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PRELIMINARY

Alternate Process Flowsheet

For WAROX Production

Introduction

Development has continued at Giant Yellowknife Mines on a process for production of a marketable white arsenious oxide (WAROX). Pilot plant work at Research and Productivity Council (RPC) in New Brunswick identified the major parameters of the process for a separate WAROX plant. Preliminary engineering was completed at Fenco Engineers Inc, including a capital cost estimate for the production of 7000 tonnes/yr of WAROX.

The process involved feeding current and underground crude As_2O_3 to a fluosolids reactor operating at 450°C to sublime the arsenic. Inert impurities and gold were collected on a high temperature filter. Cold air was added to cool the gas stream to 110°C and condense a purified arsenic. This final WAROX product was collected in a cold baghouse and compacted for shipment.

Final tests at RPC used sintered metal stainless steel filters for hot gas filtration at 450°C . Additional tests were required, and a pilot plant is currently under construction to further test hot gas filtration. Concepts regarding antimony elimination and As_2O_3 particle size growth are also being evaluated.

Consideration is also being given to the purification of arsenic within the existing gas cleaning plant. Replacement of the existing cottrell with sintered metal filters would result in a marketable WAROX product. The addition of crude As_2O_3 from underground would give the projected 7000 tonnes per year of WAROX. A process is described in this report incorporating WAROX production into the existing plant. Pilot plant tests are required to demonstrate that a pure product can be produced and to obtain engineering data for sizing and costing a full scale plant, modifying the existing roaster off-gas system.

General Process Description

The attached flowsheet shows major equipment and flows for the process which is based on the production of 7000 tonnes/yr of WAROX product. This is derived from two sources, (1) current roaster off-gas arsenious oxide (As_4O_6) and (2) arsenic from underground stockpile material.

The crude As_2O_3 is fed into the hot roaster off-gas in a fluosolids sublimator. Available heat in the gas stream is used to sublime arsenic with a resultant temperature drop from 430°C to 370°C . The gas stream, enriched in As_4O_6 and reduced in volume flow is passed through a hot filter to remove Fe_2O_3 and inert solids. The filter off-gas is mixed with ambient air to obtain condensation of the arsenic at 110°C . High purity As_2O_3 is collected in a baghouse (existing) and discharged to a briquetting and flaking process. Final WAROX product is drummed for shipment.

Features of the proposed process include:

1. Utilization of roaster off-gas heat to sublime the crude As_2O_3 .
2. Reduced volumetric flows in the off-gas system as follows:

	<u>Current ACFM</u>	<u>Proposed ACFM</u>
Hot filtration (ESP)	8,700	7,970
Cooling Air (20° C)	26,160	10,514
Baghouse/stack (110° C)	35,000	18,446

3. Utilization of existing fan, condenser and baghouse for WAROX production.
4. Flexibility in that treatment of crude As_2O_3 can be shut off and downstream cooling air adjusted to accommodate the higher temperature.
5. Increased concentration of As_4O_6 and SO_2 in the gas streams. The effect of this in terms of As_2O_3 crystal size and SO_2 emissions requires evaluation.
6. An expected decrease in arsenic emissions by about 50%.

Detailed Process Description

Vaporization of Arsenic Trioxide From Stockpile Dust

The crude As_2O_3 from a surface storage bin is dried and fed to a reactor along with roaster off-gas. The fluosolids reactor/sublimator utilizes heat in the roaster off-gas to heat and sublime the arsenic in the crude dust. Gas cooling occurs (430° C to 370° C) with a net decrease in volume and increase in As_4O_6 concentration. The heat balance is given in Appendix I.

The requirements of the reactor are twofold, namely (1) to obtain good gas/solid mixing and (2) to provide the necessary residence time for the vaporization of As_2O_3 . Conceptually, the reactor size is determined by the vaporization kinetics which in turn is dependent on dust particle size and heat transfer. Data on this is lacking. The dust is known to be extremely fine (<2 microns) and is expected to vaporize readily at 370° C. The data needed for reactor sizing will have to be obtained from pilot plant tests. A coarse bed material would be required to maintain fluidity and provide a constant bed temperature. Inert solids from the roaster and from crude dust would be carried through the reactor.

The vapor pressure/temperature relationship of As_4O_6 is given in table I. A temperature of 370° C can contain over 8000 g/m³ As_4O_6 . Condensation of As_4O_6 from a gas stream containing 59.0 g/m³ will begin at about 230° C.

Hot Gas Filtration

Roaster off-gas, inerts and gaseous As_4O_6 from the vaporization reactor pass into the high temperature sintered metal filter. Fine inert solids are retained on the filter and gaseous As_4O_6 passes through. Filter size and design with blowback will be established from the RPC tests and current pilot plant testwork. Fine (0.2 to 1.0 micron) filters are required to remove inerts. With the flows shown in Figure I, a 98.0% solids filtration will yield a 98.0% As_2O_3 product. The fine filter must be maintained above 250° C to prevent arsenic contamination of the inerts. These are transferred to the mill for gold recovery.

Booster Blower

Pressure drop across the filter will be substantially higher than that currently found in the ESP. A booster blower will be required downstream of the filter to operate at 370° C. Enquiries are currently in progress regarding design and supply of a blower for this application.

Arsenic Condenser

The hot gas from the blower is transferred to the existing fan mixer-condenser. Gas volumes are substantially reduced as given in the "General Process Description".

Cold Baghouse

The condensed As_2O_3 is removed from the carrier gas in the existing cold baghouse. With the gas flows reduced to less than one-half the current flow, baghouse utilization can be decreased proportionately with significant operating cost reduction.

Stack gas at 110° C will contain about twice the sulphur dioxide concentration. Arsenic concentration in the off-gas should be the same as in the present system. With reduced gas volume, overall arsenic emissions are expected to be about one-half the current rate.

WAROX Packaging

The WAROX baghouse product will be compacted and flaked as outlined in the Fenco Engineers WAROX Feasibility Study (Dec. 1988).

 VAPOUR PRESSURE - TEMPERATURE RELATIONSHIP FOR As406

Temp. (c)	Temp (k)	log p	As406 p (mm Hg)	As406 g/cu.m	As g/cu.m
90	363	-6.8005	0.00012	0.0021	0.002
100	373	-6.3514	0.00034	0.0058	0.0044
110	383	-5.9257	0.00090	0.0149	0.0113
120	393	-5.5218	0.0023	0.0369	0.028
130	403	-5.1378	0.0055	0.0871	0.066
148	421	-4.4927	0.0244	0.3683	0.279
170	443	-3.7754	0.127	1.825	1.382
180	453	-3.4724	0.256	3.586	2.716
200	473	-2.9049	0.946	12.69	9.610
220	493	-2.3834	3.144	40.46	30.64
240	513	-1.9025	9.513	117.6	89.09
260	533	-1.4577	26.490	315.3	238.8
289	562	-0.8787	100.49	1135.4	859.9
300	573	-0.6613	165.76	1835.2	1389.9
310	583	-0.4793	252.06	2742.8	2077.2
320	593	-0.3034	377.91	4042.9	3061.8
330	603	-0.1334	559.03	5881.4	4454.2
335	608	-0.0505	676.65	7060.3	5347.0
337	610	-0.0177	729.71	7589.0	5747.4
338	611	-0.0013	757.65	7866.6	5957.6

Range 90 -338 deg.C $\log P(\text{atm})(\text{As406}) = - 6080.6/T(\text{deg K}) + 9.9506$

Appendix I
Preliminary Heat Balance for Sublimation
of As_2O_3 From Underground Crude
Storage Dust

The attached heat balance was carried out to determine the temperature drop in roaster off-gas that would result from addition of sufficient crude As_2O_3 to meet a production target of 7000 t/y WAROX product. The balance is based on 3000 t/y As_2O_3 from current roaster operations and 4000 t/y from stockpiled dust.

Heat Balance Calculation

Crude Dust Treatment Rate Based On Gas Stream Temperature Drop
from 430 deg C to 376 deg C

Gas Flow (ACFM) 8630 (SCFM) 3658
Temp. In (deg K) 703
Temp. Out (deg K) 649
Gas Comp. % N₂= 100 mole/min. 4236.40
% O₂=

Specific Heat cal/o/mole
N₂ 6.66 +0.00102T
Heat Content 1681316. cal/min.

Heat available from inerts (Fe₂O₃)

11.0 t/d
7638.888 g/min
47.83274 moles/min.

Specific Heat cal/o/mole
Fe₂O₃ 23.49+0.0186T-355000T-2

Heat Content of Fe₂O₃ 91141.35 cal/min

Heat available from gaseous As₂O₃

11.0 t/d
7638.888 g/min
38.61925 moles/min.

Specific Heat of As₂O₃ vapour 21.5 cal/o/mole

Heat Content of As₂O₃ Fume 44836.95 cal/min.

Total heat available

N₂ 1681317
Fe₂O₃ 91141
As₂O₃ (g) 44837

1817294. cal/min

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Calculation of heat required to raise crude As₂O₃ to 371 deg C
and sublime As₂O₃

(calculation for 1.0 kg dust)

Composition %As₂O₃ 50
%Fe₂O₃ 50
Moles As₂O₃ 2.53
Moles Fe₂O₃ 3.14

Heat required to raise solids temp. from 298 deg K to 644 deg K

Specific Heat cal/o/mole
As₂O₃(g) 21.5
As₂O₃(s) 8.37 +0.04860T

Heat Content of Solid As₂O₃ Product 27815.95 cal/kg dust