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Flowmeter validation for metallurgical balance in Minera Michilla, using radiotracers

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MICHILLA
ANTOFAGASTA MINERALS

INTRODUCCIÓN

Michilla (MIC) is located in the Second Region, 110 km northeast of Antofagasta, north of the Chilean dessert, in the south of the world.

It belongs to the Antofagasta Minerals' group.

MIC is divided in two leaching plants, one for oxides and the other for sulphides.

The oxides are leached using seawater and sulfuric acid, while for the sulfides it is used the Cuprochlor process.

PROCESS BALANCE

The mass balances are of a great importance in a mining labor, to know the flow of the solutions in the processes of obtaining copper allows improving and optimizing the production processes.

Wich way can I measure a flow through a pipe?

RADIOTRACER

The method is denominated radioactive tracer and consists in that the radiation is physically inserted in the flow to determine by the addition of a measured amount of the tracer. The I-131 emits radiation γ which is detectable trough the walls allowing it's measured online, that radiation decreases in time, reason why radioisotopes are used with intensities useful in relation to the test period.

NORMA

"International Standard ISO 2975/VII – 1977 (E)"

Measurement of Water Flow in Closed Conduits - Tracer Methods-Part VII : Transit time method using radioactive tracers.

First edition – 1977-12-01

METHODOLOGY

Flow rate speed on pipes

Flow rate measurement by the transit time method is based on measuring the transit time of labeled fluid particles between two cross-sections of the pipe at a known distance. Labeling of the fluid particles is achieved by injecting a tracer into the flow upstream, then, the transit time is determined from the difference of the mean arrival times of the tracer at each of the detector positions located at two different cross-sections of the pipe, were the detectors are installed.

PIPES FLOW RATE SPEED ANALYZED

The following facilities where the solutions are transported by pipes by positive pressure were analyzed:

Rich solutions 1, 2 and 3

Refine solutions 1, 2 and 3

ILS solutions 1, 2 and 3

Organic solutions 1 and 2

CONSIDERATION FOR MEASURING

Tracer Selection

Tracer Quantity

Tracer Injection

Tracer Detection

TRACER SELECTION

Physicochemical behavior.

Halftime life of the radioisotope.

Type and energy of the radioisotope radiation.

Due to the excellent dissolution in water I-131 is used as radiotracer.

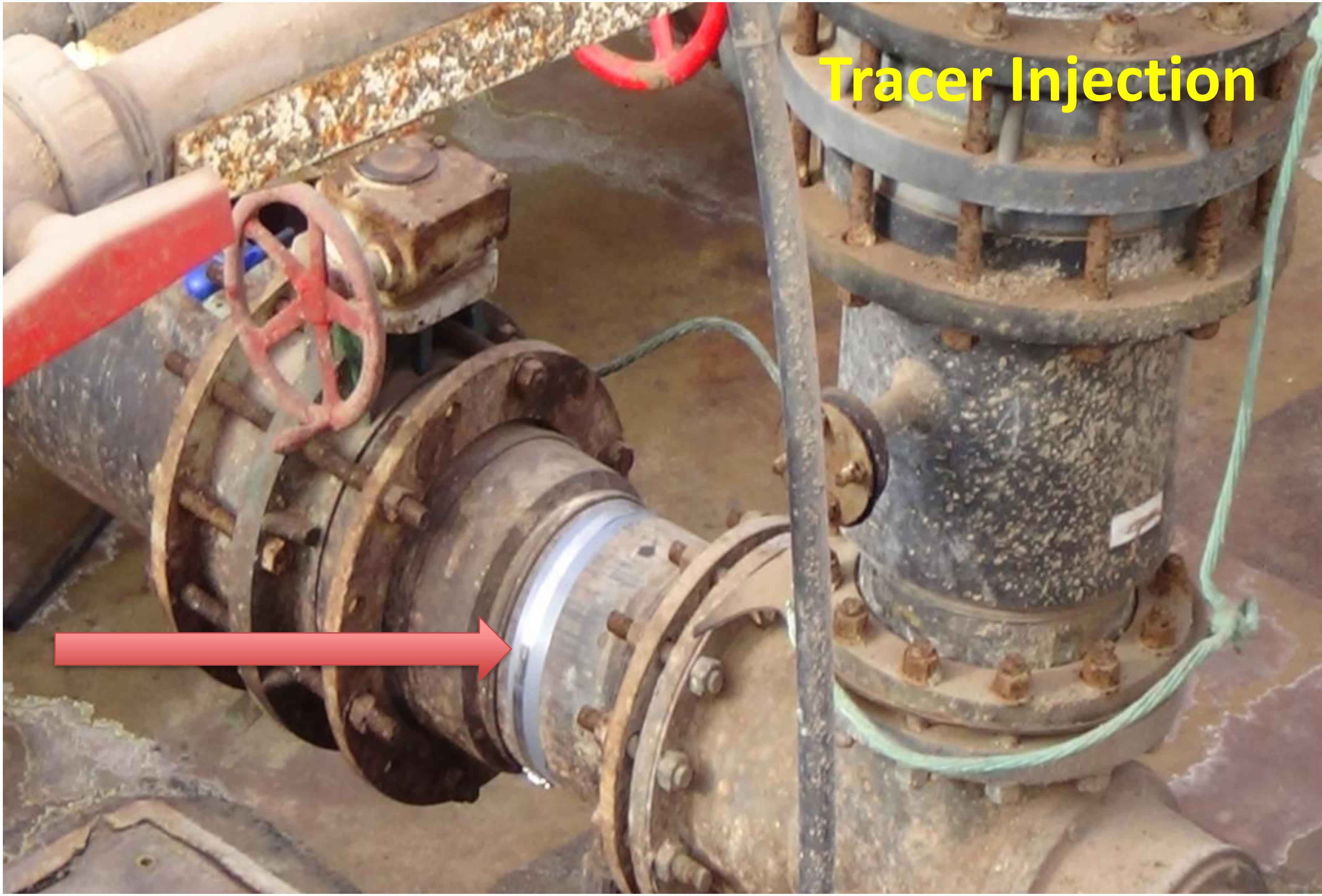
TRACER QUANTITY

Longer experience.

Flow in which the tracer is injected.

Geometry of measure.

With the previous considerations amounts of 5 mCi of I-131 are enough to obtain count rates appropriate.


Tracer Injection


Data Acquisition System
Detectors
ATENCION
LINEA CON
ACIDO SULFURICO
TRAZADO NUCLEAR

Mobile Laboratory

RESULTS

The data acquired through radiation intensity are corrected by radioactive decay and by natural radiation background.

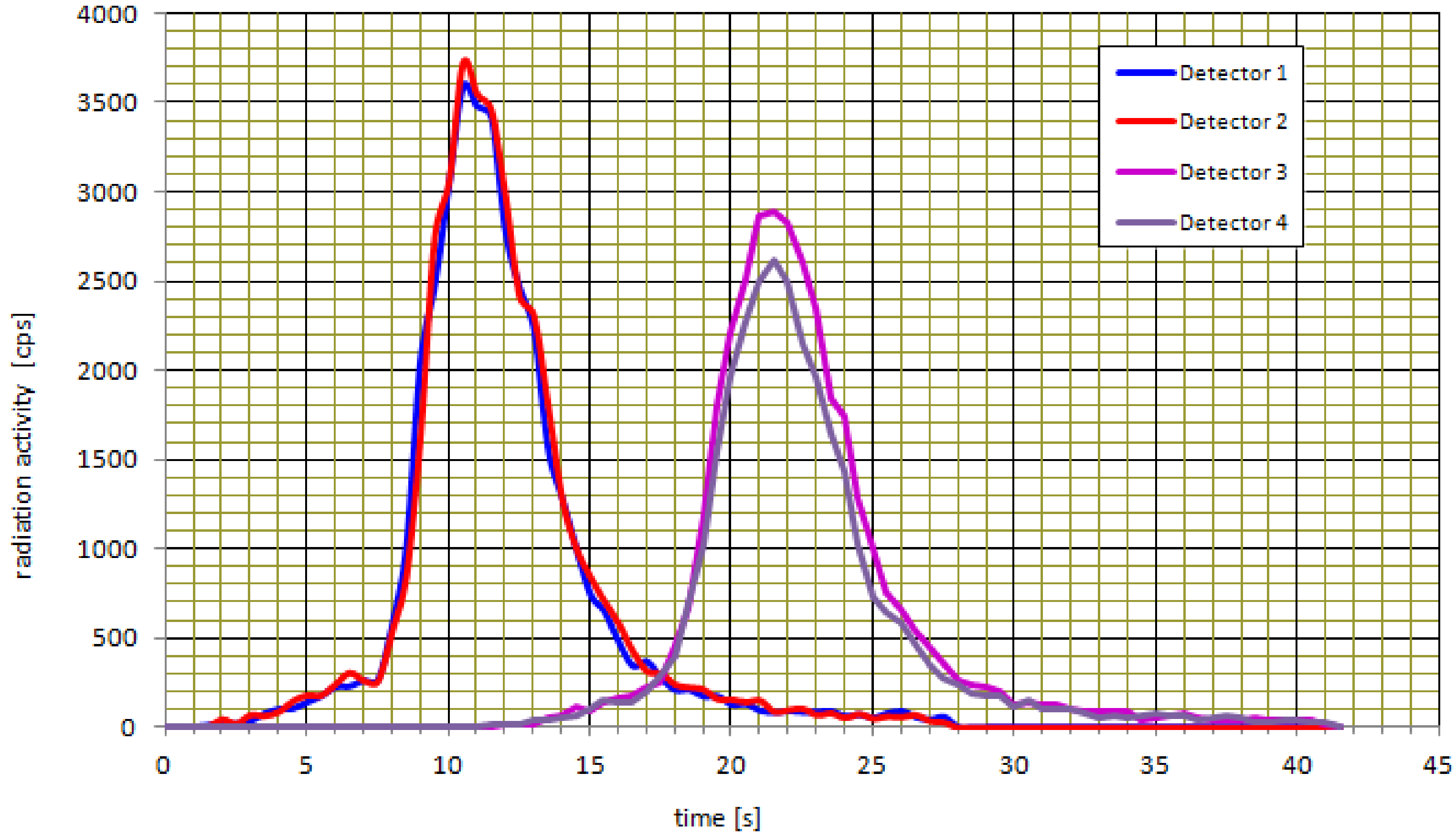
$$A_{cor} = (A_{med} - BG) * e^{\left(0.693 * t / t_{1/2}\right)}$$

To get the flow rate speed it is necessary to obtain the experimental half residence time of each "Residence Time Distribution Curve", applying the moment's method, as follows:

$$t_{exp} = \frac{\int_0^{\infty} t * A_{cor}(t)dt}{\int_0^{\infty} A_{cor}(t)dt}$$

DETECTION GRAPHICAL

As an example, we see the measurements of transit time in the pumping station rich solution 1.



Average flow rate speeds in pumping solution refine 1

Speeds and transit times in solution refine 1 sulphides

Exp.	Time [s]	Distance between detectors [m]	Speed flow rate [m/s]
1	13,43 ± 0,07	17,37	1,29 ± 0,01
2	13,53 ± 0,06	17,37	1,28 ± 0,01
3	13,54 ± 0,06	17,37	1,28 ± 0,01
4	13,60 ± 0,05	17,37	1,28 ± 0,01
5	13,57 ± 0,05	17,37	1,28 ± 0,01

Average flow rate in solution transporting lines

With the internal diameters of each pipes and the flow rate speeds measured, it is obtained the flow of solutions transported.

Comparing the data obtained through the flowmeters online and those obtained by the radioactive tracer technique, corrections and calibrations of the instrumentation can be done.

SUMMARY RESULTS

Solutions	Internal Diameter [m]	Average Speed [m/s]	Flow rate measured with tracers [lts/min]	Flow rate in flowmeters [lts/min]	Difference between flows [%]
Rich 1 Sulphides	0,327	1,53	7.710	8.145	-5,65
Rich 2 Oxides	0,397	1,59	11.785	10.520	10,74
Rich 3 Ripios	0,353	1,42	8.319	8.581	-3,14
Refino 1 Sulphides	0,384	1,282	8.899	8.123	8,72
Refino 2 Oxides	0,441	1,36	12.441	11.708	5,89
Refino 3 Ripios	0,397	1,24	9.191	9.392	-2,19
ILS 1 Sulphides	0,409	1,52	11.994	12.394	-3,34
ILS 2 Oxides	0,555	1,04	15.107	14.865	1,60
ILS 3 Ripios	0,555	0,582	8.454	7.917	6,35
Organic SX-1	0,290	2,30	9.115	9.802	-7,53
Organic SX-2	0,313	2,52	11.619	13.680	-17,74

CONCLUSIONS

Differences lower than 5% regarding the flow rate measured through radiotracers and the information given by the flowmeters online are found in the transporting lines of solutions rich 3, refine 3, ILS 1 and ILS. 2.

Differences between the 5 and 10% are obtained in the solutions rich 1, rich 2, refine 1, refine 2 and ILS 3. Difference in the order of the 8%, being higher the flow indicated in the flowmeter, is obtained in the solution Organic SX-1.

The biggest difference is found in the solution Organic SX-2, with a value of the order of 18% being higher the value indicated in the flowmeter.

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