



FALCONBRIDGE

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Mr. W.F. Drinkard, Jr.
President
THE APPLIED RESEARCH GROUP, INC.
Box 5471
CHARLOTTE, North Carolina
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Dear Bill:

Following our meetings in Charlotte we have reviewed your proposal to produce C.A. from Giant's crude. The steps involved in your proposal appear to be practical and we are optimistic that the concept could form the basis for a technically viable operation. However, there is much work to be done to furnish the necessary data for engineering and constructing a practical manufacturing facility.

In the interest of obtaining the necessary data we suggest the following steps:

Phase 1

- (a) Carry out small scale tests on the dissolution of As_2O_3 from crude dust in an ammoniated solution with the objectives of determining:
 - i) the time required for dissolving the available As_2O_3 and the impurity content of the pregnant solution.
 - ii) the settling characteristics of the residue.
 - iii) the filtration characteristics of the residue.
 - iv) the physical and chemical characteristics of the residue in preparation for subsequent treatment for gold recovery and disposal.

- (b) Carry out larger scale batch dissolution tests to prepare sufficient material for solid/liquid separation using manufacturers test equipment.
- (c) Carry out bench scale tests on copper dissolution/oxidation, arsenic oxidation and C.A. precipitation.

Phase 2

Upon completion Phase 1 larger scale tests or pilot plant testing should be contemplated to:

- (a) Resolve uncertainties with respect to scale up to commercial scale.
- (b) Produce C.A. in quantities for marketing studies.

The details of this phase will depend on the extent to which technical uncertainties in scaling up to production scale remain after completion of small scale tests and the need for quantities of C.A. for marketing studies.

Phase 3

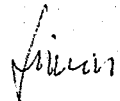
Update the feasibility study and recommend action for commercial implementation.

It is recommended that items (a) and (b) in Phase 1 be conducted by Giant using our own resources. Item (c) in Phase 1 should be undertaken by Applied Research. The suggested details of A.R.'s program is outlined in the Appendix.

I trust that the foregoing meets your approval, and look forward to any suggestions you may have regarding the test program. I suggest that once you have a few test results we discuss the interpretation and make changes if required.

Yours truly

FALCONBRIDGE LIMITED



S.O. Fekete
Chief Metallurgical Engineer

SOF:sc
attch.

cc: Mr. Hans Woerner, Director R & D
P.J.R., K.B., D.J.E., F.G.T.P.

APPENDIX

Bench Scale Test Program into the Production of Copper Arsenate from Ammonium Arsenite Solutions

The following tests should be carried out in the laboratory reaction kettle using materials approximating those expected in practice.

1. Equipment

Laboratory reaction kettle equipped with a heating mantle, thermometer to measure the liquid temperature, means of introducing oxygen and a manometer. The kettle in your possession may be sufficient. However, a larger, say 2 liter size may be more suitable to minimize the effect of liquid depletion as samples are withdrawn for analysis during the tests.

2. Copper Dissolution/Oxidation

Suggest the following procedure for this step.

- (a) Charge the kettle with appropriate volume of ammonium arsenite solution and add the copper chips.
- (b) Heat the contents to the desired temperature.
- (c) Introduce oxygen in quantities sufficient to maintain pressure slightly positive as indicated by the manometer.
- (d) Draw samples at 10 minute intervals and assay for Cu^+ , Cu^{2+} , As^{3+} , As^{5+} and NH_3 . Also observe if possible the time of disappearance of copper chips.
- (e) Record the temperature and the pressure at 5 to 10 minute intervals throughout the test.

It is recommended that these tests be run at least two temperatures and possibly at two levels of ammonia contents to see if they have any influence on the rate of dissolution/oxidation.

3. Arsenic Oxidation

These tests should be run with starting solutions containing the desired level of copper as cupric, arsenic trioxide, with appropriate ammonia content. The procedure is the same as for the copper dissolution/oxidation tests, except that determination of cuprous copper can be deleted from the assays.

There were indications that during this phase of the process the presence of C.A. crystals catalyzes the oxidation. It would be informative to attempt to run some tests while suppressing the formation of solid C.A. to see the extent to which this can be done and the quantitative effect on the rate of arsenite/arsenate oxidation.

4. Copper Arsenate Precipitation

These tests should be conducted on starting solutions containing the appropriate level of copper as cupric, arsenic in the pentavalent form and appropriate ammonia contents. There are two possibilities to induce C.A. precipitation: (1) drive off the ammonia by boiling, and (2) drive off ammonia by air sparging. Both methods should be attempted.

The suggested procedure is as follows:

- (a) Charge the kettle with the solution and heat to operating temperature.
- (b) Boil or sparge air, as the case may be, and sample at 10 minute intervals. The liquid portion of the sample should be assayed for copper, arsenic and ammonia.
- (c) Keep a record of the temperature throughout the test.

5. Cautionary Notes

The oxidation steps will be conducted with bottled oxygen, which contains small quantities of inerts. The inerts will tend to accumulate in the gas cap, since the kettle is gas tight (should be to the extent possible). Periodic opening of the kettle to draw samples will tend to vent the inerts. However, this may not be sufficient and an

accumulation of inerts could take place which in turn will slow down and/or stop oxidation. The rate of oxygen input should be regulated to maintain a slight positive pressure relative to atmospheric, say 2 or 3 inches of water. Pressure will tend to build up if the rate of oxygen input is too high relative to that taken up by the reactions or the reactions stops because of completion or inerts build up in the gas cap. Carrying out a couple of tests and checking the assays will give guidance as to whether or not the build up of inerts in the gas cap is a problem.

The copper dissolution/oxidation and the oxidation of As^{3+} to As^{5+} are exothermic. As far as one can tell from the literature the exothermic heat is on the order of 200 to 300 kJ per kg of C.A. This may make it difficult to maintain the temperature constant. If the temperature increases unduly the pressure in the vessel will go up and in fact may blow out the manometer. It is important to maintain reasonably constant temperature during the tests, as this is expected to have a significant effect on reaction kinetics.

It is also important to hold the ammonia content in the solution constant during the copper dissolution/oxidation and As^{3+} to As^{5+} oxidation.

The results obtained can be plotted as composition versus time which can be translated into reaction rates. In turn, these relations can be utilized to determine whether or not there are any potential scale up problems or guide the selection of process conditions and equipment for commercial scale.