# THE INFLUENCE OF $SiO_2$ ADDITIVE ON THE MAYENITE FORMATION PROCESS AND ITS ADSORPTION CAPACITY FOR THE REMOVAL OF $Cu^{2+}$ / $SO_4^{2-}$ IONS

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Mayenite ($C_{12}A_7$) has recently attracted considerable research attention due to its outstanding accelerating effect and rapid hardening behaviour [1], as well as its high oxygen mobility, ionic conductivity, and catalytic properties compared with other calcium aluminates [2]. The synthesis route influences its practical applications, as well as the type and concentration of intercalated ions [3]. In previous work [4], it was observed that in unstirred $CaO–Al_2O_3–H_2O$ suspensions, when the molar ratio $CaO/Al_2O_3$=2.8, after 4 h of isothermal curing at 130 °C katoite was formed. Synthetic katoite at 350 °C fully recrystallised into mayenite. To the best of our knowledge, no data has been published, and it is still completely unknown how intercalated $SiO_2$ in the mayenite structure affects its adsorption properties.

This work aimed to determine the formation (from synthetic precursor) and adsorption properties of pure mayenite (M350) and mayenite with intercalated $SiO_2$ (MS350) after 1 h extra calcination at 350 °C. The synthesis was carried out in unstirred suspensions, with molar ratios of $CaO/(Al_2O_3+SiO_2)$=2.8 and $SiO_2$=0 or 0.25. The liquid-to-solid ratio of the suspension was 10:1. Hydrothermal synthesis conditions: 130 °C, 1 h. Adsorption experiments were carried out at 25 °C for different time periods. 1 g of adsorbent was added to 100 ml of a $CuSO_4$ aqueous solution containing 2.5 g/L $Cu^{2+}$ ions.

It was observed that the $SiO_2$ additive did not influence the thermal stability of the products: in both systems, synthetic katoite fully decomposed to mayenite at 350 °C.

It was obtained that, after 3 min of adsorption, the amount of the adsorbed ions by M350 was equal to 22.5 mg $Cu^{2+}$/L (9%), and after 60 min duration, 100.5 mg/g $Cu^{2+}$ ions (40.2%) were adsorbed (Table 1). In comparison with M350, MS350 has better adsorption capacity for copper ions: 3 min, 76.5 mg/g, and after 60 min, 131.5 mg/g of copper ions were absorbed. It is 30.6% and 52.6%, respectively. It was also observed that MS350 has better sorption properties for $SO_4^{2-}$ anions: after 60 min, the adsorption capacity of MS350 was 1.5 times higher than that of M350.

It was observed that mayenite is unstable during adsorption and fully reacts under all experimental conditions (Fig. 1). After adsorption, the diffraction peaks characteristic of ettringite are higher in sample MS350.

Table 1. The adsorbed amount of $Cu^{2+}$ ions (a) and $SO_4^{2-}$ anions.

| Initial concentration of $Cu^{2+}$ = 2.5 g/L | | The amount of adsorbed $Cu^{2+}$ ions and $SO_4^{2-}$ anions, mg/g | | |
|---|---|---|---|---|
| | Duration of adsorption | 3 | 20 | 60 |
| M350 | $Cu^{2+}$ | 22.5 | 83 | 100.5 |
| | $SO_4^{2-}$ | 0 | 37.5 | 115 |
| MS350 | $Cu^{2+}$ | 76.5 | 95 | 131.5 |
| | $SO_4^{2-}$ | 0 | 40 | 170 |

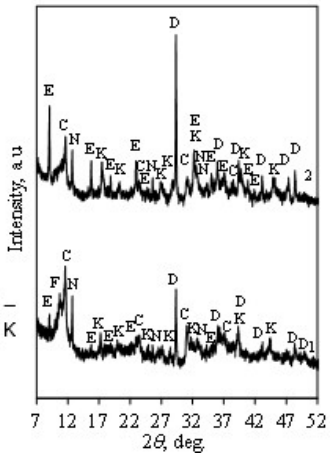


Fig. 1. XRD patterns of products after adsorption. Adsorbent: 1 – M350, 2 – MS350. Indexes: E – ettringite, C – calcium monocarboaluminate, N – posnjakite, K – katoite, D – calcite, F – calcium aluminum oxide carbonate hydroxide hydrate.

These results confirmed that after calcination of the synthesis products, pure mayenite and mayenite with intercalated $SiO_2$ were formed. $SiO_2$ additive gives a significant improvement in the adsorption properties of mayenite with intercalated $SiO_2$. Our research indicates that adsorption reactions are specific to chemisorption.

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