

To: Gary Halverson

From: Larry Connell

Date: October 14, 1992

Subject: Bench Scale Testing of the SO₂/Air Effluent Treatment Process

The standard test employed by INCO to evaluate the SO₂/air effluent treatment process uses a laboratory one stage continuous set up (figure 1). They use a one liter vessel, set to overflow at 0.82 liters. The vessel is equipped with baffles and agitated with a mechanical agitator at a speed of 600 RPM.

The slurry feed is added to the vessel on a continuous basis using a peristaltic pump. The rate of feed addition is a function of desired retention time in the reactor vessel.

The pH of the slurry is measured continuously by a pH probe and meter. Lime is added by a titrator to maintain the pH in the reactor at the desired set point. A steady pH is critical to the effective oxidation of cyanide.

Air is added through a sparger to the reactor at a rate of 1 liter per minute. The rate of addition is controlled by a rotameter.

SO₂ is added to the reaction in the form of sodium metabisulphite (Na₂S₂O₅). Sodium Metabisulphite is dissolved in water at 200 grams/liter and added to the slurry from a reservoir at a controlled rate by a peristaltic pump. The rate of addition is calculated by measuring the concentration of CN_p in the feed slurry solution.

Zinc Sulphate (ZnSO₄) or Copper Sulphate (CuSO₄), which act as a catalyst for the oxidation of cyanide, is added to the reactor from a reservoir using a peristaltic pump. Cu²⁺ or Zn²⁺ additions are recommended when the Cu + Zn to Fe ratio in the feed slurry solution is below 2.5.

Two full reactor volumes are treated prior to taking any samples for evaluation. This ensures that the reaction is catalyzed and running at steady state before evaluation samples are taken. Feed and effluent samples are analyzed for CN_T , CN_{WAD} , Cu_T , Zn_T , Fe_T . It is important that the samples be analyzed shortly after they are taken or chemically preserved to obtain accurate cyanide readings. Tests campaigns are run to evaluate the effects of:

pH in the reactor

Retention Time

SO_2 Dosage

Cu^{2+} Additions

Zn^{2+} Additions

Based on other gold operations a recommended starting point would be as follows:

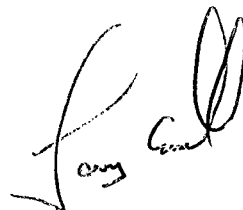
pH 8.5

Retention Time 60 minutes

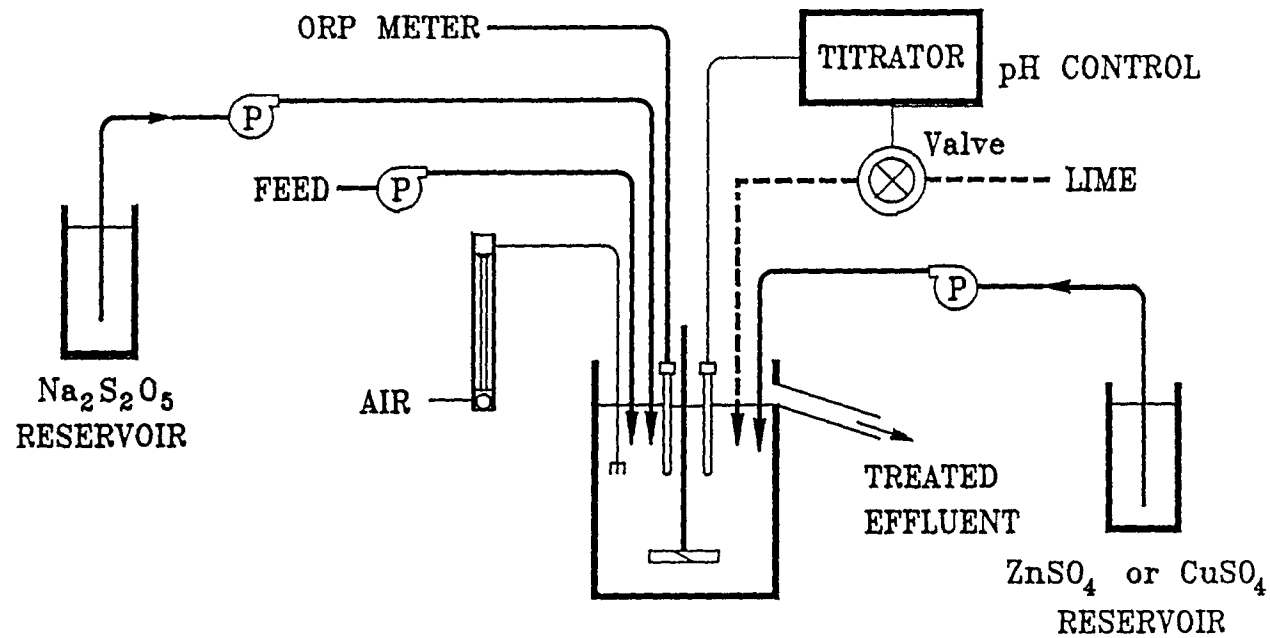
SO_2 Dosage 4 g SO_2 per g CN_p in feed

Once the optimum operating parameters have been established, samples of the treated effluent should be left to "age" for 24 hours and then resampled. Experience indicates that further reductions in the metals often takes place after the initial cyanide oxidation reaction step. A copy of the standard picric cyanide analytical method is attached. It is used as a relatively fast technique for measuring weak acid cyanide in the slurry feed to the SO_2 /Air process. This concentration of CN_p is then used to calculate the required dosage of SO_2 in the form of sodium metabisulphite.

We could set up a similar test apparatus at Giant using a laboratory flotation cell as the reactor tank.

A handwritten signature in cursive script, appearing to read 'Fong' followed by a large, stylized flourish.

LABORATORY ONE STAGE CONTINUOUS SET-UP



(P) Pump



Flowmeter

Precision is listed as linear, expressed as $0.085 \times \text{cyanide concentration} + 0.0032$ for reagent water. Conn (1981) reported a 7.5 percent relative standard deviation at the 0.08 mg/l as CN level.

2.3.5 Picric Acid Method for Wad Cyanide

The picric acid colourimetric method for wad cyanide is included in this section as it has been shown to be a relatively reliable and accurate procedure down to about 0.5 mg/l cyanide in solution. The method involves developing colour with picric acid in the presence of nickel followed by heating over a water bath for 20 minutes prior to measurement using a visible range spectrophotometer.

As an example of the use of the picric acid method for wad cyanide, Brohm Mining Corporation located near Lead, South Dakota (USA), evaluated the applicability of the picric acid to solution from their heap leach pads. The data were developed in a study designed for the State of South Dakota to investigate the chemistry of cyanide in leach pads (ASCI/SRK, 1990). The data in Table 2.7 show that there is generally little difference between wad cyanide values determined by the picric acid and the ASTM Method C wad cyanide analytical protocols for these solutions. This is consistent with previous experience which has indicated that the picric acid procedure is a reliable analytical method, capable of providing quantitative evaluations of wad cyanide down to 0.50 mg/l. The method is not as rigorous as the standard distillation/colourimetric procedures but can be set up more conveniently and less expensively in a mine laboratory. It can provide a good method for use in estimating the wad cyanide concentrations during a field pilot plant evaluation. Prior to implementing the picric acid method for compliance purposes, its accuracy and reproducibility should be confirmed independently on a site specific basis using an outside commercial laboratory.

Quantification below 0.50 mg/l down into the range of 0.10-0.20 mg/l is possible with certain samples. It was also found in the study that filtration of the samples prior to analysis provided accurate comparisons of wad cyanide values below 0.20 mg/l using either the picric acid or standard methods.

Another rapid field method for the estimation of wad forms of cyanide has been developed by DeVries and Mathre (1984). This method does not involve heating of the sample using either a silver nitrate titration or ion selective electrode finish for cyanide quantification. Currently, the method is being evaluated and compared with the picric acid and wad cyanide methods at Brohm Mining (Damon, 1991).

TABLE 2.7

Sample Date	Samp
11 Apr 90	Barren Solu
11 Apr 90	Cell #5 Effl
11 Apr 90	Column D I
11 Apr 90	Column C I
11 Apr 90	Column B I
31 May 90	Column A
31 May 90	Column B I
31 May 90	Column C I
31 May 90	Column D
31 May 90	Cell #5 Effl
28 Jun 90	Column B
28 Jun 90	Column C
28 Jun 90	Column D
28 Jun 90	Cell #5 Effl
28 Jun 90	Neutralizat

Notes:

- (1) April data: leach cycl
- (2) May/June data: rinse

**TABLE 2.7 Comparison of Leach and Rinse Effluent
Wad Cyanide Analyses**

Sample Date	Sample I.D.	Picric Acid wad Cyanide (mg/l)	ASTM Method C wad Cyanide (mg/l)
11 Apr 90	Barren Solution	220	224
11 Apr 90	Cell #5 Effluent	193	199
11 Apr 90	Column D Effluent	169	170
11 Apr 90	Column C Effluent	172	171
11 Apr 90	Column B Effluent	177	173
31 May 90	Column A Effluent	11.8	11.7
31 May 90	Column B Effluent	11.2	11.2
31 May 90	Column C Effluent	11.5	11.3
31 May 90	Column D Effluent	12.4	12.2
31 May 90	Cell #5 Effluent	16.5	16.5
28 Jun 90	Column B Effluent	0.25	0.17
28 Jun 90	Column C Effluent	0.11	0.07
28 Jun 90	Column D Effluent	0.21	0.13
28 Jun 90	Cell #5 Effluent	2.7	2.8
28 Jun 90	Neutralization Pond Effluent	0.13	0.11

Source: ASCI/SRK, 1990

Notes:

- (1) April data: leach cycle.
- (2) May/June data: rinse cycle.

To: L. Connell
 From: G. Halverson
 Feb 6/93.

Things to check out:

- item cost checklist
- power? mill/top
- lines - size / flows / balance feed / o/f - u/f.
- pumps - size / availability
- process chemistry - check out
- compressors - size / availability
- drives - tank / size / availability
- tanks - size / location / bridge
- tank in mill to dist. to Quast / W6 / Creek & pump.
- reagent system - sizing / location - Cu / CaO / SO₂ / Fe
- manpower operation
- instrumentation
- filter for SO₂ / SO₂ line
- Thickener Insulate - Cover - Heat for winter + better access to it.

- bypass sys. for SO₂ / Power outage / Thickener Bypass
- ETP operation approx amount
- Tail Dam / Pond operating scenarios.
- Operate with all lines inside pond
 new pond access to TRP along pond.
 new lines by ETP to NW Pond & NPond to bench.

