Dangerous fly ash as a solution for global warming

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Background

Global warming is mainly caused by continual rise of CO₂ emissions in the atmosphere, as it can be seen in Fig. 1. Combustion fossil fuels, except CO₂ and other pollutants, produces also fly ash, which is captured by ESP or Baghouse filters. This material is dangerous for humans but it can be used in the post-combustion CO₂ capture to mitigate climate changes. One of the post-combustion technology is adsorption, which was tested in this study. This process has quite high financial demand and for that reason various ways are tested to decrease the cost. One of the possibility is to find low-cost adsorbent, which can be fly ash.

Material and methods

Fly ashes from power plants in the Czech Republic were tested in high-temperature sorption of carbon dioxide. For all samples characterization including pore size distribution, specific surface area, XRF analyses and apparent density was done. The measurement principle is based on calcination loop method. The measurements of sorption properties were performed in a laboratory apparatus in 10 cycles for both samples. One cycle of the measurement consisted of calcination and carbonation part. Calcination was performed with increasing temperature up to 900 °C in the nitrogen atmosphere and carbonation run at 650 °C in the atmosphere of 12 %mol. CO₂ in N₂. The gas mixture used in carbonation part simulated desulphurized flue gas. The arrangement of the laboratory apparatus is shown in Fig. 3. The amount of captured/released CO₂ was analyzed in an infrared analyser ASEKO AIR LF. And then the measured data were calculated to the amount of sorbed/desorbed CO₂ in grams per 100 g of the fly ash.

Results and discussion

Based on the characterization two samples (K31 and Z30) were chosen, because they reached the highest amount of CaO according to XRF; about 30 % wt. Their TGA curves showed very good thermal decomposition. The sorption properties of chosen materials were tested in a fixed-bed reactor (Fig. 3). Both experiments were done under the same conditions mentioned above and the calculated data are shown in Fig. 4. This graph illustrates that the release of CO₂ in calcination steps is always higher then the capture in carbonation part, this suggests the sintering pores. Also from the curves one can see that after each cycle the sorption capacity decrease. The outcome is based on the sintering process which occurs during calcination/carbonation of material containing CaO, respectively CaCO₃. In general, sintering process affects the pore size together with BET surface because it causes clogging of pores and therefore the sorption capacity decrease. This statement is supported by the results of BET surface and pore size distribution before and after the measurement, which are stated in Table 1. Bet_1 identify BET surface before experiments and Bet_2 after cyclic tests of sorption desorption and TPV is abbreviation for the total pore volume and the labelling is with the same meaning.

The sample BET_1 BET_2 TPV_1 TPV_2

<table>
<thead>
<tr>
<th>The sample identification</th>
<th>BET_1 m²/g</th>
<th>BET_2 m²/g</th>
<th>TPV_1 cm³/g</th>
<th>TPV_2 cm³/g</th>
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<tbody>
<tr>
<td>K31</td>
<td>11.461</td>
<td>9.431</td>
<td>0.1253</td>
<td>0.0489</td>
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<tr>
<td>Z30</td>
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<td>7.215</td>
<td>0.1219</td>
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REFERENCES