12. University of Liverpool, Department of Physics, Nuclear Physics radiometric Subject page https://ns.ph.liv.ac.uk/~ajb/radiometrics/glossary/sodium22.html
13. Wonjin Kim, Chaewon Leea, Jaegi Lee, Young Rang Uhm, Gwang-Min Sun, Source Correction for Positron Annihilation Lifetime Spectroscopy: A Monte Carlo Study, Transactions of the Korean Nuclear Society Virtual Spring Meeting July 9-10, 2020
14. K.Siemek and J.Dryzek, The Computer Code for Calculations of the Positron Distribution in a Layered Stack Systems, Proceedings of the 41st Polish Seminar on Positron Annihilation,Lublin,September 9-13,2013
15. Essmat Mahmoud Hassan Sayed Ahmed, Characterization of Control Mesoporous Glasses (CPGs) Using Positron Annihilation Lifetime Spectroscopy (PALS), PhD thesis https://sundoc.bibliothek.uni-halle.de/diss-online/08/08H048/
16. Schultz, Peter J. and Lynn, K. G, Interaction of positron beams with surfaces, thin films, and interfaces, Rev. Mod. Phys., 60, 1988, 701
17. R.S. Brusa, W. Deng, G.P. Karwasz, A. Zecca, Doppler-broadening measurements of positron annihilation with high-momentum electrons in pure elements, Nucl. Instr. and Meth. in Phys. Res. B 194 (2002) 519–531
18. Uedono, Akira & Ishibashi, Shoji & Nagayasu, Oshima & Suzuki,Ryoichi & Sumiya, Masatomo. (2014). (Invited) Point Defect Characterization of Group-III Nitrides by Using Monoenergetic Positron Beams. ECS Transactions. 61. 19-30. 10.1149/06105.0019ecst.
19. Monograph "Positron Annihilation in Semiconductors" R.Krause-Rehberg and H.S. Leipner Springer-Verlag , Berlin 1999 Vol. 127 of Series "Solid-State Sciences" ISBN 3-540-64371 - 0

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SYNTHESIS OF ZEOLITES FROM RAW MATERIALS

Zeolites are aluminosilicate materials, and its properties are determined by the interaction of the two main minerals in composition: silicon (Si) and aluminum (Al). [1-3] The Si / Al ratio in its oxide forms (SiO_2 / Al_2O_3) determines the possibility of the formation of specific zeolites, since each type

has a specific ratio associated. [2,3] Zeolites are porous materials that are currently used in different applications in industry, mainly for adsorption processes and as catalysts. [2,4]

The zeolite structure is produced in a hydrothermal reaction with a strong base, when the Si and Al atoms are rearranged, thus forming a stable structure with the compensating cation X^+, which is the base cation, usually sodium (Na^+) or potassium (K^+), as seen in the Figure 1. [2, 5-7]

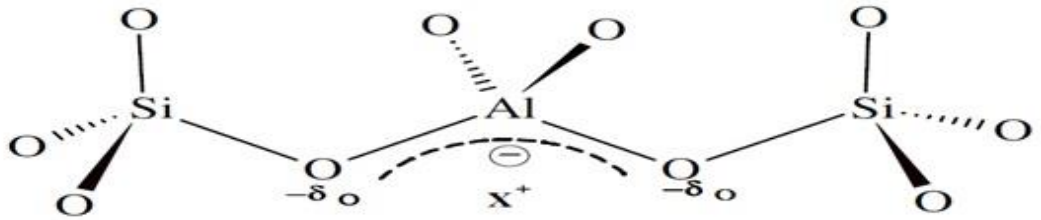

Figure 1. Structural figure of zeolite, where X + is a compensation cation. [2,3]

Figure 1 shows the structure of a zeolite, formed by the two main components. When selecting the type of ash, the presence of different minerals: potassium (K), calcium (Ca) and iron (Fe) are also a possibility. [3,4] Unfortunately, if these minerals are present in the raw material in high concentrations, the possibility of zeolite synthesis declines significantly. The reason is the competition between these three minerals for the reaction with the base, leading to the formation of different materials. [2,5]

The synthesis method used in the zeolite formation has many associated variables that are responsible for the type of product obtained, but the main parameters are temperature and time. Temperature determines how strong the interaction of the base with minerals will be; and time determines the phases of crystal formed in the zeolite structure. [2, 6,7]

Zeolites synthesized with the method are characterized by their crystallinity and porosity, which are determined by X-ray diffraction analysis (XRD) and BET (Brunauer-Emmett-Teller) analysis, respectively. Further, the confirmation of the zeolite structure is accomplished using the scanning electron microscopy (SEM) analysis, where the image of the obtained material is analyzed and compared with the materials obtained as a result of X-ray analysis. [1,3,7]

Zeolite synthesis is possible using two different methods: classic and two-stage method, which vary according to the interaction intensity between the ions and the base associated. [1,2] Moreover, the synthesis can be carried using pure oxides of the main minerals, following the method of the International Zeolite Association (IZA) or a variant containing raw materials, which have high concentration of these minerals. From the materials available, the main products currently used in the synthesis are coal fly ash and rice husk

ash. [2,4,6] The parameters of the synthesis methods have many variations and depend primarily on the concentration of materials in the ash, where adjustments must be performed to accomplish the synthesis [1-5]. Therefore, another important analysis is the determination of the characteristics of the materials using XRF (X-ray fluorescence analysis), in which the main concentration of oxides is analyzed. [2,7]

In Russian Federation, since raw materials from biomass are not available, the main materials suitable for the zeolite synthesis are coal ashes. [1,3,5] After analyzing the materials, considering the availability and characteristics favorable for synthesis, the main types of coals that can be used in the synthesis are: coals from the Seversk and Kemerovo regions. [1,2,5] Furthermore, optimization of the process must be performed aiming for the improvement of time and temperature in the synthesis process. [4,6]

REFERENCES

1. ЮРЬЕВ И. Ю. Стеновые керамические изделия с использованием микродисперсных алюмосиликатных отходов ТЭС. Томск: Наука, 2013. 23 с.
2. IZIDORO J. d. C. Dissertação (Doutorado em Ciências na Área de Tecnologia Nuclear - Materiais) – Programa de Pós-Graduação em Ciências na Área de Tecnologia Nuclear – Materiais. São Paulo: Instituto de Pesquisas Energéticas e Nucleares, 2013. 148 f.
3. PETKOWICZ D. I.. Zeólitas sintetizadas como fontes alternativas de silício e alumínio. Aplicação em fotocatálise. Dissertação (Mestrado em Ciência dos Materiais) – Programa de Pós-Graduação em Ciências dos Materiais. Porto Alegre: Universidade Federal do Rio Grande do Sul, 2009. 124 f.
4. INTERNATIONAL ZEOLITE ASSOCIATION (IZA). Databases. Washington: 2020.
5. КАРТАШОВ К. К. Модернизация котла при переходе на другой тип угля. Томск: Наука, 2017. 96 с.
6. BIESEKI L. E. A.. Zeolite A synthesis employing a Brazilian coal ash as the silicon and aluminum source and its applications in adsorption and pigment formulation. V. 16, São Carlos, 2013, pp. 38-43.
7. F. CORIOLANO A. C. et al. Aplicações ambientais de zeólitas na indústria do petróleo. pp. 9-18, 2015.