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" TREATMENT OF GRANULAR GYPSUM ("CASO") FROM STENHOUSE BAY"

by

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TREATMENT OF GRANULAR GYPSUM FROM STENHOUSE BAY.

Abstract

This report gives details of tests made to beneficiate granular gypsum ("caso"), which is at present regarded as overburden on the rock gypsum deposits at Stenhouse Bay, into a product suitable for the making of plaster.

1. SUMMARY.

Beneficiation tests made on "caso", the local name for the granular gypsum overlying the beds of solid rock gypsum at Marion Lake near Stenhouse Bay, show that a gypsum product assaying 95 percent $CaSO_4.2H_2O$ with a recovery of about 93 percent can be made by water washing in a classifier. The present washing plant would be suitable to handle the caso thus almost halving the cost of mining and delivering the crude material to the plant by using as feed the material now discarded as overburden.

Alternatively, under the Company's plans for increasing output by the building of a new and larger plant, feed to the plant could be increased almost two-fold without extra mining equipment or labour. In the new plant, consideration should be given to the incorporation of a D.S.M. cyclone into the circuit to recover an extra three percent of the gypsum. However economic considerations which are outside the scope of this report, such as pumping costs, effect of the lower grade material in the plaster works etc., would have to be studied. No beneficial effect would be

obtained from the treatment of the gypsum, by the use of microcyclones, sizes finer than that recovered in the D.S.M. cyclone.

A study was made of the present treatment plant and it was found that a comparatively high loss of fine gypsum was occuring due to the high rising velocities of the drag classifiers. Attempts to upgrade this material were not successful but in any case the amount of wash water used in the plant has been greatly reduced with consequent decrease in the loss of gypsum.

2. INTRODUCTION.

The Waratah Gypsum Company of Melbourne, makers of plaster board and other gypsum products, obtain their main supplies from gypsum deposited in a series of lakes behind Stenhouse Bay, where the treatment works for the preliminary washing of the crude gypsum together with the wharf and loading facilities are situated.

A description of the deposit, mining methods, reserves etc., has been made in Mining Review No. 92 by the State Mining Engineer and may be summarised as follows:

The main deposit consists of four to six feet of solid rock-gypsum sitting on top of about one foot of shells, organic material etc., which comprises the lake bottom. Deposited over the rock gypsum is a layer of granular material, of similar thickness to the rock gypsum, comprised mainly of gypsum, locally called "caso". This term will be used throughout this report. The present method of working the deposit is in two stages:

(a) Stripping:

The caso which, although dense is not of a concretionary nature, is stripped from the surface of the rock gypsum by a diesel-electric shovel and is stacked on the lake bed in the strip from which the rock gypsum has been removed.

(b) Mining:

As the stripping shovel moves forward the exposed rock gypsum is loosened by blasting and the gypsum is loaded into trucks by a second shovel which follows behind the stripping shovel. When the strip of rock gypsum has been worked out the rail tracks are moved and the shovels start moving back across the lake repeating the above processes. The loaded trucks are drawn by a small locomotive to the treatment plant - a distance of one to two miles.

Although the stripped caso is piled in long rows parallel to the working faces any future reclaiming of it would have to be done from the bed of the lake. This may be an impossible task during the wet winter months, besides entailing expenses equal to or greater than the original cost of stripping.

If this material could be treated with the rock gypsum to produce a product at least equal in quality to that now being produced then, except for the small expense of trucking the material to the treatment plant, the amount of feed delivered to the plant could practically be doubled without any extra mining costs.

It was the main object of this investigation to determine whether the caso could be washed to produce a clean product and whether this gypsum would calcine into a plaster product of the necessary strength and colour. If this proved to be successful then the rapidly decreasing ore reserves of rock gypsum would be conserved and the total ore reserves increased to almost double in addition to the large reserves of caso stacked on the lake bed. The investigation was hastened by the Company's plans to increase

capacity either by the enlargement of the existing plant or by the erection of a new plant designed to treat the mixed product of rock gypsum and caso.

A subsidiary part of the investigation was a study of the working of the present plant to determine whether the washing was efficient and if gypsum was being lost with the tailings, whether it could be recovered.

3. DESCRIPTION OF SAMPLES.

No attempt was made to obtain representative samples from the whole of the lake but approximately one ton of sample was obtained from the exposed face by channel sampling with a spade from the surface of the deposit to the rock gypsum.

In the south-eastern end of the face towards the edge of the lake the caso deposit was shallower and layers of gypsum alternated with layers of a blue clay-like material. The depth of caso increased to four or five feet away from the edges of the lake and the blue clay became concentrated in a layer about 12 inches thick on the surface of the rock gypsum, the probable cause being downward washing of the clay by rain water percolating through the more porous portions of the gypsum.

Separate samples were taken from the south-eastern section and from the concentrated clay-layer, but the large sample for test purposes was taken from the good quality caso.

3.1 Petrological examination.

A petrological examination and grain count of the various types mentioned above showed the following approximate compositions.

Sample A

Bulk sample of good quality caso from centre of lake.

Clay-calcareous aggregate	15 percent
Gypsum	55 "
Dehydrated gypsum	30 "
Shell fragments.	trace

Sample B

Sample of caso towards edges of lake.

Clay-calcareous aggregate	80 percent
Gypsum	10 "
Dehydrated gypsum	10 "
Shell fragments	trace

Sample C

Blue-clay concentration on surface of rock gypsum

This sample comprises part of sample A

Clay-calcareous aggregate	30 percent
Gypsum	35 "
Dehydrated gypsum	35 "
Shell fragments	trace

An X-ray examination of this material shows that the clay-calcareous aggregate consists in the main of the carbonates calcite and aragonite mixed with gypsum $CaSO_4 . 2H_2O$ and "anhydrous" gypsum.

The portion reported as dehydrated gypsum consists of several types of calcium sulphate with optical properties intermediate between those of anhydrate and gypsum, and consists of a mixture of intermediate hydrates. It occurs intergrown with or as alteration rims round gypsum or individually.

3.2 Chemical Analysis:

Sample A only was sent for chemical analysis the results being:

$CaSO_4 \cdot 2H_2O$	81.9 percent
$CaCO_3$	8.9 "
$Fe_2O_3 + al2O3$	0.3 "
SiO_2	0.2 "
NaCl	7.4 "

4. DESCRIPTION OF TESTS MADE:

The following tests were made on sample A the good quality ease from the centre of the lake, and the calcined products. They are described under their respective headings:

4.1 Washing tests

a. Classifier and cyclones.

4.2 Assay and recovery of products.

4.3 Screen analyses of products.

4.4 Petrological report on products.

4.5 Calcination.

a. Loss of weight; reflectivity.
b. Consistency - tensile strength.
c. Compressive strength.

4.1 Washing

a. Classifier and cyclones.

Approximately 800 lb. of sample A was pulped with tap water at 25 percent solids and pumped continuously to a 6" Denver spiral classifier set at a slope of 18° and having a spiral speed of 24 r.p.m. Sprays were fitted above and about half way along the spiral. The classifier

overflowed at between two and five percent solids. The classifier sands were stored as a finished product.

The classifier overflow sized at approximately 93 percent -200 mesh was pumped, after thickening to 10 percent solids, to a 3" diameter, 12½° cone, D.S.M. cyclone operated at 20 p.s.i. with a 7/32" orifice. The underflow from the first pass contained an appreciable quantity of clay material and was repassed through the cone. The underflow from this second pass was retained as a finished product. The overflow products from both passes were combined and pumped at 5 percent solids through a microcyclone with a 1/10 inch orifice operating at 40 p.s.i. The underflow from the microcyclone was approximately 50 percent solids. Fractions were settled, filtered and dried. A diagrammatic flowsheet of the test circuit is attached.

4.2 Assay and Recovery of Products:

In Table No. 1 there are listed the percentage weights of the various products together with the assays and distribution of the main constituents.

Table No. 1

METALLURGICAL DATA ON PRODUCTS FROM WASHING.

Product	Feed		Classifier sands.		D.S.M. U/F		M.C. U/F		M.C. O/F		Solids in Solution.	
% Weight	100.0		80.3		2.4		5.0		5.1		7.2	
	Assay %	Dist. %	Assay %	Dist. %	Assay %	Dist.%	Assay %	Dist.%	Assay%	Dist.%	Assay%	Dist%
$CaSO_4 \cdot 2H_2O$	81.9*	100.0	95.3	92.6	90.9	2.6	69.7	4.2	9.5	0.6	-	-
$CaCO_3$	8.9	100.0	1.4	15.9	6.8	0.2	22.0	32.1	72.0	51.8	-	-
$Fe_2O_3 + Al_2O_3$	0.3	100.0	0.6	-	0.5	-	0.7	-	1.6	-	-	-
SiO_2	0.2	100.0	0.3	-	0.3	-	0.6	-	2.6	-	-	-
NaCl	7.4	100.0	0.2	2.2	0.1	0.1	0.1	0.1	0.3	0.3	100.0	97.3

* Assay calculated from fractions 82.7 percent.

From the above figures it was calculated that the classifier overflow contained 12.5 percent of the original solids and assayed 31.3 percent $CaSO_4 . 2H_2O$ and the D.S.M. cyclone overflow assayed 22.0 percent $CaSO_4 . 2H_2O$.

4.3 Screen analysis of products.

Screen analyses were made on the feed and the various products and are listed in Table No. 2.

The apparent discrepancy in the proportion of coarse material in the feed to that in the products is due to the gypsum crystals breaking up during agitation and classification.

Table No. 2

Screen Analyses of Products.

(weight percent)

Screen mesh	Classifier sands	D.S.M. U/F	M.C. O/F	M.C. U/F	Feed
+ 14	6.0	-	-	-	9.0
- 14 + 20	5.4	-	-	-	14.7
-20 + 44	23.5	-	-	-	13.8
- 44 + 60	20.6	0.7	-	-	17.4
- 60 +100	9.5	0.7	-	-	8.9
-100 +150	22.6	4.4	-	-	12.2
-150+200	4.9	29.1	-	2.0	5.3
-200	7.5	65.1	100.0	98.0	18.5

The +14 mesh fractions was made up of:

+ ¼"	0.8 percent.
- ¼" + 6 mesh	1.2 "
- 6 +10 "	2.5 "
-10 +14 "	4.5 "
	9.0 percent.

4.4 Petrological Examination of Products.

A grain count showed the following mineral compositions:

a. Classifier sands.

Gypsum (containing ultra fine inclusions of clay-calcareous material)	98 percent
Free clay-calcareous material	1.5 "
Dehydrated gypsum	0.5 "
Shell fragments	trace.

b. D.S.M. Cyclone underflow.

Gypsum	87 percent.
Dehydrated gypsum	nil
Clay-calcareous material.	7.0 "
Shell fragments	6.0 "
Quartz mica	trace.

c. Microcyclone underflow.

Gypsum.	66 percent.
Dehydrated gypsum.	nil
Clay calcareous material	16 "
Shell fragments	18 "

It will be noticed the amount of dehydrated gypsum present in the products is practically nil. Although the microcyclone overflow was not examined, being too fine for accurate determinations, the quantity there is too small to account for the dehydrated gypsum originally present. The only possible explanation seems to be that this material has reverted to the normal form under water action.

Attention is drawn to the concentration of the shell fragments in the cyclone underflow.

4.5 Calcination.

These tests were done on the products from the washing tests after their reduction to -20 mesh. All tests were made in accordance with procedure laid down in the Standards Association of Australia Int. 317.

a. Loss of Weight and Reflectivity of product.

The classifier sands were calcined at 120, 140, and 170°C for varying times. As a result of these tests a calcination temperature of 140°C for one hour was selected as being the best. It should be pointed out that very few tests were made and further calcination tests would have to be made before the correct conditions could be determined.

Alteration to calcining conditions would probably change the results shown for strengths etc.

Reflectivity was determined on both the calcined and set plasters using a EEL reflectometer with a magnesia block (taken to have 98 percent reflectivity) as standard. Loss in weight is reported as a percentage of the original material. The theoretical loss due to conversion from $CaSO_4 \cdot 2H_2O$ to the hemi-hydrate $CaSO_4 \cdot \frac{1}{2}H_2O$ is 15.7 percent.

Results are shown in Table No. 3 below:

Table No. 3.

a. Loss in weight on calcination.
b. Reflectivity of products.

Fraction	Calcining Temp. °C	Calcining Time Hrs.	% Loss Wgt.	Reflectivity Calcine	Reflectivity Set
Classifier Sand	120	½	8.2	-	-
	120	1	14.1	-	78
	140	½	14.5	-	-
	140	1	16.9	82	78
	170	½	19.1	-	-
	170	1	19.9	-	78
	170	4	19.9		
3" D.S.M. Cyclone U/F	140	1	14.9	78	77
Microcyclone U/F	140	1	12.1	77	77

Note: Loss in weight $CaSO_4 \cdot 2H_2O \longrightarrow CaSO_4 \frac{1}{2}H_2O$ = 15.7 percent.

b. Consistency - Tensile Strengths.

These were made on products of 140°C calcination for one hour. The consistency is reported as the cubic centimeters of demineralised water added to 100 grams of the plaster as described in SAA Int. 137. Consistencies determined in this way were very high and weak plaster, as shown by the low tensile strengths, was produced. Where insufficient sample was available a consistency of 70 was used.

The test casts were oven dried at 25°C for fifteen days. Results are shown in Table No. 4.

Table No. 4.

CONSISTENCY AND TENSILE STRENGTHS

Fraction	Calcining Temp. °C	Consistency	Final Wt. Cast grms.	Tensile Strength p.s.i.
Classifier Sands	120	70	75.0	252
	140	70	75.7	289
	140	120	49.3	142
	170	70	78.5	329
3" D.S.M. Cyclone U/F	140	160	40.1	81
Microcyclone U/F	140	110	50.2	94

Test casts were oven dried at 25°C for 15 days.

c. Compressive Strengths.

Conditions for these tests were:

Calcination temperature	140°C
Time of calcination	one hour.
Consistency	70
Size of test piece	1 inch cube
Ageing time	37 days.

Table No. 5.
COMPRESSIVE STRENGTHS OF PLASTER CASTS.

Fraction	Final Wt. cast grams.	Compressive Strength p.s.i.
Classifier sands	18.3	1840
	18.3	1760
	18.1	1690
	18.1	1705
	18.1	1510
	Average	1700
3" D.S.M. Cyclone U/F	18.4	525*
	18.4	1030
	18.4	820
	18.6	910
	Average	800
Microcyclone U/F	18.2	795
	18.1	530*
	18.0	660
	18.1	730
	18.0	790
	Average	700

* These results were discarded in determining the average of the series as differing by more than 15 percent from the initial average.

Minimum compressive strength recommended in the SAA code is 1200 p.s.i.

5. DISCUSSION OF RESULTS OF WASHING TESTS.

The tests show that the caso assaying, in the raw state, approximately 82 percent gypsum can be upgraded by simple water classification to a product of 80 percent of the original weight and assaying least 95 percent gypsum, the chlorine content being about 0.1 percent. (0.2 percent NaCl). The recovery of gypsum is approximately 93 percent.

This product is relatively coarse, being only 12 percent -150 mesh.

A further 2.6 percent of the gypsum can be recovered as a product assaying over 90 percent gypsum with 7 percent calcium carbonate by treating the classifier overflow in a D.S.M. cyclone ("Dorrclone"). This product is much finer, consisting of 95 percent -150 mesh, but the amount (2.4 percent of the original weight or 3 percent of the weight of a combined product) is small. No trouble should be experienced in handling the product from the treatment of caso even on its own. In a plant treating the mixture of caso and rock gypsum percentage of -150 mesh product would be greatly reduced by the presence of the extremely coarse product resulting from the treatment of the rock gypsum.

However the product from the D.S.M. cyclone contains 6 percent of shell fragments, and the plaster produced from it has a low tensile and compressive strength. The inclusion of a cyclone in a new plant would have to be decided by economic considerations balancing the extra recovery against any possible complications in the plaster works.

Any further treatment of the finer products by means of a microcyclone would definitely not be justified owing to the poor quality of the products.

6. PRESENT TREATMENT PLANT.

6.1 Description of process.

The rock gypsum trucked from the lake bed is dumped into a crusher, the discharge from which falls on to an oscillating punched plate thus dividing the feed into

a coarse and a fine fraction both being fed into separate rake classifiers in which the soluble salts and fine clay are washed out. The coarse product after the first wash is re-crushed and then fed to a further washing classifier.

All products are combined and stockpiled in the open by a stacker conveyor until reclaimed by a power scraper on to the main conveyor system which feeds directly into the hold of the boat. Thus between the periods of loading the stacked products have a chance to drain and also to have further soluble salts leached out by rain.

Washing in the plant was by sea water with the overflows from the washers flowing in a concrete launder into the sea. The natural drift kept this dirty overflow from contaminating the supply of washing water.

When a visit was made to the plant in February 1955 it was found that a total of 7 tons per hour of solids containing 3.5 tons of gyp sum were being discarded from the washing plant. However the tests described below show that it would be difficult to reclaim this lost gypsum in a product of high grade. Information has since been received that a product of such fineness would cause trouble in the calcining kettles and in addition the amount of wash water has been considerably reduced and consequently the lower rising velocities in the classifiers have materially reduced the loss.

These tailings on petrological examination showed the following composition.

Clay calcareous aggregate	50 percent
Gypsum	20 "
Dehydrated gypsum	30 "

6.2 Treatment of Tailings sample.

A sample of the solids was collected by settling and decantation from the tailings pulp (at 5 percent

solids) to a pulp density of between 50 -60 percent solids. This was diluted in the laboratory with tap water to 5 percent solids and pumped to the microcyclone unit operating with a 3 millimetre orifice at 40 p.s.i. Feed rate was 2 pounds of solids per minute.

6.3 Test Results.

Petrological examination of the products showed the following results.

a. Microcyclone underflow

Clay-calcareous aggregate	54 percent
Gypsum	46 "
Aragonite	trace

b. Microcyclone overflow

This sample was composed of less than 5 percent gypsum and approximately 95 percent of fine grained calcareous-clay.

6.4 Assay of Products.

Table No. 6.

MINERAL COMPOSITION OF PRODUCTS.

Wt. %	Original 100.0	M.C. U/F 84.0	M.C. O/F 16.0
	Assay %	Assay%	Assay %
$CaSO_4 \cdot 2H_2O$	62.1	68.1	6.9
$CaCO_3$	29.9	31.8	68.9
$Fe_2O_3 + Al_2O_3$	0.5	0.5	2.0
SiO_2	0.3	0.4	3.6
HaCl	0.1	0.3	0.6

6.5 Discussion of Results.

The results listed in Table No. 6 indicate that there is a concentration of clay-calcareous material into the microcyclone overflow but the amount of this and the increase in grade in the underflow portion is too small to warrant the installation of pumping equipment, etc. to

treat the tailings. As stated before the tailings loss has been reduced by the reduction on the volume of wash water used.

7. REFERENCES.

a. D.M. 1497/54: Report on Stenhouse Bay Activities.

b. Mining Review No. 92 pp. 145-150.

"Mining of Gypsum - Marion Lake"
by A.T. Armstrong.

c. ibid p. 176:

"Stenhouse Bay Deposits"
by M. Willington.

d. ibid p. 193-195

"Suggested Washing Plant for Overburden from Marion Lake"
by N. Jackson.

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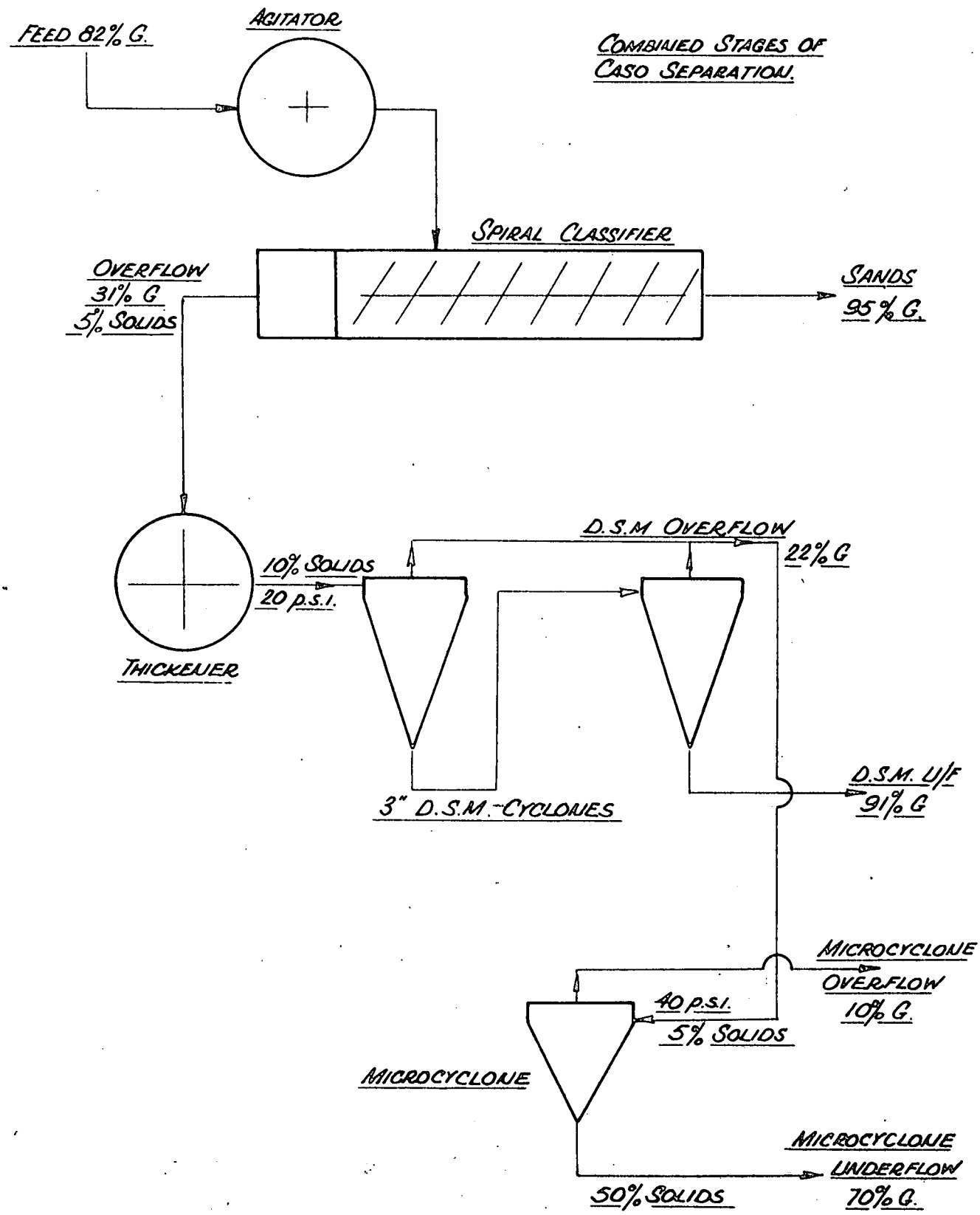
STENHOUSE BAY GYPSUM
FLOWSHEET



$G = CaSO_4 . 2H_2O$.

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