ADSORPTIVE REMOVAL OF SELECTED HEAVY METALS FROM URBAN STORMWATER RUNOFF

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The Future of Urban Water: Solutions for Livable and Resilient Cities
Paris, 24-26 Jan 2011

Background

Urban stormwater runoff characteristics:

- contaminants,
- high velocity flow with very high picks.

Most frequently detected priority pollutants in urban runoff are:

- lead and zinc (94%), copper (91%), chromium (58%), arsenic (52%), cadmium (48%), nickel (43%), etc. (adopted from: Strassler, et al., 1999)

Heavy metals can have:

- acute and chronic toxic impact on aquatic life,
- adverse effects on human health.

Research Statement

Adsorption has proved to be a promising method for removing dissolved metal ions from water.

Many researches revealed that effective removal of heavy metals can be achieved by using:

- iron oxide based adsorbents e.g. Iron Oxide Coated Sand (IOCS) - by-product from water treatment plant

Research on heavy metal removal from stormwater runoff:

- majority of work using filtration/adsorption is conducted as treatment in a single heavy metal system.

Goal and Objectives

The goal of this research was to better understand and advance knowledge on adsorptive removal of selected heavy metals by using iron oxides coated sand (IOCS).

Main objectives:

- Assess effect of water quality (e.g. pH, HCO_3^-) on co-occurring stability of Cd, Cr(III), Cr(VI), Cu and Pb in water.
- To determine competitive adsorption efficiency of IOCS for removal of selected metals at different HCO_3^- concentrations.

Composition of Model Water

Materials and Methods

Parameters	Model water *	Unit
pH	6	-
Cr(III)	25	µg/l
Cr(VI)		µg/l
Cd	25	µg/l
Cu	140	µg/l
Pb	525	µg/l
HCO_3^-	0 and 100	mg/l

* Model water was prepared with demineralized water.

Experimental Set-up

Materials and Methods

Model water

500 ml PE-bottle with(out) IOCS

Shaker - 100 rpm

Sampling through filter paper of 0.45 µm pore size

Acidification of samples (conc. HNO_3)

Sample analysis (AAS-GF)

PHREEQC was used for equilibrium predictions of selected metals under studied conditions.

Extraction of IOCS Coating

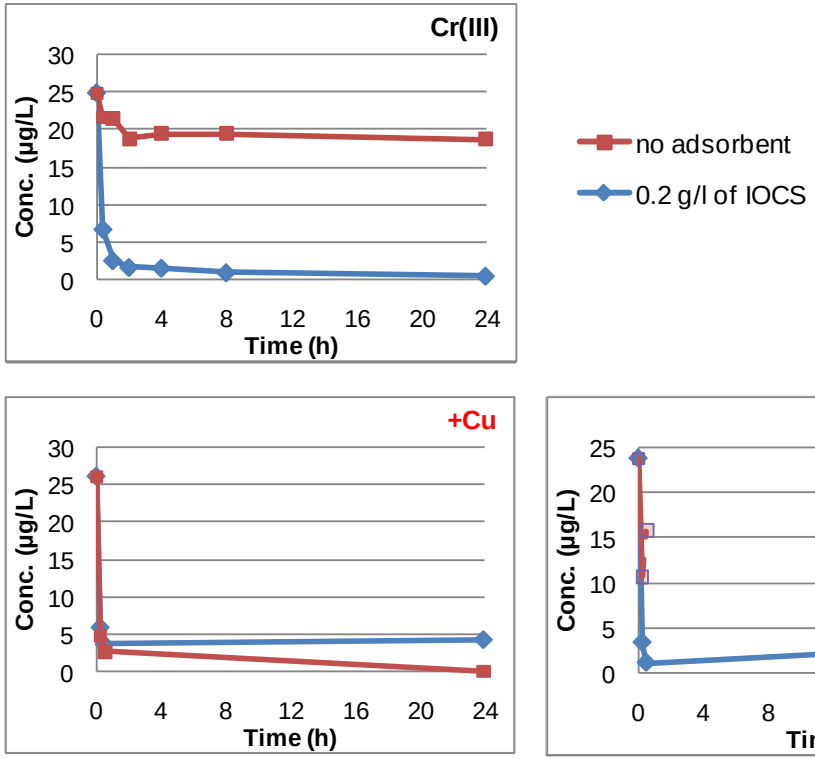
Results

Table: Chemical composition of IOCS from WTP Brucht

Composition	Concentration	Unit	%
Arsenic	0.7	µg/g	0.07
Calcium	12.3	mg/g	1.23
Iron	324.5	mg/g	32.45
Magnesium	0.3	mg/g	0.03
Manganese	1.6	mg/g	0.16
Oxygen	182.5	mg/g	18.25
Phosphorus	19.5	mg/g	1.95
Sand	54.2	mg/g	5.42
Silica	2.2	mg/g	0.22
Unknown compounds	402	mg/g	40.2
Total	**1000**		**100**

Removal of Cr(III)

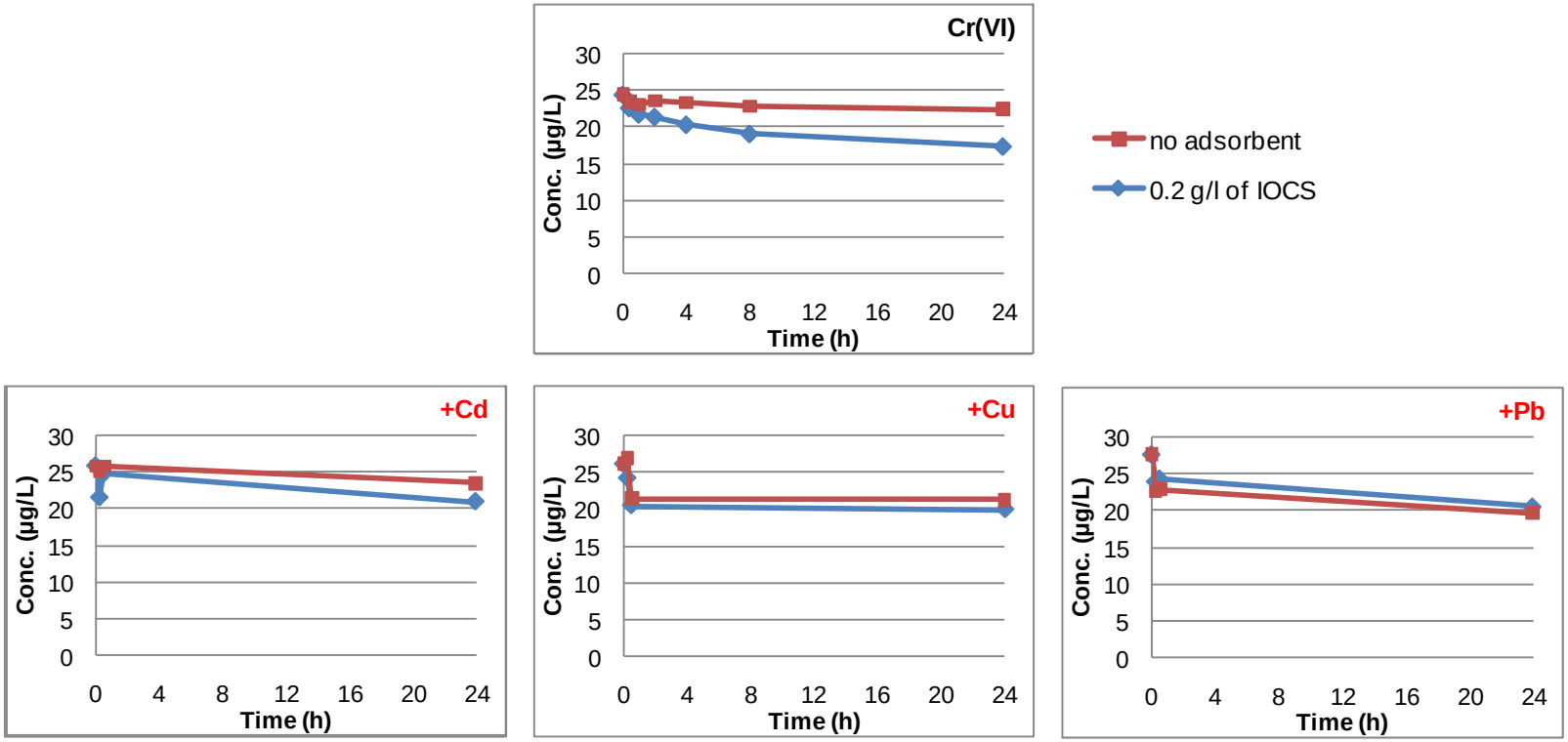
Results



Change in Cr(III) concentration as a function of contact time and IOCS/other metals' presence.

Removal of Cr(VI)

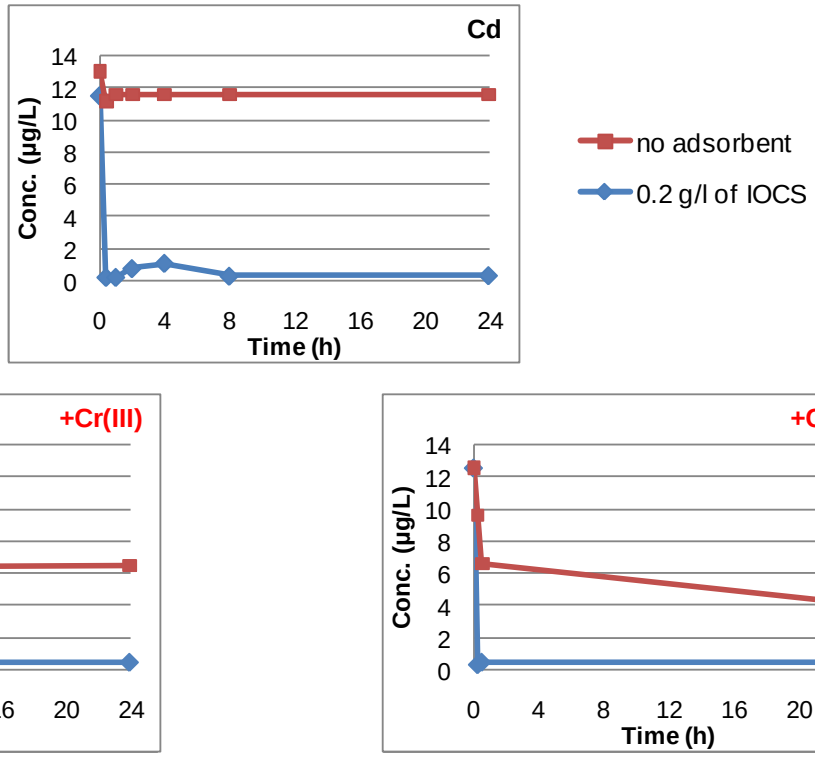
Results



Change in Cr(VI) concentration as a function of contact time and IOCS/other metals' presence.

Removal of Cd

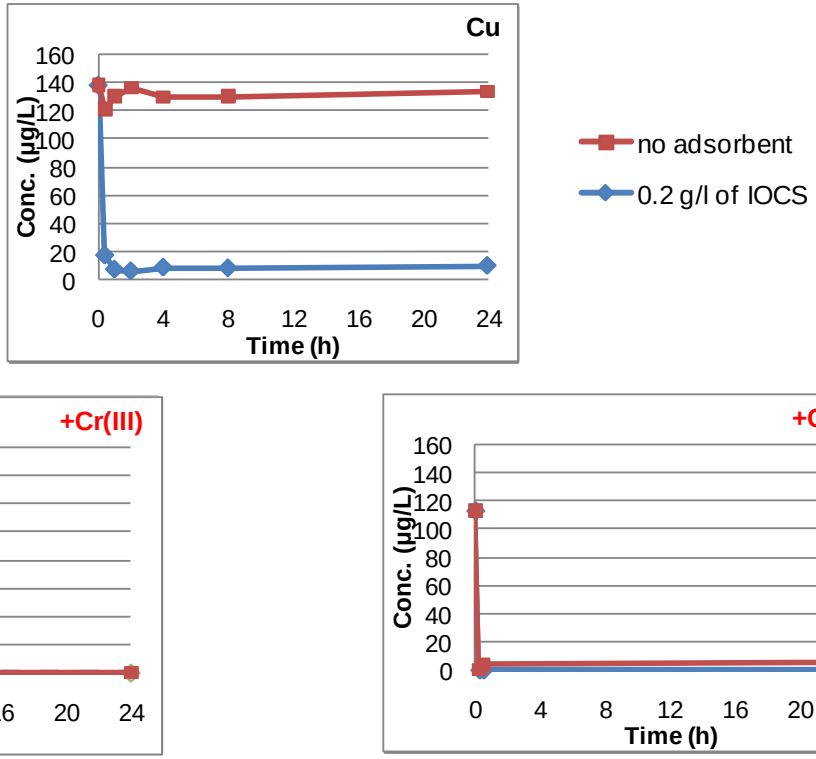
Results



Change in Cd concentration as a function of contact time and IOCS/other metals' presence.

Removal of Cu

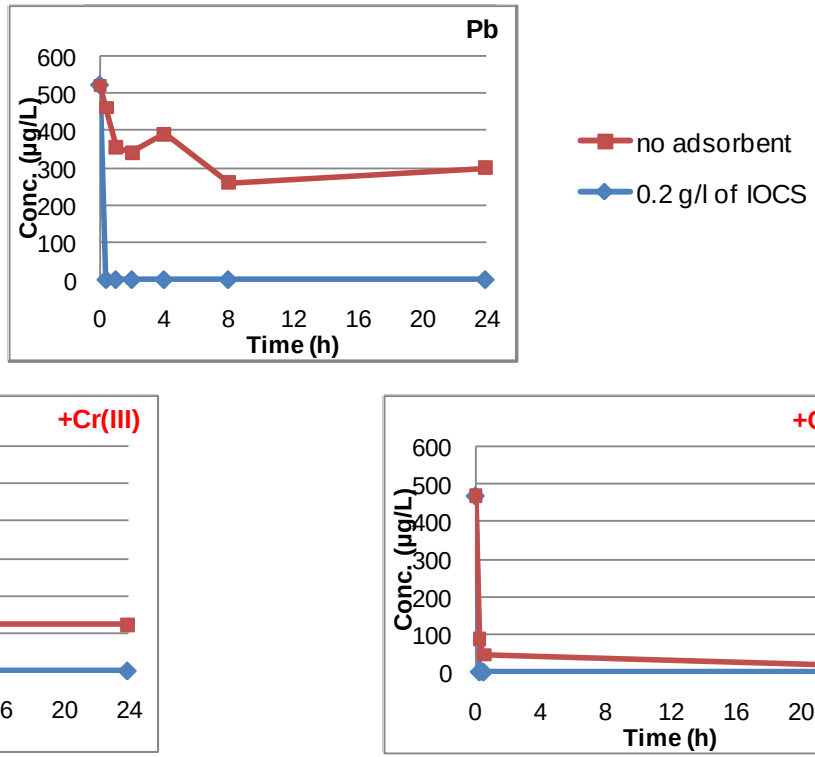
Results



Change in Cu concentration as a function of contact time and IOCS/other metals' presence.

Removal of Pb

Results



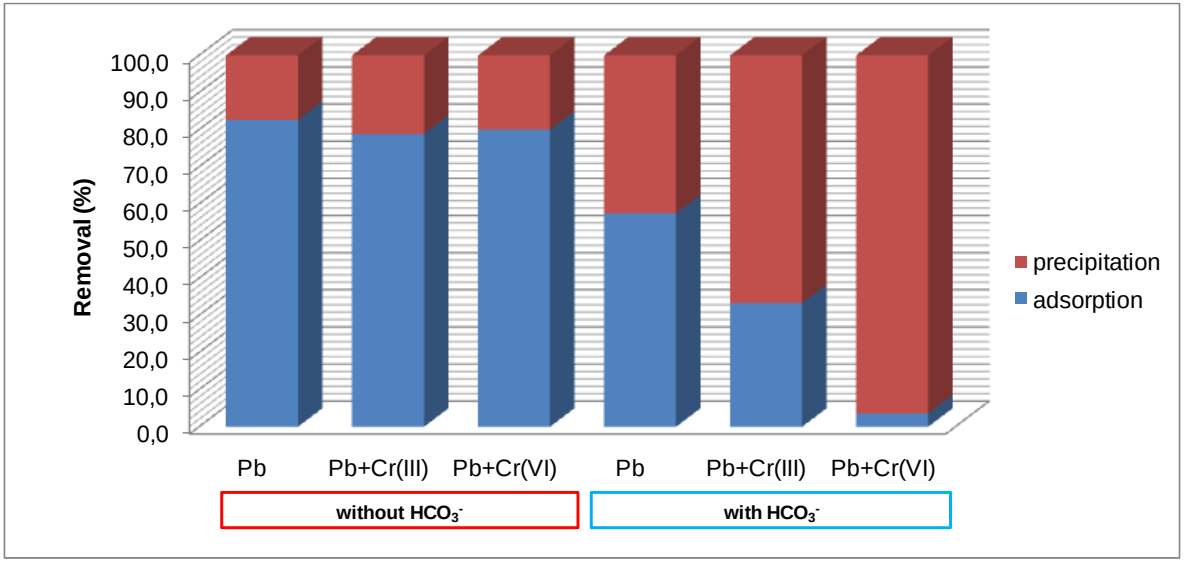
Change in Pb concentration as a function of contact time and IOCS/other metals' presence.

Influence of HCO_3^- Concentration

Results

Example of Pb removal:

- Pb is removed by precipitation and adsorption processes.
- Presence of HCO_3^- increases the precipitation.
- Precipitation at the pH=6 is different in presence of Cr(III) and Cr(VI).
- PHREEQC showed that precipitated fractions are in the form of $Pb(OH)_2$ and $PbCrO_4$ specie.



Conclusions

Short batch experiments:

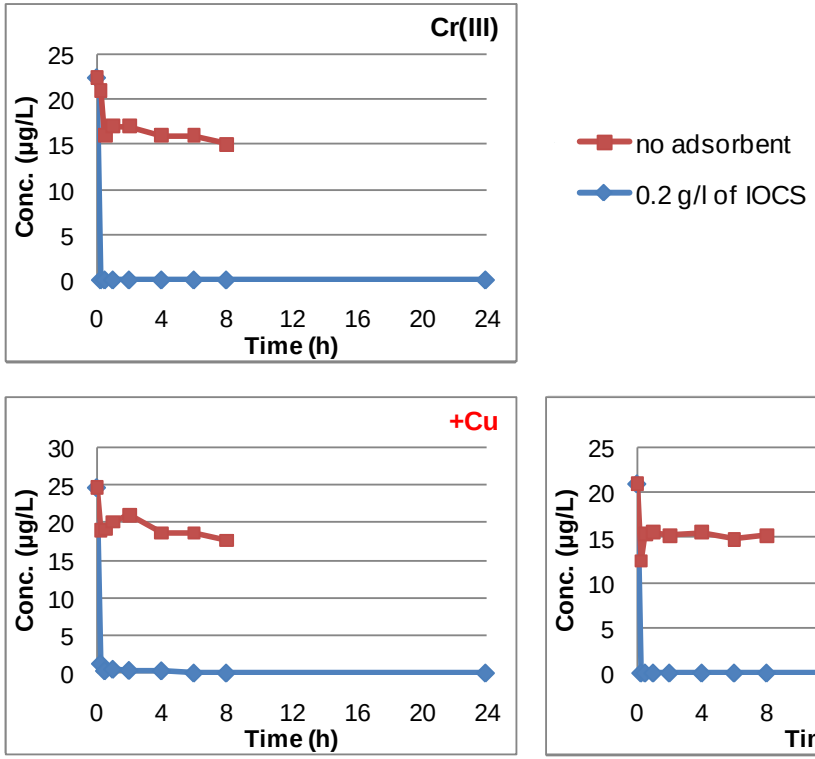
- complete removal was achieved for all metals except for Cr(VI);
- two basic removal mechanisms: precipitation and adsorption;
- contribution of precipitation and adsorption to overall removal is a function of a metal type and water quality (e.g. pH and HCO_3^- concentration);
- under studied conditions presence of Cr(VI) increased precipitation of metals;

Based on the presented study combination of precipitation and adsorption on IOCS could be feasible method for removal of heavy metals from urban stormwater runoff.

Thank you for your attention!

Removal of Cr(III)

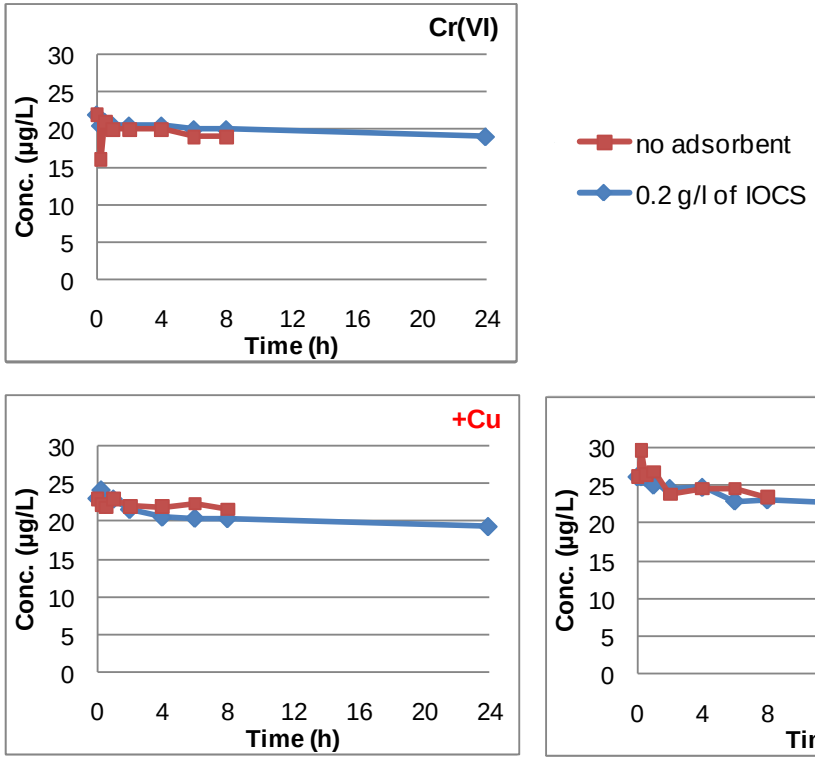
Results



Change in Cr(III) concentration as a function of contact time and IOCS/other metals' presence.

Removal of Cr(VI)

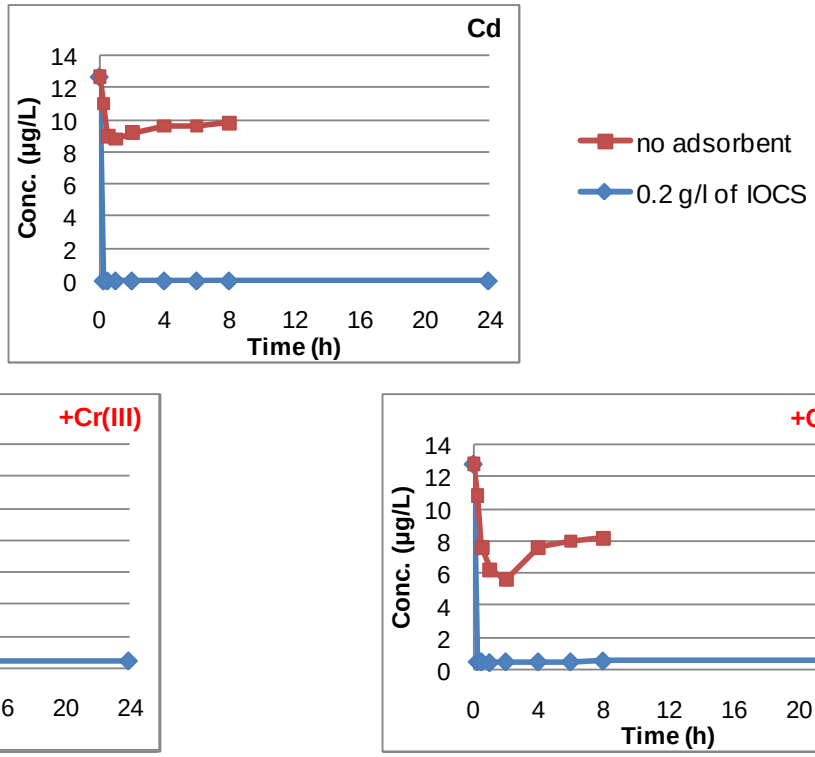
Results



Change in Cr(VI) concentration as a function of contact time and IOCS/other metals' presence.

Removal of Cd

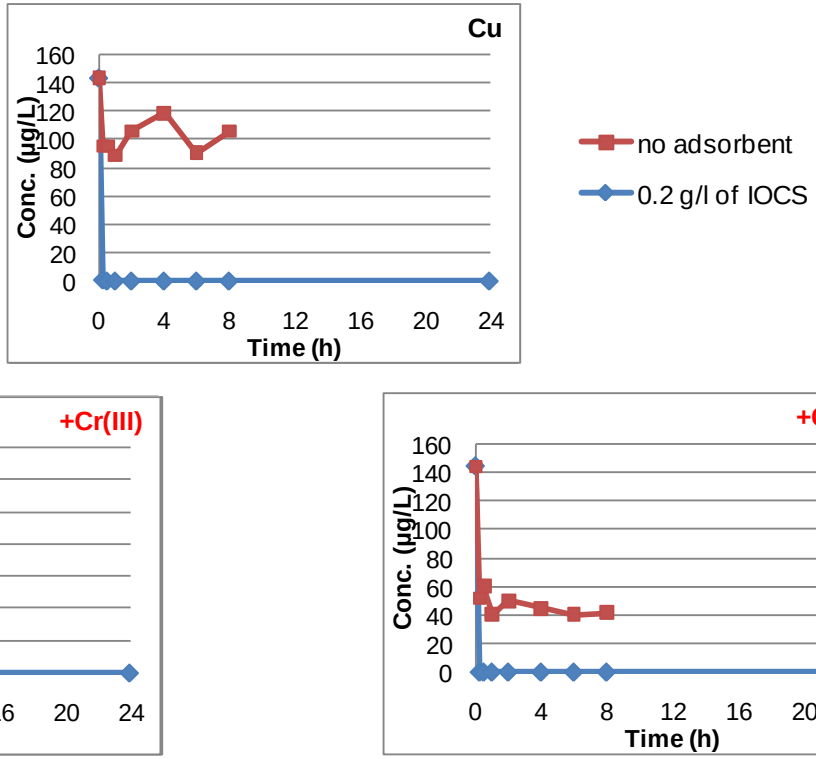
Results



Change in Cd concentration as a function of contact time and IOCS/other metals' presence.

Removal of Cu

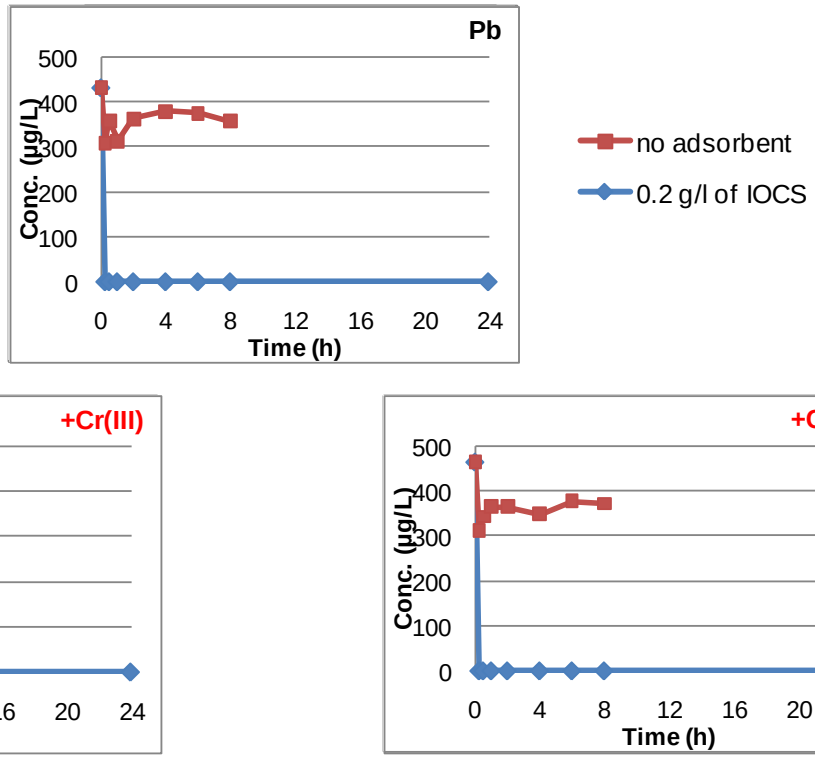
Results



Change in Cu concentration as a function of contact time and IOCS/other metals' presence.

Removal of Pb

Results



Change in Pb concentration as a function of contact time and IOCS/other metals' presence.