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REPORT ON THE CRUSHING OF FINE EVAPORATOR SALT

SUBMITTED BY

THE CANADIAN SALT COMPANY LIMITED, WINDSOR, ONTARIO

by

R.K.Collings

Industrial Minerals Division

April 22,1958.

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Introduction

Mr.H.E.Sills, Development Engineer, The Canadian Salt Company Limited requested that an investigation be undertaken to determine whether the Hazemag FAP-1 crusher, recently installed in the Mineral Dressing laboratory of the Mines Branch, could be utilized to reduce the size of Common Fine salt without the excessive production of minus 100-mesh fines. Mr.Sills indicated that a yield of 7 tons per hour of minus 35, plus 100 mesh salt containing not more than 5 per cent plus 35 mesh nor more than 5 per cent minus 100 mesh, was desired.

A 4000-pound sample of Common Fine salt, consisting of forty, 100-pound bags, was received on February 28, 1958. This salt was typical of the evaporator salt produced at the Windsor plant of The Canadian Salt Company Limited. Representative screen analyses indicated that this salt was minus 20, plus 100 mesh in size.

Purpose

The purpose of this investigation was to determine whether the Hazemag FAP-1 crusher could effectively be used to reduce the minus 20, plus 100-mesh Common Fine salt to minus 35 mesh without excessive production of minus 100 mesh salt.

Description of the Hazemag FAP-1 Crusher

The Hazemag FAP-1 Impeller Breaker, manufactured by Hazemag G.M.B.H.,Munster, Germany, consists of a single large rotor-impeller suspended on a central shaft in an enclosing metal frame. The rotor is 20 inches in diameter and 14.5 inches in width. Four impact bars spaced equally around the circumference of the rotor catch the material being fed to the unit and throw it against a series of breaker plates that are suspended above the impeller. The impact against the breaker plates fractures the ore resulting in a considerable size reduction. The broken ore is discharged through an opening in the bottom of the unit. The FAP-1 has four breaker plates, two of which measure 5.5 inches in length by 14.5 inches in width while the remaining two measure 7.5 x 14.5 inches. These plates are mounted in two groups of two each on arms that are hinged at one end only. Each arm is suspended in such a manner as to permit movement away from the impeller blade thereby allowing foreign materials such as tramp iron or large pieces of wood to pass through the machine without damage to its component parts.

The product size or percentage reduction may be controlled by three factors namely.

1. feed rate
2. rotor speed
3. breaker plate clearance

The Hazemag FAP-1 has a capacity of 3 to 10 tons per hour depending on the nature of the feed. The rotor speed may be varied from 600 to 2000 revolutions per minute while the breaker plates may be adjusted to allow a clearance of 1/8 to 2 inches between the bottom edge of the plates and the breaker bars.

Details and Results of Test Work

Six preliminary crushing tests were made. These tests were conducted on samples of the fine salt as received using feed rates of 4, 6 and 8 tons per hour. The rotor speed was varied from 1000 to 1700 revolutions per minute. All tests except number 6 were made with a clearance of 1/4-inch between the breaker bars and plates. A 1-inch clearance was used in Test Number 6.

The results of these preliminary tests indicated that it was difficult to obtain a substantial increase in the recovery of minus 35, plus 100 mesh salt without producing an excessive amount of minus 100 mesh material. To overcome this the finer salt was removed by screening before crushing. A small rotex screening unit fitted with a 30 mesh screen was used for this purpose. Four, separate, 200-pound samples (Numbers 7,8,9 and 10) were screened. The recovery of coarse and fine fractions/screen was as follows -

Sample Number	Percentage Recovery	
	Coarse Fraction	Fine Fraction
7	64.2	35.8
8	51.0	49.0
9	51.5	48.5
10	55.5	44.5

Tests 7 to 10 were made using the coarse fractions from the Rotex. Feed rates were established at 6 and 8 tons per hour. The Hazemag was run at 1000 and 1500 revolutions per minute with a clearance of 1/4-inch between the impact plates and breaker bars.

An examination of the results of tests 1 to 10 revealed that the size of salt used as feed varied from test to test. To overcome this a number of samples were riffled from a large 1600 pound sample. Tests 11 to 16 were conducted on samples of the riffled salt. These samples were designed to have similar size characteristics, however, slight size variation continued to exist as indicated by the screen analyses of the feed samples (Table III).

The rotor speed was maintained at 1700 revolutions per minute during runs 11 to 16 inclusive. Feed rates were set at 8 and 10 tons per hour while the impact plate clearance was varied from 1/4 to 1½-inches.

Screen analyses were conducted on samples of all products. The screen analyses of the products that would be obtained by combining the fine fractions removed from samples 7, 8, 9 and 10 with the crushed coarse products were calculated in order to compare these results with those obtained in tests 1 to 6 and 11 to 16. All screen analyses and other relevant data are contained in the included tables.

Analysis of Results

It is difficult to accurately compare the results of these tests because of size variations in the feeds for the various tests. However, a number of general observations may be made as follows -

(1) An increase in the rate of feed of fine salt (minus 20, plus 100 mesh) to the Hazemag crusher, other factors remaining constant, generally is accompanied by a corresponding increase in the percentage recovery of minus 35, plus 100 mesh salt. (Compare tests 4 with 1, 1 with 5, 11 with 12, and 15 with 16). This does not apply for tests 13 and 14 because the feed used in 14 was considerably finer than that of number 13. When feeding coarse, plus 48 mesh salt from the rotex screen an increase in feed usually resulted in decreased recovery of minus 35, plus 100 mesh salt (compare test 7 with 10 and 8 with 9).

An additional effect of an increase in the feed rate of either the fine or coarse salt is that it tends to favour the production of minus 100 mesh salt which is undesirable.

(2) Increasing the rotor speed, other factors being constant, tends to result in increased recovery of minus 35, plus 100 mesh salt, however, this is always accompanied by increased production of fine, minus 100 mesh salt. (Compare tests 1 with 3, 7 with 8, and 9 with 10).

(3) Increasing the impact plate clearance from 1/4-inch to 1-inch (Tests 1 and 6) resulted in increased recovery of minus 35, plus 100 mesh salt. This also applies in test 11 and 13 where the impact plate clearance was increased from 1/4-inch to 3/4-inch, however it does not appear to apply when comparing tests 13 with 15 and tests 12, 14 and 16. This again could be because of variation in the feed sizes. In all tests an increase in the impact plate clearance was accompanied by decreased formation of minus 100 mesh salt.

(4) Removal of the fine salt by screening on a 30-mesh screen before crushing followed by its combination with the coarse crushed product after crushing resulted in increased recovery of minus 35, plus 100 mesh salt and decreased production of minus 100 mesh material. (Compare tests 1 with 7 and 3 with 8).

To summarize - when feeding fine salt the percentage recovery of minus 35, plus 100 mesh salt may be increased by -

1. increasing the feed rate
2. increasing the rotor speed
3. increasing the impact plate clearance

Removal of the fine, minus 35 mesh salt by screening before crushing followed by its combination with the crushed coarse product will also result in increased recovery of minus 35, plus 100 mesh salt. However, when feeding coarse, plus 35 or plus 48 mesh material an increase in the feed rate does not result in increased recovery of minus 35, plus 100 mesh salt.

An increase in the feed rate or in the rotor speed tends to favour the production of minus 100 mesh fines which is undesirable. The formation of minus 100 mesh salt may be minimized by -

1. increasing the impact plate clearance
2. removal of the fine, minus 35 mesh salt before crushing

Therefore, since screening before crushing is considered undesirable it will be necessary to achieve a balance of the feed rate, rotor speed, and impact plate clearance which will give the greatest recovery of minus 35, plus 100 mesh salt without excessive production of minus 100 mesh fines. The test which best fulfills these conditions is number 6 (6 tons per hour, 1500 revolutions per minute, impact plate clearance 1-inch). A greater recovery of minus 35, plus 100 mesh product with a minimum of minus 100 mesh salt could probably be obtained by careful adjustment of the feed rate, rotor speed and impact plate clearance used in test 6.

CONCLUSIONS

The results of this investigation indicate that it would be virtually impossible to reduce minus 20, plus 100 mesh salt in the Hazemag FAP-1 crusher to obtain a product which would contain not more than 5 per cent in both the plus 35 and minus 100 mesh fractions.

This unit may be used to increase the percentage recovery of minus 35, plus 100 mesh salt, however, further detailed investigation would be required to determine the optimum feed rate, rotor speed and impact plate clearance. The efficiency of this unit when operated in closed circuit with suitable screens or air separators should also be investigated.

R. K. Collings.

April 22,1958.

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Industrial Minerals Division.

TABLE I

TEST DATA AND SCREEN ANALYSES

Test Number	1		2		3		4		5		6	
Feed Rate	6 tons/hr.		6 tons/hr		6 tons/hr		4 tons/hr		8 tons/hr		6 tons/hr	
Rotor Speed	1500 R.P.M.		1670 R.P.M.		1000 R.P.M.		1500 R.P.M.		1500 R.P.M.		1500 R.P.M.	
Impact Plate Clearance	1/4-inch		1/4-inch		1/4-inch		1/4-inch		1/4-inch		1 1-inch	
Screen Analyses	Feed	Product	Feed	Product	Feed	Product	Feed	Product	Feed	Product	Feed	Product
+28	5.7	0.9	4.8	0.8	2.9	1.6	5.1	0.9	8.0	1.3	4.8	2.3
+35	46.3	14.7	46.3	11.2	39.5	37.2	45.8	12.1	56.2	14.2	57.6	23.1
+48	36.9	32.0	38.9	26.3	44.4	40.7	39.7	29.4	29.0	28.1	26.9	35.5
+65	9.9	19.7	9.1	19.2	11.4	12.7	9.2	19.6	6.2	18.0	9.5	15.9
+100	1.2	10.2	0.9	11.4	1.4	3.5	0.2	10.9	0.6	10.9	0.9	6.6
-100	-	22.5	-	31.1	0.4	4.3	-	27.1	-	27.5	0.3	16.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Percent -35 +100	48.0	61.9	48.9	56.9	57.2	56.9	49.1	59.9	35.8	57.0	37.3	58.0
Percent increase -35+100		29		16.3		-0.5		22.0		59.2		55.5

TABLE II

TEST DATA AND SCREEN ANALYSES

Test Number	7					8				
Feed Rate	6 tons / hour					6 tons / hour				
Rotor Speed	1500 R.P.M.					1000 R.P.M.				
Impact Plate Clearance	1/4 inch					1/4-inch				
Screen Analyses	Coarse Feed	Coarse Product	Fine Fraction	(1) Comb. Crse. Feed & Fine Fraction	(1) Comb. Crse. Prod.& Fine Fraction	Coarse Feed	Coarse Product	Fine Fraction	(1) Comb. Crse. Feed & Fine Fraction	(1) Comb. Crse. Prod. & Fine Fraction
+28	10.0	2.7	-	6.4	1.8	5.7	2.9	-	2.9	1.5
+35	75.3	27.6	23.0	56.6	25.9	70.8	45.8	6.5	39.3	26.5
+48	14.4	27.3	63.2	31.9	40.2	22.6	35.3	75.5	48.5	55.1
+65	0.3	12.9	13.0	4.8	12.9	0.9	7.7	17.4	8.9	12.4
+100		9.3	0.8	0.3	6.3	-	3.4	0.3	0.2	1.9
+100		20.2	-	0.0	12.9	-	4.9	0.3	0.2	2.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Percent -35 +100 mesh	14.7	49.5	77.0	37.0	59.4	23.5	46.4	93.2	57.6	69.4
Percent Increase -35 +100 mesh		236.7			60.6		97.4			17.0

(1) Calculated Values.

TABLE II (CONT'D)

TEST DATA AND SCREEN ANALYSES

Test Number	9					10				
Feed Rate	8 tons / hour					8 tons / hour				
Rotor Speed	1000 R.P.M.					1500 R.P.M.				
Impact Plate Clearance	1/4-inch			(1)	(1)	1/4-inch				
Screen Analyses	Coarse Feed	Coarse Product	Fine Fraction	Comb. Crse. Feed & Fine Fraction	Comb. Crse. Prod. & Fine Fraction	Coarse Feed	Coarse Product	Fine Fraction	Comb. Crse. Feed & Fine Fraction	Comb. Crse. Prod. & Fine Fraction
+28	5.4	2.7	-	2.8	1.4	8.5	1.7	-	4.7	0.9
+35	68.2	44.2	5.7	37.8	25.5	72.8	20.4	13.4	46.4	17.3
+48	25.5	34.3	72.9	48.6	53.1	17.7	25.5	67.0	39.6	44.0
+65	0.9	8.3	19.5	9.9	13.8	1.0	12.5	18.2	8.8	15.1
+100	-	4.2	1.6	0.8	2.9	-	9.6	1.1	0.4	5.7
-100	-	6.3	0.3	0.1	3.3	-	30.3	0.3	0.1	17.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Percent -35+100 mesh	26.4	46.8	94.0	59.3	69.8	18.7	47.6	86.3	48.8	64.8
Percent Incr. -35+100 mesh		77.3			17.7		154.6			32.8

(1) Calculated Values.

TABLE III

TEST DATA AND SCREEN ANALYSIS

Test Number	11		12		13		14		15		16	
Feed Rate	8 tons/hour		10 tons/hr.		8 tons/hr.		10 tons/hr.		8 tons/hr.		10 tons/hr.	
Rotor Speed	1700 R.P.M.		1700 R.P.M.		1700 RPM		1700 RPM		1700 RPM		1700 RPM	
Impact Plate Clearance	1/4-inch		1/4-inch		3/4-inch		3/4-inch		1¼-inches		1¼-inches	
Screen Analysis	Feed	Product	Feed	Product	Feed	Product	Feed	Product	Feed	Product	Feed	Product
+28	4.5	0.5	6.5	0.5	6.0	0.5	2.5	0.5	3.0	1.0	4.5	1.0
+35	40.0	13.0	43.0	10.5	45.5	20.5	34.0	17.5	36.5	22.0	39.0	21.0
+48	45.5	30.5	41.5	27.5	41.0	35.0	47.0	34.5	46.5	36.5	45.0	36.5
+65	9.5	18.0	8.5	20.0	7.0	20.0	14.5	20.5	13.0	18.5	10.5	20.0
+100	0.5	10.5	0.5	10.5	0.5	6.5	1.5	8.5	1.0	6.0	1.0	6.0
-100	-	27.5	-	31.0	-	17.5	0.5	18.5	-	16.0	-	15.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Percent -35, +100	55.5	59.0	50.5	58.0	48.5	61.5	63.0	63.5	60.5	61.0	56.5	62.5
Percent increase -35+100		6.3		14.8		26.8		0.8		0.8		10.6