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Characterization of silica sand from grinding and sieving, for use and handling as raw materials by dry means

Caracterización de la arena silica a partir de la molienda y tamizado, para el uso y manejo como materias primas por vía seca

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Abstract

Objectives

The present research work allows to apply the grinding and sieving in the characterization of raw materials by dry way in Chemical Engineering in the same way it allows studying the behavior of the diameters and the distribution of the particles from the sand screening silica, whose purpose is to determine the efficiency in the grinding of solids, in the sieving of particles of different sizes from Tyler sieves, whose purpose is to characterize the silica sand as solid raw materials by dry way, related to the different applications of the unit operations such as: in the glass, ceramic, metallurgy, foundry, construction, abrasive and drying industries.

Methodology

This article describes the methodology of the grinding and sieving of silica sand in the laboratory of Chemical plants of the Technological University of the southeast of Veracruz, from which the operation is developed and obtaining its efficiency, as a product in the mesh 70, from the screening and characterization of this solid raw material by dry method. for later uses in industry and in Chemical Engineering.

Contribución

Las industrias hoy en día requieren del analisis de sus materias primas de acuerdo a las especificaciones de los clientes, es por ello que la molienda y el tamizado ha permitido a la ingeniería Química un amplio desarrollo en las operaciones unitarias, así como la mejora de la calidad en los productos solidos ya sea por vía seca o húmeda, en este proyecto se desarrolla un tratamiento por vía seca de la arena silica. a partir de la molienda en un molino de bolas y tamizado en un tamizador Axial desarrollado en el Laboratorio de plantas de la Universidad Tecnológica del Sureste de Veracruz, se pretende comercializarlo con empresas del ramo, como: MADISA, cuyo propósito sea aplicarlo en la producción, elaboración y manufactura de envases de color ámbar ya se medicinal o envases de cerveza (Retsch,2012).

Engineering, Processes, Prototypes

Resumen

Objetivos

El presente trabajo de investigación, permite aplicar la molienda y tamizado en la caracterización de materias primas por vía seca en la Ing. Química de la misma forma permite estudiar el comportamiento de los diámetros y la distribución de las partículas a partir del cribado de la arena silica, cuyo propósito es determinar la eficiencia en la molienda de sólidos, en el tamizado de partículas de diferentes tamaños a partir de tamices Tyler, cuyo propósito es caracterizar la arena silica como materias primas sólidas por vía seca, afines a las diferentes aplicaciones de las operaciones unitarias como: en la industria del vidrio, cerámica, metalurgia, fundición, construcción, abrasivos y el secado.

Metodología

El presente artículo describe la metodología de la molienda y tamizado de la arena silica en el laboratorio de plantas Químicas de la Universidad Tecnológica del sureste de Veracruz, de la cual se desarrolla la operación y obtención de la eficiencia de la misma, como producto en la malla 70, a partir del cribado y caracterización de esta materia prima solida por vía seca. para usos posteriores en la industria y en Ing. Química.

Contribution

Industries today require the analysis of their raw materials according to customer specifications, which is why grinding and sieving has allowed chemical engineering a broad development in unit operations, as well as the improvement of the quality in solid products either by dry or wet route, in this project a dry treatment of silica sand is developed. From the grinding in a ball mill and sieving in an Axial sieve developed in the Plant Laboratory of the Universidad Tecnológica del Sureste de Veracruz, it is intended to commercialize it with companies in the field, such as: MADISA, whose purpose is to apply it in production, elaboration and manufacture of amber containers, whether medicinal or beer containers (Retsch,2012).

Ingeniería, Procesos, Prototipos

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Introduction

This research project describes the methodology of unit grinding and mallet operations, as India Moreno, E. G, (2001). He mentions that the operation and graphic interpretation of the characterization of the grinding and sieving of silica sand, used in various applications of Chemical Engineering, Despite the situation of the pandemic, controlled research is still being carried out at the facilities of the Technological University In the Chemical plants laboratory, silica sand is selected due to its applications, in addition to that it was donated by the MADISA company, based on these conditions it is decided to use the prototypes already previously designed in previous years and proceed to operate them to give a report of the results of this project, from a ball mill and an axial type sieve, its control system allows the user to modify variables such as time, adjust it according to their needs, which is a functional prototype to screen and characterize particle diameters.

It is important because it allows to characterize solids and calculate the efficiency of the dry milling of raw materials

Description of the design method and characterization methodology

Selection of raw material

In the first instance, according to Perry & Green (2012), the decision is made to select the raw material, considering the design conditions of our prototype and the availability of the raw material. It has a hardness of 7 on the Mohs scale; specific gravity of 2.65; refractive index of 1,548, lacks obvious exfoliation; It has pyroelectric and piezoelectric properties, being found naturally as silica rocks in clay sand mounds, according to these conditions, the raw material is ground in the ball mill and corroborated that the equipment does silicon rock due to hardness. As indicated in fig. 1

Figure 1 Illustration of the crushing and grinding of silicon rock
Source: (Own elaboration, 2021)

The silica stone is crushed and grinded for 30 min in the ball mill, with a hardness of 7 on the Mosh scale, as indicated in Figure 1, then the screening is carried out on the Axial sieve for 15 min, as indicated in Figure 2, designed in the plant laboratory of the Universidad Tecnológica del Sureste de Veracruz.

Figure 2 Axial Sieve
Source (Own elaboration, 2021)

The operation of the sieve is essential for the screening of the raw material, according to Smith, (2007), he mentions that it is more efficient with horizontal movement, it is much more efficient than vertical shaking movement, Axial in 15 min automatically on the control panel display, it is programmed and the start and stop cycle, programmed in the ARDUINO, is fulfilled.

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We proceed to record the weights of the Silica sand, of each of the sieves, placed from larger to smaller particle diameter, to later record the data in tables and corresponding graphs in Microsoft Excel, as indicated in Figure 3.

Figura 3 Tyler Sieves
Source (Own elaboration, 2021)

Tyler sieves are ordered from largest to smallest diameter, coarse solids to fine solids from largest to smallest particle diameter in (mm or in). The sieves are arranged vertically, and the mesh is developed before and after crushing and grinding in the ball mill. It is preferable to carry out a sieving prior to grinding to know the conditions and the graphic behavior of the raw material, this allows to know in which% the silica rock enters and to know the% of fine solids according to the client's specifications and the data sheets. techniques of silica sand as a product (Santos Carpio J.C., 2021).

When consulting Perry (2012), we set ourselves the task of carrying out a methodology of the sequence of operation of the process.

Analysis of the method and programming of the prototype

Milling and sieving operation methodology

Figure 4 Feeding the raw materia, Ball mill
Source: (Own elaboration, 2021)

a) The raw material, previously weighed (1000 grs) together with the balls, is introduced for grinding in ranges of 10 and 15 min, in the mill, as indicated in fig. Four.

b) The raw material is removed together with the balls and fig. 4

c) Once the sample is collected, it is introduced to the axial sieve to develop the Malleo, as indicated in fig. 5

Figure 5 Axial Sieve
Source: (Own elaboration, 2021)

d) Subsequently, the sieving is started in ranges of 1 min, 5 min according to the operation and specification needs.

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Figure 6 Display, screen of the Axial sieve module
Source (Own elaboration, 2021).

Results of the analysis of the method and programming of the prototype

Characterization of the silica sand

For the purposes of characterizing the raw material, we took on the task of collecting data from the Laboratory of grinding and sieving in an operation mode of 15 min of grinding and 10 min of sieving, below, the results table is indicated of the granulometric analysis.

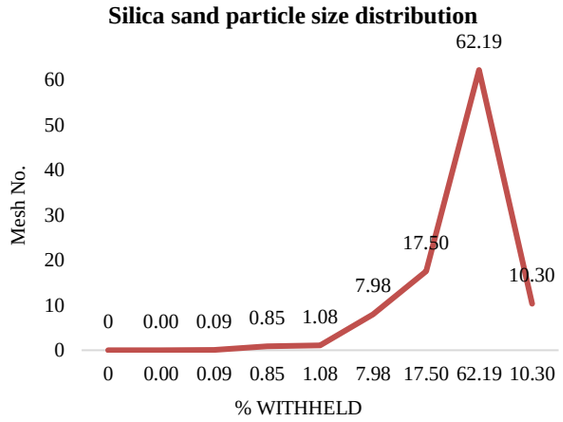
In table 1 it can be observed in an experimental way that the highest% retained is found in mesh 8, with 62.19%, which indicates that it is the product obtained, its granulometry favors since it represents 37.81% of passing solids However, efficiency can be improved by developing N characterizations, until the specification of either the supplier or the customer is met and from the point of view of the investigation of the solid being analyzed. Whether they are zeolites, calcium carbonates, concretes, aggregates, limestone, marble, silicon sands etc. (Chryssis, 1989).

Mesh No.	D (mm)	Mesh weight (gr)	Sample weight (gr)	Fraction	% Retained	% of interns
8	2.36	449.6	0	0	0	100
14	1.4	446.3	0	0	0.00	100
30	600um	437.8	0.9	0.00090	0.09	99.91
40	425um	432.5	8.5	0.00850	0.85	99.15
50	300um	362.6	10.8	0.01080	1.08	98.92
60	250um	380.4	79.81	0.07981	7.98	92.02
70	212um	378	175.01	0.17502	17.50	82.50
80	180um	379.3	621.89	0.62194	62.19	37.81
200	75um	347	103	0.10300	10.30	89.70
0		0				
CHAROLA		400	999.91	1.00	100.00	

Table 1 Characterization of silica sand
Source: (Own elaboration, 2021)

Representation and graphic interpretation of silica sand

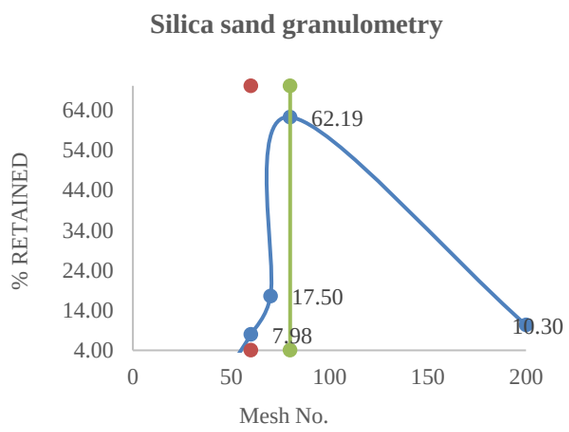
From the data in Table 1, collected from the laboratory, we proceed to develop the particle distribution of the product, the granulometry with respect to the% retained and the granulometry with respect to the sieve opening. Next, the representation of graphic 1, graphic 2 and graphic 3 is indicated.



Graphic 1 *Product distribution*
Source (Own elaboration, 2021)

As can be seen in graphic 1, it is observed that the product is obtained in the 80 mesh, with 62. 19% of retained solids. For study purposes this raw material, we indicate that the corresponding particle diameter is 180 µm.

In the same way with the data obtained in the laboratory, from the table 1, we develop the corresponding granulometry, to confirm the size of the product that is being characterized based on the No. of mesh with respect to the% retained, obtaining Graphic 2.



Graphic 2 *Granulometry of the product*
Source: (Own elaboration, 2021)

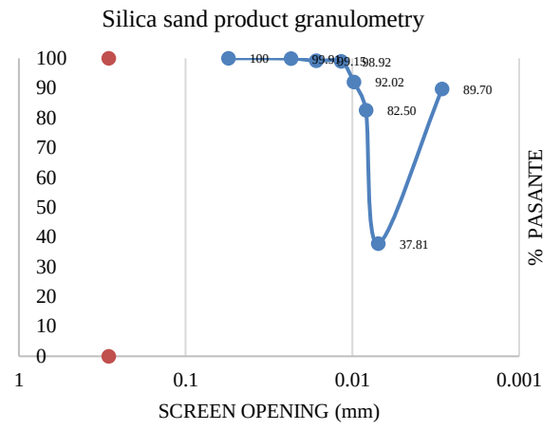
Indeed, it is corroborated and verified that indeed the 80 mesh is the product obtained, according to the literature Perry (2012), silicas are raw materials that are applied in the chemical industry, for the production of Amber colored containers in medicines, in beers and in chemical reagents, of which the blocking of light is necessary since these substances are hygroscopic.

In the same way, from the experimental table, table No. 1, the opening of the sieve of our product is elaborated and analyzed with respect to the% passing, that is, the% that passes through each sieve, according to the particle diameter of silica sand, obtaining 37.81% of solids passing through the 80 mesh. With this, the experiment and the graphical representations of the characterization are concluded.

Without a doubt, this analysis is of great importance for the glass processing industry in its different presentations and applications. (Tapia medina, 2021).

The ball mill and the sieve used in this research for the purposes of writing and publishing this article are functional for the purposes for which they were created, for the investigation and characterization of solids by dry method, with hardness on a scale of Mosh, for soft materials from 0 to 3, with operation up to 60 min of operation of the ball mill with 30 min of rest and with sieving of 5, 10, 15 min according to the needs of the project and research, it should be clarified that the sieve, according to its programming in ARDUINO, in seconds, which works every minute, allowing the restart at the end of the count at 60 seconds of operation. (Mohan & Robbins, 2003).

From the data in table 1, we obtain the% of solids that pass through the sieve opening, as indicated in the graphic 3



Graphic 3 Sieve opening vs% passing
Source: (Own elaboration, 2020)

This efficiency represents 62.19% in an operation time of 15 min of grinding and 10 min of sieving. With 37.81% of solids passing through.

Results

According to Retsch (2012), a laboratory test was developed. Next, the results obtained from the particle distribution of silica sand in a 15 min grinding operation. Where the weight of sample A, fraction A and% Retained A, represents the raw material before being crushed and / or ground by a ball mill and the weight of sample B, fraction B and% Retained B, represents the finished and sieved product, by this prototype, of this research work (Perry, 2012)

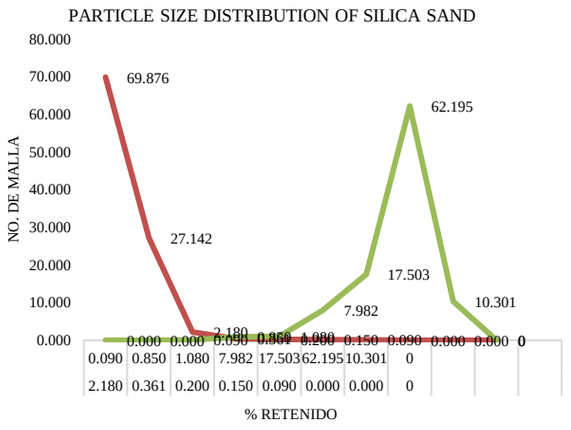
Next, it is indicated in table 2. The laboratory analysis of the distribution of the grinding particle and sieving of the silica sand and in graph 3, the graphic interpretation is observed, obtaining an efficiency of 62.19% of grinding, as product in mesh No. 80 according to the specification of the characterization of silica sand.

Malla	Fracc. A	Fracc. B	% Retenido A	% Retenido B	%Pasante A	%Pasante B
8	0.699	0.00	69.876	0.00	30.12	100.0
14	0.271	0.00	27.142	0.00	72.85	100.0
30	0.022	0.00	2.180	0.09	97.82	99.91
40	0.004	0.00	0.361	0.85	99.63	99.15
50	0.002	0.01	0.200	1.08	99.80	98.92
60	0.002	0.08	0.150	7.98	99.85	92.01
70	0.001	0.17	0.090	17.50	99.91	82.49
80	0.000	0.62	0.000	62.19	100.0	37.80
200	0.000	0.10	0.000	10.30	100.0	89.69

Table 2 Characterization before and after grinding and sieving of silica sand
Source: (Own elaboration, 2021)

Figure 7 Results of sieving in mesh 80
Source (own elaboration, 2021)

The following figure represents the product obtained in mesh No. 80 of the characterization of the silica sand, as a result of the characterization of the silica sand.



Graphic 4 Product obtained in mesh No. 80
Source (Own elaboration, 2021)

Observations

1. After operating the axial strainer for more than one hour, allow 20 minutes so that the motor does not overheat.

2. Press the buttons well, since being a capacitive screen it will not respond correctly if it is not pressed correctly.

3. Operate the ball mill for a maximum of 60 min, let it rest for 30 min, preferably work in less time, to avoid overheating of the motor and the belts.

Suggestions

1. Maintain the mechanical system of the sieve once a year.

2. Lubricate the rods, rails and the mechanical system of the sieve, preferably monthly.

3. When it is required and there is wear of the neoprene coating of the ball mill on its external part, it is advisable to change it, to avoid overheating in the balls.

4. When there is a need and there is deterioration in the bands, it is preferable to change them.

Appreciation

This project was financed by the Technological University of the southeast of Veracruz, by the Rectory, managers and the finance department, who work as a team, to improve the quality of the institution, it would not be possible without the workforce of students of the Chemistry Engineering career to carry out laboratory tests and characterizations of the raw materials under study, for the interpretation of the results and the writing of this article.

Conclusions

This project is functional for the purposes for which it was proposed, however, it can have continuous improvement, to have higher performance in terms of the pretreatment of solid raw materials, not only for the University laboratories, even for the Industry chemistry, it is advisable to improve the time per material, in order to obtain a specific pattern which can help you when looking for a granulometric analysis.
As we now know there are improvements and innovations in control, which are coming to the market in the field of technology that provides instruments, which help us in our daily or specific activities, that is why we seek to make the grinding process more efficient and sieving, from the automated control of the same, with a low economic cost for the purposes and specifications according to the need in the investigation.

References

Chryssis, G. C. (1989). High-frequency switching power supplies: theory and design. McGraw-Hill

Devia Téllez, M. E. (2018). Design of a glass container crushing machine (Bachelor's thesis, Fundación Universidad de América).

Moreno, E. G. (2001). Automation of industrial processes. Valencia: Alpha omega.

Mohan, N., Undeland, T. M., & Robbins, W. P. (2003). Power electronics: converters, applications, and design. John wiley & sons.

Retsch. (2012). Sifted for perfect quality control. Germany: Retsch GimbH.

Santos Carpio J.C. (2021). Procesamiento y análisis en laboratorio química de muestras de geología y planta metalúrgica en proyecto minero cerro lindo.

Technical manual of operation of the Axial sieve, Own elaboration. (2021). UTSV Chemical Plant Laboratory

Tapia medina, C. (2021). Evaluación del concreto adicionando residuos de cerámica y porcelanato.

Perry Robert & Green Don w. " Chemical Engineer's Manual"; 7th Ed; McGraw Hill Co. Madrid (2012).

Smith, Mc cabe, (2007). Unit operations in Chemical Engineering, Seven edition. McGraw Hill Interamericana

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