rotary kilns and stationary flash driers have been used for this purpose.

Expanding: The expansion process and characteristics of furnace design have been more fully treated in the technical literature than have the other phases of perlite processing. The reader is accordingly referred to the thorough discussion by Murdock and Stein[1] for an analysis of furnace design features, and to King et al.[2] for thermal expansion and energy requirements data. Calculations of energy requirements should, of course, include a correction for the low thermal efficiency of conventional furnaces.

To date there has been no scheme devised for accurately predicting the furnace behavior of a given perlite on the basis of its chemical composition and physical character. Crude differentiation between *lively* and *dead* perlites may be made by an evaluation of the megascopic physical character and water content. Laboratory expansion tests will provide details relative to the practical ranges of expansion, ranges of bulk density, resultant particle shape and texture, compressive strength, proportion of nonexpansible waste, and preheat requirements. The difficulty of duplicating laboratory results with the commercial type of furnace, however, dictates the need for final testing on a pilot mill scale.

Perlite is sensitive to slight changes in furnace operating conditions; hence the use of only a manual control system is largely precluded. Interlocked automatic systems that provide close instrumental control of fuel-air ratio, upheat rate, temperature level, kiln pressure, and feed rate are now considered a necessity rather than a luxury.

Difficulty has been encountered in obtaining uniform expansion of both fine and coarse particles in the graded feed. Treatment favoring optimum expansion of the fine feed does not fully expand the coarser fraction, whereas treatment geared to optimum expansion of the coarser fraction may result in overheating the fine fraction, thus promoting the formation of kiln rings and the collapse of expansion cells in the product. Various techniques have been devised to resolve this problem; one operator uses two rotary kilns in series, whereby the fine particles expanded in the primary kiln are removed from the circuit by cyclones and the coarser particles are finished in the secondary kiln.

Miscellaneous Problems: Perlite, in both crude and expanded form, is highly abrasive. Careful consideration should be given to this property in planning equipment requirements, operational techniques, and repair and replacement costs.

Disposal of the excess —100-mesh fraction of both crude and expanded products has proved troublesome at many plants. There is currently little market outlet for this material; hence it is largely wasted to the dump, where it constitutes an objectionable dust hazard in urban areas and may occupy ground that could be put to more beneficial use. If the costs of this waste which accrue from mining, transportation, crushing, sizing, drying, and expansion (in the case of the finished product) are considered, and if it is noted that the waste usually constitutes from 5 to 10 pct or more of the milled product, and a significant fraction of the expanded product, it is evident that efforts to develop markets for its disposal would be well expended. Possible uses include ceramic glazes,[3] glasses (here is a field for applied research), pozzolanic concrete additives, abrasives, filter aids, and fillers.

Conclusions: Great advances have been made in the technology of perlite processing during the past several years, but relatively few of these advances have been adequately documented in the available literature in response to growing public interest.

The variable character of perlite and its somewhat capricious response to conventional process practice precludes a standardization of treatment which parallels that of many industrial mineral operations. Thorough testing from laboratory through pilot mill scale is considered a prerequisite to a full evaluation of equipment needs and treatment procedure.

The current trend is directed away from the production of a multipurpose aggregate and toward an increasing array of specification products tailored to meet industry standards and the individual requirements of consumers. This factor, coupled with inherent variations likely to be found in the character of the crude, clearly indicate that the plant should be designed for rigid control, yet permit a considerable range of flexibility of operational scope.

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