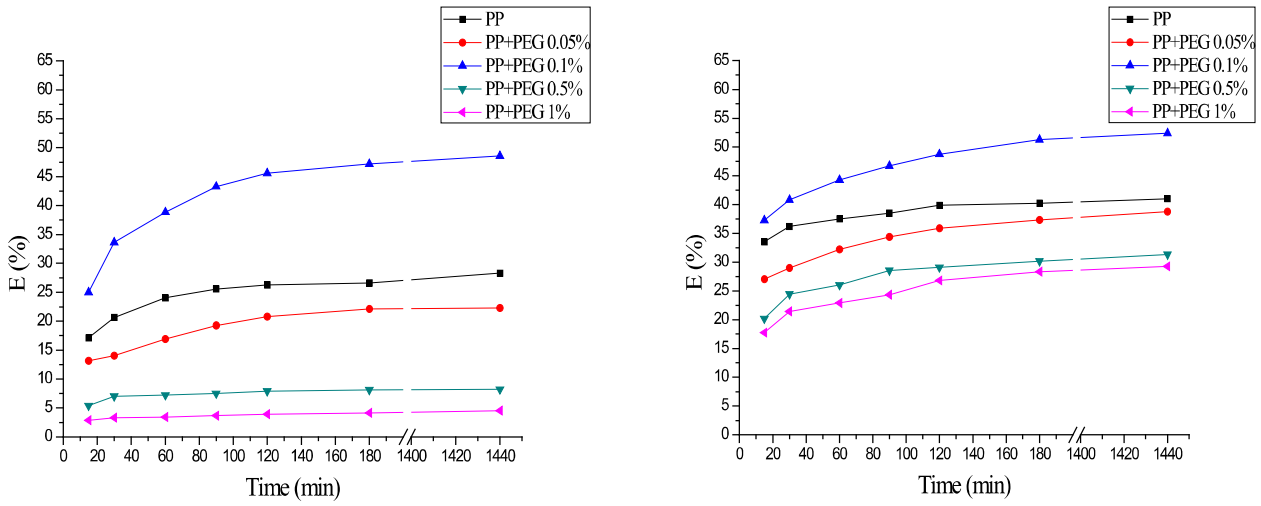
tion of PEG is not enough to improve the sorption activity of OP. Meanwhile increasing the concentration of modifier reduces the removal degree of the metal ions due to closing the active centers of peel surface.

Figure 3 represents a comparative analysis of Zn^{2+} and Cu^{2+} ions sorption by modified PP at different concentrations of PEG.

The consequence of sorption activity of modified pomegranate peels are the same as in the case of modified orange peels: 0.1 % > 0.05 % > 0.5 % > 1 %. The removal degree of zinc (II) ions by PP-PEG 0.1 % highly increases in comparison to the initial pomegranate peel (49 %). The lowest removal degree of zinc (II) ions by modified PP (about 5 %) has been observed at the concentration of PEG = 1 %.



a) Zn^{2+} b) Cu^{2+}

Figure 3 – Dependence of removal degree (%) of (a) Zn^{2+} and (b) Cu^{2+} ions on time by modified PP at different concentrations of PEG

The adsorption ability of modified PP towards Cu^{2+} ions are shown in Figure 3 (b). The extraction degree of copper (II) ions by modified polyethylene glycol reaches 52%.

According to the results from the graphs of removal degree dependence of HM ions from time, it can be concluded that the optimal time of equilibrium establishment is 180 minutes. The concentration of the modifier (PEG) equal to 0.1% is optimal to reach the highest removal degree of the metal ions from aqueous solutions, while the lowest results are observed at 1 %. The removal of Zn^{2+} and Cu^{2+} ions by modified OP is about 75 % and the removal degree by modified PP reaches up to 50 %.

Figure 4 shows a comparative analysis of Zn^{2+} and Cu^{2+} ions sorption by modified OP at different masses of sorbents. It can be seen from the graphs that with increasing the mass of the modified orange peel the removal degree of zinc (II) and copper (II) ions also increase. However, there is no considerable difference between the removal degree at 2 g and 2.5 g. Hence, 2 g of modified orange peel was chosen as the optimal mass of sorbent for removal of both Zn^{2+} and Cu^{2+} ions. The removal degree of Zn^{2+} and Cu^{2+} ions by the optimal mass of modified OP reaches about 80 %.

Figure 5 represents a comparative analysis of Zn^{2+} and Cu^{2+} ions sorption by modified PP at different masses of sorbents. In the case of modified pomegranate peel, 2.5 g was the most effective for sorption of zinc (II) and copper (II) ions. The removal degree of Zn^{2+} ions was 80 % and of Cu^{2+} ions was 70 %.

Analysis of isotherms of the sorption process of $Zn^{2+}$and Cu^{2+}ions from aqueous solutions

Sorption isotherms are of great importance for describing the sorption process. There is no unified model that accurately and fully describe all types of adsorption on different interfaces. Three of the most frequently used models (Langmuir, Freundlich and BET) were used to describe the process of HM ions sorption by the obtained composite materials. Table 1 summarizes the isotherm constants of sorption by composite materials, where K is adsorption equilib-