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Production of aluminum requires high energy consumption. Using high quality row material could reduce energy consumption

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Abstract

Graphitic carbon as the anode is the one of the main row material of aluminum production. Aluminum is produced by electrolysis of Alumina powder. Pre-baked Anode technology is used in this process. Anode baking is the final step of Anode production. The effect of packing coke size on gas consumption and baked anode quality in open type furnaces were fully investigated in this thesis. For this purpose the three sizes of packing coke were tested (very coarse, coarse, and medium).Gas consumption and Anode quality parameters were tested and recorded according to ISO standard in each baking cycle by laboratory. The lowest gas consumption is related to medium size packing coke which is 12% lower than the case of usage coarse. The highest gas consumption occurred when very coarse packing coke was used which is 9% more than coarse usage and also the quality of Anode when coarse packing is used has less deviation from standard parameter finally with regards to results of the investigation done the coarse grain size is the optimum size in comparison with others and also to avoid Anode burning, usage of medium size packing coke even fine on top layer of Anode coverage in baking furnace is recommended

Keywords: “;Anode, Backing furnace, packing coke, Gas consumption.
”

Introduction

Almahdi Aluminum was established in Bandar Abbass , the center of Hormozgan province , in July 1990 with an approximate investment of 1.5 bUSD , targeting 110,000 Mt aluminium per year increasable to 330,000 Mt/y. The first phase was inaugurated in 1997 and by early 2002 , it reached to half capacity using 120 cells in operation.The erection of 2nd phase of line one was started in 2002 and completed in May 2005. In June 2006 , the 2nd phase , called hereafter Hormozal , was started with an investment of 600 m euros.The technology of 2nd phase was D20 with the line current of 230 kA and 228 cells aiming annual production of 147,000 Mt aluminium. With cooperation of Iranian experts and foreign EPC contractor , FATA Hunter s.p.a from Italy , the whole project finished in 40 months and inaugurated in October 2009.For the time being 124 cells are in operation and the plan is to achieve full line capacity by mid 2015.

Petroleum coke (often abbreviated pet coke or petcoke) is a carbonaceous solid delivered from oil refinery coker units or other cracking processes.[1] Coking processes that can be employed for making petcoke include contact coking, fluid coking, flexicoking and delayed coking. Other coke has traditionally been delivered from coal.

This coke can either be fuel grade (high in sulfur and metals) or anode grade (low in sulfur and metals). The raw coke directly out of the coker is often referred to as green coke.[1] In this context, "green" means unprocessed. The further processing of green coke by calcining in a rotary kiln removes residual volatile hydrocarbons from the coke. The calcined petroleum coke can be further processed in an anode baking oven in order to produce anode coke of the desired shape and physical properties. The anodes are mainly used in the aluminium and steel industry.

Petcoke is over 90 percent carbon and emits 5 to 10 percent more carbon dioxide (CO_2) than coal on a per-unit-of-energy basis when it is burned. As petcoke has a higher energy content, petcoke emits between 30 and 80 percent more CO_2 than coal per unit of weight.[2] The difference between coal and coke in CO_2 production per unit energy produced depends upon the moisture in the coal (increases the CO_2 per unit energy – heat of combustion) and volatile hydrocarbon in coal and coke (decrease the CO_2 per unit energy).

Figure1-
Delayed coker operation, schematic (a) and delayed coker (b)

Calcined coke is the best material for making carbon usually calcined in a gas-fired rotary kiln or rotary heath at high temperatures, around 1200 to 1400 c, to remove moisture, drive off strength, and electrical conductivity of the material. Rotary kilns have been used successfully for many years to produce calcined coke for the aluminium industry and they offer a high level of automation, performance and flexibity. Shift caciners make high bulk density, coarse particle size product and several papers have been published recently highlighting these benefits

Experimental Procedure (Model)

In statistics, the residual sum of squares (RSS), also known as the sum of squared residuals (SSR) or the sum of squared errors of prediction (SSE), is the sum of the squares of residuals (deviations of predicted from actual empirical values of data). It is a measure of the discrepancy between the data and an estimation model. A small RSS indicates a tight fit of the model to the data. It is used as an optimality criterion in parameter selection and model selection. In general, total sum of squares explained sum of squares + residual sum of squares. For a proof of this in the multivariate ordinary least squares (OLS) case, see partitioning in the general OLS mo

The sum of squares represents a measure of variation or deviation from the mean. It is calculated as a summation of the squares of the differences from the mean. The calculation of the total sum of squares considers both the sum of squares from the factors and from randomness or error

In regression, the total sum of squares helps express the total variation of the y's. For example, you collect data to determine a model explaining overall sales as a function of your advertising budget.

The total sum of squares = regression sum of squares (SSR) + sum of squares of the residual error (SSE)

$$\Sigma(y - \bar{y})^2 = \Sigma(\hat{y} - \bar{y})^2 + \Sigma(y - \hat{y})^2$$

The regression sum of squares is the variation attributed to the relationship between the x's and y's, or in this case between the advertising budget and your sales. The sum of squares of the residual error is the variation attributed to the error.

By comparing the regression sum of squares to the total sum of squares, you determine the proportion of the total variation that is explained by the regression model (R^2, the coefficient of determination). The larger this value is, the better the relationship explaining sales as a function of advertising budget. For thermal conductivity values, see List of thermal conductivities. In physics, thermal conductivity (often denoted k, λ, or κ) is the property of a material to conduct heat. It is evaluated primarily in terms of Fourier's Law for heat conduction. Heat transfer occurs at a lower rate across materials of low thermal conductivity than across materials of high thermal conductivity. Correspondingly, materials of high thermal conductivity are widely used in heat sink applications and materials of low thermal conductivity are used as thermal insulation. The thermal conductivity of a material may depend on temperature. The reciprocal of thermal conductivity is called thermal resistivity.

Differential scanning calorimetry or DSC is a thermoanalytical technique in which the difference in the amount of heat required to increase the temperature of a sample and reference is measured as a function of temperature. Both the sample and reference are maintained at nearly the same temperature throughout the experiment. Generally, the temperature program for a DSC analysis is designed such that the sample holder temperature increases linearly as a function of time. The reference sample should have a well-defined heat capacity over the range of temperatures to be scanned.

Figure 3-DSC SET

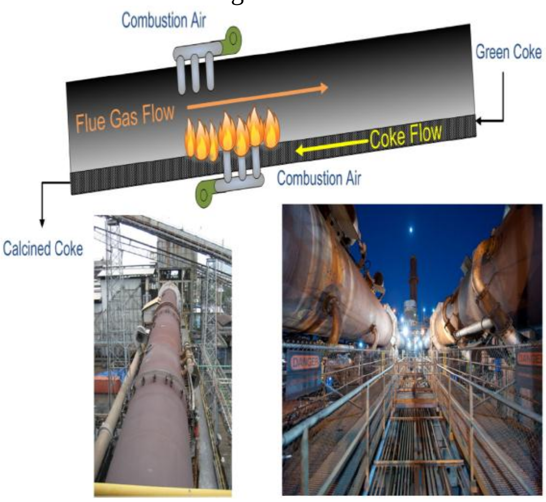

Figure4-. Rotary kiln schematic and kilns equipped with tertiary air 1 fans.

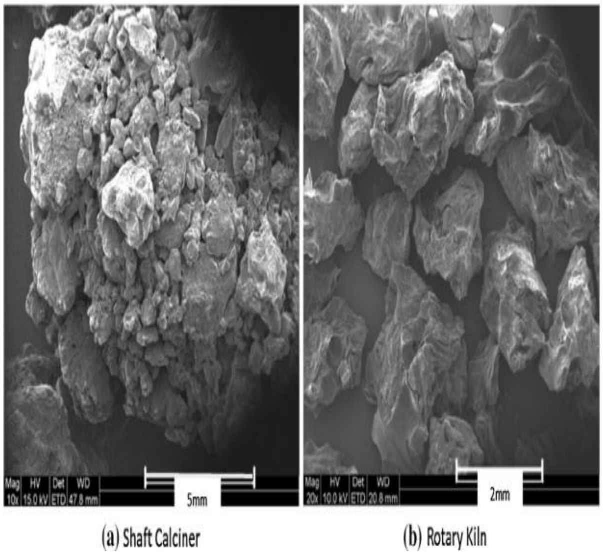

Figure 2- SEM images of shaft (a) and rotary kiln CPC (b).

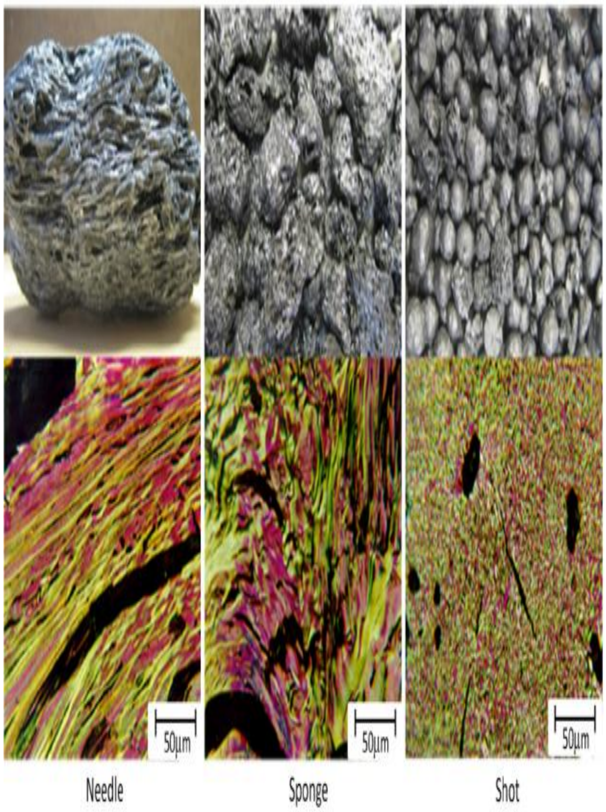

Figure 2 Delayed coke types and optical textures

Results and Discussions

Heat capacity and specific heat, and their

variation with temperature can be determined by both methods, DTA and DSC, but generally the preferred method is DSC, which in this case provides greater accuracy. The variation of the heat capacity with temperature different is produced in a crystalline solid characterized by a melting temperature T_t and a non-crystalline solid characterized by the glass transition temperature T_g. The heat capacity can be determined by the dimensional relationships, dividing the flow of heat from the heating rate of the sample

According to the test on Cp and k changes depending on the temperature in the table (4-3) is shown.

Temperature	$C_P(\frac{j}{kg.°k})$	$k(\frac{w}{m.°k})$
100	820	0.025
200	865	0.031
300	920	0.038
400	985	0.045
800	1270	0.073
1200	1590	0.105

Table1- changes of Cp and K coke to temperature in expermintals

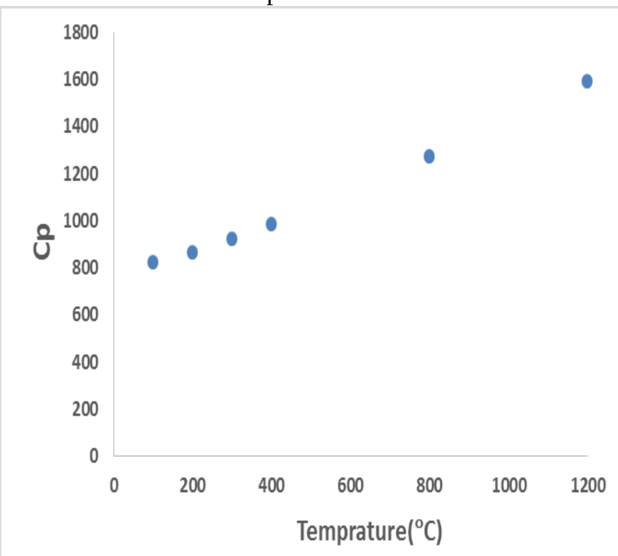

Figure 8-3 Cp changes in temperature, for example coke

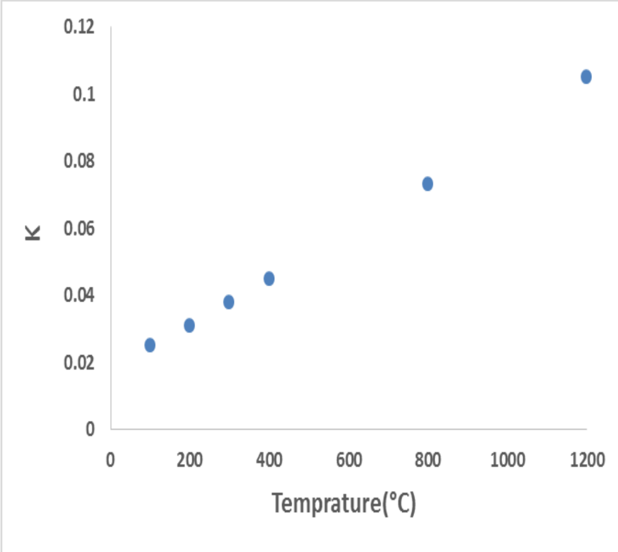

Figure 9- Thermal conductivity changes depending on the temperature, for example coke

Function changes depending on the temperature Cp and K are as follows:

$$C_p = 0.0001T^2 + 0.548T + 749.39$$
$$k = 7 \times 10^{-0.5T} + 0.0174$$

According to the above equations in terms of the temperature graph plots predicted Cp 8 and thermal conductivity versus temperature graph charts 10 is drawn:

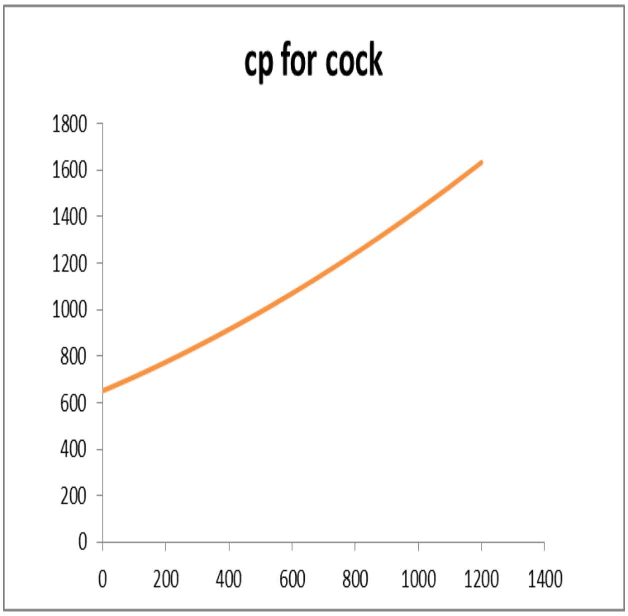

Figure 10- Cp changes according to temperature slope for coke

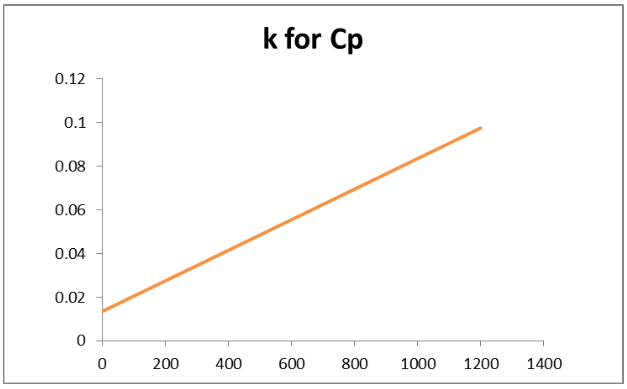

Figure 11- graphs the equation in terms of temperature changes K for coke

The effect of aggregation coke on gas consumption

In this study, three different aggregation anode baking cycle medium, coarse, very coarse examined In each of these tests in addition to testing the quality of baked anodes gas consumption was recorded during t The remarkable thing is that one of the very influential parameters on gas consumption during the anode baking process, asphalt content is available in green anodes he cycle. . If the asphalt content in green anodes high adhesion to the body of the anode coke during the cooking process and also low asphalt content reduces the strength and rising consumption of gas. In experiments conducted in this study, the percentage of bitumen in green anodes average between 14 to 15 percent.

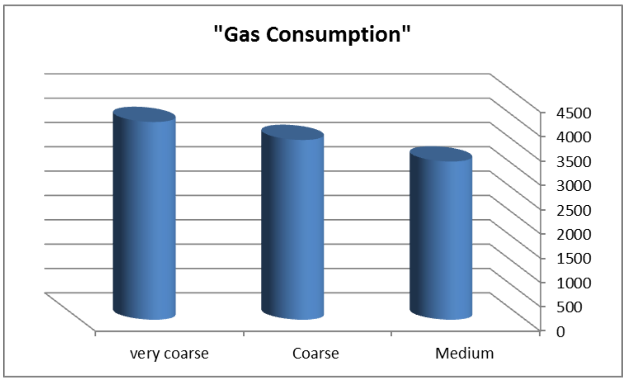

Figure 12- gas consumption by type of aggregation

The effect of aggregation coke on the quality of baked anodes

One of the main objectives of this study was to evaluate the impact on the quality of grain packing anode coke during the cooking process

Percent have the coke particles	Air burn anode percent	Type of aggregation	Row
14	2	Medium	1
2	5	Coarse	2
0	16	Very Coarse	3

Table 2- Evaluation of visual quality anode baked

The accuracy of the results presented in Table 2 shows less likely to cause aggregation Medium air burn anode during the cooking process and the reason for this is that the grain size is smaller than the particles into the air to mingle Medium heat to the dough comes coke particles adhere to the body

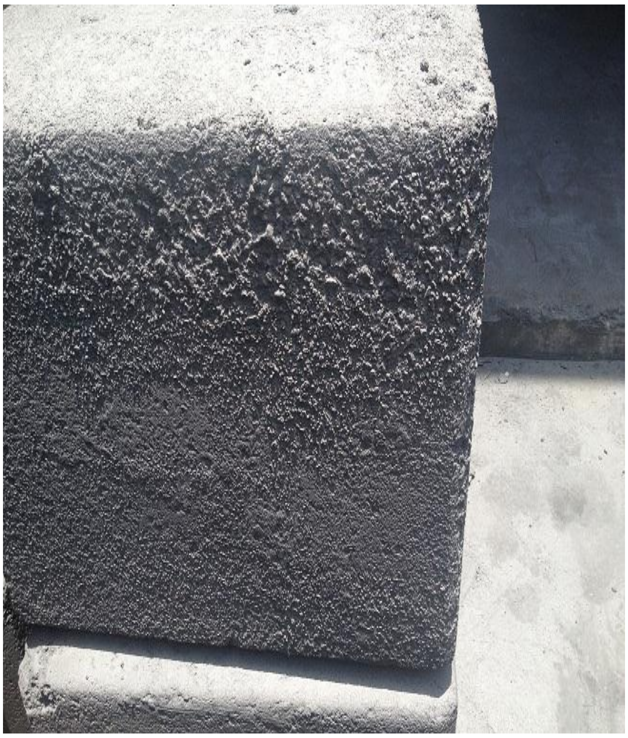

Figure 4-sample of air burn anode

Laboratory parameters

	Parameter		Unit	Customer code Lab cod / 104132 D18 / QP 5623	Normal value
1	Air permeability		nPm	2.2	≤ ۱.۵
2	Thermal Conductivity		W/mK	3.4	4.5-3.2
3	Flexural strength		Mpa	10.08	13-9
4	Electrical resistance		µΩm	60.8	55-50
5	Apparent density		g/cm^3	1.59	-1.56 1.61
7	.Air re	Residue	٪	79.68	90-75
8	.Co2 Re	Residue	٪	86.24	95-54

Table3-The results of samples tested for Medium Group is as follows:

Conclusion

Grading Medium

The results also show a gradation in electrical resistance Medium anodes produced was higher than the other two types of aggregation that this increases the power consumption during the production process of aluminum

Thus, although apparently in this way about 10% gas savings, but we end up with this type of aggregation anodes produced a negative impact on energy and next consumption in aluminum production processes.

Very Coarse grain

but in Very Coarse graindue to high porosity greater heat loss to the outside and therefore greatly increases gas consumption.

However, in this type of aggregation is due to air infiltration through the empty spaces of Peking flea control in the upper layers of the air burn anode will strongly affect the visual quality. In this type of aggregation due to high temperature and sufficient oxygen and temperature of the walls also risen drastically and reduces the lifetime of the walls.

Coarse grain

but in Coarse grain also in terms of quality indicators and in terms of lower fuel consumption than the standard deviation.

But we're in this type of aggregation due to air infiltration through the empty space in the upper layers of packing air burn coke have happen that the amount of the air burn compared to Very Coarse less.

Finally, according to the results of this study suggest an optimum Coarse grain for baking anodes for this process is relatively good and that it is recommended to avoid air burn.

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