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EXFOLIATION TESTS ON VERMICULITE FROM NORTH BAY, ONTARIO

by

H.S. Wilson

Industrial Minerals Division

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EXFOLIATION TESTS ON VERMICULITE

FROM

NORTH BAY, ONTARIO

Introduction

Two small samples about two pounds each in weight, and one larger 65 pound sample of raw vermiculite were submitted by Mr.Norman Miller, Room 50, 511 King Street West, Toronto, Ontario. They were reported to have been taken from two deposits in the vicinity of North Bay, Ontario. One of the small samples and the large sample were from the same deposit. This material designated as sample one was nearly black in color. The other small samples designated as sample two was brown in color. As the samples were frozen when received they were allowed to thaw and were dried before being tested.

Preliminary Tests

Portions of the two smaller samples were tested in a gas-fired stationary kiln at various temperatures. The firing temperatures were in increments of 100 degrees between 1500 to 1900°F. The charges were placed in the kiln at the desired temperature and removed when exfoliation appeared complete. In all cases the retention time was between 1 and 1½ minutes. The products from these tests were examined.

Sample one which was approximately minus 8 mesh in size exfoliated well, but sample two which was minus 3/8 inch exfoliated only slightly. Both samples contained rock impurities. The impurities in sample one appeared to be mainly hornblende amphibole while the impurities in sample two appeared to be mainly quartz and feldspar. The vermiculite after being fired was brown in color.

Exfoliation Tests

The 65 pound sample used in these tests was dried and screened into various sized fractions. The screen analysis is shown below:

TABLE I

	+	4	mesh	6%
- 4	+	8	"	4%
- 8	+	14	"	6%
-14	+	28	"	23%
-28	+	35	"	16%
-35	+	100	"	29%
	-	100	"	16%
				100%

Portions of each size fraction were examined in order to estimate the amount and type of impurity present with the vermiculite.

The observations are shown below:

TABLE II

Size Fraction	% Rock Contained
+ 4 mesh	50
- 4 + 8 "	25
- 8 + 14 "	20
- 14 + 28 "	5
- 28 + 35 "	20
- 35 + 100 "	10
- 100 "	60

The rock impurity appeared to be mainly hornblende amphibole, with minor quartz, feldspar and garnet.

All fractions but the minus 100 mesh were exfoliated in a glo-bar tube furnace. A stainless steel pipe extending through the furnace was mechanically vibrated to carry the material through it. The fractions of the raw material were fired separately at various temperatures between 1500 and 1850°F. The unit weight of each product was measured. It was noted that there was break down of the vermiculite during firing. To determine the amount of break down a portion of each product was screened on the smaller screen used to separate each fraction of feed. The test conditions and results are shown in Table III.

TABLE III

Head Feed Size	Firing Temp. (°F)	Unit Wt. (lb/cu ft)	Color Of Product	Break Down (%)
-4 + 8	1650	19.0	brown	55
-8 +14	1650	15.6	brown	29
	1750	15.5	brown	32
	1850	18.1	grey	24
-14+28	1500	19.3	brown	14
	1650	15.0	brown	14
(A)	1750	16.3	brown	11
(B)	1750	19.2	grey and brown	11
	1850	18.3	grey and brown	9
-28+35	1550	21.4	grey and brown	12
	1650	20.6	brown	11
	1800	20.7	grey and brown	12
-35+100	1650	23.6	grey and brown	5

Beneficiation

Upon examination it was found that in all size fractions, the vermiculite particles had exfoliated quite well although the unit weights were too high. The American Society for Testing Materials specifies a maximum unit weight of ten pounds per cubic foot, for vermiculite used in concrete and plaster. Two methods of beneficiation were tried in an attempt to improve the quality of the product; winnowing and screening. Two of the products of the exfoliation tests were treated by each method. The -8+14 mesh material fired at 1850° and the -14+28 mesh material fired at 1650° were winnowed. The -14+28 mesh

material fired at 1850° and the -28+35 mesh material fired at 1800° were screened.

The winnowing machine was a laboratory-size model 7 inches wide, 10 inches high and 27 inches long. The material to be beneficiated was allowed to drop into an air stream blowing into the end of the machine. Air separation of the particles took place. The heaviest particles dropped quickly while the lighter particles were blown progressively further along the machine. Three fractions were obtained, vermiculite concentrate, middlings, and tailings. The percentages by weight and volume of each fraction were calculated. The unit weight of the vermiculite concentrates and the concentrates plus the middlings were determined.

In the screening method, two fractions were obtained. The percentages by weight and volume of each fraction and the unit weights of each were determined. The results of these tests are shown in Tables 4 and 5.

TABLE IV

Winnowing

Head Feed -8+14 mesh, Temperature 1850°

	% By Weight	% By Volume	Unit Weight(Lb/Cu Ft	
Concentrate	25.2	56.5	8.7	} 16.1
Middlings	41.6	34.5		
Tailings	33.2	9.0		
	100.0	100.0		

Head Feed -14+28 mesh, Temperature 1650°

	% By Weight	% By Volume	Unit Weight(Lb./Cu Ft	
Concentrate	20.8	52.7	6.6	} 9.6
Middlings	23.5	32.0		
Tailings	55.7	15.3		
	100.0	100.0		

TABLE V

Screening

Head Feed -14+28 mesh, Temperature 1850°
Screened on 14 mesh.

	% By Weight	% By Volume	Unit Weight
Concentrate	15.3	55.2	7.4
Tailings	84.7	44.8	32.8
	100.0	100.0	

Head Feed -28+35 mesh, Temperature 1800°
Screened on 28 mesh

	% By Weight	% By Volume	Unit Weight
Concentrate	57.2	65.8	13.5
Tailings	42.8	34.2	45.9
	100.0	100.0	

The tailings obtained from the screening of the -28+35 mesh material shown in Table 5 contained a quantity of fine vermiculite. In order to increase the quantity of vermiculite concentrate recovered by the screening, these tailings were winnowed. The relative percentages of the two fractions obtained from this winnowing are shown in Table 6.

TABLE VI

	% By Weight	% By Volume
Concentrate	11.5	38.4
Tailings	88.5	61.6
	100.0	100.0

Combining the vermiculite concentrates obtained by the screening and winnowing the tailings of the -28+35 mesh material, the total vermiculite recovered was 62.1 percent by weight and 78.9 percent by volume of the original fired product.

CONCLUSIONS

The preliminary tests made on the two small samples indicate that sample one exfoliates well, but sample two does not show too much promise.

Sample one is quite fine grained. As can be seen from the screen analysis shown in Table I, 45 percent of the raw material is minus 35 mesh. This size is not generally exfoliated commercially. Of the plus 35 mesh material nearly 85 percent is minus 14 mesh. The vermiculite produced from the minus 14 plus 35 mesh size would possibly be suitable for concrete or plaster aggregate but would probably be too fine to be used as loose insulation.

The unit weights of the fired fractions shown in Table 3 indicate that beneficiation is necessary to give a product of sufficiently low unit weight to meet specifications. Separation of the vermiculite and the non-exfoliating material could be accomplished before or after firing, or both. Air separation of the two materials before firing may give satisfactory results. Screening or a combination of screening and winnowing the exfoliated product appears to give good results. Table 4 shows 34.5 to 52.7 percent concentrate recovered by winnowing, whereas Table 5 shows 55.2 to 65.8 percent concentrate recovered by screening. Winnowing the tailings from the screening operations increased the recovery of the concentrate from 65.8 to 78.9 percent.

Error ?

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H.S.Wilson,
Industrial Minerals Division.