The use of industrial waste as an adsorbent solves 2 problems: 1) purification of water from pollution; 2) wastes disposal. For the first time, secondary commodities of refractory material chamotte clay (ChC) were used for water purification. ChC is a white heat-treated kaolin clay with a stone properties, resistant to aggressive media, which contains highly dispersed hydroaluminosilicates. The clay does not require additional purification after secondary use. It can be used in industry in large quantities [10, 11].

Polyvinylpyrrolidone (PVP) was chosen as a modifier. The choice of modifier is based on the availability and safety of this compound. The presence of the lactome cycle in PVP macromolecule ensures its good solubility in water [12]. The high molecular weight PVP compound is chemically stable and capable of complexation due to the presence of potential nitrogen monoxide donors in its structure. The binding of PVP increases pores on the clay surface, thereby improving its sorption properties [13, 14]. The adsorbing properties of polyvinylpyrrolidone allow it to be used as part of detoxifying agents. It is used in medicine as a stabilizer of emulsions and suspensions [14].

## Experimental part

*Materials and methods.*

In this work, chamotte clay (the Ukrainian deposit Teplosvet Inzhiniring, LLC, Kiev) was selected as an object of the study and polyvinylpyrrolidone 10000 (AppliChem GmbH) – as a modifier. To prepare model solutions for studying the adsorption properties of the obtained sorbents, chemically pure grade salts of $Pb(NO_3)_2$ and $CdCl_2$ (Laborfarm) were used. The residual concentrations of $Pb^{2+}$ and $Cd^{2+}$ ions were determined by atomic absorption spectroscopy on a 'Shimadzu 6200' (Japan) instrument.

The obtained samples were studied by physicochemical methods of analysis, which included FTIR – spectroscopy (Spectrum 65, Perkin Elmer, USA), scanning electron microscopy (SEM) (Zeiss Supra 40VP instrument) to determine particle size and topography, elemental analysis by EDAX (energy dispersive spectroscopy) method to study chemical composition (Quanta FEG 250 scanning electron microscope, FEI, USA)

*Composite sorbents obtainment.*

The process of obtaining composite material consisted of the following steps:

1) A weighed portion of ChC (20 g) was poured into 100 ml of a 1% PVP solution (these objects did not need preliminary treatment). The resulting mixture was stirred using a dynamic stirrer for 1 hour, then left for 24 hours.

2) the drying process was carried out at T368–373K for 3-4 hours. The resulting sorbent was subjected to grinding to obtain a homogeneous powder mass.

*Adsorption experiments.*

A portion of the obtained sorbent was added to a 10 mg/l aqueous solution containing lead or cadmium ions at a temperature of (296 ± 2) K. At certain time intervals, samples were taken, filtered, and the content of heavy metal ions was determined. The degree of extraction of the studied ions was calculated by the Formula 1:

$$E = (C_0 - C_e) / C_0 * 100\%, \quad (1)$$

where E is the degree of extraction of metal ions,%;

$C_0$ and $C_e$ – initial and equilibrium concentrations of metal ions, respectively, mg/l.

## Results and discussion

The technical characteristics of the chamotte clay used in the current work are presented in Table 1 [15].

**Table 1** – Technical characteristics of the ChC [15]

| Specifications | Values |
|---|---|
| Average grain size | 2 mm |
| Moisture absorption | from 2% to 20% |
| Humidity | not more than 5% |
| Refractoriness | from 1550$^0$C to 1850$^0$C |

The technical characteristics of ChC are especially important, since with prolonged storage or upon expiration (3 years) it loses its unique properties [16].

The structure of the modifier for creating the sorbent (PVP) is shown in Figure 1. The presence of the lactome cycle in the polymer macromolecule ensures solubility in water. PVP molecules in aqueous solutions are static tangles that bind molecules that results ability to complexation with ChC [17].

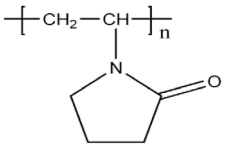


**Figure 1** – Molecular structure of PVP