THE USE OF THE HYDROTHERMAL METHOD FOR SORBENTS SYNTHESIS

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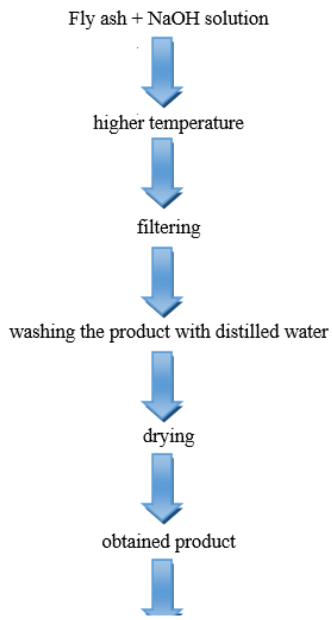
INTRODUCTION

The energy industry in the world is still mainly based on fossil fuels. Due to the growing awareness of society and the interest in environmental protection, it is gradually moving away from it and new waste recycling methods are being sought. The source of waste is, among others, combustion by-products generated during the operation of power facilities that burn a variety of solid fuels. The global production of fly ash exceeds 500 million ton/year. However, only 15% are reused. Thanks to the in-depth knowledge of the physicochemical properties of fly ashes and the ability to use their specific features, their use has increased. New products began to be developed, in which fly ash is the main ingredient. The fly ash in its structure has a significant content of silicon and aluminum, thanks to which it is a good substrate for the synthesis of zeolites. Due to its huge diversity, there is no universal method of converting them into zeolitic material[1,2]. The aim of the thesis was to select the optimal parameters in the hydrothermal method of zeolite synthesis, in order to obtain the zeolite material with the highest possible efficiency.

EXPERIMENTS

The hydrothermal method is one of the best known methods of zeolite synthesis. It is a complex physicochemical process, taking place in the liquid phase, in an alkaline environment. The process involves solid substances (amorphous and crystalline). The temperature range in which the synthesis is carried out is 80-200 °C. Application of too high temperatures can lead to damage to zeolite structures. The most important parameters for the synthesis of zeolites are: temperature, time and pressure. The process can take place in two variants: under increased pressure in the autoclave and under atmospheric pressure. Both stages differ only in the value of the pressure over the reacting slurry. It is usually one-step process **(Picture 1)**[1].



Picture 1: Scheme of hydrothermal synthesis of zeolites from fly ash [1]

RESULTS AND DISCUSSION

After the test, the obtained sample was analyzed by X-ray diffraction at room temperature. Based on the obtained spectra, it was possible to identify the resulting zeolite form.

The XRD diffraction pattern before synthesis (**Chart 1**) , shows the presence of basic constituents in the studied fly ash.. They are: quartz, mullite and calcium carbonate.

On the diffractogram of fly ash after synthesis (**Chart 2**), characteristic reflections for sodalite can be observed. It means that the proposed method of conducting the synthesis process was correct. No other zeolite forms were found in the tested material. Characteristic reflections from quartz and mullite are still present. The intensity of reflections from quartz decreased. No reflections from calcium carbonate were observed.

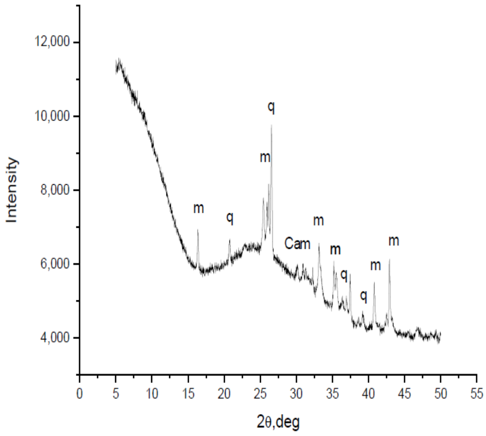


Chart 1: XRD diffractogram of fly ash from coal combustion in EDF power plant before the synthesis, where: m-mullite, q-quartz, Ca-calcium carbonate

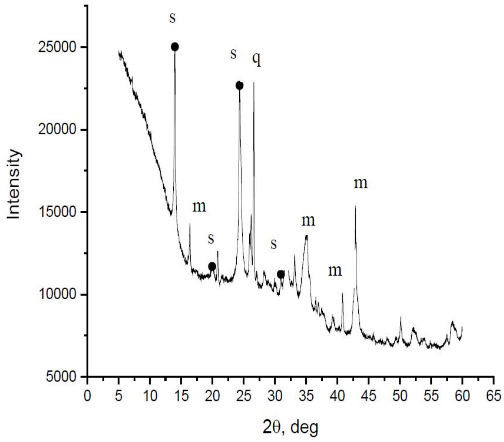


Chart 2: The fly ash diffractogram after hydrothermal synthesis, where: s-sodalite, m-mullit, q-quartz

CONCLUSION

After the hydrothermal synthesis, the product was identified by X-ray diffraction (XRD). This made it possible to confirm the presence of zeolite with a crystalline structure. The obtained zeolite is sodalite. It is built of cuboctahedrons, connected with each other by square walls. There are 24 silicon or aluminum ions in each of the cuboctahedron that combine with the oxygen anions at the endings. Its structure includes 8 hexagonal and 6 square front faces[3].

Its chemical formula is: $Na_8[Cl_2(AlSiO_4)_6]$[4]

The hydrothermal method is the most common method of fly ash zeolite synthesis. The process takes place in a liquid environment, thanks to which synthesis is easy to perform. It is less energy-intensive compared to other methods. Also from an economic point of view, this method is relatively low cost. For this reason, it is possible to obtain zeolites on an industrial scale. The disadvantage of the hydrothermal method is the formation of highly alkaline wastewater, which must be disposed of later. It also occurs with lower efficiency compared to, for example, the fusion method.

REFERENCES

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