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STUDY OF INFLUENCES ON THE BAUXITE MOISTURE AND SOLIDS IN FILTRATE IN THE HYPERBARIC FILTERS THROUGH DESIGN OF EXPERIMENTS (DOE) STATISTIC TOOL

[1]Alex Pinheiro, [1]Américo Borges, [1]Enio Laubyer,
[1] Hydro-Alunorte – Alumina do Norte do Brasil S.A; highway PA 481-km 12, Barcarena-Pará, 66447-000, Brasil

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Abstract

Part of bauxite which is used in Hydro Alunorte comes from MBP (Mineração Bauxita Paragominas) by pipeline to 240 Km away through seven cities. This mine provides bauxite to five production lines in the Hydro Alunorte. The objective of this work was to study the influence of the variables that influence the control cake moisture bauxite and solids in filtrate. We conducted an experimental plan based on statistical tool DOE. The parameters evaluated were: rotation speed, basin level and air pressure. The interaction between rotation speed, pressure and basin level was the condition of greater influence on the moisture. Alone the rotation was the most influential variable, followed by pressure. The experimental design in hyperbaric filtration process showed the factor of influence of each control parameter study and determined the strategy to achieve the goal of reducing the moisture content of bauxite.

Introduction

MBP is located in Paragominas city in the southeastern state of Pará. MBP (Paragominas Bauxite Mining) is the largest supplier of bauxite to Hydro Alunorte. Slurry is made with water and ground bauxite to be sent to the EDB (Distribution Station Barcarena) by a 240 Km.

Arriving in the refinery, the bauxite needs to pass through the stage of hyperbaric filtration to dewater the slurry. The filtered bauxite moisture must be less than 14%. Hyperbaric filters have a disc filter within a cylindrical pressure vessel. The pressurized atmosphere in the hyperbaric chamber pushes filtrate through the filter cloth bauxite accumulates an the cloth. As the filter sectors leave the filter bath air passes through to help dry the cake. Prior to entering the bath blow air is applied to the cloth to discharge the product bauxite cake down a chute. The bauxite cake is them transported by belts to a sequentially operated discharge chamber to retain system pressure. The bauxite is them conveyor to the tanks where spent liquor and lime is added to form a slurry and send digestion.

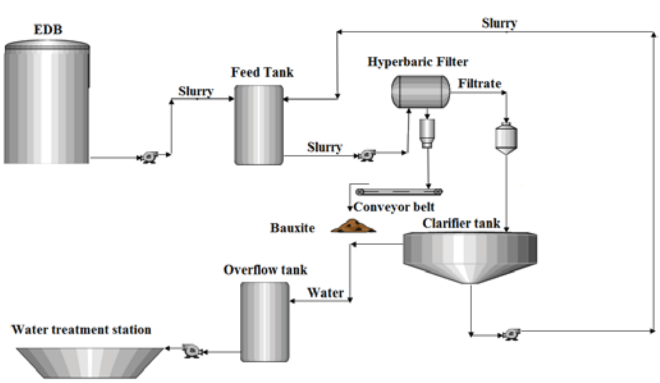

Figure 1 – Dewatering process.

The objective this work was to study the influence of variables that influence the bauxite cake moisture and filtrate solids. The experiment was developed using statistical tool DOE, which can be defined as a technique for planning experiments that allows us to define what data, in what amounts and in what conditions must be sampled during a given experiment, basically seeking the largest possible statistical accuracy in response.

Materials and Methods

Initially the input variables of the process were elected, which were: rotation speed, basin level and air pressure.

Table 1 – Variables and theirs variation level.

Factors	Variation Level	
	+	-
Rotation Speed (rpm)	2,3	1,5
Air Pressure (bar)	6	5
Basin level (%)	97	85

With the definition of the input variables was performed a factorial design of experiments, where the permutation of these 3 variables totaled 38 experiments (considering duplicate).

The experiments were carried out using specific filter in the Hydro Alunorte Dewater bauxite. The first step of the experimental design consisted of the electric and mechanical maintenances in the filter, necessary to the good performance of the filter. All the indicating electronic instruments of the variations of the factors levels had been verified and calibrated as specific procedure. Samples were collected by an analyst who followed a standard procedure.

(a) (b)

Figure 2 – (a) Hyperbaric filters. (b) Filter discs

After experiments a statistical model was create for predict the bauxite moisture and filtrate solids values, based on teoric model (figure 3).

$$y_{ijk} = \mu + \alpha_i + \beta_j + \tau_k + (\alpha\beta\tau)_{ijk} + \xi_{ijk}$$

α_i = Rotation speed efect

β_j = Air pressure efect

τ_k = Basin level efect

Figure 3 – Estastical teoric model.

Results

Dewatered Bauxite Production

The results obtained for the laboratory experiments, showed that for dewatered bauxite production the factors that exercise major influences are: Speed rotation and the three variables together.

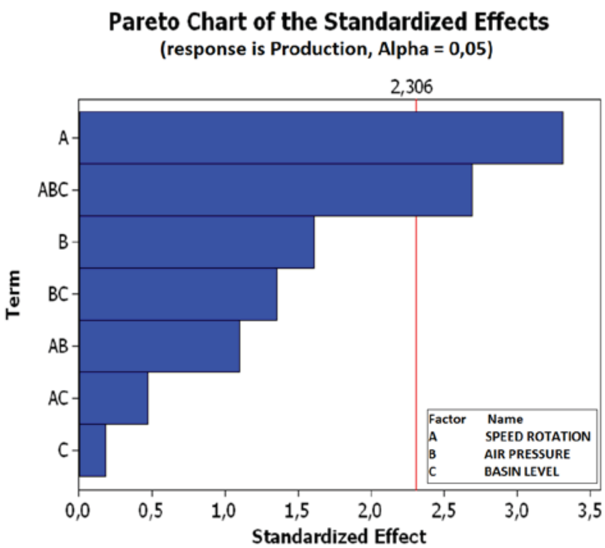

Figure 4 – Board of influences on the dewater bauxite porduction.

The results were accord with expected, the production is high dependent of the speed rotation, and this can be explained through the equations filtration.

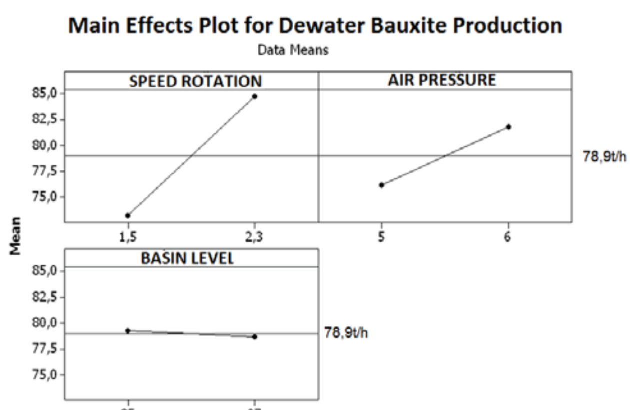

Figure 5 – Influences of each variable on the dewater bauxite production.

Bauxite Moisture

For bauxite moisture, the results concluded that the factor that has major influences is: Speed rotation, air pressure and basin level together.

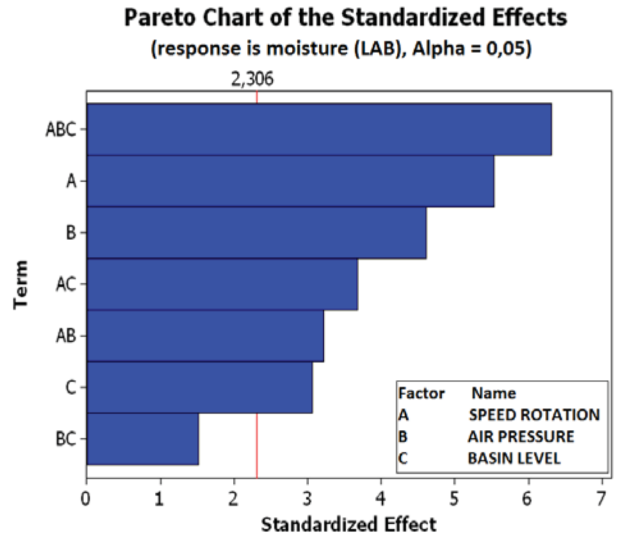

Figure 6 – Board of influences on the bauxite moisture.

The speed rotation and air pressure were the second and third major influence variables, respectively.

Obviously the parameters evaluated in the filter affected the quality of moisture bauxite dewatered but the most appropriate directions to be followed for this type of filtration showed better understanding with these experimental results. It is possible to explain that the higher the basin level and speed rotation the higher is the bauxite moisture expected due to reduction of drying area assuming an air pressure constant.

The Figure 7, show the influences of each variable on the bauxite moisture.

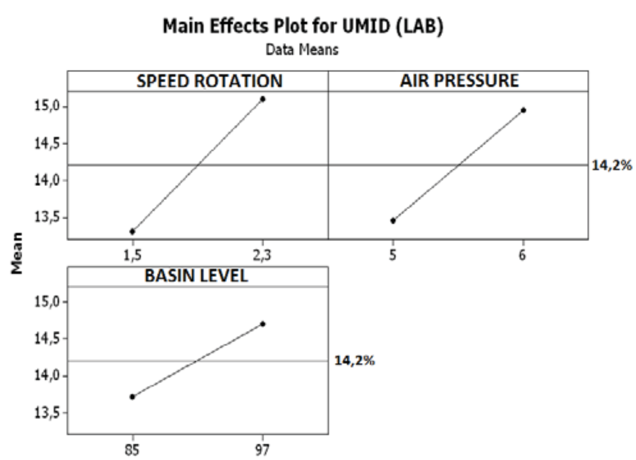

Figure 7 – Influences of each variable on the bauxite moisture.

Solids in Filtrate

For solids in filtrate the parameters analyzed that showed most influence is: Speed rotation and basin level together.

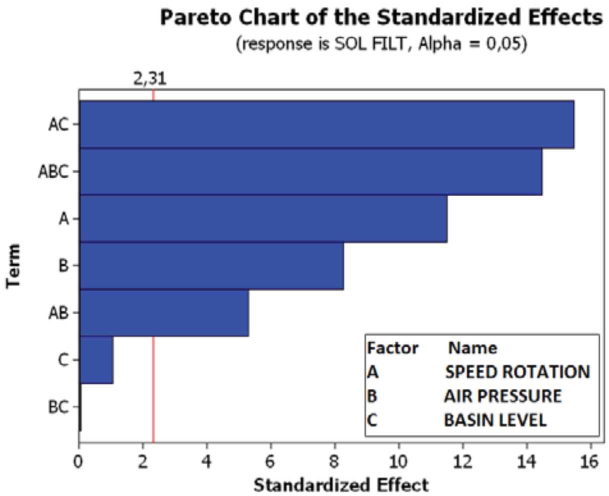

Figure 8 – Board of influences on the solids in filtrate.

As the filter used for the test had all cloths start to the campaign, issues with holes in cloths cannot be predicted in the equation but present good indications that holes in cloths are occurring when there is discrepancy between simulated values and lab results.

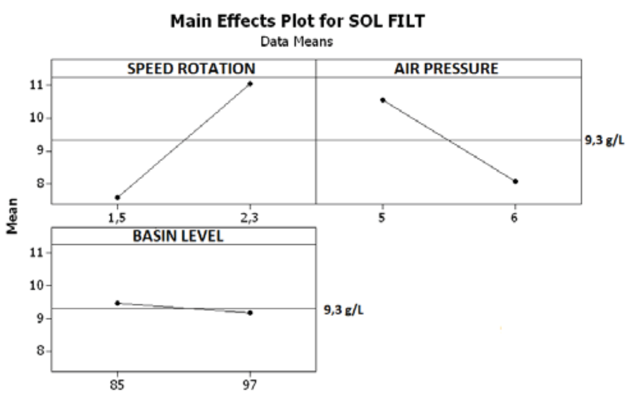

Figure 9 – Influences of each variable on the solids in filtrate.

Particle Size Distribution

Correlation studies were performed to verify the interference of bauxite particle size in this filtration process: results of bauxite moisture and dewatered bauxite production. The study showed no significant correlations.

Variables	Correlations Matrix - 2012								
	MOISTURE	MEDIAN	<210um	<44um	<20um	<10um	<5um	DENS	SOLIDS
MOISTURE	**1,000**	0,035	-0,014	-0,071	-0,079	-0,075	0,000	0,029	0,027
MEDIAN	0,035	**1,000**	-0,899	-0,969	-0,941	-0,912	-0,874	0,168	0,071
<210um	-0,014	-0,899	**1,000**	0,880	0,824	0,782	0,740	-0,133	-0,061
<44um	-0,071	-0,969	0,880	**1,000**	0,986	0,958	0,917	-0,163	-0,102
<20um	-0,079	-0,941	0,824	0,986	**1,000**	0,985	0,948	-0,167	-0,100
<10um	-0,075	-0,912	0,782	0,958	0,985	**1,000**	0,961	-0,160	-0,089
<5um	0,000	-0,874	0,740	0,917	0,948	0,961	**1,000**	-0,122	-0,058
DENS	0,029	0,168	-0,133	-0,163	-0,167	-0,160	-0,122	**1,000**	0,287
SÓLIDS	0,027	0,071	-0,061	-0,102	-0,100	-0,089	-0,058	0,287	**1,000**

Figure 10 – Correlations matrix bauxite moisture and particle size.

Variables	Correlations Matrix - 2012								
	PRODUÇÃO	MEDIAN	<210um	<44um	<20um	<10um	<5um	DENS	SOLIDS
PRODUCTION	**1,000**	-0,053	0,028	0,058	0,062	0,070	0,062	0,208	0,001
MEDIAN	-0,053	**1,000**	-0,899	-0,969	-0,941	-0,912	-0,874	0,168	0,071
<210um	0,028	-0,899	**1,000**	0,880	0,824	0,782	0,740	-0,133	-0,061
<44um	0,058	-0,969	0,880	**1,000**	0,986	0,958	0,917	-0,163	-0,102
<20um	0,062	-0,941	0,824	0,986	**1,000**	0,985	0,948	-0,167	-0,100
<10um	0,070	-0,912	0,782	0,958	0,985	**1,000**	0,961	-0,160	-0,089
<5um	0,062	-0,874	0,740	0,917	0,948	0,961	**1,000**	-0,122	-0,058
DENS	0,208	0,168	-0,133	-0,163	-0,167	-0,160	-0,122	**1,000**	0,287
SÓLIDS	0,001	0,071	-0,061	-0,102	-0,100	-0,089	-0,058	0,287	**1,000**

Figure 11 – Correlations matrix dewatered bauxite production and particle size.

The conclusions obtained through influences studies allowed the create of statistical model can show the bauxite moisture and solids in filtrate values, the coefficients to these statistical models can be showed on the Figure 12 and 13.

Estimated Coefficients for solids in filtrate (LAB) using data in uncode units

Term	Coef
Constant	1956,16
Speed Rotation	-1015,66
Air Pressure	-324,499
Basin Level	-20,8781
Speed Rotation*Air Pressure	169,38
Speed Rotation*Basin Level	10,9687
Air Pressure*Basin Level	3,45573
Speed Rotation*Air Pressure*Basin Level	-1,81771

Figure 12 – Statistical model coefficients created for bauxite moisture.

Estimated Coefficients for Moisture (LAB) using data in uncode units

Term	Coef
Constant	-923,663
Speed Rotation	463,978
Air Pressure	160,613
Basin Level	9,87192
Speed Rotation*Air Pressure	-79,8612
Speed Rotation*Basin Level	-4,91739
Air Pressure*Basin Level	-1,69449
Speed Rotation*Air Pressure*Basin Level	0,849103

Figure 13 – Statistical model coefficients created for solids in filtrate.

Conclusions

The results of the study indicate the hyperbaric filter showed run at maximum level for the feed rate, at maximum pressure and the speed rotation to increase the dewatered bauxite production however to reduce the bauxite moisture is necessary to work in another levels of the control conform to the direction that showed per the equations obtained. After the completion of these results some filters in the dewatering area were modified as indicated equations and thus a decrease is observed on average in bauxite moisture dewatered. New tests and developments of other studies are ongoing.

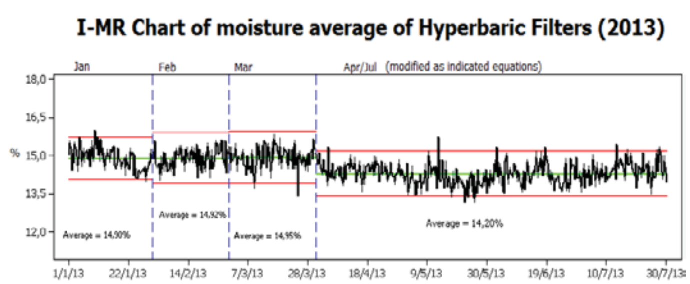

Figure 14– Results to bauxite moisture before and after tests.