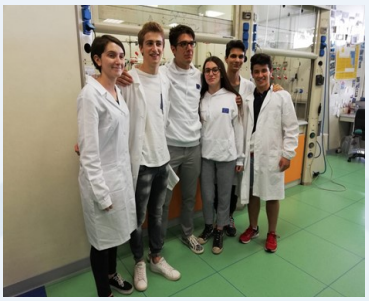
PRUSSIAN BLUE

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



Nicolò Angeleri, Cristina Caprioglio, Gabriele Merlo, Stella Piccone, Matteo Poncina, Andrea Zeppa

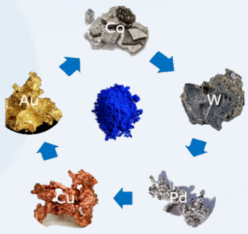
Introduction

Given the present geopolitical and economical situation in Europe and in the rest of the world, CRM recovery is becoming more and more important. Thus it is fundamental to focus on the research of new sustainable solutions that reduce our reliance on the earth's natural capital and the need for mining raw materials.

A method is the Prussian Blue, also known as iron hexacyanoferrate. This pigment can interact with metals such

What is Prussian Blue?

Prussian Blue is one of the first synthetic pigments ever created. Thanks to its particular structure it can interact with CRMs ions in order to capture them. Actually, it is also used in pharmaceutical sector to soak up dangerous substances such as Cesium and Thallium in infected hosts.



Goals

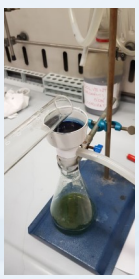
- Synthesis of Prussian Blue with high yields and low cost
- Capture of CRMs exploiting Prussian Blue
- Recovery of CRMs
- Application of Prussian Blue as decontaminant for lead in water.

Synthesis of Prussian Blue

We have found two different syntheses. We chose the first one because it allows you to produce more compound.

The following reaction is the commercial one:

$$4FeCl_3 \bullet 6H_2O + 3K_4[Fe(CN)_6] \bullet 3H_2O \rightarrow Fe_4[Fe(CN)_6]_3 + 12KCl$$



1° synthesis:

I. 2:1 stoichiometric ratio between $FeCl_3$ and $K_4[Fe(CN)_6]$.

II. 2.6 g of $FeCl_3$ were dissolved in 10 ml of distilled water.

III. 1.0 g of $K_4[Fe(CN)_6]$ was dissolved in 10 ml of distilled water

IV. The two solutions were mixed and a blue precipitate was obtained (Prussian Blue).

2° synthesis:

I. 1:1 stoichiometric ratio between $FeCl_3$ and $3K_4[Fe(CN)_6]$.

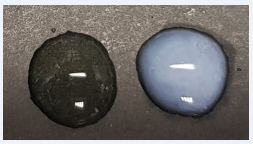
II. The same methodology of the first one but with the addition of $C_6H_8O_7$.

Capture of CRMs

We tried to retrieve metal ions from different solutions using Prussian Blue.

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.

Treated manganese →  ← Non-treated Manganese

Results:

We observed that the treated solution had become transparent, meaning that it had lost the metal ions.

Conclusions

- This synthesis of Prussian blue has high yields and low costs
- CRMs, which are not treated with Prussian Blue, change colour once they fall on the paper soaked with hexacyanoferrate.
- CRMs, which are treated with Prussian Blue, do not cause a colour changing when they come into contact with the aforementioned paper.

This demonstrates that Prussian Blue can absorb CRMs from solutions.

Future prospectives

This method is suitable for chemistry in schools because it is very cheap, easy to understand and it doesn't take too much time to do it.

In the future, this precious pigment could be used as a filter in other different fields such as metallurgy, especially in the water purification sector.

Bibliography

[1] Mohammadreza Shokouhimehr, "Prussian blue Nanoparticles and its Analogues as New-Generation T1-Weighted MRI Contrast Agents for Cellular Imaging", 2010ù

[2] www.ec.europa.eu

[3]Yanfeng Yue, Andrew J. Binder, Bingkun Guo, Zhiyong Zhang, Zhen-An Qiao, Chengcheng Tian and Sheng Dai, «Mesoporous Prussian Blue Analogues: Template-Free Synthesis and Sodium-Ion Applications.