

FALCONBRIDGE NICKEL MINES LIMITED  
METALLURGICAL LABORATORIES  
THORNHILL, ONTARIO

FALCONBRIDGE METALLURGICAL LABORATORIES

Evaluation of Arsenious Oxide  
Crystallization Test at  
Struthers Wells

by  
W.R. Hatch

July 16, 1979

KEYWORDS: Giant Yellowknife

PROJECT No. 201  
JO#2484

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File, Circ.

## ABSTRACT

Arsenious oxide crystallization tests were carried out at Struthers, Scientific and International Corp., (SSI) Warren Pa. using their pilot plant facilities and Krystal Crystallizer operating as a contact cooling type unit. This testwork was an extension of that carried out previously by Giant personnel operating the same pilot unit as a vacuum crystallizer.

The present testwork involved leaching Giant baghouse dust at 95°C, settling the leach residue and pumping the supernatant solution through a filter and into the crystallizer unit. A suite of samples was taken at various stages of the operation which ran continuously for 50 hours. The crystallizer operating temperature ranged from 8 to 14°C and the average residence time in the single crystallizer unit was 10 hours.

Supersaturation occurred when water leach solutions were fed to the crystallizer with  $\text{As}_2\text{O}_3$  concentrations in the crystallizer mother liquor reaching approximately 37 g/L. Stable crystallizer operation was experienced when recycle leaching was carried out with  $\text{As}_2\text{O}_3$  mother liquor concentrations of 17 to 20 g/L. A solid concentration of 13% w/v (8% v/v) provided a satisfactory level of  $\text{As}_2\text{O}_3$  for crystal growth.

From measurements of the temperature drops across the heat exchanger and from observation of the heat exchanger tubes after the run, no scaling was evident under these severe conditions of feeding a 95° saturated solution into a 10°C single unit crystallizer. From this test one would not anticipate any problem operating a two stage contact cooling crystallizer or a contact cooling crystallizer following one or more vacuum crystallizers, the merits of each approach requiring careful evaluation.

The crystalline arsenious oxide product analyzed 99.6%  $\text{As}_2\text{O}_3$ , 0.19%  $\text{Sb}_2\text{O}_3$  and 0.015% Fe, meeting marketing requirements for this product.

## INTRODUCTION

The production of a high purity arsenious oxide product from Giant Yellowknife baghouse dust is currently under investigation. The method involves a hot water leach of the dust followed by crystallization of the  $\text{As}_2\text{O}_3$  product, and various studies are in progress in support of the pilot plant at Giant.

Earlier crystallization tests were conducted at SSI, Wells, Warren Pa. during the last week of May/79. Giant personnel were at Struthers Wells to assist in the operation of their crystallizer pilot plant. Tests were carried out operating the crystallizer under vacuum at  $25^\circ\text{C}$ . The products from this run have been evaluated<sup>(1)</sup> and L. Connell will report the results of the pilot campaign.

Additional testwork at Struthers-Wells was planned for June 18-20 operating the crystallizer as a contact unit only (no vacuum) to simulate the use of low temperature cooling water. The main purpose of the test was to produce crystals by contact cooling, introducing hot solution into the crystallizer and determining any problems which might arise due to scaling etc. FML was asked to supply one operator to assist in and evaluate the pilot plant investigation.

## PILOT PLANT OPERATION

The crystallizer pilot plant is housed in a separate building and is known as Struthers Scientific and International Corporation (SSI). The schematic flowsheet of the plant is shown in Figure 1. In addition, the plant is equipped with 2 stirred leach tanks, pumps, filter (Labmaster-Serfilco Model LCL 30 1/2 VW PPV) and a centrifuge for handling the crystal product. Mr. Steve Glasgow was assistant manager of the crystallizer division and two operators alternated between 12 hr. shifts.

A full drum of baghouse dust was available and was the remainder of three drums shipped from Giant to SSI in May. Five batches of leach solution were prepared from both water and recycle solution during the run adding dust to 45 U.S. gal of water and recycle solution as in Table I. The slurry was stirred and heated by a steam coil to  $\approx 98^\circ\text{C}$  and held at temperature for a minimum of 0.5 hr. Flocculant was then added to the slurry (500 mL of a 0.1% solution of Aquafloc 467\*) and stirred well before allowing to settle. The clear supernatant was then pumped through the Labmaster cartridge filter coated with Johns Manville High Flow Super Cell filter aid into the crystallizer feed holding tank. The feed tank held the solution at  $86^\circ\text{C}$ . This temperature drop of about  $10^\circ\text{C}$  was not expected to result in crystallization in the feed tank.

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(1) Evaluation of  $\text{As}_2\text{O}_3$  Products from Struthers Wells, Crystallization Tests, W.R. Hatch, 201-0-790614, JO#2484.

\* Dearborn Chemical Ltd.

TABLE I: Feed Preparation For Crystallizer

<u>Batch No.</u>	<u>Solution</u>	<u>Recycle As<sub>2</sub>O<sub>3</sub> (g/L)</u>	<u>Dust Added (lbs)</u>	<u>As<sub>2</sub>O<sub>3</sub> (g/L)*</u>
1	Water	0.	30	N.D.
2	Recycle	N.D.	20	N.D.
3	Recycle	15.	23	71.
4	Water	0	25	N.D.
5	Recycle	17.	25	68

\* As<sub>2</sub>O<sub>3</sub> concentration from specific gravity  
measurement

N.D. = not determined

(PILOT PLANT OPERATION, Cont'd.)

The crystallizer was initially filled with cold water and contained 128 L to the inlet of the vaporizer. About 6 kilos of  $\text{As}_2\text{O}_3$  crystals from the previous campaign were added as seed and the slurry was circulated through the heat exchanger which was glycol reffridgerant cooled.

When the solution temperature had been lowered to  $10.5^\circ\text{C}$ , feed solution was metered into the circulating crystal slurry. The log sheets attached record the data obtained by the operators. Samples of baghouse dust, feed solutions, crystallizer slurry, overflow solution, centrifugate and product  $\text{As}_2\text{O}_3$  crystals were taken at various times.

RESULTS

The samples taken and their analysis are listed in the following Table II.

As shown in the operating sheets and the results plotted in Figure 2, the system was operated continuously for 50 hours.

The initial feed prepared from a water leach of dust resulted in a super-saturated solution, in the crystallizer, reaching  $\approx 37$  g/L  $\text{As}_2\text{O}_3$  at  $10^\circ\text{C}$  (saturated equilibrium value at  $10^\circ\text{C} = 16$  g/L  $\text{As}_2\text{O}_3$ ). At this point batch #2 leach solution was fed to the crystallizer and the  $\text{As}_2\text{O}_3$  content of the mother liquor dropped to the equilibrium value. There was a corresponding increase in the % solid  $\text{As}_2\text{O}_3$  circulating in the crystallizer. There was another period of super-saturation when batch #4 water leach was fed to the crystallizer but there was a return to normal operation when #5 batch recycle leach solution was used. This crystallization problem has been documented previously<sup>(2)</sup> and the reason has not been fully investigated or explained. The presence of seeding or a high solid  $\text{As}_2\text{O}_3$  content in the crystallizer appears to limit the degree of super-saturation, and the problem does not occur when recycle solutions are used to make up the feed.

From the  $\Delta T$  values recorded across the heat exchanger there was no loss in heat transfer from crystallizer liquor to cooling water. At the end of the run the ends were removed from the heat exchanger and the inside walls of the tubes inspected. There was no visible indication of scaling on the tube walls. Some of the "sight" windows on the crystallizer were partly covered with  $\text{As}_2\text{O}_3$  but the material appeared to be as fines, loosely held rather than scale.

The pH+ of the leach solutions and crystallizer were not adjusted until the final batch #5 was started. The pH+ of the as-leached baghouse dust gave a crystallizer mother liquor of pH+=6.9. This gradually dropped to about 6.4 at 2145 hrs on the 19th. Batch #5 feed solution was adjusted to pH+=2.5 with 100 mL of 1:1 sulphuric acid. This feed gradually lowered the pH+ of the mother liquor to 4.0. No significant changes were noted due to the pH+ change. The effect of pH+ on crystallization is being investigated in a separate study.

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- (2) Purification of Arsenious Oxide from Roaster Dusts by the Hot Water Leach Process, FRL-159, Jan. 25, 1979.

TABLE II: Samples from SSI Pilot Campaign

Sample No.	Description	Day/Time	Analysis (% or g/L)				
			As <sub>2</sub> O <sub>3</sub> (T)	As <sub>2</sub> O <sub>3</sub> (S)	Sb <sub>2</sub> O <sub>3</sub>	Fe	pH <sup>+</sup>
79-408	Baghouse Dust Feed	-	96.3	94.2	0.29		
79-409	Thickener Underflow	-	-	88.0			
79-410(1)	Feed Solution	19-0815	62*		0.032		7.0
(2)	Feed Solution	20-0315	62*		0.072		
79-411-1	As <sub>2</sub> O <sub>3</sub> from Crystallizer Slurry	19-1245		99.5	0.20	0.017	
2	(Solids in Suspension)	"-1645	-				
3	"	"-2145		99.5	0.20	0.016	
4		20-0045	-				
5		-0245					
6		-0445					
7		-0645		99.5	0.21	0.014	
8		-0845					
9		-1045					
10		-1245					
11		-1315		99.5	0.19	0.015	
79-412-1	Overflow Solution	19-2045		32			
-2	(Mother Liquor)	18-2115		26			
79-413	Centrifugate	20-1500		22			
79-414	As <sub>2</sub> O <sub>3</sub> Product	20-1500		99.6	0.19	0.015	

\* As<sub>2</sub>O<sub>3</sub> concentration calculated from solution density.

(RESULTS, Cont'd.)

The concentrations of the feed solutions were determined by measuring the specific gravity at 25°C and the figure of 62 g/L is probably within 10% of the value. The reason for the high As<sub>2</sub>O<sub>3</sub> content of the leach residue (thickener underflow) can be attributed mainly to the fact that recycle solution concentrations were high due to As<sub>2</sub>O<sub>3</sub> super-saturation. An analysis of the baghouse dust feed was not available and additions to the leach were made on the assumed basis of 80% soluble As<sub>2</sub>O<sub>3</sub>. Thus a large excess of dust was added. The settled slurry from the leaching operation had a solids content of 58%.

The final As<sub>2</sub>O<sub>3</sub> product contained 6.5% moisture and analyzed 99.6% As<sub>2</sub>O<sub>3</sub> (dry basis). The screen analysis was carried out at Struthers-Wells on a methanol washed and dried sample. A screen analysis was also carried out at FML on a dried sample the results being as follows:

Mesh	Struthers Wells	FML
	Screen Analysis	Screen Analysis
	%	%
+100	0	0.5
+200/-100	5.6	6.8
+325/-200	77.1	69.1
-325	17.3	23.6

The analysis of the final product (79-414) is given in Table II. The only other impurities found by spectrographic analysis were Si, Al, Mg and Ca all less than 0.003%.

CONCLUSIONS

Arsenious oxide can be continuously crystallized from solution operating the Krystal crystallizer as a contact cooled unit. Satisfactory operation was achieved when baghouse dust was leached in recycle solution with no scaling evident over a 50 hour operating period.

To avoid short circuiting of feed solution through the crystallizer, two or more units would be required in plant design. The contact cooled crystallizer could be operated in conjunction with one or more vacuum crystallizers recycling the overflow through the condensor. Assuming that the previous stage vacuum crystallizer was operated at 25°C, there would appear to be little added advantage cooling to 18°C in an additional unit using cold water as coolant. From a knowledge of the temperature-solubility curve one would expect an additional 4 g/L As<sub>2</sub>O<sub>3</sub> product. A drop of at least 30°C would provide a reasonable product yield in the crystallizer.

(CONCLUSIONS, Cont'd.)

The lower capital cost of the contact cooling crystallizer would appear advantageous providing the recycle solution can be recycled to pick up heat from the initial unit. The possibility of a two or three stage contact cooling crystallization circuit should be considered providing heat can be recovered in the heat exchangers of the initial units by recycling the final overflow liquor.

*W. R. Hatch*

W.R. Hatch

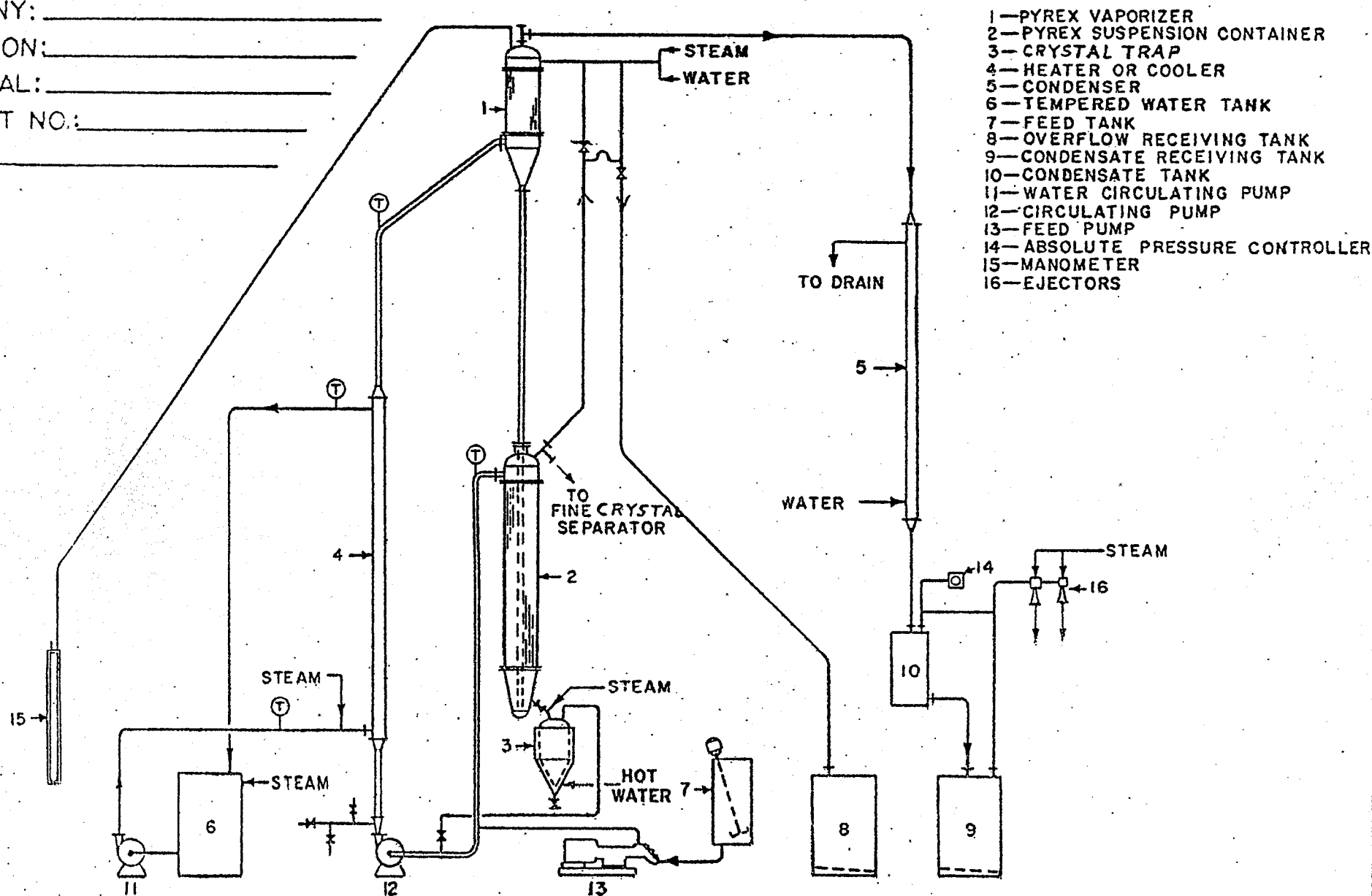
WRH/lbm  
Attach.



As<sub>2</sub>O<sub>3</sub> Balance for Struthers-Wells Pilot Test

	<u>Kg. As<sub>2</sub>O<sub>3</sub></u>
As <sub>2</sub> O <sub>3</sub> In - Baghouse Dust - 123 lbs x 0.94% = 112 lbs As <sub>2</sub> O <sub>3</sub>	51.0
Seed Crystals - 15 lbs x 0.94% = 14.1 lbs As <sub>2</sub> O <sub>3</sub>	<u>6.3</u>
Total As <sub>2</sub> O <sub>3</sub> In	<u>57.3</u>
As <sub>2</sub> O <sub>3</sub> Out - Crystal Product (including samples) 51 lbs.	23.0
<u>Solution</u> - Centrigugate (34 U.S. Gal. @22.4 g/L)	
= 2.8 kg	
Overflow Tank (25 U.S. Gal. @26 g/L) = 2.5 kg	
Recycle Leach Tanks (60 U.S. Gal. @ 26 g/L)	
= <u>4.9 kg</u>	
10.2 kg	10.2
<u>Residue</u> - (59 lbs at 88% As <sub>2</sub> O <sub>3</sub> ) = 51.9 lbs As <sub>2</sub> O <sub>3</sub>	23.3
Total As <sub>2</sub> O <sub>3</sub> Out	<u>56.5</u>

COMPANY: \_\_\_\_\_  
 LOCATION: \_\_\_\_\_  
 MATERIAL: \_\_\_\_\_  
 PROJECT NO.: \_\_\_\_\_  
 DATE: \_\_\_\_\_



STRUTHERS TECHNICAL SERVICES LABORATORY  
 WARREN, PENNSYLVANIA

SCHEMATIC FLOWSHEET OF PILOT PLANT, KRYSTAL CRYSTALLIZER  
 FIGURE NO. 1

KR-010-1

## CRYSTALLIZER OPERATIONAL DATA

COMPANY GIANT MINES  
 LOCATION \_\_\_\_\_  
 MATERIAL AS<sub>2</sub>O<sub>3</sub>

PROJECT NO. 10569  
 SAMPLE NO. \_\_\_\_\_  
 OPERATION CONTACT COOLING

DATE 6-18-79  
 RUN NO. \_\_\_\_\_  
 OPERATOR 175

TIME	HEAT EXCHANGER			MOTHER LIQUOR							FEED LIQUOR			EVAP.		PROD.		P. R E S S Hg.	FEED, SP. GR.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
	IN	OUT	ΔT	HT. EXCH.			UNIT TEMP T-5	CIRC RATE GPM	SPECIFIC GRAVITY	CIRC SALT %	TEMP T-8	LITERS		LITERS		LB. HR.	TOT		FEED, %	FEED, PH	M.L., PH	M.L., %																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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1145	0	2	2	10.5	10.5	0	10.5	18	1.0000	2.47%	86	116.5																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					

ADDED 15# SEED  
 1.5 #/HR. PROD RATE = 12.2 HR.

D.O.T. FOR FEED MAKEUP

STROTHERS TECHNICAL SERVICES LABORATORY  
CRYSTALLIZER OPERATIONAL DATA

COMPANY GIANT YELLOWKNIFE MINES  
LOCATION YELLOWKNIFE, N.W.T.  
MATERIAL As<sub>2</sub>O<sub>3</sub>

PROJECT NO. 10569  
SAMPLE NO. \_\_\_\_\_  
OPERATION CONTACT COOLING

DATE 6-19-79  
RUN NO. \_\_\_\_\_  
OPERATOR BWF

TIME	HEAT EXCHANGER			MOTHER LIQUOR							FEED LIQUOR			EVAP.		PROD.		P. RES. S. Hg.	FEED, SP. GR.	
				HT. EXCH.			UNIT TEMP T-5	CIRC RATE GPM	SPECIFIC GRAVITY	CIRC SALT %	TEMP T-8	LITERS		LITERS		LB. HR.	TOT		FEED, %	FEED, PH
	IN T-1	OUT T-2	ΔT	IN T-3	OUT T-4	ΔT						TANK	NET	TANK	NET				M.L., PH	M.L., %
0015	-6	3.5	2.5	11.0	10.5	.5	10.5	18			86	88								
0045	-7	-4.5	2.5	11.0	10.5	.5	10.0	"	1.0220/10	4.0%	86	81	14.0							
0115	-7.5	-4.5	2.0	10.5	10.0	.5	10.0	"			86	75								
0145	-7.5	-5	2.5	10.0	9.5	.5	9.5	"	1.0210/10	4.8%	86	69	12.0							
0215	-7	-4.5	2.5	10.0	9.5	.5	9.5	"			86	63								
0245	-6	-4	2.0	10.0	9.5	.5	9.5	"	1.0220/10	5.6%	86	57	12.0							
0315	-6	-3.5	2.5	10.0	9.5	.5	9.5	"			86	51.5								
0345	-8	-5.5	2.5	10.5	10.0	.5	10.0	14.5	1.0190/10	5.2%	86	47.0	10.0					0330 POWER OFF FOR 2 SEC. SIPHONING CLOSED OVERFLOW REGAINING CIRCULATION		
0415	-10	-6.5	3.5	9.5	8.5	1.0	8.5	17.0			86	40.0								
0445	-9.5	-7.0	3.5	8.5	8.0	.5	8.0	18	1.0180/8	5.2%	86	34.5	12.5							
0515	-10	-7	3.0	8.5	8.0	.5	8.0	"			86	28.5								
0545	-9.5	-6.5	3.0	8.0	7.5	.5	7.5	"	1.0180/8	6.0%	86	22.5	12.0							
0615	-9.5	-6.5	3.0	8.5	8.0	.5	8.0	"			86	16.5								
0645	-9.5	-6	3.5	8.5	8.0	.5	8.0	"	1.0180/8	6.4%	86	10.5	12.0							
0715	-8	-6	2	9	8.5	.5	8.5	"			86	5								
0745	-8	-5.5	2.5	9.5	8.5	1	8.5	"	1.0160/8	6.4%	86	-1	115	132						
0815	-8	-5.5	2.5	9.5	8.5	1	8.5	"			86	122	116							
0845	-8	-5.5	2.5	9.5	9	.5	9	11	1.0160/9	6.4%	86	109	13							
0915	-8	-5.5	2.5	9.5	9	.5	9	11			86	102								
0945	-8	-5.5	2.5	10	9.5	.5	9.5	11	1.0150/9	7.2%	86	96	13							
1015	-7	-4.5	2.5	10	9.5	.5	9.5	11			86	89								
1045	-4.5	-2	2.5	11	10.5	.5	10.5	11	1.0150/10	7.2%	86	82	14							
1115	-6	-3.5	2.5	11	10.5	.5	10.5	11			86	75								
1145	-6.5	-4	2.5	11	10.5	.5	10.5	11	1.0150/10	8.2%	86	68	14							
1215	-6.5	-4	2.5	11	10.5	.5	10.5	11			86	61						150 lb Feed liquor		

0330 POWER OFF FOR 2 SEC.  
SIPHONING CLOSED OVERFLOW  
REGAINING CIRCULATION

150 l Feed liquor

CRYSTALLIZER OPERATIONAL DATA

COMPANY GIANT YELLOWKNIFE MINES  
 LOCATION YELLOWKNIFE N.W.T.  
 MATERIAL AS2O3

PROJECT NO. 10569  
 SAMPLE NO. \_\_\_\_\_  
 OPERATION CONTACT COOLING

DATE 6-19-79  
 RUN NO. \_\_\_\_\_  
 OPERATOR AS

TIME	HEAT EXCHANGER			MOTHER LIQUOR							FEED LIQUOR			EVAP.		PROD.		PRESS Hg.	FEED, SP. GR. <u>1.055 @ 25°</u> <u>5% clean</u> FEED, % <u>70% per l</u> FEED, PH _____ M.L., PH _____ M.L., % _____																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
				HT. EXCH.			UNIT TEMP T-5	CIRC RATE GPM	SPECIFIC GRAVITY	CIRC SALT %	TEMP T-6	LITERS		LITERS		LB. HR.	TOT																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
	IN	OUT	ΔT	IN	OUT	ΔT						T-1	T-2	ΔT	T-3					T-4	ΔT	T-5	T-6	TANK	NET	TANK	NET																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	TANK	NET	T-1	T-2	ΔT	T-3	T-4			ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6	TANK	NET	T-1	T-2	ΔT	T-3	T-4	ΔT	T-5	T-6

STRUTHERS TECHNICAL SERVICES LABORATORY  
CRYSTALLIZER OPERATIONAL DATA

COMPANY GIANT YELLOWKNIFE MINES  
LOCATION YELLOW KNIFE, N.W.T.  
MATERIAL As<sub>2</sub>O<sub>3</sub>

PROJECT NO. 10569  
SAMPLE NO. \_\_\_\_\_  
OPERATION CONTACT COOLING

DATE 6-20-79  
RUN NO. \_\_\_\_\_  
OPERATOR BWF

TIME	HEAT EXCHANGER			MOTHER LIQUOR						FEED LIQUOR			EVAP.		PROD.		P R E S S Hg.	FEED, SP. GR.	
				HT. EXCH.			UNIT TEMP T-5	CIRC RATE GPM	SPECIFIC GRAVITY	CIRC SALT %	TEMP T-8	LITERS		LITERS		LB. HR.		TOT	FEED, %
	IN T-1	OUT T-2	ΔT	IN T-3	OUT T-4	ΔT						TANK	NET	TANK	NET				
0115	-5.5	-3	2.5	11.5	11.0	.5	11.0	17.5			86	102							
0145	-5.5	-3	2.5	11.5	11.0	.5	11.0	18	1.0200	11	9.6%	86	96	12					
0215	-6	-3.5	2.5	11.0	10.5	.5	10.5	"			86	90							
0245	-6	-3.5	2.5	11.5	10.5	1.0	10.5	16	1.0180	10	9.6%	86	84	12					
0315	-6	-3.5	2.5	11.5	10.5	1.0	10.5	18			86	128 122							
0345	-6	-3.5	2.5	11.0	10.5	.5	10.5	"	1.0160	10	9.6%	86	116	12					
0415	-6	-3.5	2.5	11.0	10.5	.5	10.5	"			86	111							
0445	-6	-3.5	2.5	11.0	10.5	.5	10.5	"	1.0140	10	8.0%	86	105	11					
0515	-6	-3.5	2.5	11.0	10.5	.5	10.5	"			86	99							
0545	-6	-3.5	2.5	11.0	10.5	.5	10.5	"	1.0160	10	9.2%	86	93	12					
0615	-6	-3.5	2.5	10.5	10.0	.5	10.0	"			86	87							
0645	-6	-3.5	2.5	10.5	10.0	.5	10.0	17.5	1.0140	10	9.2%	86	81	12					
0715	-6	-3.5	2.5	10.5	10	.5	10	"			86	75							
0745	-6	-3.5	2.5	10.5	10	.5	10	"	1.0140	10	10.4%	86	69	12					
0815	-6	-3.5	2.5	10.5	10	.5	10	"			86	67							
0845	-6	-3.5	2.5	10.5	10	.5	10	"	1.0160	10	10.4%	86	57	12					
0915	-6	-3.5	2.5	10.5	10	.5	10	"			86	51							
0945	-6	-3.5	2.5	10.5	10	.5	10	"	1.0160	10	10.4%	86	44	13					
1015	-6	-3.5	2.5	10.5	10	.5	10	"			86	38							
1045	-6	-3.5	2.5	10.5	10	.5	10	"	1.0160	10	10.4%	86	32	12					
1115	-6	-3.5	2.5	10.5	10	.5	10	"			86	25							
1145	-6	-3.5	2.5	10.5	10	.5	10	"	1.0180	10	10.0%	86	19	13					
1215	-6	-3.5	2.5	10.5	10	.5	10	"			86	12							
1245	-6	-3.5	2.5	10.5	10	.5	10	"	1.0180	10	10.2%	86	7	12					
1315	-6	-3.5	2.5	10.5	10	.5	10	"	1.0180	10	11.2%	86	1						

OPENED OVER FLOW  
D.O.T. 0300  
LEVEL DROPPING WILL PERIOD-  
ICALLY OPEN & CLOSE OVER-  
FLOW TO PREVENT SIPHONING

PH<sup>+</sup> 5.8

HEAT EXCHANGER TUBE  
SHOWED NO APPRECIABLE  
SCALE

PH<sup>+</sup> 5.2

PH<sup>+</sup> 4.2

PH<sup>+</sup> = 3.8

PH<sup>+</sup> 3.7 4.0

Feed liquor 14.5 l  
45.5#  
CENT FROM SUSP

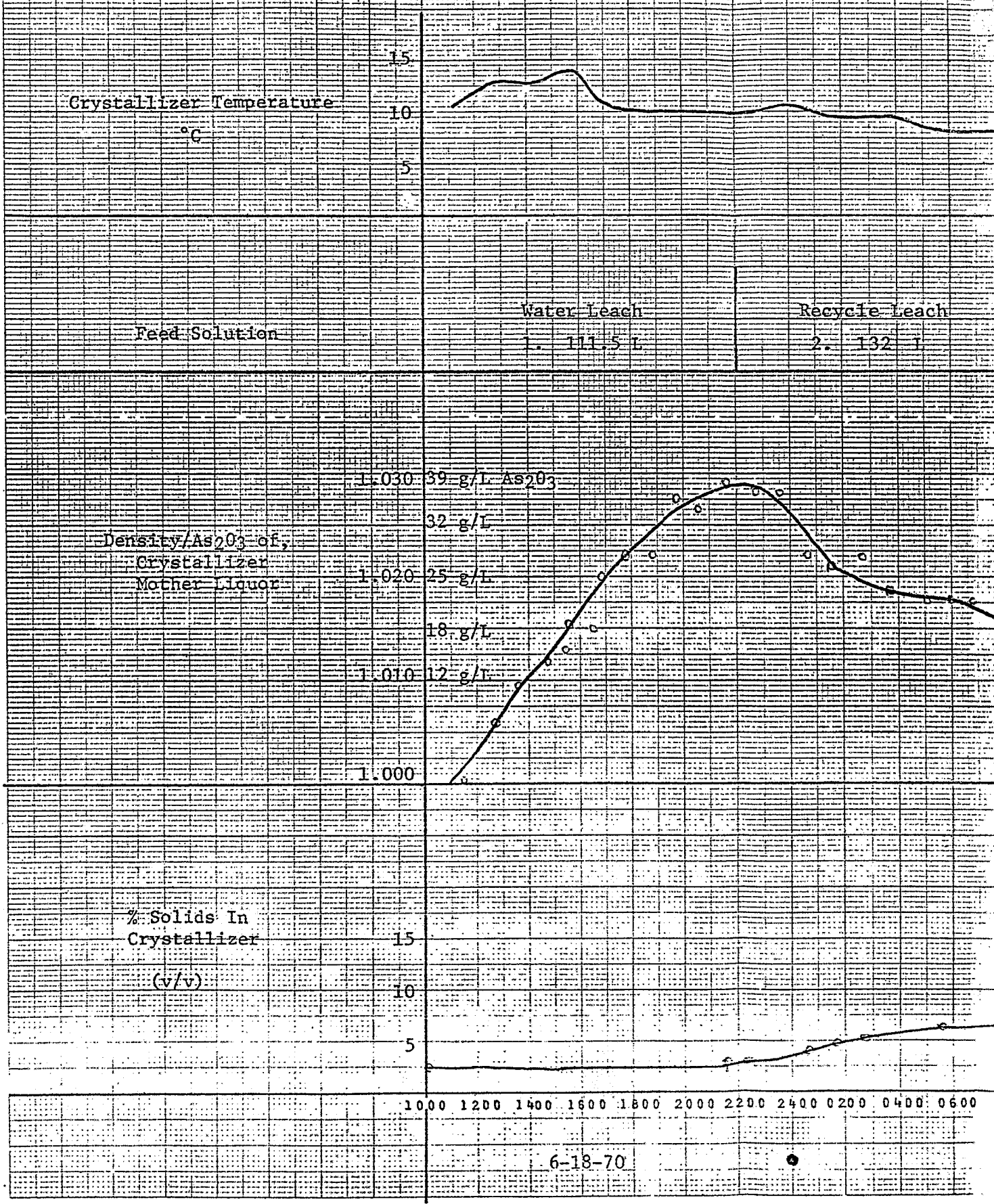
pH<sup>+</sup> = 3.8

Feed liquor 14.5 l  
45.5% CENT FROM SUSP

47 1510

10 X 10 TO THE CENTIMETER • 25 X 38 CM.  
KEUFFEL & ESSER CO. MADE IN U.S.A.

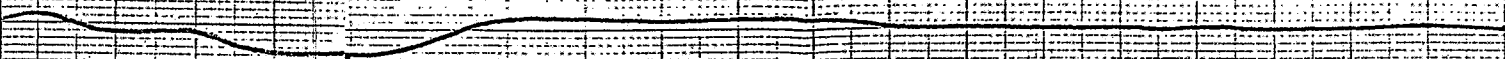
FIGURE 2: Arsenious Oxide Crystalliza



6-18-70



# us-Oxide Crystallization Test Data



Recycle Leach

2. 132 L

Recycle

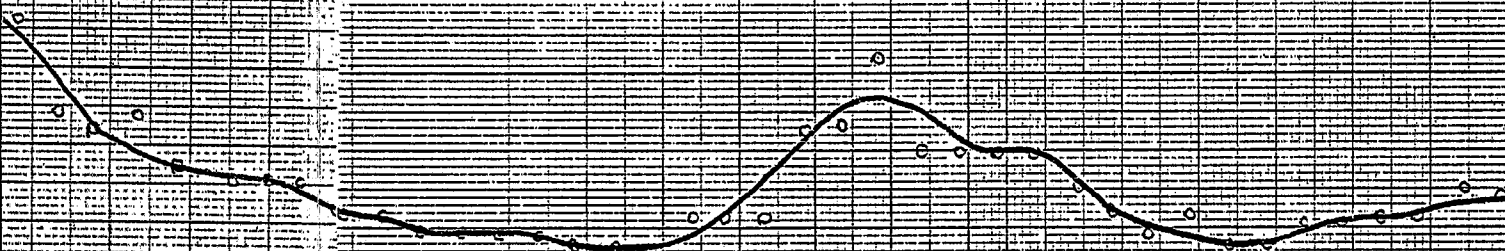
3. 112 L

Water

4. 133 L

Recycle

5. 121 L



2400 0200 0400 0600

0000 1000 1200 1400 1600 1800 2000 2200 2400 0200 0400 0600 0800 1000 1200 1400

6-19-79

6-20-79