

EXPERIMENTAL DISSOLUTION OF ASBESTOS, AIMED ON PASSIVATION OF ASBESTOS WASTE DUMPS

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A number of asbestos mines in the Rhodope Mountains, SE Bulgaria, were extensively exploited for anthophyllite asbestos in the middle of the 20th century. After the late 70-ies, when mining was discontinued for safety regulation reasons, a large number of unsecured asbestos dumps was left behind. These dumps are currently very hazardous, because of their location close to settlements and because neither remediation nor any kind of insulation have been done there.

From financial point of view, all existing approaches for securing asbestos dumps represent pure expenditure (DELLISANTI *et al.*, 2009; YANAGISAWA *et al.*, 2009; GUALTIERI, 2000). In contrast, the idea behind the experiments reported here is to convert asbestos into another, usable product, using cheap reactants and reasonable temperatures, in order to minimize the conversion cost. Additional motivation for the experiments was the fact that asbestos are calcium- and magnesium-bearing silicates. These cations readily react with CO₂, providing opportunities for the so called “mineral CO₂ sequestration” – another “greening” effect.

In this study complete decomposition of anthophyllite- and tremolite-asbestos was achieved by treatment with NaOH and formation of brucite, sodium carbonate hydrate and sodium silicate as run products. The experiments were performed in a Teflon covered stainless steel autoclave, where asbestos was reacted with NaOH in aqueous solution, at temperatures 90 and 200°C. Two types of experiments were conducted: with heat pre-treated anthophyllite-asbestos and raw, non-treated anthophyllite and tremolite-asbestos. In the first case anthophyllite-asbestos was heated at 950°C for 4 hours and then reacted with highly concentrated solution of sodium hydroxide (25 M) at a temperature of 200°C. The run product was gelatinous substance without any trace of asbestos. In the second series of experiments, asbestos was reacted with the same concentrated solu-

tion of NaOH (pH = 15.4), but at temperatures 90 and 200°C. Complete decomposition of asbestos was achieved only in the experiments at 200°C. Brucite was the only one newly formed phase (Fig. 2), determined by powder XRD analysis.

In order to check the influence of concentration and pH of the aqueous solution over the degree of asbestos dissolution, a third series of experiments were accomplished, using concentrations in the range 1 M to 27.5 M NaOH. Considering the equation: $Mg_7Si_8O_{22}(OH)_2 + 16Na(OH) = 7Mg(OH)_2 + 8Na_2SiO_3 + 2H_2O$ our presumption was that a pH = 14 (provided by 1 M NaOH) would be enough to convert asbestos. However, the experiment with 1 M NaOH solution resulted in just partial dissolution of anthophyllite and formation of respectively small amount of brucite. The reason presumably was that the reaction leads to falling pH down to 11, where further reaction stops. Obviously, the extreme pH values are crucial for the complete dissolution of anthophyllite- and tremolite-asbestos in this experiment. The results of autoclave experiments demonstrate that under suitable conditions (pH > 11) asbestos are readily converted to brucite and sodium silicate (Fig. 3), which are both valuable by-products and could be used for industrial applications, or reacted with CO₂ for its mineral sequestration.

References

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- GUALTIERI, A. F. (2000): Journal of Applied Polymer Science, 75: 713–720.
- YANAGISAWA, K., KOZAWA, T., ONDA, A., KANAZAWA, M., SHINOHARA, J., TAKANAMI, T. & SHIRAIISHI, M. (2009): Journal of Hazardous Materials, 163: 593–599.



Fig. 1. BSE image of anthophyllite-asbestos.

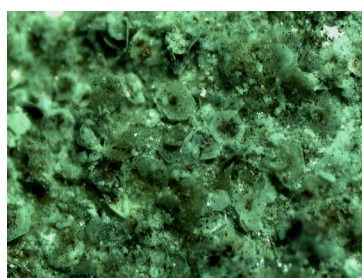


Fig. 2. Microphotograph of brucite.

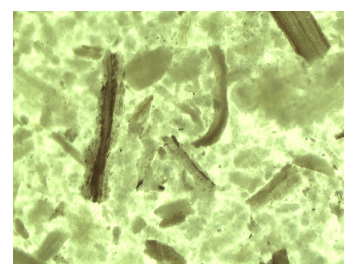


Fig. 3. A gel of destroyed anthophyllite in sodium silicate sol.