New generations of materials obtained in order to metal ions removal from water

(a) Summary

Habilitation thesis entitled “New generation of materials with applications in metal ions removal form water” summarizes scientific and also research activity carried out after defending my PhD thesis, when I obtained the PhD into the field of Chemical Engineering, confirmed by Education Ministry order no. 3439 issued on 12.03.2008.

Habilitation thesis was structured into three main parts: Part one (b-i) – Scientific, professional and academic achievements; Part II (b-ii) – Proposal of professional, scientific and academic career evolution and development; and Part III (b-iii) – References, based on 31 Thompson Reuters (ISI) indexed research papers plus 10 papers indexed in other national and international data bases. I am the leading author of 12 out of these 31 papers and coauthor of 19 papers.

First part of habilitation thesis is shortly presenting my main professional, scientific and academic achievements from the moment when I defended my PhD thesis until present. Research directions developed and deepened during postdoctoral period are conducted in close relation with chemical engineering and also environmental protection areas.

Main objective of the scientific and research activity, in which I was involved was represented by preparation of a new generation of materials used in environmental protection, and especially for metal ions removal from water by using adsorption.

The promoter of this objective approached in habilitation thesis was a POSTDOC scholarship which I obtained through national competition during 2010-2013 by the strategic grant “Performance by postdoctoral for integration into the European Research Area” (PERFORM–ERA) ID–57649, co-financed by the Structural Funds. The research theme was “Functionalized materials in environmental protection”.

Starting from the fact that metal ions water pollution represents one of the greatest environmental problem, a major concern is represented by their removal from water, which impose development of physical, chemical, physical-chemical and also biological

methods in order selective elimination of pollutants. The most eloquent method forms the economical and also efficiency point of view is adsorption.

Starting from these premises habilitation thesis follows the projection and development of an experimental model for production of new generation materials, whose adsorptive properties are improved through functionalization with nitrogen, phosphorus and

Two functionalization methods were used: physical (impregnation) using SIR-Solvent-Impregnated-Resin methods and chemical (synthesis) using „One–Pot" Kabatachnik–Fields reaction.

Into studies performed, in addition to classical material bearing by impregnation, also studied and mentioned in research papers, was developed a new functionalization method n dynamic regime, on the column, method which is also mentioned in literature and which has not been applied yet.

Were studied three different polymers from Amberlite XAD series (XAD7, XAD8 and XAD4) and one Polysulfone (PSf) polymer which were functionalized by impregnation with phosphorus and sulfur pendants groups using di-(2-ethylhexyl) phosphoric acid (DEHPA) as extractant.

Also, ten new chelating polymers were obtained by chemical synthesis, by functionalization with amino-phosphinic groups (S1-S4, C1, C2) and amino-phosphonic acid groups, gel type polymers (APA1, APA2) and macroporous one (APA3, APA4) starting from styrene-1% divinylbenzene and styrene-15% divinylbenzene, propionaldehyde and benzaldehyde.

After functionalization all produced materials were physical-chemical characterized using various analyses methods such as: scanning electron microscopy (SEM) coupled with X-Ray photoelectrons dispersion (EDX), Fourier transform infrared spectroscopy (FT-IR) and thermal analysis (TG-DTA).

After obtaining and characterization of materials, these were tested to establish their adsorption capacities for metal ions removal from water.

In this sense were performed thermodynamic, kinetic and equilibrium studies.

Thus, a number of physical-chemical parameters, such as: solutions pH, adsorbent material amount, contact time, initial concentration of the metal ions and temperature were studied.

For the materials whose support was represented by Amberlite XAD7 and Amberlite XAD8 resins have been studied the possibility of Zn^{2+}, Cd^{2+} and Cr^{3+} ions removal.

For Cr^{3+} adsorption process on Amberlite XAD7 and also Amberlite XAD8 functionalized materials by impregnation with DEHPA was proposed an adsorption mechanism. Based on proposed mechanism the adsorption process was optimized by modeling the adsorption experiments using factorial design. Adsorbent properties of Polysulfone (PSf-DEHPA) material were studied for removal of Cu^{2+} ions. In case of Amberlite IR120-Na material experimental studies were focused on removal of Cs^{+} ions from aqueous solutions.

All materials obtained by chemical synthesis were tested in order to remove Cu^{2+} and Ni^{2+} form aqueous solutions.

Behavior of the metal ions adsorption process from aqueous solutions was studied using Langmuir and Freundlich isotherms.

For the kinetic studies of the metal ions adsorption on studied materials were used the pseudo-first order and respectively pseudo-second order kinetic models. By analysis of correlation coefficient was found that the metal ions adsorption process is more accurately described by the pseudo-second order kinetic model.

Were calculated the values of the separation factor, R_L and it was found that in all cases this was comprised between 0 and 1, which means that the absorption process is favored in the adsorbent-adsorbate system.

From studies presented was demonstrated that all obtained materials present representative performance for metal ions removal from water by adsorption and the process efficiency is higher in the case of materials obtained by the physical functionalization method – Solvent- Impregnated- Resin- SIR.

Second part of habilitation thesis present the development plan of didactic, research and academic career.

The references are included in the third part of habilitation thesis, these are 186.