Student's Card 2 **Let's make recycling Blue**

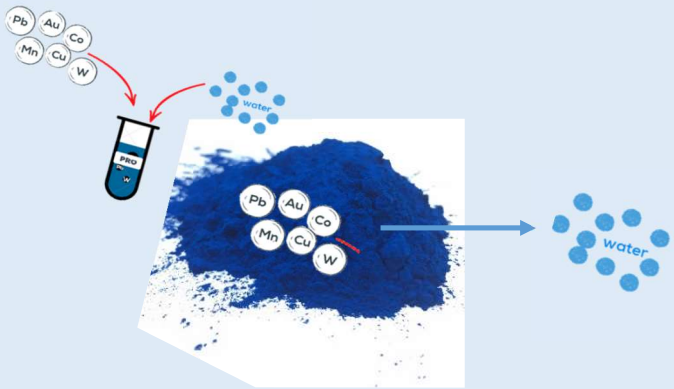
A versatile system for a sustainable recovery of Critical Raw Materials from water

Module 2

Objective: Extraction of metal ions from water

Introduction

The protection of water resources is featured in two of the 17 Objectives of Sustainable Development (goal 6, on sustainable water management, and goal 14, dedicated to the oceans) contained in the Agenda 2030 of the United Nations. In this scenario the water takes on a strategic and priority role to protect, preserve and guarantee for all its uses. One of the most critical issues concerns the chemical state of the water: rivers, lakes, coastal seawater and groundwater have been used for too many decades as landfills where to dispose of the wastewater from industrial processes.
The European Union, in order to draw up the first list of priority substances to be researched, has therefore started from a list created with the advice of the Fraunhofer Institute for Environmental Chemistry and Ecotoxicology, which was later remodelled by a committee of experts, and we've come to the definition of an official list in 2001. Those substances belong to one of two categories: organic, and heavy metals. The latter include nickel, lead, cadmium and mercury.
Prussian Blue is a coordination compound capable of "capturing" heavy metal ions that are not present in water. It has also been tested on metals such as cadmium and thallium, different metals will be treated in class for safety reasons.



Necessities

Reagents	Formula	!	Quantity (g) or Concentration (M)
Solution of Copper (II)	Cu^{2+}	*	0.05 M in Cu^{2+}
Solution of Cobalt (II)	Co^{2+}	*	0.05 M in Co^{2+}
Solution of Manganese (II)	Mn^{2+}	*	0.05 M in Mn^{2+}
Solution of Hexacyanoferrate	$K_4[Fe(CN)_6] \cdot 3H_2O$		1.0 g in 10 ml of distilled water
Prussian blue	$Fe_4[Fe(CN)_6]_3$	None	solid

* For the preparation of the solutions it is necessary to use soluble salts of the metals. Depending on the salt used, the danger symbols change, so pay attention to what is on the container and follow the cautionary advice described.

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List of materials/tools

- Test tubes
- Paper towels
- Pasteur pipette
- Cotton wick

Lab Procedure

- Put the cotton plug into a pasteur pipette.
- Fill the pipette with Prussian blue and water, up to 1/3 of its volume, to get a well-packed column.
- Let some droplets fall.
- Add the solution containing the metal ions.
- Put the paper towel (soaked with hexacyanoferrate) under the pipette.
- Observe the reaction between the drops, fallen from the pipette, and the hexacyanoferrate.

Additional Safety Notes

$K_4[Fe(CN)_6]$ is harmful to aquatic life with long lasting effects and it must not be dispersed in the environment.

For more information read the relevant safety data sheets.

Questions/Quiz

1. Why is it important to remove heavy metals from the water?
2. Why does Prussian Blue retain metal ions?
3. How can you control that the Prussian Blue has "captured" the metal ions?
4. Why is there a reaction between the metal ion solution and the paper soaked in potassium hexacyanoferrate?