Effect of Damper Suction on Anode Spike and AnodeBurn off in Aluminium Electrochemical Cell (Case Study: South Hormoz Co)

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Abstract: Nowadays, dry scrubber is very important in Hall–Héroult aluminum reduction technology, and despite the environmental impact and lower consumption of aluminum fluoride, the duct fan suction also affects on the pot performance and improves the surface temperature of the pot and increases production.

During the production of 1 Kg aluminum, more than 1.2 kilograms of used material are converted to gas. Carbon dioxide and carbon monoxide are removed from the interior of the pot by means of the damper suction; and the anodes, which have high reactivity with carbon dioxide and air, lead to the pot blackness.

Therefore, in the case of failure of the damper, the exiting of gas will be faced with problem and will lead to a series of events, which are discussed in this paper.

At first, the output gas was measured using the pivot tube and then, the static pressure behind the damper was measured and its relationship with the number of spikes and burn off was studied apertures. Moreover, the quantity of dust output from main chimney of the dry purification system, and its effect on burn off and spike were studied.

In this research, information were categorized and analyzed using Pivot tables in Excel software and data was compared with the data analysis tool in the Excel program and its correlation with other parameters and pot events was studied. The main reason of the spike is the free carbon inside the butt and the blackness. With the continuity of the blackness in the butt, this excess carbon is bound to the anode end, especially the end of cold anodes, and it intensifies the flow passing through the anode and accelerates the destruction process of the anode. The purpose of this study is to reduce production costs.

Keywords: “FTP,Anode burnoff, anode spike, aluminium smlter”

Introduction

South Hormoz Co. was established in 1990 in Bandar Abbas,(Metal Industry Special Zone) with the aim of a total production of 330,000 MT per year.(in 3 phases) The First phase development was planned in two parts (with each part comprising 120 cells), in order to produce 110,000 MT on the basis of domestic resources and Iranian experts as well as cooperation of foreign manufacturers.

Phase 1 was initially commissioned with 6 pots in 1997, with a gradual increase up to 120 pots by 2002, at which point the production capacity reached 55,000 MT per year. The second part of phase 1 commenced in 2003 and completed in 2005, with a further 120 pots, achieving the desired 110,000 MT capacity.

In 2006, executive operations started for Phase 2 (Hormozal), with a primary investment of EU 400 million and 2000 milliard Rls with the target to commission an additionally 228 pots. Phase 2 was completed significantly ahead of schedule, in just 40 months. A further development was commissioned in 2009, and Hormozal presently has a capacity of 170 active pots The production plan for Almahdi and Hormozal for coming year is 180,000 MT that gradually till the end of next year will reach the nominal capacity of 253,000 MT After assigning Almahdi Hormozal Aluminum Complex to Geno Ferro Alloys it is planed that new Phase with the advanced technology of 600KA with a Power Plant of 2000 Mw to be constructed in near future in the complex to increase the final capacity up to 1 million MT per year .

Figure 1-South Hormoz aluminium smlter

The effects of anode spikes in aluminum electrolysis are well-known. Examples are the

disruption of operations, the thermal and chemical imbalance of pots and the loss of current

efficiency; and there are many more. Especially after a spike crisis, some of these consequences

can degrade operations for weeks or even months after the faulty anodes have been changed.

Studying the reduction in alumina feeding in pots before spikes are spotted clearly shows the

loss of current efficiency involved by such incidents,

As in any data analysis, information has to be preprocessed according to the needs of the study

and what is required in the dataset. This is sometimes ignored in algorithms such as Deep

Learning, where features are in fact generated by the model itself, but this requires a much

greater mass of data than that available in a spikes database. Consequently, two main features

have been extracted from the anode current signals, according to the knowledge we have of the

phenomenon; these are described in.

The process of spike development comprises of three steps, as follows:

Step 1 (Figure 2). An area of the anode is less conductive, or even insulated. This could

be caused by dirt and bath pollution, the quality of the anode itself or to thermal

imbalances in the anode, especially just after changing (leading to spikes or deformation

on the sides of anodes).

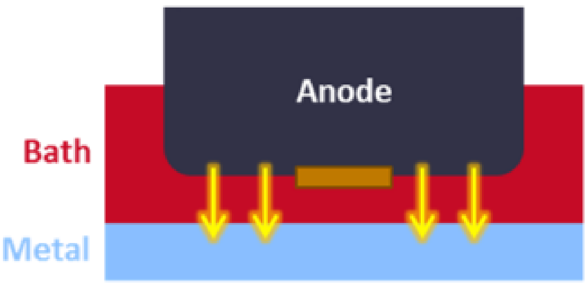

Figure 2- Less- or non-conductive area under an anode as the origin of a spike. (Source: Arthur Martel, Process Control Engineer, Rio Tinto, St Jean de Maurienne, France) [2]

Step 2 (Figure 3). The spike begins to appear under the anode. At this stage waves in

the metal pad could well reach the growing spike, thus creating a temporary local short-circuit, or at least increasing local variations in anode current density.

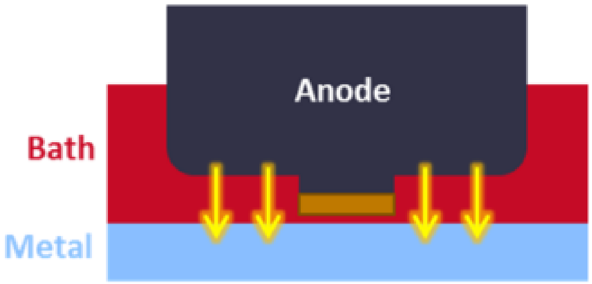

Figure 3- Beginning of a spike development (Source: Arthur Martel, Process Control Engineer, Rio Tinto, St Jean de Maurienne, France)[2]

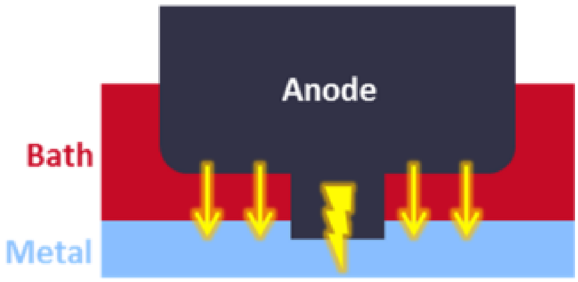

Figure 4-. A fully developed spike(Source: Arthur Martel, Process Control Engineer, Rio Tinto, St Jean de Maurienne, France) [2]

The rate of consumption of the anode carbon is comparable to the rate of aluminium production, and the anode blocks must be continually lowered to maintain a constant anode to cathode distance, which determines the electrical resistance of the cell.

Most airburn occurs on the upper part of the sides of the anodes (see dia• gram) as this area is often uncovered, especially early in the life of the anode. The rate of airburn .depends on the surface temperature, oxygen access and the intrinsic reactivity of the carbon. The surface temperature is very variable, typically ranging from 500° C to 800° C depending on position, anode age and depth of cover. Airburn of exposed surfaces commences at around 450° C and in• creases rapidly with temperature, reaching a maximum rate at around 650-700° C when the rate of gas diffusion in the boundary layers becomes limiting.

Traditionally the process used has been loosely described by the methods used to remove hydrogen fluoride from the gaseous phase. "Wet Scrubbing" is where an aqueous spray is used to remove the fluorides in the form of a solid or soluble fluoride, while in "Dry Scrubbing" processes the gaseous fluoride is chemisorbed on to alumina.

Wet scrubbing has several inherent problems which are:

i) Poor scrubbing efficiency which results in higher energy consumption.

ii) There are several severe corrosion problems resulting from constituents of the emission and scrubbing solution.

iii) Only a limited amount of fluoride is recovered in a form that can be recycled to the cells.

iv) There are disposal problems of bleed-off and waste liquids.

Consequently, the dry scrubbing process which is based on chemisorption of gaseous hydrogen fluoride on to alumina, has become the more popular system because of higher efficiency, although it does not satisfy all criteria of an ideal system. One major disadvantage is the recycling of impurities which leads to a lowering in current efficiency and a less pure metal product.

An important limitation of the wet scrubbing system is the difficulty in removing the submicron particles. The basic principle of dry scrubbing systems circumvents this problem and makes it easier to meet more stringent fluoride emission standards. As will be discussed in detail, the design of dry scrubbers involves passing the gas through a bed of alumina and then bag filters. These ensure that the particle material collide and are bonded together, thus removing all the particles for a much lower pressure drop than is required for wet scrubbers with comparable efficiencies.(fig5)

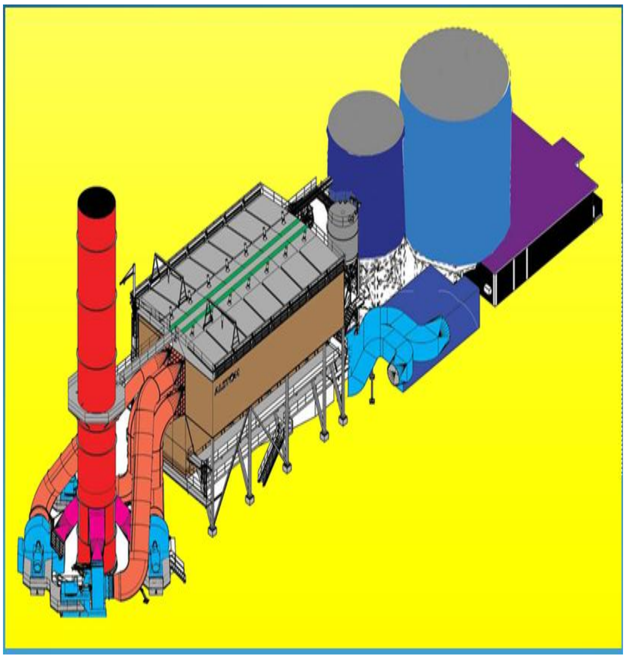

Figure 5- Fume Treatment Plant in aluminium smelter [3]

Experimental Procedure

first, the output gas was measured using the pivot tube and then, the static pressure behind the damper was measured and its relationship with the number of spikes and burn off was studied apertures. Moreover, the quantity of dust output from main chimney of the dry purification system, and its effect on burn off and spike were studied.

In this research, information were categorized and analysed using Pivot tables in Excel software and data was compared with the data analysis tool in the Excel program and its correlation with other parameters and pot events was studied.

Results and Discussion

Nowadays, dry scrubber is very important in Hall–Héroult aluminum reduction technology, and despite the environmental impact and lower consumption of aluminum fluoride, the duct fan suction also affects on the pot performance and improves the surface temperature of the pot and increases production.

During the production of 1 Kg aluminum, more than 1.2 kilograms of used material are converted to gas. Carbon dioxide and carbon monoxide are removed from the interior of the pot by means of the damper suction; and the anodes, which have high reactivity with carbon dioxide and air, lead to the pot blackness.

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The above graph displays the ratio of the number of anode effects to the suction of gas inlet to the FTP building. In this graph, the number of anode effects was classified as upward for 200 days, and the average pressure was recorded at each point. It was observed that if the FTP fan suction was decreased, the number of spikes and burn off was increased sharply.

In the above graph, the effect of burn off and spike on the gas outlet temperature in the FTP input was investigated. In this case, burn off and spike information was categorized as follows. It was observed that on days with the highest number of spike and burn off, temperature of the output gas was also increased correlationally.

According to the above graph, with the increase in the input temperature in the inlet of the FTP building, the crystalline temperature of the room is also increased. In this graph, we compared the effect of spike and burn off on the crystalline temperature of the room.

In this graph, the amount of dust output from the main chimney of FTP was compared with classification of the number of burn off and spike. It was observed that the amount of dust is increased with increasing spike and burn off.

In the above graph, the pressure of gas output from each pot was measured individually. For this purpose, a Pivot tube and pressure gauge were used, and the measurement method was measuring the static pressure in the back of the output gas damper. Then we compared the number of spikes and burn off of each pot with gas pressure. It was found that spike and burn off had a dramatic increase in pots whose damper were damaged or suctioned poorly.

Figure 5-anode spike

Figure 6-anode burnoff

Figure 7-pot with low suction-

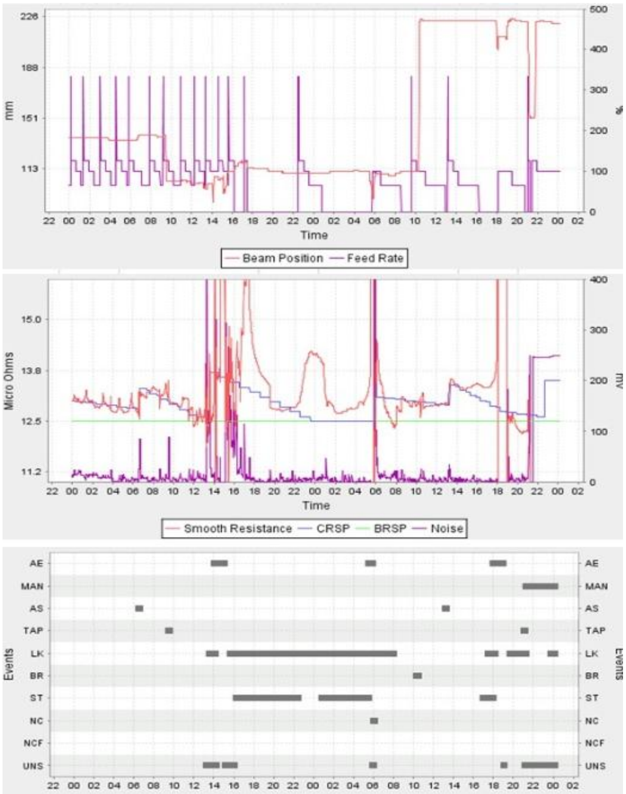

Figure 8-pot with low suction-producer spike(I POT soft ware)

Figure 9-anode spike

When an anode carbon becomes separated from its supporting rod and drops into the molten bath.

Figure 10DUCT GAS MEASSURING BY FLUKE GAS FLOW METER

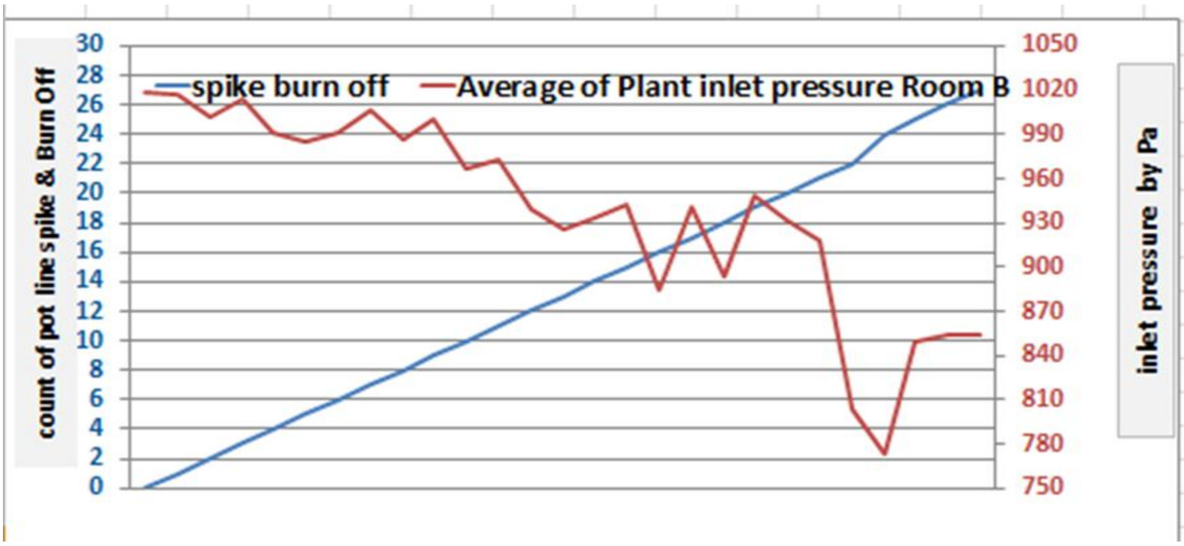

Figure 11- realtion between gas pressure with number of spike and burnoff (sectionA)

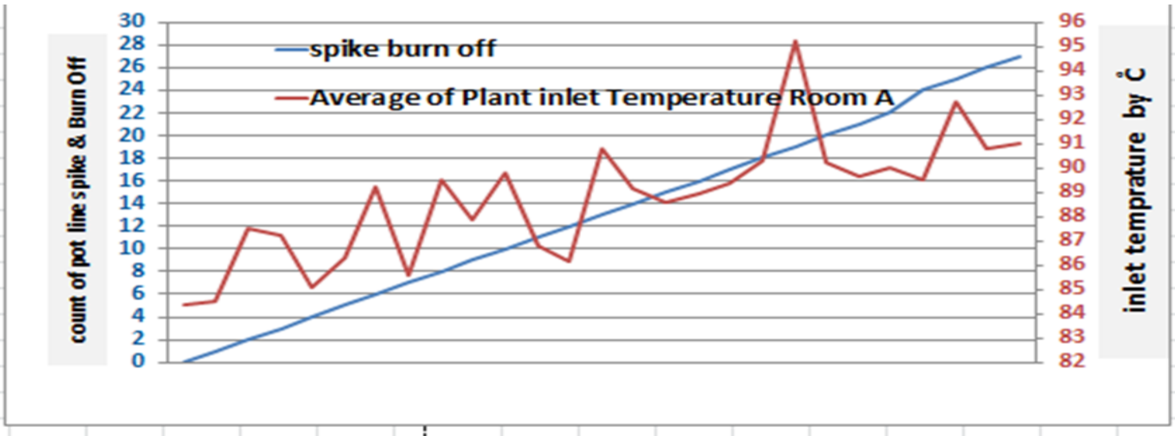

Figure 12- realtion between gas pressure with number of spike and burnoff (sectionB)

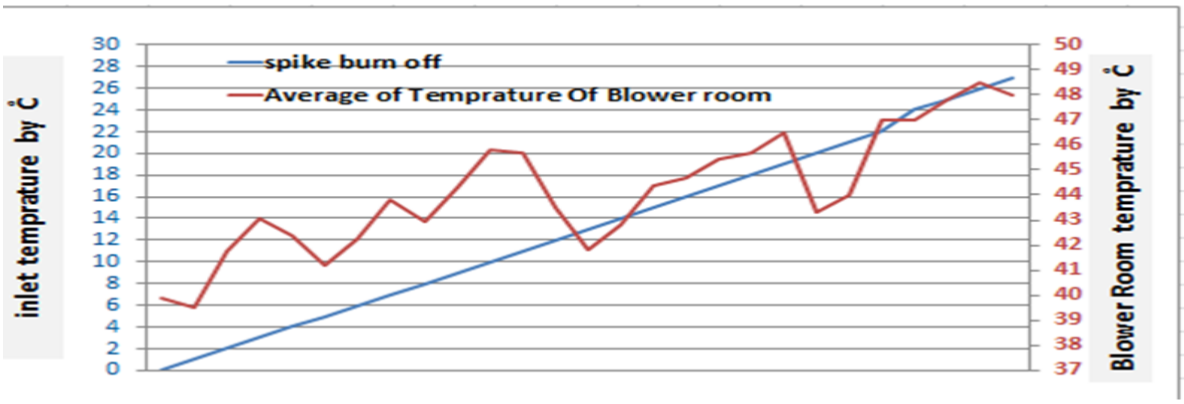

Figure 13- realtion between gas pressure bloriroom(FTP) with number of spike and burnoff

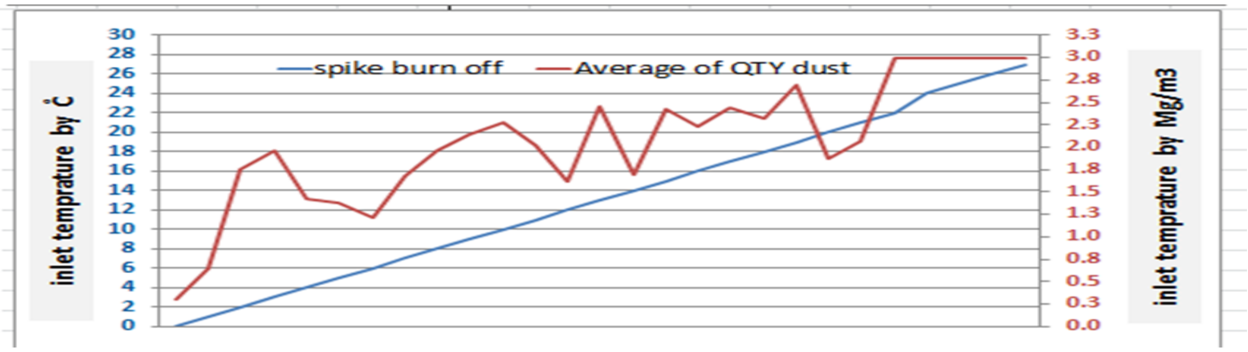

Figure 14- realtion between quantity dust with number of spike and burnoff

Spike & Burn off per pot Vs. Static Pressure Per Pot

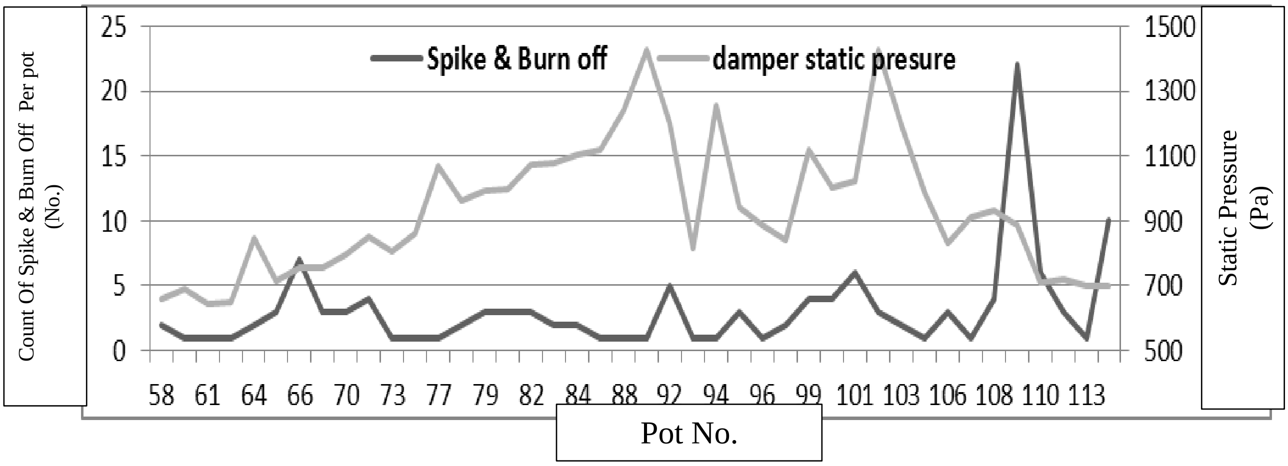

Figure 15- Spike & Burn off per pot Vs. Static Pressure Per Pot

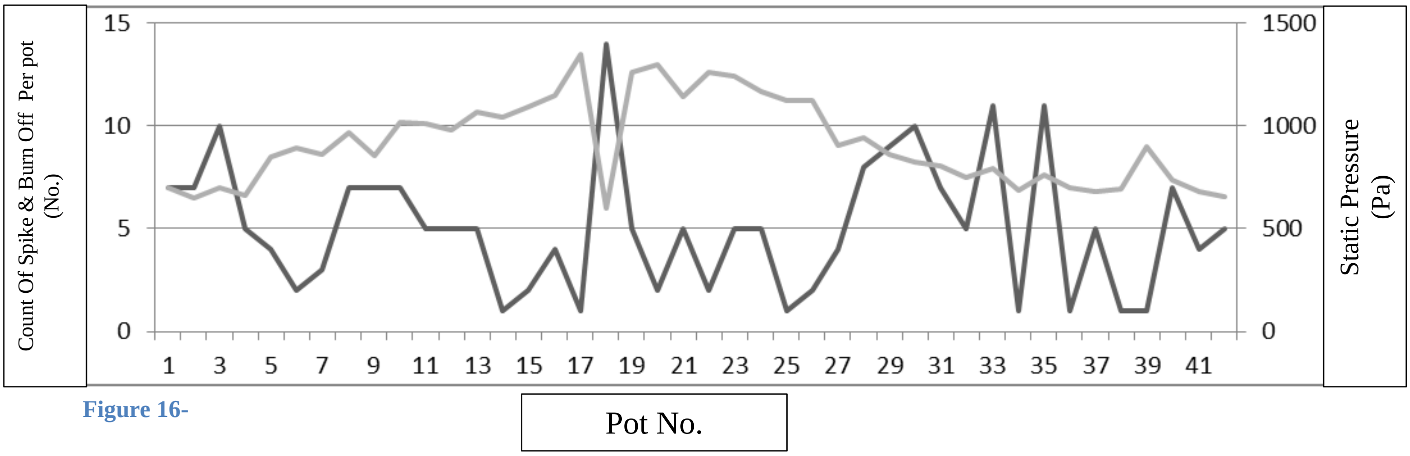

Figure 16-

Conclusion

This study show that amount of dust output from the main chimney of FTP was compared with classification of the number of burn off and spike. It was observed that the amount of dust is increased with increasing spike and burn off.

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