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FALCONBRIDGE NICKEL MINES LIMITED

INTER OFFICE MEMORANDUM

MEMO TO: R. A. Bergman

FROM: M. Collins

DATE: June 18, 1979

SUBJECT: Minutes of Meeting on June 4th 1979;
As₂O₃ Pilot Plant at Giant Yellowknife

PROJECT No. 201-790615
JO#2484

KEYWORDS: (in title)

COPIES TO: PGT, PJR, LSP, FGTP, WRH/LB, FRA, LC, DNZ, Cir., File

A meeting was held on June 4th 1979 at FML to discuss the Giant Yellowknife arsenious oxide pilot plant. The main purpose of the meeting was to set objectives for the next stage of the pilot plant programme following a review of Struthers-Wells crystallization tests and other information.

Present at the meeting were:

P. J. Raleigh
L. S. Price
F. G. T. Pickard
P. G. Thornhill
R. A. Bergman
M. Collins
W. R. Hatch
L. Beky
F. R. Archibald
L. Connell
D. N. Zeraldo

The items covered at the meeting are outlined in the attached agenda.

I N D E X

Chronicle of Project Development

Present Market for As_2O_3

Guidelines for As_2O_3 Production

Struthers-Wells Crystallization Tests

Beattie Flowsheet for As_2O_3 Production

The GYK As_2O_3 Pilot Plant

Future Pilot Plant Operation

Testwork at FML

Action List

Chronicle of Project Development

PJR prefaced the meeting with the following chronicle of project development:

- Shipment of 200 tons of GYK bag-house dust to Koppers, Georgia, for production of As_2O_5 (1978)
- Bag-house dust found to be unsuitable because of consumption of oxidizer by iron, ferric arsenate precipitation and presence of unwanted elements (SiO_2 , Sb)
- Presence of 1/2 oz/ton gold in GYK material stored underground was pointed out by L. Connell
- PJR/LSP carried out a preliminary economic evaluation of As, Sb and Au recovery from GYK material
- DNZ market evaluation suggested that 6000 tons of pure As_2O_3 could be sold for approximately 23¢/lb
- D. Emery authorized FML study (Nov. 1978)
- Flowsheet development by W. R. Hatch
- P. J. Raleigh established that economic As_2O_3 and Au recovery was possible based upon a complete flowsheet
- L. Connell built and operated As_2O_3 leach/crystallization pilot plant (April 1979)
- Pilot operation encounters problems especially in the areas of leach residue filtration and As_2O_3 crystallization
- Visit and on-site assistance by WRH/LB (May 1979)
- Evaporative As_2O_3 crystallization evaluated at Struthers-Wells; visit by L. Connell.

Present Market for As_2O_3

D. N. Zeraldo stated that 19-23,000 tons As_2O_3 per year is consumed by 5 or 6 companies in the U.S.A. for use in wood preservatives and agro-chemicals. A product of more than 96 wt% As_2O_3 purity is required. ASARCO produces about 10,000 tons As_2O_3 per year and the remainder is imported, mainly from Sweden and Mexico. As_2O_3 produced in the U.S.A. sells for 23 1/4¢/lb and imported As_2O_3 sells for 25 1/4¢ US/lb F.O.B. port of entry. The wood preservative market is growing at 20%/year and the 6000 tons of Giant Yellowknife As_2O_3 should sell.

Guidelines for As₂O₃ Production

PJR stated that estimates of As₂O₃ production costs had included 11¢ CDN/lb transportation and 2¢ CDN/lb for insurance. Hence, the As₂O₃ should be sufficiently dry to prevent dusting and to allow the material to flow freely. There are two periods in the year when shipment is not possible so that on-site storage of As₂O₃ is required. A discussion of methods of shipping As₂O₃ ensued during which the disadvantages of methods other than pneumatic trucking were reviewed.

The As₂O₃ product should be produced as soon as possible to prevent the expenditure of \$750,000 for new stopes to store bag-house dust.

Reliable production of a product containing more than 98 wt% As₂O₃ is required.

The pilot plant is required to operate continuously and produce a consistent product before capital is committed to scale-up. Of concern is the build-up and elimination of impurities. Product form will depend upon the type of crystallizer employed.

Struthers-Wells Crystallization Tests

Larry Connell, having just returned from Struthers-Wells pilot operation at Warren, Pa, described the tests performed. Tests were based upon treatment of similar ASARCO material. A diagram of the pilot plant is attached. Giant Yellowknife bag-house dust was taken to Warren and water-leached at the boiling point to produce an As₂O₃ saturated solution. In total 150 lb of damp As₂O₃ crystal product was produced in 4 days and was transported back to FML. Samples were removed for analysis and part of the remainder (15 kg) was shipped to Jennike & Johanson for "product handling tests".

Crystals were generated with the equipment run in the "vacuum cooling" mode and with solution cooled to 25°C. Small crystals were recycled through the column whereas large crystals (maximum size approx. 200 mesh) were collected in a salt trap. Struthers-Wells are investigating the possibility of further cooling to 12°C. Density measurements indicated that 25°C overflow solution contained approx. 20 g/L As₂O₃. Crystals were recovered from slurry in a basket centrifuge.

The time scale for Struthers-Wells contribution is as follows:

- a) pilot plant tests completed by 15th June
- b) report available by 30th June
- c) technical proposal will be made by 30th July.

Equipment delivery was quoted at 30-35 weeks with an extra six weeks required for changes to flowsheet drawings. A rough estimate of \$100,000 for an 1800 lb As₂O₃ / hr unit was quoted. The unit operation price would be between \$200,000 and \$500,000 depending on whether two or three columns are required.

The main advantages of the Struthers-Wells unit over scraped-wall crystallizers are the recovery of heat from leach solution (i.e. spent liquor was heated from 25°C to 70°C by passage through the cooling heat exchanger and vapour condensers) and the control of crystal habit by recycling product.

The As_2O_3 recovered per pass through the pilot unit at 15% evaporation loss was not yet known. The arsenic content of the steam was not reported.

Beattie Flowsheet for As_2O_3 Production

Mr. F. R. Archibald outlined the operations at Beattie as they were in Spring 1940 when he left Beattie Gold Mines (Quebec) Ltd. Further information can be found in the following publications:

1. "Roasting of Beattie Concentrate"
by Archibald, Martin & Koenen,
CIM Transactions, Vol. XLII, 1939, pp. 608-631.
2. "The Importance of Temperature, and of Sulphur Dioxide Concentration, in Roasting Arsenopyrite Concentrate" by Archibald & Harris,
CIM Transactions, Vol. XLIII, 1940, pp. 757-761.
3. "Roasting Arsenical Gold Ores & Concentrates"
by F. R. Archibald, CIM Transactions, Vol. LII, 1949, pp. 76-86.

Mr. Archibald offered a number of observations.

Arsenic was readily floated from fine calcine in Cottrell dust by simply sparging air through the mixture.

Sulphur trioxide concentration was quite high in the cold Cottrell and large deposits of arsenic sulphate formed.

$\text{As}_2(\text{SO}_4)_3$ acts as a pH buffer in sulphate solution so that free acid after arsenic leaching should be determined by titration and not by simple pH measurement.

It is easy to get a marked degree of super saturation when cooling arsenic solutions unless the correct conditions are employed. Cooling in large diameter wood-stave tanks at Beattie, whilst stirring with a slow moving wooden paddle (i.e. high shear) produced a good yield of very dense crystals. These were isolated by settling and decanting.

Working conditions at Beattie were good by the standards of the time. However, FRA warned that arsine gas can be generated in alkaline solution even at pH approx. 11 if a strong reductant (i.e. zinc) is present.

The GYK As₂O₃ Pilot Plant

L. Connell described how the pilot plant had been put together and the problems experienced on start-up. Thus far, 250 lb of As₂O₃ product has been made in a number of short runs under a variety of conditions. It is not suitable for marketing.

The leaching operation has to be optimized. LC feels that counter-current flow in two leach-settling tanks may be required to provide a suitably arsenic-free residue for gold recovery.

In spite of the ease of laboratory filtrations reported by WRH, filtration of leach residue in the pilot plant had been "almost impossible". Consequently, a hot settling tank has been employed. Settling is rapid and rates have been measured. At Struthers-Wells a 45 gallon drum of leached slurry settled to give a clear supernatant liquid in 30 minutes. L. Connell reported that complete As₂O₃ leaching does not decrease the settling rate. Complete leaching is characterized by a dramatic change in colour of solids to brown/black.

Crystallization of As₂O₃ has encountered problems. Air agitation/cooling did not produce satisfactory results. Best results have been obtained with forced cooling of stirred drums fitted with flexible plastic liners.

The pilot plant has operated for short periods in closed circuit and no build-up problems have been evident. PJR noted that the product specification for iron was less than 0.02 wt% Fe.

A short discussion concluded that antimony is unlikely to be recovered as a salable by-product from the existing operation.

Future Pilot Plant Operation

Objectives for future pilot operation were set out.

A. Evaluation of Materials

CON material (As₂O₃ 60% soluble) and GYK bag-house dust (approx. 12 tons/day) are to be mixed in proportion equivalent to 6000 tons As₂O₃/y production.

Cottrell dust contains only 2.5 wt% As₂O₃ and requires separate treatment. It was decided to leave this material for evaluation at some future date. Receipt of a telex from W. A. Moore following the meeting, indicated that Cottrell dust should be given a priority equal to bag-house dust.

B. Optimization of Leaching Operation

Improvements will be made to the method of addition of solids to the leach tank and the venting of vapours from the tank. An attempt will be made to produce a soluble-arsenic free residue in a two stage leach. The effect of pH on leachability will be assessed.

Direct leaching of gold from leach residue has been tested. No roast-leach tests have yet been performed. It was noted that roaster feed varies from 12 to 20 wt% S and available heat for leach residue roasting also varies. In addition, an evaluation by Lakefield 10 years ago found that 80 wt% of the dust was less than 2 μ . This dust may pass rapidly through the roaster without reaction. The general opinion was that the leach residue should not be added to the roaster.

C. Closed Circuit Operation of Crystallizers

The forced-cooled drums, fitted with stirrers and flexible liners, will be fed in closed circuit with leach liquor. At least 50 lb of As_2O_3 product will be made for marketing. The build-up of impurities will be monitored. Samples of product will be sent to FML for qualitative spectrographic analysis to give a rapid indication of impurity build-up. A run of four weeks under stable conditions will be attempted. Pilot plant operation should be complete by the end of July 1979.

D. Submerged Combustion

It was decided that since this technique is limited to temperatures below 180°F to avoid excessive evaporation, it will not be used and will not be tested.

E. Check Variability of Feed

Bag-house dust was said to contain between 87-94 wt% of total arsenic as As_2O_3 and between 0.1 - 0.12 oz Au/ton. These variations will be checked. It was noted that the dust is not easily wetted with water.

WRH reported that CON material from various depths in the tailings pond was remarkably similar in composition. It is the responsibility of CON Mine to deliver the tailings slurry to Giant Yellowknife.

F. Personnel

It was agreed that someone should be appointed full time to be responsible for pilot plant operation and that he should report to L. Connell. It was agreed that Ed Foster be considered for this duty. FGTP will discuss the suggestion with D. Emery.

A system of routine pilot plant operation reporting will be initiated to ensure that L. Connell and others are informed of plant progress.

Testwork at FML

A. Filtration Tests

A sample of bag-house dust will be sent to FML. Filtration tests will be carried out on leach residues from both bag-house dust and CON material. Factors affecting the filterability will be assessed. Equipment from filtration specialists will be used to gauge the size and type of filters required by the plant. A portable test filter will be supplied to FML from Johns-Mansville within two weeks.

B. Cottrell Dust

Laboratory leaching tests will be carried out to help identify the particular problems that might be associated with treatment of this material.

C. Crystallization/pH Tests

The influence of pH on the crystallization of As_2O_3 will be assessed.

D. Struthers-Wells Samples

A physical and chemical characterization of the 150 lb As_2O_3 made at Struthers-Wells will be carried out. The material will be shipped to Jennike & Johanson.

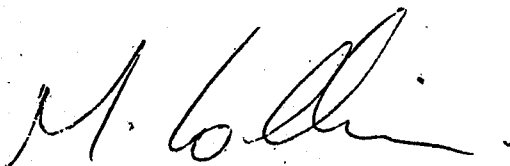
FML assistance with further tests in Warren is available if required.

E. Evaluation of Closed Circuit Product

Provision will be made for rapid spectrographic analysis of product samples sent to FML from the pilot plant and for immediate telexing of data to Yellowknife.

F. Wetting of Bag-House Dust

Tests will be performed on methods of wetting bag-house dust prior to leaching. Dusts may be easier to mix with CON slurry than with water.



M. Collins.

MC/et
attach.

ACTION LIST

FGTP: Discuss with D. Emery the suggestion that Ed Foster be asked to run the pilot plant.

DNZ: Monitor the As_2O_3 market for price changes and new opportunities.

LC: Pilot plant studies:

Materials evaluation

Optimizing leaching

Closed circuit operation (Report on Initial Pilot Campaign)

Variability of feed

Liaison with Struthers Wells

Circulate test report by 30th June 1979

Ensure technical proposal is made by 30th July

WRH: Filtration tests on leach residue

Leaching of Cottrell dust

Influence of pH on As_2O_3 crystallization

Wetting of dry bag-house dust

Evaluation of pilot plant products

Send As_2O_3 product to Jennike & Johanson

LSP: Obtain flowsheet and operational details of Beattie Operation if available.

A G E N D A

Arsenious Oxide Purification Meeting

Monday, June 4, 1979 - FML Conference Room

RAM, PGT, PSR, LSP, FGTP, WRH, LB, MC, DNZ, Larry Lomell, Andrichold

1. General Guidelines and Objectives of Project
(timing, marketing requirements, etc.)

(PJR) ✓

2. Struthers-Wells Crystallization Test

(LJC) ✓

3. Beattie Flowsheet for As₂O₃ Production

(FRA) ✓

4. Pilot Plant Program

Review of Previous Campaign and Status

(LJC) ✓

Future Program - Materials to be Evaluated

- Changes Required in Equipment
(filtration, pumps, crystallizers)
- Chemical and Engineering Data Requirements
- Product Assessment

Personnel - Requirements

5. Miscellaneous Testwork

(WRH) ✓

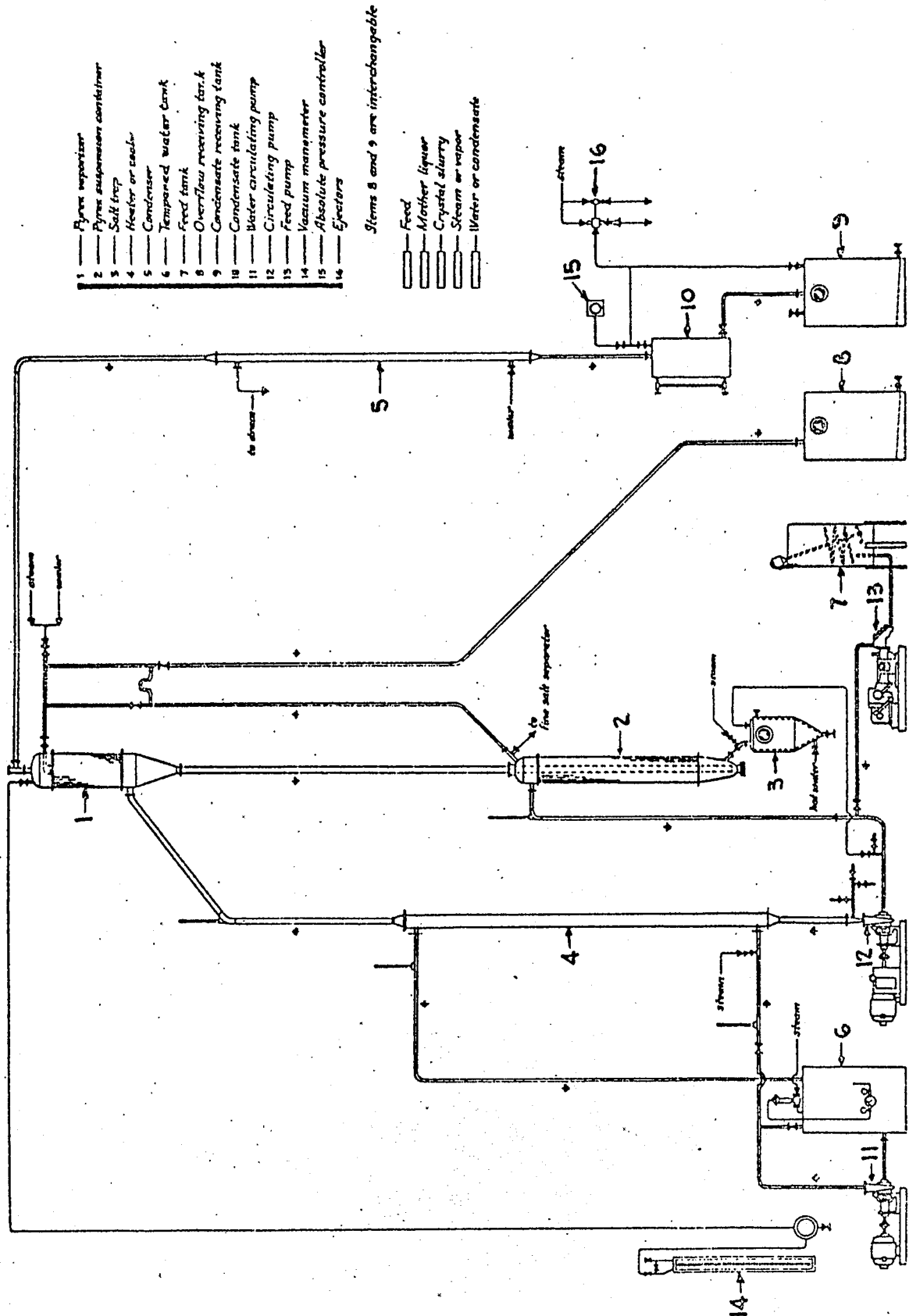
Filtration Studies ✓

Crystallization (effect of pH⁺) ✓

Product Handling (Jennike and Johanson)

Analytical (FML) ✓

6. Other Items for Discussion



- 1 — Pyrex evaporator
- 2 — Pyrex suspension container
- 3 — Salt trap
- 4 — Heater or cooler
- 5 — Condenser
- 6 — Tempered water tank
- 7 — Feed tank
- 8 — Overflow receiving tank
- 9 — Condensate receiving tank
- 10 — Water circulating pump
- 11 — Vacuum manometer
- 12 — Absolute pressure controller
- 13 — Ejectors

Stems 8 and 9 are interchangeable

- Feed
- Mother liquor
- Crystal slurry
- Steam or vapor
- Water or condensate