FILE NAME: WR Grace (WRG)

DATE: April 30, 1954

DOC#: WRG274

DOCUMENT DESCRIPTION: 1954 Description of process for beneficiating asbestos gres.

DATE: April 30, 1954

DRAWING & DESCRIPTION:

PROCESS FOR BENEFICIATING ASBESTOS ORES

The term "Asbestos" as now used is not the name of a distinct mineral, but is a commercial term applied to any mineral that can be readily separated into more or less flexible fibers. There are many varieties of Asbestos minerals but they are essentially Iron Magnesium Silicates which occur fibrous (Asbestiform) with varying length of fiber. These silicates have varying compositions of Silica, Aluminum, Iron, Magnesium, Calcium, Sodium, Manganese, Potassium and water with specific gravities ranging from 2.2 to 3.3.

The principal types of Asbestos are Chrysotile, Crocidolite, Anthophyllite, Amosite, and Amphibole which includes Tremolite, Actinolite and Hornblende. Asbestos deposits very rarely occur in pure masses, but rather are intermixed with varying amounts of gangue minerals and the fibers require liberation as well as separation from the gangue minerals before they can be used in the many varied forms and products.

The gangue minerals are also essentially Magnesium Silicates with varying quantities of Silica, Aluminum, Iron, Magnesium, Calcium, Sodium, Manganese, Potassium and water. The Pyroxene group includes such minerals as Augite, Pyroxene, Diopside, Aegirite, Dialage, Enstatite, Bronzite, Hypersthene, etc. The mica mineral group includes such minerals as Mica, Vermiculite, Hydrobiotite, Biotite and Talc. Other gangue minerals are Serpentine, Quartz, Feldspars, Apatite, Calcite, Magnetite and Syenite rock. The specific gravities of the gangue minerals range from 2.3 to 3.5.

Asbestos is now produced for the commercial markets by dry processing using principally a physical means such as crushing to free the fibers and then separating the fibers from the rock or gangue minerals with a series of air aspirator devices and screening.

The process developed by A. D. Rovig and A. R. Nicholls under the direction of J. W. Ransone is a wet process. That is, the ore is in the form of a water slurry throughout the process until the final stage of drying the asbestos fibers which have been separated from the gangue mineral at various stages of the process.

Process for Beneficiating Asbestos Ores

The wet process has distinct advantages:

1. Liberated asbestos fibers can be separated from gangue minerals regardless of fiber length or specific gravities.

2. Associated minerals of the Mica group such as mica, vermiculite, hydrobiotite and biotite are separated and concentrated and can be recovered as such (Rod milling & screening stage)

3. Associated minerals of heavier specific gravities such as Pyroxene, Apatite and Magnetite are separated and concentrated and can be recovered as such. (Gravity tabling stage.)

4. Feed ore is washed prior to liberation stage which preserves fiber color.

5. Fibers are more easily liberated and fiber length preserved when wet than when dry.

6. Exact and automatic control of liberation stage (Rod Milling).

7. Recovery of exceptionally fine-sized asbestos by classification (Cyclone overflow-Bird centrifuge).

8. Separation of asbestos from gangue minerals by classification, particle size and specific gravity by tabling with exact control of asbestos concentrate, asbestos content of tailing, and material requiring further processing.

9. Positive separation of asbestos from gangue with Cell Flotation. Chemical reagent scheme using Amine and Oil will float gangue away from asbestos. Chemical reagent scheme using Fatty Acid or soap scheme will float asbestos away from gangue.

10. Process uses equipment well established in the ore beneficiation field as economical, generally high capacity, and low maintenance machines of standard design.

11. Process can concentrate very low-grade asbestos ore.

12. Process is wet so that dust problem is non-existent during actual separation of asbestos from gangue. Dust problem exists only after drying of final asbestos concentrate.

13. Only the asbestos concentrate is dried. The drying of gangue is eliminated.

April 20, 1964

Process for Beneficiation of Asbestos Ores

Laboratory Phase:

Initial investigation for the development of a wet process for the beneficiation of Tremolite Asbestos was begun in April 1962. This work was confined to the Libby laboratory for the purpose of determining how the actual separations could be made and what series of conditions were required to obtain these separations. A Flow Sheet was developed from the laboratory data. The Flow Sheet outlined the required feed preparation by crushing, screening and desliming, the concentrating by classification, the concentrating by part classifier and specific gravity on tables, the concentrating by cell flotation and dewatering, drying and fluffing of the final concentrates.

Two reagent schemes for concentrating the asbestos with cell flotation were developed. These reagent schemes are the Fatty Acid scheme and the Amine and Oil scheme. With the Fatty Acid or soap scheme, the asbestos is floated away from the gangue. With the Amine and Oil scheme, the gangue is floated away from the asbestos.

The laboratory phase is covered in the report "A Laboratory Investigation for the Beneficiation of Tremolite Asbestos" by A. R. Nicholls and A. D. Revig, Libby, Montana, dated July 14, 1962.

Pilot Plant Phase:

The laboratory work was highly successful and the Flow Sheet developed from this work was transposed into a pilot plant operation.

The Asbestos Pilot Plant operation is summarized in the report "A Pilot Plant Investigation for the Beneficiation of Tremolite Asbestos" by A. R. Nicholls and A. D. Revig, dated July 25, 1963, at Libby, Montana. This report presents a compilation and study of the asbestos pilot plant performance during the year prior to July 25, 1963.

The Pilot Plant operation was successful in producing an asbestos concentrate of 85% asbestos at a 90% recovery from an ore feed containing approximately 20% asbestos. The operation also simultaneously produced one vermiculite by-product of 79% vermiculite grade and another of 56% vermiculite grade at a combined recovery of 67% when the ore feed contained approximately 20% vermiculite in addition to the asbestos. Asbestos concentrates were also produced from ores containing less than 20% asbestos. One development not included in the report is that when the cell concentrate is further crushed and gravity tabled before dewatering and drying, a higher grade asbestos concentrate results.

All equipment used in the pilot plant is small scale commercial equipment. The machines such as Hammer Mills, Cone crushers, Screens, Spiral Classifiers, Wet Cyclones, Pumps, Tables, Cells, Bird Centrifuge, Rotary Dryer, etc. perform exactly as their larger counterparts except for capacity and can be used for continuous operation. Therefore the pilot plant is a production plant capable of continuous operation at its rated capacity of 1000# of feed per hour and all data can be directly scaled up for capacity purposes.

Process for Beneficiating Asbestos Ores

During the period June 1, 1962 to June 1, 1963, a contract between Superior Asbestos Company and the Division of Industrial Research of Washington State University at Pullman, Washington was in effect. This contract covered a Research Project established for the purpose of developing a flotation process for the beneficiation of Asbestos ores. The project was under the supervision of Dr. W. C. Altenhead, Director of Mining Experiment Station, Division of Industrial Research of WSU. Mr. John A. Jeakel, Associate Metallurgist, was in direct charge of the project and did the work. Monthly progress reports were submitted to Superior Asbestos Company and progress meetings were periodically held between Dr. Altenhead, Mr. Jeakel, Mr. Bovig and Mr. Nicholls. The WSU project was confined almost entirely to research on improving the Fatty Acid or Soap reagent scheme in which the asbestos is floated away from the gangue minerals. This reagent scheme differs from the Amine or Oil scheme with which the gangue minerals are floated away from the asbestos. A Fatty Acid scheme which will concentrate asbestos was developed by the WSU project. The final report on the WSU project was issued on May 31, 1963.

General:

The asbestos mineral in the Libby deposit has been identified as Tremolite which is a mineral of the Amphibole group. The coarse silssile fibers tend to be short and brittle and in some cases the mineral may not appear in fiber form. However, the developed process makes equal separations regardless of fiber length and with good control for the preservation of existing fiber lengths. Because the asbestos mineral in the Libby deposit is Tremolite, the process was developed on that ore.

In October 1963, we were contacted by Mr. William C. Streib, Research Center, Johns-Manville Products Corporation, Manville, New Jersey. Mr. Streib wished to make arrangements for us to wet-process some asbestos ore samples. These ore samples from Johns-Manville were received in January 1964 and tested in the Libby laboratory during February and March 1964. The work was supervised by A. R. Nicholls and J. W. Ransone, and the results are covered in the report entitled "Research Report on Johns-Manville Asbestos Samples" by John W. Ransone, dated April 23, 1964. These ore samples are identified as Chrysotile Asbestos in peridotite and Serpentine. The separation of the fiber from the gangue appears to be satisfactory and complete. The process worked equally well on the longer fibered Chrysotile asbestos as on the shorter fiber Serpentine. The Coal Flotation stage of the process was not used on these samples because the separation appeared to be complete after the table stage.

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Copies of reports attached to this disclosure:

Nicholls, A. R., and Rovig, A. D., "A Laboratory Investigation for the Beneficiation of Tremolite Asbestos", (Zonolite Company report) July 14, 1962, Libby, Montana

Nicholls, A. R., and Rovig, A. D., "A Pilot Plant Investigation for the Beneficiation of Tremolite Asbestos", (Zonolite Company report) July 25, 1963, Libby, Montana

Ransone, J. W., "Research Report on Johns-Manville Asbestos Samples", (Zonolite Division - W. R. Grace & Co. report) April 23, 19[illegible], Libby, Montana

Alvin R. Nicholls
Allen D. Rovig
Full Name of Inventor

July 25, 1963
Date of Conception

Explained to and understood by me this _____ day of _____.

Signature of Witness

Date of Signature

Explained to and understood by me this _____ day of _____.

Signature of Witness

Date of Signature

Records may be found: Files, Zonolite Division - W. R. Grace & Co., Libby, Montana