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BENEFITS OF THE UTILIZATION OF CLEANING LIQUOR IN RED SIDE OF CVG-BAUXILUM

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Abstract

CVG-Bauxilum, in trying to reduce the maintenance costs and the cleaning time of equipment, has made changes to the original cleaning system with the purpose of obtaining a more versatile chemical cleaning system with caustic liquor to pipes and equipment with incrustations. The revised system has the possibility of making at least ten individuals circuits. The present work approaches mainly three topics:

1. Comparison of costs between manual cleaning, cleaning with high pressure water and cleaning pipes with caustic liquor;
2. Main circuits used to guarantee scale removal, higher levels of production and current reliability of equipment;
3. Previous analysis made in the laboratory to optimize and to guarantee results.

The exact knowledge of the characteristics of material to remove, the magnitude of the incrustations in each one of the cases and the appropriate conditions of liquor for the effective accomplishment of the removal constitute essentially the beginning of this work.

Introduction

CVG-Bauxilum utilizes the Bayer Process to produce alumina from bauxite. Because of the recycling liquor in this process, some compounds (Si, Al, P) become supersaturated and are slowly precipitating inside the pipes and on the plant equipment.

After the beginning of CVG-Bauxilum operations in 1983, scale formation was observed in diverse sections of pipe around the plant which hindered the flow of liquor. During general plant shutdowns, there have been opportunities to observe, sample and analyze scale samples.

The varying levels of alumina and silica contained in those samples, makes it difficult to choose the most efficient and least costly cleaning method. Chemical cleaning without disassembling of the equipment, however, would be a much more convenient solution to the problem then the traditional mechanical cleaning.

At the start of the plant, two tanks of 80 m^3 volumes were used for preparing and dosing petroleum coke to the Kelly filters as a filtration aid. This function has since been discarded when it was shown that there was very little benefit in the operation of the filtration area.

One of these tanks has now been re-conditioned to work as a storage and distribution tank for cleaning liquor. This tank presented all the conditions required for the operation - sufficient capacity, addition of steam, mechanical agitation and good structural condition. All that was needed was piping and pumps to connect to the cleaning liquor system previously constructed.

Objective

The present paper has the following three objectives:

1. Comparison of three methods used for cleaning of equipment with incrustations.
2. Analysis and interpretation of the results obtained in the laboratory.
3. Introducing the system used for the accomplishment of chemical cleaning of pipes and equipment.

Comparison Of Cleaning Methods

Three methods had been and continue being used in CVG-Bauxilum to descale equipment:

1. High pressure water cleaning, HPWC.
2. Mechanical Cleaning, MC.
3. Chemical Cleaning with cleaning liquor, LC.

Each of these methods has the same objective, but is quite different in their efficiency to do the work. Another difference is that in the first two cases the company must contract the personnel for the accomplishment of the job, but in the third case, all of the cleaning operations are done by company personnel.

A comparison of the costs of the pipe cleaning methods is shown in Table I below.

Table I. Cost Relation Among
The Cleaning Processes

	High Pressure Water Cleaning	Mechanical Cleaning	Chemical Cleaning
High Pressure Water Cleaning	--	3.5:1	20:1
Mechanical Cleaning	1:3.5	--	16.5:1
Chemical Cleaning	1:20	1:16.5	--

A relative comparison of the more important items that contribute to cleaning costs is shown in Table II below.

Table II. Cost Associations

	High Pressure Water Cleaning	Mechanical Cleaning	Chemical Cleaning
Use Of Steam	--	--	Low
Use Of Caustic	--	--	Low
CVG-Bauxilum Workers	--	--	Low
Contract Workers	Medium	High	--
Hiring Time	High	High	--
Disassembling Of Equipment	High	High	--
Cost Associated With The Equipment Out Of Service	Medium	High	Low

The majority of the circuits used in CVG-Bauxilum are with cleaned with cleaning liquor for two important reasons:

1. The scales are Gibbsite alumina mainly.
2. The cleaning liquor is re-used in the process after the cleaning

The circuits with acid cleaning are specifically used in a couple of cases, in heat exchangers and in Kelly filters. In this paper these methods are not mentioned.
The methods used for cleaning pipes are shown in the Figure 1 below:

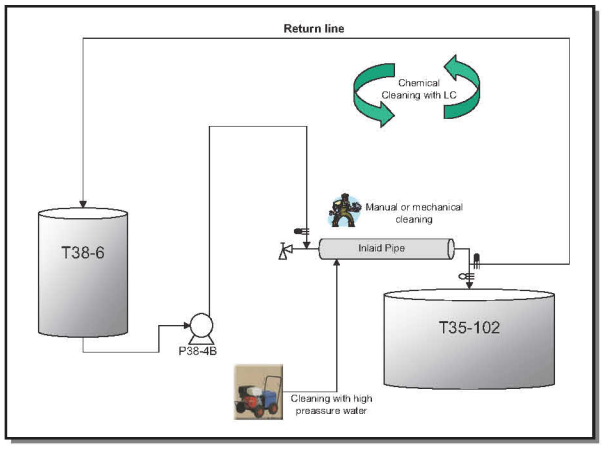

Figure 1. Typical Cleaning Circuit

The comparative advantages of each option are the following:

Table III. Advantages And Disadvantages Of The Three Options

	Advantages	Disadvantages
High Pressure Water Cleaning	• Lower damage to equipment. • Final cleaning 100% • Elimination of very hard scale	• Need to disassemble each section of the pipe. • High consumption of water during the process. • Amount of space needed for the equipment. • Specialized workers are required. • Longer cleaning times required according to the length of the pipe.
Mechanical Cleaning	• Final cleaning 100% • Old equipment used	• Need to disassemble each section of the pipe. • Isolation must be by removal of each pipe section. • Damage to the pipe by the constant hitting. • Longer cleaning times required according to the length of the pipe.
Chemical Cleaning	• Pipe disassembling is not needed. • Insulation removal is not necessary. • Low cost operation. • The equipment is out of service for a short period of time. • Results almost Immediate	• Final cleaning may not be 100%

The factors of greater weight in the above comparisons that definitively favor chemical cleaning are the following:

1. The only raw material that is not reused is the steam necessary for the heating of the liquor.
2. Disassembly of pipe sections is not necessary to do the cleaning.
3. It's not necessary to disassembling the heat insulation to carry out the maintenance of the circuit.
4. The time required to carry out cleaning is an average of 24 hours.
5. The small interference that occurs in this practice does not have a major impact on the daily operations of the plant.
6. It is possible to carry out cleaning of long lengths of pipe in a single circuit.
7. The flexibility of being able to clean more than five (5) circuits per week without need to transfer equipment or use excessive personnel to do the work.

The number of interventions for manual cleaning and cleaning by high pressure has been reduced year to year, as a result of utilizing more chemical cleaning. These trends are shown in the Figure 2 below. These interventions are associated solely with pipe cleaning in the Desanding, Thickener, Washer and Kelly Filter areas of the plant.

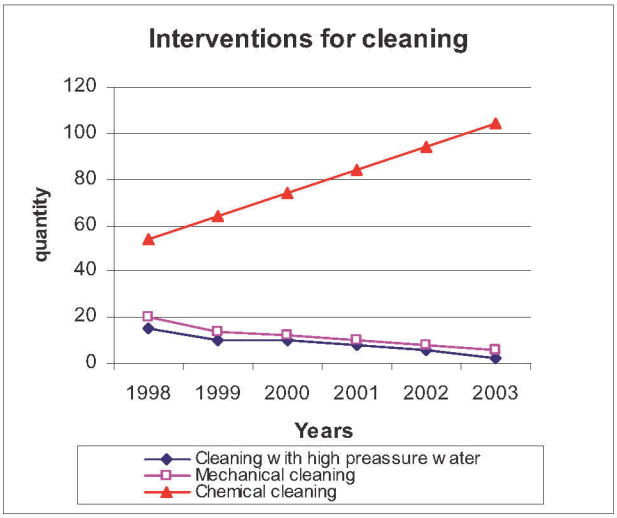

Figure 2. Cleaning Interventions Per Year

Laboratory Tests

The laboratory tests on three collected scale samples are reported in Table IV below. These samples were obtained from thickener, washer and Kelly filter pipe sections on three different dates

Table IV. Chemical Composition

	Sample A %	Sample B %	Sample C %
Al_2O_3	76.9	89.2	70.7
CaO	4.6	0.8	1.5
Fe_2O_3	2.0	1.3	1.5
Na_2O	3.2	0.4	0.4
SiO_2	1.0	0.6	1.2
TiO_2	<0.2	<0.4	<0.5

Mineralogical analysis and technical considerations:

1. According to the results of x-ray diffraction, these scale samples are majority Gibbsite (70.7%), with 1,5% of Hematite and 1,2% of Quartz.
2. With scale containing 70% of the phase Gibbsite alumina, it is recommended to use caustic liquor for dissolution.
3. For tests at lower holding times - 2, 4 and 8 hours, the amount of dissolution was 11, 14 and 21% respectively
4. Tests showed that 42%, of the scale was dissolved using a caustic liquor with high Na_2O concentration and high RMC for 24 hours at high temperatures. RMC is a relation between caustic concentration and alumina concentration by the following equation:

$$RMC = 1.645\frac{[Na_2O]}{[Al_2O_3]}$$

Caustic Cleaning Circuits

The main caustic cleaning circuits available in the Red Side of CVG-Bauxilum are the following:

1. Cleaning Circuit of weak liquor lines LCD
2. Cleaning Circuit of Thickeners overflow lines
3. Cleaning Circuit of Thickeners underflow lines
4. Cleaning Circuit of Thickeners feed lines

Tanks Used For Chemical Cleaning

T38-6

The tank that has now been placed in service as a receiver of the cleaning liquor is the T38-6 with a nominal capacity of 80 m^3. The proximity of the existing 10 inch distribution lines of cleaning liquor was beneficial and required only short sections of pipe of less than 6 meters, as well as valves, flanges and blinds to isolate the system. Originally the plant had a network of supply and return piping for LC which was extended in strategically important points to include additional circuits

The T38-6 is now equipped to receive process condensate, fresh caustic and steam. Specific instructions have been prepared to make the exact LC mixture suggested.

This tank was prepared to carry out the cleaning of a washer tank by making the following connections:

1. Connection of the discharge line of the pumps with the original T38-8 connection
2. Connection with the return line of LC that was originally directed to T38-8
3. Additional connections in area 35 to establish the additional circuits described here

The original connection of cleaning the washer tanks with the T38-8 caustic cleaning tank was inconvenient because this tank was needed for the frequent chemical cleaning of the Kelly filters. To fulfill the goal of chemically cleaning each filter every three (3) cycles, requires around nine (9) LC washings per day for a period of three hours each (18 effective hours of tank occupation).

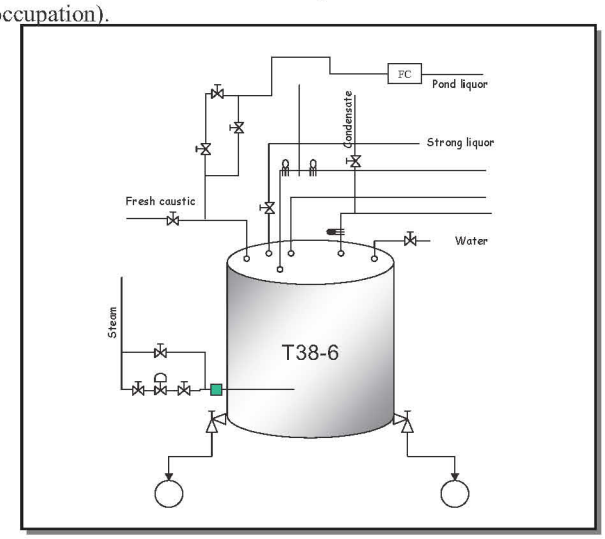

Figure 3. Additional Tank Being Utilized For Cleaning Liquor

T38-23
This tank, not contemplated in the original design of CVG-Bauxilum, is available for the immersion of small and medium sized equipment parts within a bath of LC. The tank is equipped with re-circulation and steam heating.

In order to clean valves, pumps and other small pieces of equipment, the ideal procedure is to totally immerse the equipment for approximately 24 hours in the caustic cleaning solution.

Figure 4. Equipment Caustic Cleaning Tank

Future Projects

Based on the excellent results obtained to date with the implemented chemical cleaning, there are two projects being studied.

1. Chemical cleaning of thickener tanks, including internal lines to reduce the costs of manual cleaning and to reduce the maintenances times of these tanks
2. Recovery and return to the process of the alumina dissolved out of the scale.

New Circuits Used In The White Side

Recently, with piping and equipment additions, the white side of plant has also been added to the chemical cleaning circuits. Two of the most important areas now being cleaned are:

1. Chemical cleaning of scale in the headers on the vacuum pumps in areas 55 and 58. With this operation it is possible to clean 750 mm and 400 mm pipes that are up to 70% blocked by scale. The current blockage of air flow forces the plant to operate three vacuum pumps instead of two.
2. Cleaning of the vacuum system of the pan filters in area 44 with cleaning liquor to recover the suction capacity and to eliminate the scale and hydrate accumulations that form during the operation of the equipment.

Conclusions

1. According to the results of the x-ray diffraction, the scale samples tested are composed are mainly gibbsite, hematite and quartz.
2. Because gibbsite alumina is the greater percentage in the samples, caustic liquor is needed for the dissolution.
3. In a dissolution time of 24 hours with a liquor of a high caustic concentration and high RMC, the laboratory tests showed 42 % dissolution of the samples.
4. The chemical cleaning of pipes and equipment adopted by CVG-Bauxilum has meant a significant saving in the recovery of the equipment and lowered costs up to 20 times.
5. It has not been necessary to disassemble pipes with the chemical cleaning and thus the equipment can be returned to operation quickly.
6. In inspections made after caustic cleaning, it was observed that those lines that received periodic cleaning were kept free of heavy scale.
7. The good results obtained have generated the possibility of using this system of cleaning in larger areas of the plant.

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