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AUSTRALIAN BLUE ASBESTOS LIMITED -

FIRST REPORT.

RECOVERY OF ASBESTOS FROM MILL TAILING.

ISSUED BY

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AUSTRALIAN BLUE ASBESTOS LIMITED.

FIRST REPORT

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- Contents -

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RECOVERY OF ASBESTOS FROM MILL TAILING.

1. SUMMARY.

A sample of current mill tailings was submitted by Australian Blue Asbestos Limited, of Wittenoom, W.A., for work on the recovery of additional asbestos.

Only dry methods of concentration similar to those now being used in the plant were tried. A recovery of approximately one-third of the asbestos was achieved, the grade of product apparently being equal to that of the present standard grade.

Of the methods tried, that which gave the best results consisted of reducing the gangue rock to minus 10 mesh by stage crushing in rolls, the oversize being removed by screening after each stage.

The final oversize product consisted mainly of asbestos, which was then fiberised. Recovery of asbestos by this method was 32.6 per cent., the dust content (determined by screening at 200 mesh) being 13 per cent.

An additional 9.7 per cent. of the fibre was recovered by aspiration from the minus 10 mesh undersize in a product which contained 48.5 per cent. dust and which could be cleaned to less than 28 per cent. dust in a trommel fitted with an air blast for only a slight loss in recovery.

The asbestos products have been returned to the Company for checking of dust contents and the evaluation of the fibre.

2. INTRODUCTION.

A request dated 19th January, 1959, was received from Australian Blue Asbestos Limited, Wittenoom Gorge, Western Australia, initiating an investigation for recovering the asbestos fibre not being recovered by the existing treatment methods. The asbestos recovered from the mill tailings preferably was to be a product which could be blended with the present standard grade fibre. However, consideration was to be given, if necessary, to the production of lower grades of fibre.

Dry methods of concentration were to be used.

An officer of the Mines Department visited the plant in May, 1959, and obtained a general understanding of the problems involved.

3. MILL FLOWSHEET.

At the time of the visit the milling section had two sections operating in parallel. A third section was in the course of construction. A fourth section is proposed.

Figure 1 shows a schematic layout of the crushing plant and Figure 2 one of the existing milling sections.

4. MATERIAL EXAMINED.

A sample of mill tailings taken from the belt feeding the tailing bin during the period 25th to 29th May, 1959, was supplied by the Company.

5. EQUIPMENT.

The following were the main items of equipment used in the test work:-

(1) Gyratory Screen, 3' diameter.

(2) Vacuum cleaner with an air displacement of 500 c.f.m.

(3) Rolls crusher, 6" x 10".

(4) Laboratory steel batch ball mills, 500 grm. and 10 lb. capacity.

(5) B.S.S. test screens.

6. EXPERIMENTAL PLAN.

An increase in recovery of the fibre could be obtained either by

(a) Minor alterations to existing plant practices.

(b) Major alterations or additions to the plant.

The work was therefore planned to investigate these two problems in the following manner.

Figure 1.

Crushing Section,

A.B.A. Ltd. Colonial Mill.

May, 1959.

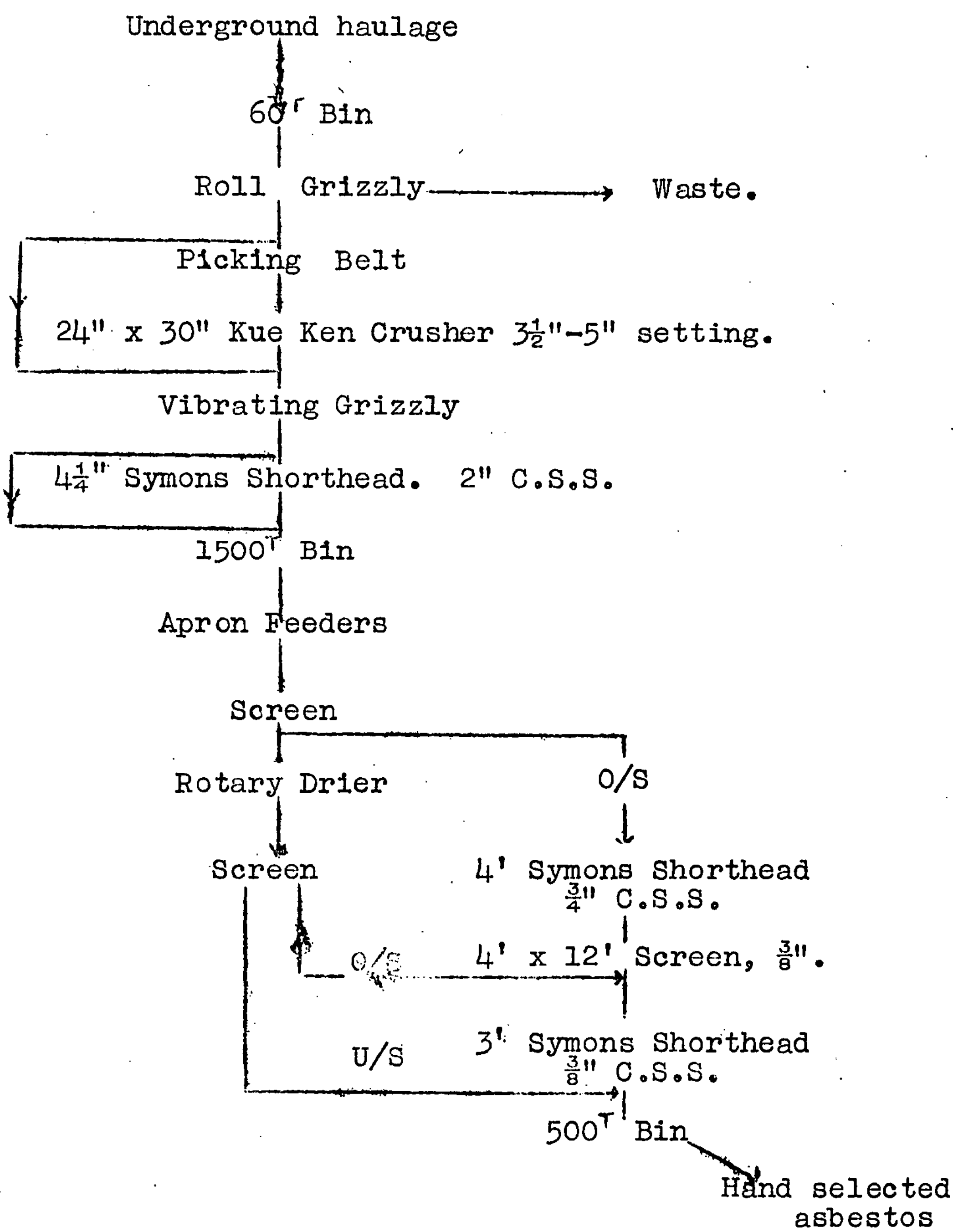
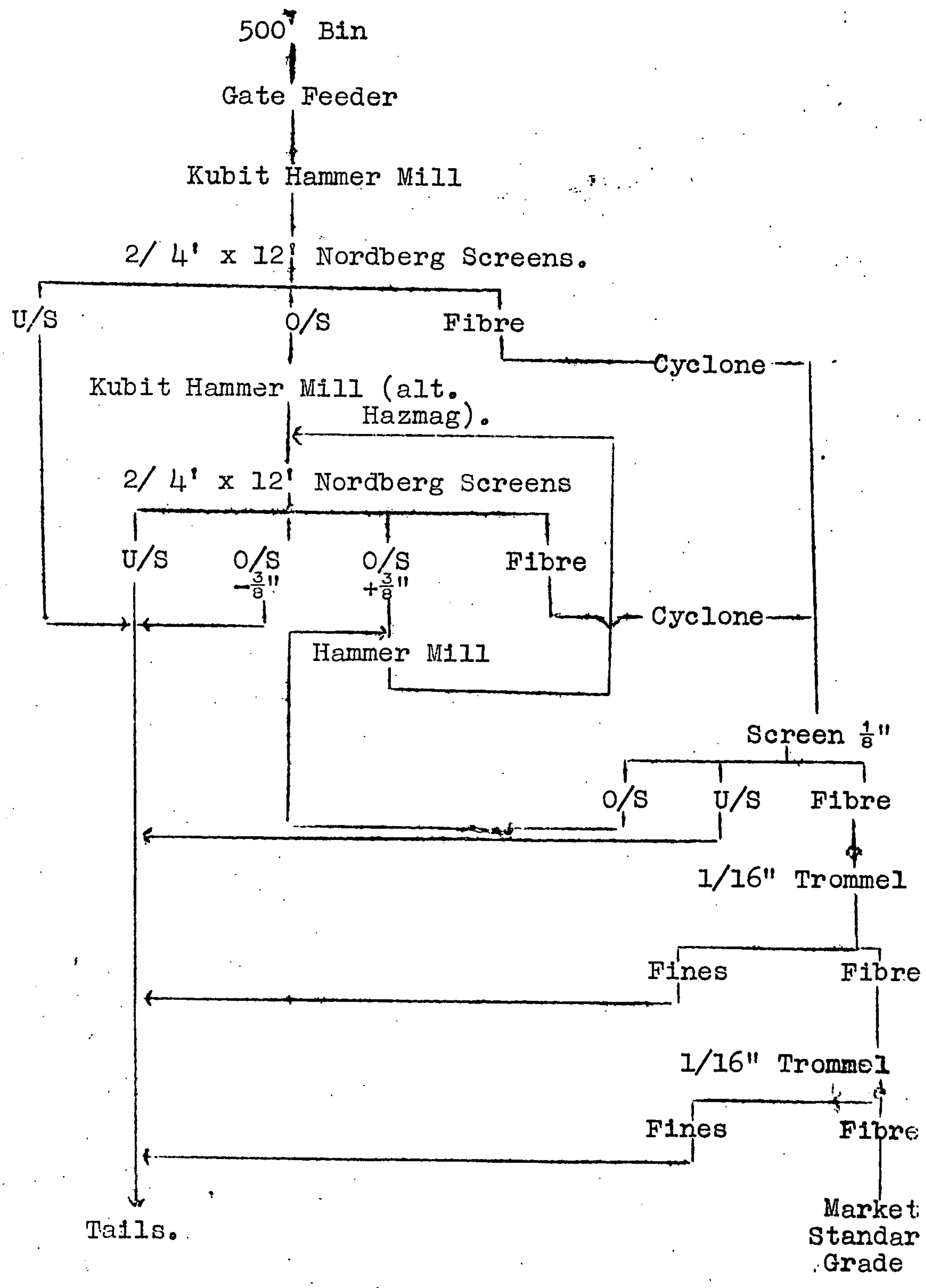


Figure 2.

Milling Section (showing 1 section only)

A.B.A. Ltd. Colonial Mill,

May, 1959.



6.1 Minor Alterations to Plant:

6.1.1 Efficiency of plant aspirating system:

Some fibre loss would be possible from the aspirating system, which, if working inefficiently, would permit freed fibre to pass into the tailings.

The first test was to treat the tailings by intense aspiration and thus determine the amount of free fibre which was not being collected in the plant.

6.1.2 Variation of screen mesh sizes:

The tertiary hammer mills are in closed circuit with screens having an opening of three-eighths of an inch, this opening being governed by the capacity of the hammer mills.

A screen analysis of the tailings was made, together with a determination of the fibre content of each fraction. This was designed to show whether recovery could be improved by decreasing the mesh size of the screen.

6.2 Increase in Recovery by Major Plant Additions:

6.2.1 Selective fiberising without reduction:

The logical treatment for asbestos recovery by aspiration is one which gives maximum fiberising with minimum breakage of adhering country rock. Attempts were made to achieve this selective fiberising, without breaking, in either a hammer mill or a ball mill. The hammer mill available was entirely unsuitable for the duty required, and was not persevered with.

A ball mill with a reduced ball loading was then used as a fiberising unit. The feed was cleaned of fiberised asbestos then stage ground in a laboratory ball mill with screening and aspiration after each grinding stage. Overall recovery of fibre was low and selectivity for asbestos was not achieved. Excessive dust was also a problem. The method used is outlined in Flowsheet 1.

6.2.2 Fiberising with size reduction:

Many of the pencils of asbestos are capped on both ends with rock which must be removed before effective fiberising can be achieved. This process entails some unnecessary breaking of the free particles of rock. Roll crushing to approximately 8 mesh, then screening with aspiration was followed by stage grinding in the ball mill to effect selective fiberising. This resulted in a much higher recovery of fibre and this technique was adapted further. (See Flowsheets 2 and 3).

6.3 Recovery of Fines:

The fines thus produced appeared to contain a considerable amount of fine fluffed fibre and were treated in a Gayco air-classifier to yield a "fibre concentrate", containing 98 per cent. dust, corresponding to a further 3 per cent. recovery of fibre. Possibly this material may be concentrated to a fine fibre product by wet methods of concentration, but work on this aspect was not considered warranted.

7. EXPERIMENTAL PROCEDURE AND RESULTS.

7.1 Material Preparation:

The three drums of sample were thoroughly mixed, coned and quartered and finally riffled into lots of approximately 20 lb. for test purposes.

7.2 Fibre content of feed:

The fibre content of the feed was determined on dried samples of 1,000 g. Table 1 shows size analysis and fibre distribution in screen fractions of the feed. The method of assay used was a bag technique similar to the routine method observed in the plant. Details of this method are given in an appendix.

Table 1.

Mesh B.S.S.	Nominal Opening Inches	Weight %	Cum. Weight %	Weight Fibre %	Distribution Fibre %	Cum. Distribution %
+ 3/16	0.1875	22.5	22.5	1.7	12.6	12.6
+ 7	0.0949	24.8	47.3	2.9	23.8	36.4
+ 14	0.0474	23.8	71.1	3.2	25.2	61.6
+ 18	0.0336	6.5	77.6	3.8	8.3	69.9
+ 36	0.0166	9.6	87.2	7.5	23.8	93.7
- 36	0.0166	12.8	100.0	1.5	6.3	100.0
Calculated heads:		100.0		3.02	100.0	

The moisture content of the sample as received was 2.25 per cent.

7.3 Recoverable fibre in plant sample

A sample of approximately 20 lb of feed was passed over a 3 ft diameter 10 mesh gyratory screen having a vacuum cleaner nozzle (5½" x 3/4") one inch above the path of flow on the screen, for the purpose of collecting the free fibre.

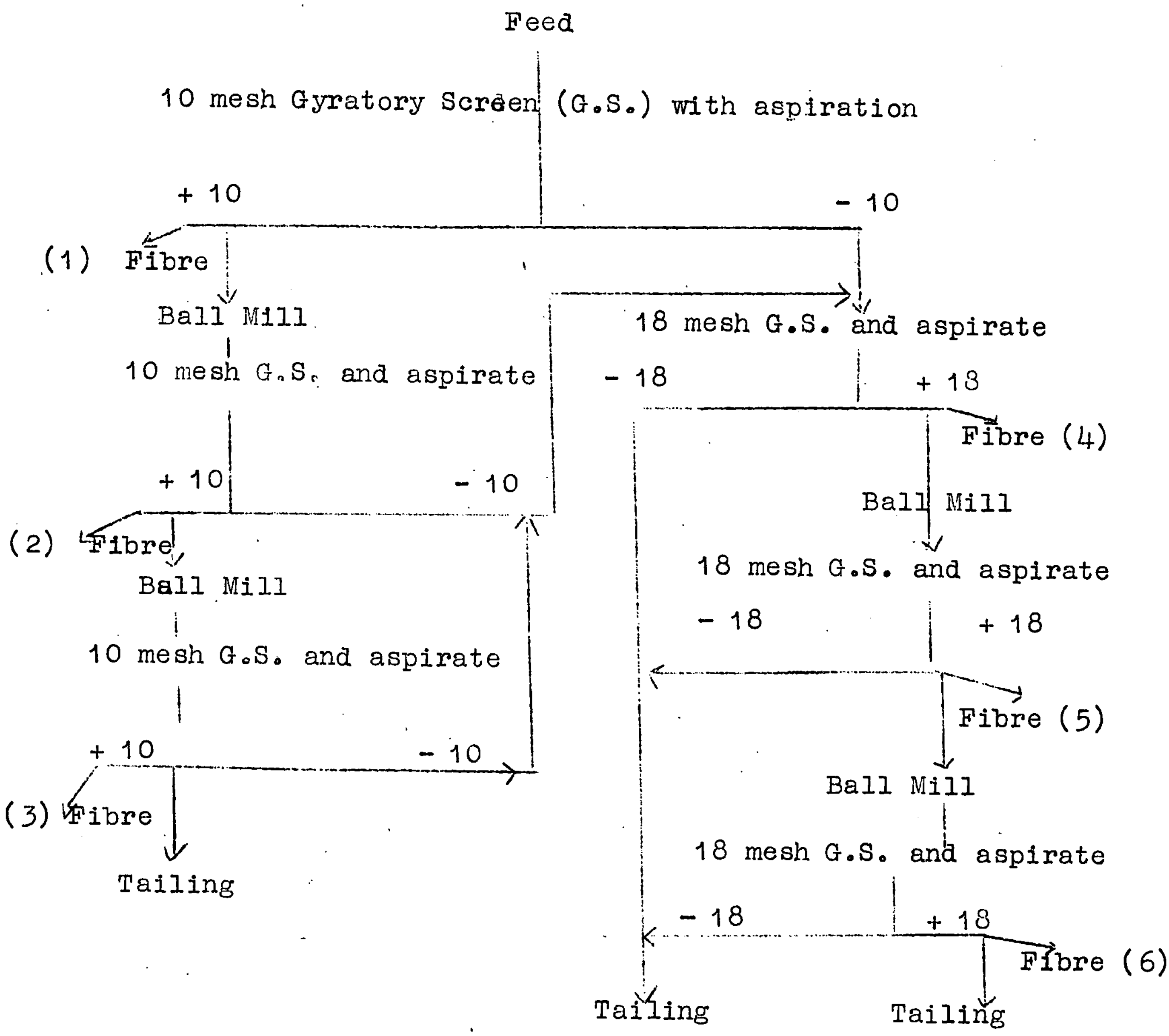
The amount of fibre recovered was negligible and the material was dried and the operation repeated. Screening with aspiration of the dry sample resulted in a recovery of 1.7 to 3 per cent of fibre. This variation was obtained from four samples of 20 to 100 lb of dry feed. The variation was undoubtedly due to the random occurrence of large pieces of fibre in the samples.

7.4 Fiberising by selective grinding

An attempt to selectively fiberise the hard bundles of asbestos by stage grinding in a ball mill was not very satisfactory. A dried sample was treated as outlined in Flowsheet 1 of Figure 3.

FIGURE 3

Flowsheet 1.



The result of treatment according to Flowsheet 1 gave a combined product (Nos. 1, 2 and 3) from the plus 10 mesh circuit containing 15 per cent dust (material passing 200 mesh), and representing a recovery of 3.4 per cent of the contained fibre in the feed. A recovery of 6.3 per cent of fibre was obtained from the -10 +18 mesh circuit (Nos. 4 + 5 + 6) and contained 31.5 per cent dust.

7.5 Size reduction and fiberising with aspiration

It was evident from the screen analysis and fibre distribution in the feed (Table 1) that size reduction of the material would be necessary to effect any worthwhile recovery of fibre.

A rolls crusher was chosen, as in this machine, the compact masses of fibre are flattened without damage to the fibre length, and in this form the asbestos is very suitable for later fiberising. As shown in Flowsheet 2 of Figure 4 the dry feed was rolls crushed to give a product of approximately 8 mesh, then screened on 10 mesh with aspiration of free fibre, and the plus and minus 10 mesh fractions treated by stage-grinding in the ball mill. The fine material (- 18 mesh) produced in this operation contained fluffed asbestos and this fraction was treated in the Gayco air-classifier. The results of the operation of Flowsheet 2 are shown in Table 2.

FIGURE 4

Flowsheet 2.

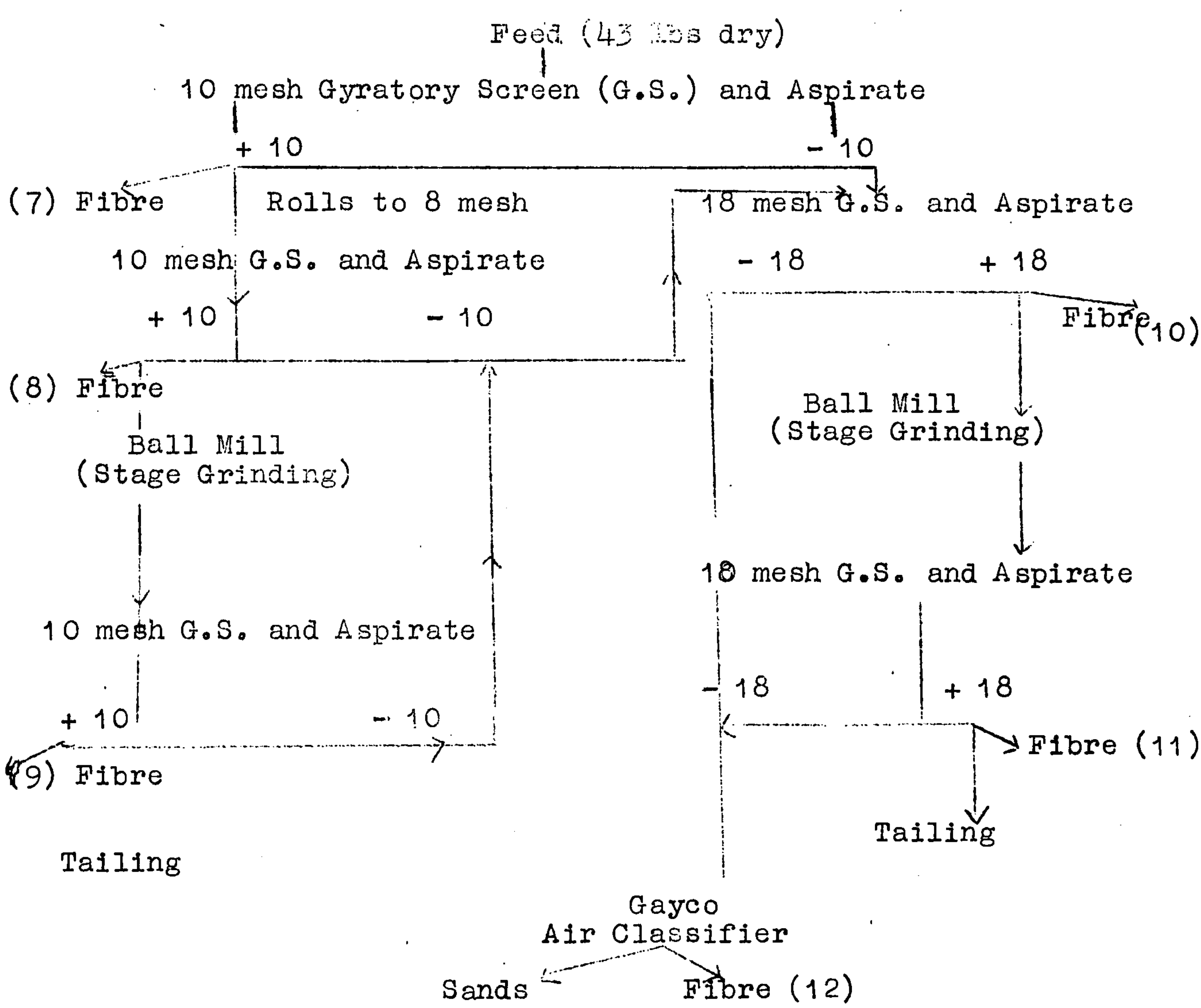


Table 2.

Result of Flowsheet 2.

Product (Fibre)	Weight Grms	Dust Content (T.200)	% Re-covery Fibre*	Cum % Recovery
(7) + (8) + (9)	185	18.3	26.7	26.7
(10) + (11)	159	51.0	12.3	39.0
(12)	907	98.0	3.3	42.3

* Note: (a) For the purpose of these and subsequent calculations of fibre recovery, samples of feed were evaluated by a wet method of assay. This gave a figure for total dust-free fibre. The figure obtained for the feed was 2.9 per cent. dust-free fibre. Details of the method of assay are given in an Appendix.

(b) The terms T200 and C200 used in this report refer to terminology used in the asbestos trade and refer to "through" and "caught" at a particular mesh.

Subsequent to the completion of the work and following discussions with Mr. Thomas of the Company, a sample of high-dust-content fibre was treated in a trommel fitted with an auxiliary air blast.

The dust content was reduced from 51 per cent to 27.5 per cent with the loss of 3.9 per cent. of the dust-free fibre in the product. This cleaned product may be suitable for blending with the first clean product.

A sample of close-sized material was treated in a Stearns disc-type dry magnetic separator to check this method of concentration. The ferruginous quartzite was strongly attracted, but no appreciable fibre concentration occurred.

In stage-grinding to fiberise the asbestos there is the disadvantage of the fine dust from grinding adhering to the fibre. To overcome this it was proposed to rolls-crush to a fairly fine particle size (10 mesh) and remove most of the rock by screening without aspiration, followed by a light fiberising of the screen oversize which would contain the majority of the fibre in the form of flattened bundles, pencils, etc., with a minimum of rock. This material would then be aspirated. This operation is outlined in Flowsheet 3 of Figure 5 amd the results are shown in Table 3.

FIGURE 5

Flowsheet 3.

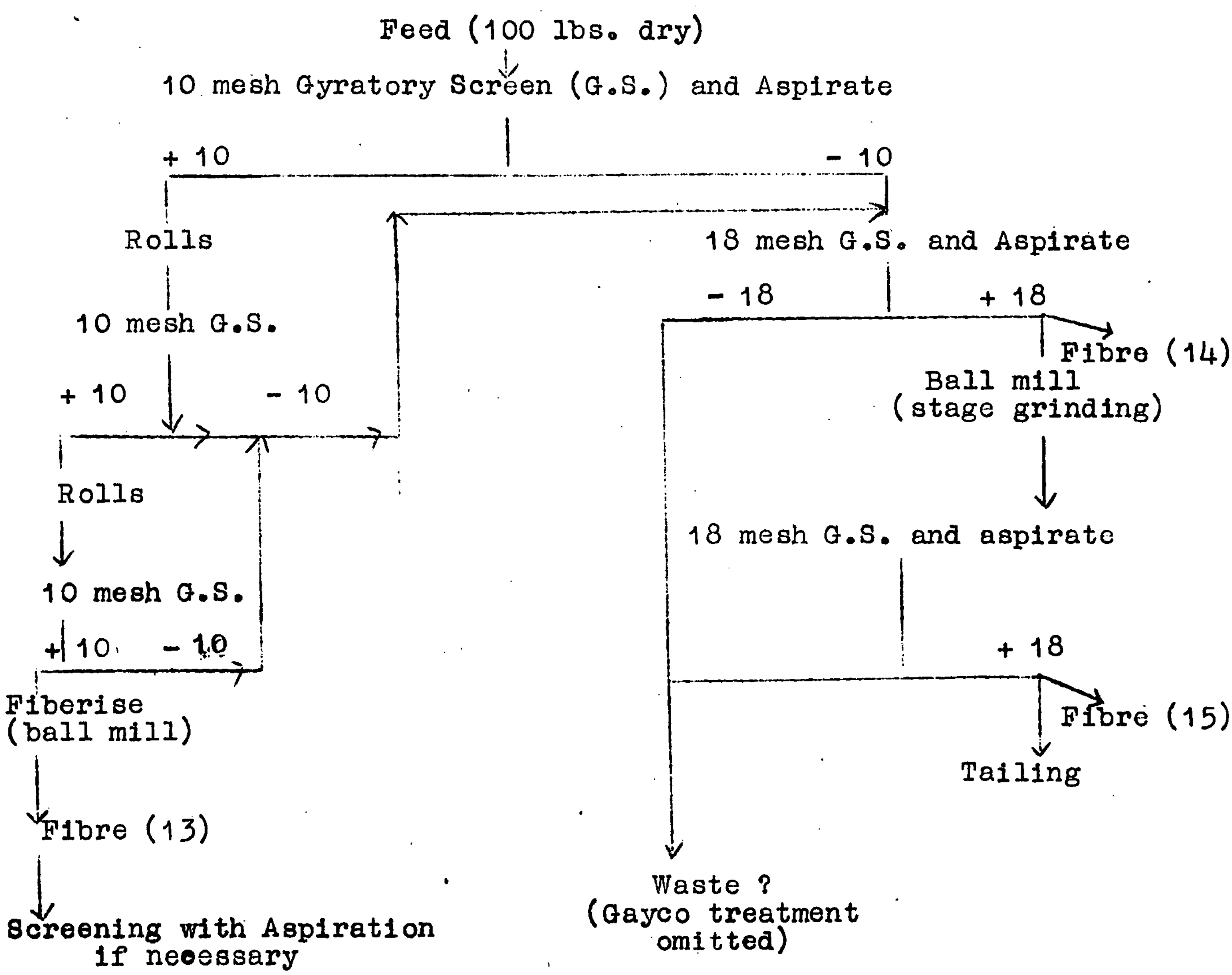


TABLE 3.

Results of Flowsheet 3

Product Fibre	Weight Grams	Dust Content (T.200)	% Recovery Fibre	Cum % Recovery
(13)	496	13.0	32.6	
(14), + (15)	249	48.5	9.7	42.3

Note: Samples of fibre products from tests are forwarded to Aust. Blue Asbestos Limited for inspection. These are listed in the appendix.

8. DISCUSSION:

The sample received contained 2.25 per cent. moisture. At this moisture content some fibre was recovered, but the dirt content made it unsuitable for standard grade fibre. Subsequent results indicated that to obtain major improvements in recovery efficient drying is essential. The discussion of results below is based on the assumption that dry material is used.

Aspiration of this dry material recovered some fibre which could possibly have been collected in the plant aspirating system. The recovery of fibre varied between 1.7 and 3.0 per cent. in various tests, the variation being due to the samples containing isolated long-fibred pieces.

This extra recovery is remarkably small, in view of the fact that the plant is treating damp feed, and indicates that plant aspiration methods are very efficient.

Screen analysis of the plant tailings showed that approximately 60 per cent. of the fibre occurs in the plus 14 mesh fraction, and only 6 per cent. occurs in the fractions finer than 36 per cent, which constitute 12 per cent. of the weight of the material. Removal of these fines would not greatly affect recovery, but would be helpful in keeping down the dust content.

The fibre in the tailings, except for a minor amount of free fluffed fibre, was predominantly in the form of bundles, which are known as "pencils" or "pins". Many of these pencils, of good quality asbestos, were capped on the ends with rock. This rock capping ties the fibres together and prevents teasing.

As the Company had specifically requested that the reduction of rock particle size be kept to a minimum, the attempts to obtain selective fiberisation with minimum rock breakage were restricted to a dry ball mill and a hammer mill.

The available hammer mill was not of a type designed for this purpose and resulted in the production of very fine and short fibres which were very dirty. An impact mill could be expected to give different results.

The use of the dry ball mill with reduced ball load resulted in excessive dust being ground into the fibre. Ten per cent. of the fibre was recovered but this contained 25 per cent. dust.

From the results obtained using flowsheets 2 and 3 and using the information obtained from screen analyses, the following results can be expected :-

Crushing to minus 8 mesh	- Recovery of fibre	27%
" " " 10 "	- " " "	33%
" " " 14 "	- " " "	39%

The recovery at minus 14 mesh, which is probably the lower limit for efficient dry screening, was not verified, but screening at this mesh should be considered.

To keep the dust content at a minimum it is essential to remove fines before any fiberisation is attempted. This is shown in the tests, where, by screening at 10 mesh before fiberisation, a product containing 13 per cent. dust is obtained, whereas without prior removal of the fines the dust content was 24 per cent.

The treatment of the minus 10 mesh fines in flowsheets 2 and 3 was by means of a gyratory type screen. The action of this type of machine tends to rppeatedly fold the material over itself as it moves across the screen surface, so that aspiration of the feed fibre is hindered and recovery decreased.

However, in a screen with vibratory motion a conveying action is imparted to the material and the fluffed material tends to remain on the surface so that recovery of short sub-standard fibre is increased.

As mentioned above, it isconsidered that 14 mesh is probably the lower limit for efficient recovery, but this mesh was not available for the gyratory screen.

However, the overall recovery obtained by the treatment of both the coarse and the fine fractions gives an indication of the limit of practical recovery.

Samples of the fibre products from the various tests will be returned to the Company for evaluation.

9. CONCLUSIONS.

(Note: In this section a mill feed containing 7 per cent. fibre and a product containing 73 per cent. fibre have been assumed for the purpose of estimating overall fibre recoveries.)

(a) The existing mill is remarkably efficient in recovering free fiberised asbestos. Even if the plant feed were dried, overall recoveries would be increased by a maximum of 1.2 per cent. No major improvements can be expected from operations using the existing flowsheet.

(b) Approximately 40 per cent. of the fibre in the tailings should be recovered by comminution and orthodox concentrating techniques.

Wet mathods of concentration would probably give a further increase in the amount of fibre that could be recovered.

(c) If the material at present being returned at 3/8 inch mesh to the tertiary mill for regrinding was reduced to 3/16 inch, the maximum possible increase in fibre recovery would be 12.6 per cent. of the fibre in the tails. This corresponds to an overall increase in fibre recovery of about 5 per cent. The recoveries being based on fibre content of screen fractions would not be attained in normal plant operation and would require major alterations to the plant.

(d) Crushing to minus 10 mesh in stages with intermediate screening to remove the plus 10 mesh fibre will increase the plant recovery of asbestos by approximately 12 per cent. The plus 10 mesh material will require fiberising and screening to remove country rock and to produce a suitable product.

Roll crushers were used in the tests, as it was considered that the action of these crushers, i.e. one breaking action followed by quick discharge of the product, was the most suitable for the purpose.

Additional fibre, equivalent to 3.5 per cent. overall recovery, can be recovered by aspiration of the minus 10 mesh material. This product may be suitable for blending with other products, provided the length of the fibre is satisfactory.

5. It is considered that no useful design information can be gleaned from the laboratory tests. It is also doubtful whether laboratory work aimed at establishing design data would be worthwhile because of the difficulties of relating test work to practical standards.

APPENDIX 1.

DRY METHOD OF ASSAY.

The fibre content of the head sample was calculated from the total fibre contained in the screen fractions (Table No. 1). The method of assay, which is similar to the routine 'bag' method used in the plant, is shown hereunder.

Assay Method:

Each screen product is crushed to 36 mesh in a rolls crusher. The minus 36 mesh fines are removed by screening and the plus 36 mesh material subjected to a rolling motion over a piece of jute bagging stretched taut on a wooden frame.

Fibre is collected by tapping the bag sharply by hand and lifting the fibre from the bag surface. This lifting is done very effectively by using a 2" paintbrush in a vertical motion on the bag. The asbestos fibres stick selectively to the ends of the bristles and can easily be removed by wiping the end of the brush on a wire screen.

APPENDIX 2

WET METHOD OF ASSAY

(1) Roll crush 1,000 g sample to minus 10 mesh

(2) Collect and weigh the oversize fibre produced.

(3) Screen the fibre and the minus 10 mesh rock on a 48 mesh screen

(4) Pulp the -10 +48 mesh fraction by stirring in a bucket containing about 2 litres of water. Allow about 15 seconds settling time and decant through a 48 mesh screen. Repeat this operation until most of the available (fluffed) fibre has been obtained on the screen.

Note: Aim at taking a "dirty" fibre in the decantation, as it is relatively easy to clean the fibre by decantation from a shallow dish.

(5) Grind the remaining rock plus fibre in a ball mill for 15 minutes and repeat the decantation procedure through a 48 mesh screen. Regrind the remaining rock for a further 15 minutes and repeat decantation.

The rock should be relatively free from fibre after the second stage of grinding.

Dry and weigh the total fibre.

Note: Two 1,000g samples of the mill testing each treated by the above method gave fibre content of 2.9 and 2.8 per cent.

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APPENDIX 3

LIST OF SAMPLE PRODUCTS FORWARDED FOR INSPECTION.

Products, Flowsheet 1:

(a) Sample + 10 mesh fibre (1) + (2) + (3)

(b) " - 10 mesh fibre (4) + (5) + (6)

Products, Flowsheet 2:

(c) Sample + 10 mesh fibre (7) + (8) + (9)

(d) " - 10 mesh fibre (10) + (11)

(e) " of (d) dust content reduced to 27.5%

(f) " of (d) washed C.200 fibre

(g) " Gayco. air classifier fibre concentrate

Products, Flowsheet 3:

(h) Sample + 10 mesh fibre (13) - 13% dust