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Contract Number AT-33-1-GEN-53

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MOUND LABORATORY

Operated By

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MIAMISBURG, OHIO

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Classification changed to
by Carlette L. Lewis 9/10/20
Reviewed by C.W. Huntington 8/21/79

PREPARATION OF BISMUTH POWDER

(Information Report)

Date: March 8, 1949

Distributed: MAR 24 1949

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INTRODUCTION

The principal object of this report is to record results of tests made on equipment installed in Room 232 of "T" Building and used to prepare bismuth powder for process operations.

Another object is to establish the most favorable operating conditions for the equipment and to prepare operating instructions therefor.

CONCLUSIONS

Bismuth powder may be prepared rapidly and economically with equipment as installed.

The hammer mill can be operated at a rate of 135 lbs. per hour of bismuth pig.

The ball mill can be operated at a rate of 3.7 lbs. per hour of 140 mesh product; 2.0 lbs. per hour of 200 mesh product, and 5.7 lbs. per hour of 140 + 200 mesh product.

The screening operation on one Ro-Tap shaker can separate material from the ball mill at this rate.

For maximum efficiency in preparing 140 mesh powder the ball mill should be operated with a feed load of 2.0 kg.; ball load 4.0 kg.; grinding time 15 minutes; jar r.p.m. 84.

For maximum efficiency in preparing 200 mesh powder the ball mill should be operated with a feed load of 2.5 kg.; a ball load of 4.5 kg.; grinding time 15 minutes; jar r.p.m. 84.

For maximum efficiency in preparing 140 and 200 mesh powder the ball mill should be operated with a feed load of 2.0 kg.; a ball load of 4.0 kg.; grinding time 15 minutes; jar r.p.m. 84.

Optimum operation of the Ro-Tap shaker is obtained with a screen time of five minutes and a screen load of 1000 grams.

No significant differences were observed in process operations at Unit IV using powder prepared on this equipment and powder prepared at Unit IV.

Description

Apparatus installed in Room 232 is as follows

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1 - Swing Sledge Hammer Mill, Style B, Size 00, manufactured by Sturtevant Mill Company, Boston, Massachusetts, Serial No. 579, U.S.A. No. 8163.

1 - Ball Mill, manufactured by Paul O. Abbe Inc., Little Falls, New Jersey, Serial No. 46680, U.S.A. No. 7444, fitted with three porcelain jars 8 1/2" in diameter by 8 1/2" high.

1 - Sieve Shaker, "Ro-Tap", manufactured by W. S. Tyler Company, Cleveland, Ohio, Serial No. 6280, U.S.A. No. 7410.

1 - Timer, manufactured by Walser Automatic Timer Company, New York, New York. Sieves, 8" in diameter by 2" deep with U.S. Bureau of Standards screens.

Bismuth is purchased in "pigs" having the dimensions shown in Figure 1. These pigs are packed in a wood box, usually 28 pigs to a box, weighing approximately 170 pounds net.

Each pig is broken at the "neck" or groove by means of a hammer, forming four truncated pyramids of metal which are fed to the swing sledge hammer mill for the first reduction.

These metal pyramids or "slugs" are reduced in the hammer mill at the rate of approximately 90 per hour, or 45 seconds per slug. Each slug weighs 1.5 lbs. and, at the rate of 90 slugs per hour, the mill will grind 135 lbs. per hour. At this rate the mill loss is 4.8 per cent consisting of fine dust which sifts out of joints in the mill housing. The mill as received was not provided with gaskets in these joints, but it is believed that tight gaskets at these places would reduce this loss somewhat. However, this material is so finely ground that it passes through the screens and is discarded as waste during separation of the powder, and it may be reported either as mill loss or as waste.

A typical screen analysis of material from this mill is tabulated in Figure 2 and the data are plotted in Figure 3.

Material distribution is shown in Figure 4 for a final product of either 140 mesh or 200 mesh.

It is assumed that a final product of either 140 mesh or of 200 mesh will be required. If both grades of material can be used, these may be separated as final product as indicated in Figure 4.

The product from the hammer mill is screened by 2" deep U.S. Bureau of Standards sieves, using a

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Figure 1

AVERAGE WEIGHT - 6 LBS

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Figure 2

SCREEN ANALYSIS

<u>MESH</u>	<u>% RETAINED</u>	<u>% CUMULATIVE</u>
On 20	18.8	18.8
On 60	38.9	57.7
On 100	16.3	74.0
On 140	6.9	80.9
On 200	6.3	87.2
On 325	6.9	94.1
Through 325	5.9	100.0

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Fig 3

OBSERVED PERFORMANCE SWING SLEDGE HAMMER MILL $\frac{3}{4} \times \frac{3}{4} \times \frac{3}{4}$ FEED

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KEUFFEL & ESSER CO., N. Y. NO. 150-02
Semi-Logarithmic, 2 cycles X 10 to the 4th inch, 5th mm centered
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PERCENT

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Figure 4

MATERIAL DISTRIBUTION

	<u>140 MESH PRODUCT</u>	<u>200 MESH PRODUCT</u>	<u>140 + 200 MESH PRODUCT</u>
Material to Hammer Mill	100.0%	100.0%	100.0%
Hammer Mill Loss	4.8	4.8	4.8
Product	6.6	6.0	12.6
To Ball Mill	70.4	77.0	70.4
Waste	18.2	12.2	12.2
Efficiency	77.0	83.0	83.0
Ball Mill Feed on 20 Mesh	25.4	23.3	25.4
Ball Mill Feed on 60 Mesh	52.6	48.2	52.6
Ball Mill Feed on 100 Mesh	22.0	20.2	22.0
Ball Mill Feed on 140 Mesh		8.3	

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and a screen time of five minutes. Generally, the sieve stack will consist of two sieves, oversize and product, with the oversize recycled to ball mills for further grinding, the product retained and the material passing the product sieve discarded as waste. By inserting two product sieves in the stack, two grades of product may be separated in one operation.

Tests were made on the ball mill over a wide range of loadings using product from the hammer mill as feed. Data from some of these tests are plotted in Figures 5 through 24.

These data indicate that the maximum quantity of 140 mesh product is obtained with a ball load of 4.0 kg. and a feed load of 2.0 kg. Maximum quantity of 200 mesh product is produced with a ball load of 4.5 kg. and a feed load of 2.5 kg. The data are tabulated in Figure 25.

Figures 26, 27, and 28 are summaries of the performance data and show the overall efficiencies obtained when grinding powders of several different grades.

The data indicate that a screen time of five minutes is adequate when sieves are shaken on the "Ro-Top" shaker. A screen time in excess of this value does not result in improved separation and does contribute to screen wear. A screen load of 1000 grams gives the best separation in the established time and does not cause undue wear while a load in excess of 1000 grams causes rapid sieve wear and screen clogging.

Samples of powder prepared on this equipment were submitted to the Production Research Department for iron analysis. The data are tabulated in Figure 29.

Bismuth powder prepared on this equipment was used in production operations at Unit IV on and after December 6, 1943. While the operations at Unit IV are different from those set up for Unit V, comparison of runs made under similar conditions should indicate significant differences in powder produced at these two locations. The data tabulated in Figure 30 show the scrubbing efficiencies of sample lots of powder from this equipment compared with runs made immediately prior thereto using powder prepared at Unit IV.

Comparison of 53 solutions processed by the Process Group from material using powder prepared at Unit V with 53 solutions from material using powder prepared at Unit IV was made. The data show an average purity of 95.2 per cent for solutions from material using powder prepared by this method and an average purity of 95.6 per cent for solutions from material using the old powder. This variation is within the usual day-to-day operating

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BALL LOAD - 2.0 Kg

FIG. 5

OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
140 MESH PRODUCT

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BALL LOAD - 2.5 Kg

FIG. 6

OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
140 MESH PRODUCT

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Fig. 7

BALL LOAD - 3.0 KG.

OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
140 MESH PRODUCT

KEUFFEL & ESSER CO.

NO. 35911. 10 x 10 to the left inch, 5th lines centered.

Engraving 7 x 10 in.

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BALL LOAD - 3.5 KG.

FIG. 8
OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
140 MESH PRODUCT

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BALL LOAD - 4.0 KG

FIG. 9

OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
140 MESH PRODUCT

KEUFFEL & ESSER CO.

60 350-11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100

BALL LOAD - 4.5 KG UNCLASSIFIED

FIG. 10

OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
140 MESH PRODUCT

KEUFFEL & ESSER CO.

NO. 359 1:1. 10 x 10 to 16 half inch, 5th lines accented.
Engraving. 7 x 10 in.

FEED LOAD - 0.5

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Fig. II

OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
140 MESH PRODUCT

BALL LOAD, KG

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Fig. 12

OBSERVED PERFORMANCE
AEBE BALL MILL GRINDING
40 MESH PRODUCT

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OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
140 MESH PRODUCT

Fig 13

FEED LOAD - 1.5 KG

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FEED LOAD - 2.0 KG UNCLASSIFIED

Fig. 14

OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
140 MESH PRODUCT

FEED LOAD - 3.5 Kg.

FIG. 15

OBSERVED PERFORMANCE
WET BALL MILL GRINDING
140 MESH PRODUCT

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BALL LOAD - 2.0 KG

FIG. 16

OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
200 MESH PRODUCT

BALL LOAD - 2.5 KG

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FIG. 17

OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
200 MESH PRODUCT

KEUFFEL & LUGER CO.

NO. 359-11. 10 x 10 to the half inch, 5th lines accented.

Engraving: 7 x 10 in.

MADE IN U.S.A.

BALL LOAD = 3.0 KG

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FIG. 18

OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
200 MESH PRODUCT

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BALL LOAD - 3.5 KG

FIG 19

OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
200 MESH PRODUCT

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BALL LOAD 4.0 Kg

FIG. 20

OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
200 MESH PRODUCT

BALL LOAD - 4.5 K UNCLASSIFIED

FIG 21

OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
200 MESH PRODUCT

KEUFFEL & ESSER CO.

NO. 35911. 10 x 10 to the half inch, 5th lines accented.

Engraving, 7 x 10 in.

MADE IN U.S.A.

FIG. 22

OBSERVED PERFORMANCE
 ABBE BALL MILL GRINDING
 200 MESH PRODUCT

KEUFFEL & ESSER CO.

NO. 55971. 10 - 10 to the 10th. 10 lines accepted.
Engineering, 10 m.

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Fig. 23

OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
200 MESH PRODUCT

KEUFFEL & ESSER CO.

NO. 359 11. 10 x 10 to the half inch, 5th lines accented.

Engraving, 7 x 10 in.

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Fig. 24

OBSERVED PERFORMANCE
ABBE BALL MILL GRINDING
200 MESH PRODUCT

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Figure 25

BALL MILL PERFORMANCE

	<u>140 MESH PRODUCT</u>	<u>200 MESH PRODUCT</u>	<u>140+200 MESH PRODUCT</u>
Ball Load, Kg.	4.0	4.5	4.0
Feed Load, Kg.	2.0	2.5	2.0
Product, Grams	284	160	438
Recycle, Grams	1208	1985	1208
Waste, Grams	508	355	354
Efficiency (Prod./Prod.+ Waste) %	35.9	31.1	55.3
Grinding Time, Min.	15	15	15
R. P. M. Jar	84	84	84
Grinds Per Hour	6	6	6
Product, Kg./Hour	1.7	.9	2.6

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MATERIAL			PRODUCT			WASTE		
100.0%								
Hammer Mill Loss			4.8			4.8%		
Product			6.6			6.6%		
Waste			18.2			18.2		
Feed to Ball Mill			70.4					
Product			10.0			10.0		
Waste			17.9			17.9		
Recycle to Ball Mill			42.5					
Total			28.9			16.6		
Efficiency % (Prod./Prod. + Waste)			28.9			40.9		
Waste %			71.1					

140 MESH PRODUCT

BISMUTH POWDER

Figure 26

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MATERIAL			PRODUCT			WASTE		
Stock to Hammer Mill			100.0%					
Hammer Mill Loss			4.8			4.8%		
Product			6.0			6.0%		
Waste			12.2			12.2		
Feed to Ball Mill			77.0					
Product			4.9			4.9		
Waste			10.9			10.9		
Recycle to Ball Mill			61.2					
Total						10.9		
Efficiency, % (Prod./Prod.+ Waste)			28.1			27.9		
Waste %			71.9					

200 MESH PRODUCT

BISMUTH POWDER

Figure 27

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Figure 28BISMUTH POWDER140 + 200 MESH PRODUCT

	<u>MATERIAL</u>	<u>PRODUCT</u>	<u>WASTE</u>
Stock to Hammer Mill	100.0%		
Hammer Mill Loss	4.8		4.8%
Product	12.6	12.6%	
Waste	12.2		12.2
Feed to Ball Mill	70.4		
Product	15.4	15.4	
Waste	12.5		12.5
Recycle to Ball Mill	42.5		
Total		28.0	24.7
Efficiency % (Prod./Prod.+ Waste)	53.1		
Waste %	46.9		

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Figure 29

ANALYSIS OF POWDER

<u>SAMPLE NO.</u>	<u>P.p.m. IRON</u>	<u>PRECISION</u>
140-A	40	± 5
140-B	28	± 5
140-C	28	± 5
200-A	38	± 5
200-B	38	± 5
200-C	34	± 5

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Figure 30

SCRUBBING EFFICIENCY

	<u>140 MESH</u>	<u>200 MESH</u>	<u>140 + 200 MESH</u>
Unit IV Powder, No. Runs	4	2	
Unit IV Powder, Mean Recovery	95.82	98.92	
Unit V Powder, No. Runs	2	2	2
Unit V Powder, Mean Recovery	95.59	99.59	98.91

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variations and indicates satisfactory performance.

These data indicate no significant differences were observed and that powder prepared by this equipment is satisfactory for use as scrub powder in process operations.

Reference: Lab. Note Book, pages 202555-202585

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