Determinaiton of the parameters of the drying process of sodium bicarbonate in a pneumatic dryer

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Abstract: This paper describes the process of drying baking soda in a pneumatic dryer. A description of a drying plant with honeycomb elements is provided. Due to the extensive work, only one part of the results of the study is presented, which is related to the material-energy balance, the calculation of the final humidity, the change of the air condition (humidity and temperature) in the bicarbonate drying process. Part of the research results related to the application of I-X - diagram in the drying process of NaHCO3 is presented.

Keywords: PNEUMATIC DRYER, SODIUM BICARBONATE, TEMPERATURE, HUMIDITY, HEAT TRANSFER

1. Introduction

The drying of the material or of a product is accomplished by different processes, depending on the purpose, further use, and the need to process the dried material. Drying can increase the usable value of a dried product [1-3]. By reducing the mass of wet material created by evaporation of moisture, drying can improve the strength, longevity of the product, its relief, additional, processing, appearance, shape, color, taste, and many features relevant to the use of the product [4-6].

The most widespread division of drying is natural drying and artificial drying. Natural drying means to leave it in an open space, being exposed to the wind or radiation of the sun, or being exposed to a drying agent - the surrounding gaseous environment. Artificial drying processes are procedures performed by externally organized coercion on moist material in order to accelerate the removal of moisture from the material [3, 7, 8].

2. Material and method

2.1 Description of the process for the production of sodium bicarbonate

Sodium bicarbonate (baking soda) is a white crystalline powder with crystals of 5-200 μm in size and a bulk density of 900 kg / kg. The solubility of sodium bicarbonate in water is low and does not change significantly with temperature.

Due to the low solubility of NaHCO3, the suspension is subjected to a suspension of NaHCO3 in mother liquor. Thus, a solution of alkaline soda of 105-110 ND is obtained. The DCB solution, which is obtained by the "wet" method in the production of calcined soda, concentration 105-110, ND - is pumped into the reservoir of DCB solution and then free flowing into the reservoir of normal solution.

In the reservoir of the normal solution, in a certain ratio established by the material balance, the mother liquor and the DCB solution are mixed, and the normal solution thus obtained is transported to the top of the carbonation column by a feed pump. A portion of the normal solution is circulated in the column by a circulation pump.

Gas from lime kilns with a CO2 content of 38-42% is added to the lower part of the carbonation column at a pressure of 1.5 - 2 bar. Before moving into a column, the gas is cleared of mechanical impurities in the gas purifier [9, 10]. To ensure a sufficiently high absorption rate, the CO2 content of the gas of the lime kilns must not be less than 38%. The pre-centrifugal humidity of the precipitate is at least 8%. Drying takes place in a pneumatic dryer using heated air in the heater to a temperature of 150 ° C. At the outlet of the dryer, the air temperature drops to 55-60 ° C.

Due to the separation of sodium bicarbonate particles, the air passes through the cyclone, behind which is the dust collector. Dry sodium bicarbonate of 45-50 ° C is brought into the hopper, where one part is taken for refining and medical bicarbonate is obtained, and the other part - as technical bicarbonate - is packaged and marketed. A sodium bicarbonate drying plant consisting of a suction fan, a heater, a dozer, a pneumatic dryer, a cyclone and a blower fan is given in Fig. 1.

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Fig. 1 Sodium bicarbonate drying plant

2.2 Material-energy balance and calculation of the drying process

Table 1: Basic information

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity relative to dry product, Gt</td>
<td>1.712 kg/h</td>
</tr>
<tr>
<td></td>
<td>(15,000 t/year)</td>
</tr>
<tr>
<td>Product Humidity:</td>
<td></td>
</tr>
<tr>
<td>- initial, Co</td>
<td>(8%) 0.087 kg/kg</td>
</tr>
<tr>
<td>- final, Ck</td>
<td>(0.1%) 0.001 kg/kg</td>
</tr>
<tr>
<td>Mean equivalents particle diameter, d_e</td>
<td>35μm</td>
</tr>
<tr>
<td>Particle shape factor, f</td>
<td>1.25</td>
</tr>
<tr>
<td>The maximum diameter of the particulate aggregate, d_max</td>
<td>200μm</td>
</tr>
<tr>
<td>Product density, ρ_m</td>
<td>2.250 kg/m^3</td>
</tr>
<tr>
<td>Material temp at input, t_ω</td>
<td>20°C</td>
</tr>
<tr>
<td>Humidity at the inlet (this = 10 °C, φ_a = 77%)</td>
<td>0.006 kg/kg</td>
</tr>
<tr>
<td>The air temperature behind the heater, t_1</td>
<td>140°C</td>
</tr>
<tr>
<td>Air temperature at the outlet of the dryer</td>
<td>60°C</td>
</tr>
<tr>
<td>Atmospheric mean pressure, p</td>
<td>98.042 Pa</td>
</tr>
</tbody>
</table>
3. Results of research and discussion

3.1 Final humidity calculation

Total moisture losses \( \Delta q \)

\[
\Delta q = q_x - (q_{w} + q_{b})
\]

Average air temperature in the dryer:

\[ t = (t_1 + t_2)/2 = 98^\circ C \]

If the calculated values are plotted in the diagram in Fig. 2, the final humidity calculation is presented [3, 4].


3.2 Amount of air to dry

\[
W = W = G = \frac{147}{0.0324} = \frac{5034}{kg} kg dry air
\]

\[
V = \frac{W}{(1 + \frac{1}{X})} = 5585 m^3/h
\]