System Optimization of Blast Furnace Gas Washing with PARETO™ Mixing Technology

NALCO
An Ecolab Company

CASE STUDY - PRIMARY METALS

CH-1349

BACKGROUND

Most countries have blast furnaces using coke as fuel. Due to Brazil's climate, where the Eucalyptus has a growth rate much faster than in other countries, the usage of charcoal produced from this type of tree is common. In 2008 about 30% of pig iron produced in Brazil came from charcoal blast furnaces.

The environmental advantage of a charcoal blast furnace is obvious, as charcoal is produced from reforestation and has much less sulfur than coke.

As the charcoal passes through a carbonization process and not coking, the volatile content is much larger, which generates a higher content of this compound in the gas washing system water and a higher tendency to foam generation.

Foam has several deleterious effects in the process:

- Impairs the suspended solid removal in the thickener;
- Holds CO inside, and when it bursts, it releases the gas in the area, with health risks;
- Harms the process control by interfering with the instruments reading.

Foam control is critical to the best performance of a system, environment improvement and financial health of the chemical conditioning.

The production of pig iron, iron with approximate carbon content from 3% to 4.5% is made in blast furnaces. In such equipment the iron source, which may be iron ore, sinter or pellet; a carbon source, which can be coke or charcoal and fluxes, are introduced. Air-heated at temperatures above 1832°F is insufflated through tuyeres located in the bottom of the furnaces.

Such insufflated air reacts with the carbon and iron sources, and the gaseous stream output leaves through the furnace top and is submitted into a gas washing system for the removal

Customer Impact	eROI℠	Economic Results
Reduction of 30% on antifoam consumption	ASSETS	Reduced raw materials consumption generated savings of US$ 72,000/year

eROI is our exponential value: the combined outcomes of improved performance, operational efficiency and sustainable impact delivered through our services and programs.

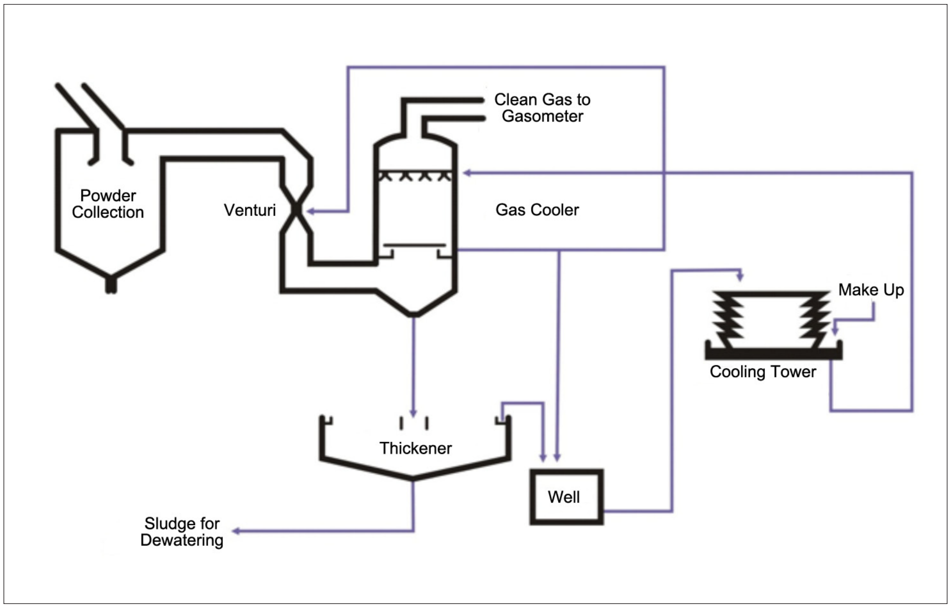

Figure 1 – *General Diagram of Washing System of Blast Furnaces Gas*

of the particulate material. As this gas is rich in CO (20 to 25%), after the particulate material removal, it is used as energy source at mills.

Gas washing is done through venturi or by equipment called *Bischoff*, where water is sprayed in the gaseous stream to remove particulate. Such water goes to thickeners where the particulate is removed and then is returned to the process.

A general diagram of gas washing process is shown in Figure 1:

The Foam

To generate the foam, three constituents are required:

- Liquid;
- Gas;
- Contaminant – stabilizing agent.

If one of these constituents is removed, the foam is not formed.

Among the parameters that influence foaming are:

- Suspended solids: act like a nucleus, necessary to start foaming;
- Air inlet: mechanical inlet of air may cause foaming;
- Microbiological activity: creates both nucleus needed to foaming and generates gases;
- Viscosity: the higher the viscosity, the greater the foam stability.

Chemicals are often used to control the foam. Some chemicals act to prevent foaming and others to disestablish the formed foam. Those products are called antifoam.

SITUATION

In a Brazilian steel mill the blast furnaces use charcoal as fuel. The arrangement of the gas washing system makes the recirculated washing water to contain high levels of dissolved organics. Because of that, there is a high generation of mayonnaise-like foam.

Such foam generates the problems mentioned previously, and it requires large amounts of antifoam to control these issues, making conditioning costs high.

Recirculation water has, to greater or lesser degrees, several factors that stabilize foam: suspended solid, aeration in several parts of the process, and high viscosity of water due to the contaminants nature, etc.

In certain conditions, foam formation may be increased, causing it to pour out of the feeding spout of the thickener, spreading through the area, and jeopardizing area safety due to the risk of being hit by the foam and slippage.

When the foam bursts, CO is also released, contributing to the increase of occupational health risk in the area.

Foam is controlled using an antifoam fed into several points of the system. The main point is the *Bischoff* outlet, or equipment used for gases cleaning. Antifoam consumption was very high.

Through June 2011, the Blast Furnace II operated with coke and the Blast Furnace I operated with charcoal. After this date, both Blast Furnaces started to operate with charcoal, which increased the potential of foam and fines generation. This event also complicated the operation of the Water Treatment Station of Reduction.

Figure 2 – *PARETO Mixing Technology*

SOLUTION

In order to minimize the negative effects from foaming, the Nalco team developed an action plan, covering the following:

- Alteration of the feeding points of the antifoam;
- Installation of PARETO Mixing Technology for optimizing the antifoam feeding;
- Replacement of the antifoam for other of better performance;
- Better operating control to reduce suspended solid content.

PARETO Mixing Technology

PARETO is a patented Nalco technology that optimizes chemical addition into the process streams. The PARETO solution ensures that the mixture is done homogeneously, which results in:

- Stability in the process;
- Reduction of chemicals consumption;
- Reduction of energy and water demand;
- Potential of improvement for finished product.

PARETO Mixing Technology was installed to reduce chemical consumption and improve performance. The point chosen was the *Bischoff* outlet.

RESULTS

The optimization process of the Gas Washing Plant is still in execution; however it is possible to quantify gains regarding the antifoam consumption and process stability.

The antifoam reduction was 30% with a slight increase of quality in relation to the previous condition. Figure 3 shows the antifoam consumption.

After the 65th day of tests, around 1 month after PARETO Mixing Technology installation, the procedures for plant shutdown were started for scheduled maintenance.

After the scheduled maintenance, with few process changes, the performance of foam reduction started to fall again. Preliminary analysis indicated that pH reduction occurred in the system.

However, interruptions done at the PARETO Mixing Technology operation showed an increase in the antifoam consumption between 20 and 30%, confirming the excellent performance of the equipment.

Needed Adjustments

Other changes are also planned, including:

- Polymers feeding optimization;
- pH control of the recirculation water;
- Alteration of the suspended solid

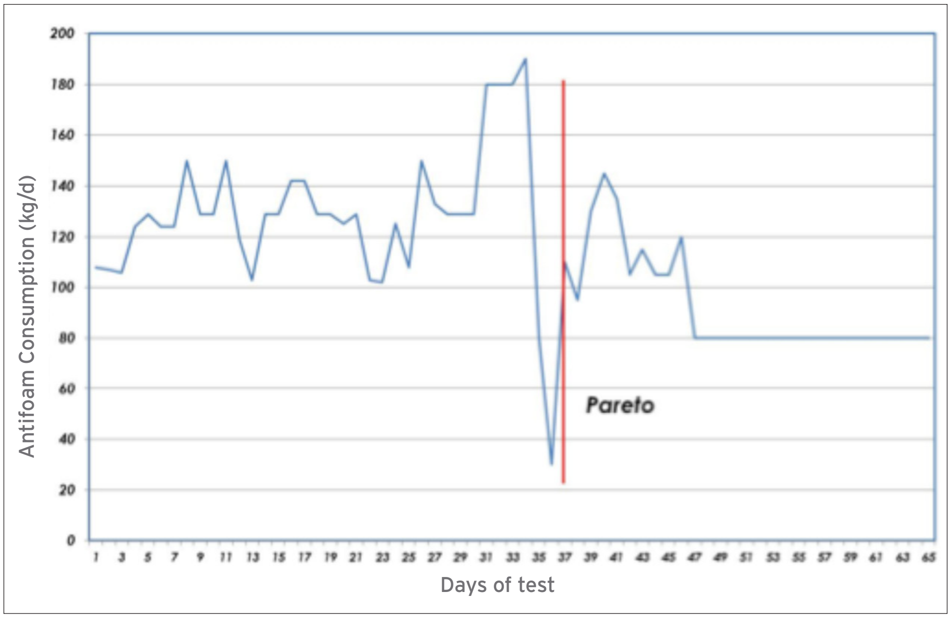

Figure 3 – *Antifoam Consumption Before and After PARETO Mixing Technology*

specification in the thickener outlet from 80 to 30 ppm;

- Effluent treatment system to make possible the blowdown in the system;
- Optimization of the thickener control.

These adjustments are already in progress and when completed shall put the station within the expected results at a lower cost.

CONCLUSION

The gains obtained with PARETO Mixing Technology installation were:

- Lesser tendency to foam overflow in the thickener outlet;
- Without PARETO Mixing Technology, the foam generation after fuel exchange of the Blast Furnace II could be out of control and/ or with an expressive increase of cost;
- Reduction of antifoam consumption.

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