High Shear Wet Granulation Of Geopolymer

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August 31, 2021
1. Introduction
2. Screening Phase
   2.1 Composition
   2.2 Samples Preparation
   2.3 Properties Tested
3. Granulation Process
   3.1 Liquid-Solid Ratio
   3.2 Granules Obtained
4. Granules Characterization
   4.1 Sauter Mean Diameter
   4.2 Compressive strength
   4.3 B.E.T
   4.4 S.E.M Images
   4.5 Breakthrough Curves
   4.6 Breakthrough Curves of granules with APTES addition
   4.7 Breakthrough curves comparison
5. Conclusions

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Geopolymer Camp 2021
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PURPOSE OF THIS STUDY
Production and characterization of the geopolymer granules for $\text{CO}_2$ adsorption test inside fluidized-bed column system
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5. Conclusions
<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>AL2O3</th>
<th>SIO2</th>
<th>K2O</th>
<th>H2O</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS2H16</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>SS2.2H16</td>
<td>1</td>
<td>2.2</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>SS2.4H16</td>
<td>1</td>
<td>2.4</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>SS3.8H16</td>
<td>1</td>
<td>3.8</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>SS2H18</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>SS2H20</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>SS2H22</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>22</td>
</tr>
<tr>
<td>SS2H25</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>SS1.96H18</td>
<td>1</td>
<td>1.96</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>SS2K0.9H18</td>
<td>1</td>
<td>2</td>
<td>0.9</td>
<td>18</td>
</tr>
<tr>
<td>SS2.5K0.8H18</td>
<td>1</td>
<td>2.5</td>
<td>0.8</td>
<td>18</td>
</tr>
<tr>
<td>SS3.8H25</td>
<td>1</td>
<td>3.8</td>
<td>1</td>
<td>25</td>
</tr>
</tbody>
</table>

*Table 1: Geopolymer compositions tested*
Figure 2: Different views of the geopolymer monoliths prepared to conduct the screening phase
Figure 3: Properties tested during the screening phase.
Outline

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Figure 4: Size distribution of the granules for different Liquid-Solid Ratio
Granulation Process
Granules Obtained

Figure 5: Images of the granules obtained

(a)  
(b)  
(c)  
(d)  

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<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>SAUTER DIAMETER [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;2.8</td>
<td>3.2958</td>
</tr>
<tr>
<td>2.8 - 1.4</td>
<td>1.9413</td>
</tr>
<tr>
<td>1.4 - 0.8</td>
<td>1.2232</td>
</tr>
<tr>
<td>0.8 - 0.6</td>
<td>0.7660</td>
</tr>
<tr>
<td>0.6 - 0.4</td>
<td>0.4237</td>
</tr>
<tr>
<td>0.4 - 0.3</td>
<td>0.3602</td>
</tr>
</tbody>
</table>

Table 2: Sauter Mean Diameter from a mastersizer 2000
Figure 6: Mean Compressive strength values for different granules dimensions

\[
\sigma = k \cdot \frac{F}{\pi \cdot R_{eq}^2}
\]
Granules Characterization

B.E.T

Figure 7: Surface Area Values

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>SURFACE AREA [m^2/g]</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;2.8</td>
<td>24.281</td>
</tr>
<tr>
<td>2.8 - 1.4</td>
<td>20.750</td>
</tr>
<tr>
<td>1.4 - 0.8</td>
<td>18.187</td>
</tr>
<tr>
<td>0.8 - 0.6</td>
<td>16.975</td>
</tr>
<tr>
<td>0.6 - 0.4</td>
<td>15.354</td>
</tr>
<tr>
<td>0.4 - 0.3</td>
<td>14.957</td>
</tr>
<tr>
<td>Initial powder</td>
<td>82.718</td>
</tr>
</tbody>
</table>

Table 3: Surface Area Values
Figure 8: SEM images of the external (a,b) and internal (c) surface of the granules and (d) of the initial powder
Figure 9: Breakthrough curves of different C/CO Ratio and (d) the comparison
Figure 10: Breakthrough curves of different C/CO Ratio and (d) the comparison
### Granules Characterization

#### Breakthrough Curves Comparison

<table>
<thead>
<tr>
<th>$\text{cm}^2/\text{s}$</th>
<th>10% CO$_2$</th>
<th>15% CO$_2$</th>
<th>20% CO$_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>u1</td>
<td>u2</td>
<td>u1</td>
<td>u2</td>
</tr>
<tr>
<td>5</td>
<td>7.4</td>
<td>5</td>
<td>7.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\text{CO}<em>2/\text{kg}</em>{\text{ads}}$</th>
<th>5.4</th>
<th>6.2</th>
<th>7.4</th>
<th>9.1</th>
<th>10.4</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_p/\text{s}$</td>
<td>18</td>
<td>16</td>
<td>17</td>
<td>14</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>$t_s/\text{s}$</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>20</td>
<td>22</td>
<td>22</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>10% CO$_2$</th>
<th>Zeolite 13x</th>
<th>Si + APTES</th>
<th>Geo</th>
<th>Geo + APTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO$<em>2$/kg$</em>{\text{ads}}$</td>
<td>15.2</td>
<td>10</td>
<td>5.4</td>
<td>8.7</td>
</tr>
<tr>
<td>$t_p/\text{s}$</td>
<td>50</td>
<td>26</td>
<td>18</td>
<td>26</td>
</tr>
<tr>
<td>$t_s/\text{s}$</td>
<td>56</td>
<td>30</td>
<td>22</td>
<td>32</td>
</tr>
</tbody>
</table>

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Conclusions

▶ Good $CO_2$ Adsorption Capability

Other Applications:

▶ Polluttant adsorption
▶ Water Purification
THANK YOU FOR YOUR ATTENTION!