A new and revolutionary technology (extractant mixture) that significantly improves on current methods for the extraction of inner transition metals (lanthanides and actinides) in complex matrices, applicable in mining, nuclear chemistry/medicine/waste.

Summary

Profile type	Company's country	POD reference
Technology offer	**Spain**	**TOES20240122013**
Profile status	**Type of partnership**	**Targeted countries**
PUBLISHED	**Commercial agreement with technical assistance** **Investment agreement** **Research and development cooperation agreement**	**• World**
Contact Person	**Term of validity**	**Last update**
Sabrina WODRICH	**22 Jan 2024** **21 Jan 2025**	**22 Jan 2024**

General Information

Short summary

A Spanish research team has patented a technology enabling more selective and efficient extraction of metals of the f series of the periodic table (lanthanides and actinides). This novel formulation can be applied industrially in areas such as mining, nuclear chemistry, nuclear medicine, and nuclear waste treatment. Companies interested in acquiring this technology for commercial exploitation through patent licensing agreements are sought.

Full description

The inner transition elements occupy the positions in the periodic table between the elements lanthanum (Z=57) and hafnium (Z=72), and are called lanthanides or lanthanoids, and between actinium (Z=89) and rutherfordium (Z=104), and are called actinides or actinoids.

All these elements are also called f-block or f-series elements, and are characterised by the fact that they are rare and widely dispersed in the earth's crust. The separation of an f-block element (or elements) from other s-, p- and/or d-block metals is a difficult, tedious and economically very costly task.

In general, lanthanides are used as very effective catalysts in industrial chemical processes. In fact, they are necessary and indispensable components in more than 200 high-tech consumer products in a wide range of applications, such as mobile phones, hard disks, electric and hybrid vehicles, flat screen monitors and televisions, in optics, in military defence applications (manufacture of electronic displays, guidance systems, lasers, radar and sonar systems), etc.

On the other hand, actinides are radioactive and release energy after their corresponding decay chains. Uranium and thorium (natural) and plutonium (artificially produced) are the most abundant actinides on Earth, and are mainly used in nuclear reactors, nuclear weapons and nuclear medicine.

The methods used to separate and obtain f-block elements free of other s-, p- and d-series metals are numerous, and most of them are based on liquid-liquid extraction procedures. The use of Ionic Liquids (IL) has been fundamental in many examples of selective chemical separation, however, the use of Task Specific Ionic Liquids (TSIL) combined with Ionic Liquids (IL) has not been used as frequently.

In any case, to date, no procedure has been carried out to recover the TSIL-IL extractant system, but only studies have been carried out to recover the metal (stripping) at the end of the extraction process.

Therefore, there is a need to obtain an extractant formulation and a procedure that allows the selective extraction of the internal transition elements (lanthanides and actinides) from the rest of the metallic elements of the s, p and d series, and that can also be used in repeated extractive cycles without losing selectivity or effectiveness.

A Spanish research team has developed an extractant mixture formed by the combination of a process ionic liquid (TSIL) and an ionic liquid (IL) that allows a more selective and efficient extraction of metals of the f series of the periodic table (lanthanides and actinides), with respect to other metals of the s, p and/or d series.

This is a patented technology that is characterised by the fact that the extractant mixture can be reused in new extraction cycles without losing effectiveness, which represents a great advance in sustainability and environmental protection.

This novel formulation can be applied industrially in areas such as mining, nuclear chemistry, nuclear medicine and nuclear waste treatment.

Companies interested in acquiring this technology for commercial exploitation through patent licensing agreements are being sought.

Advantages and innovations

Advantages:

1) Selective and very effective extraction of inner transition metals (f-block) from metals belonging to the s-, d- and/or p-blocks of the periodic table in a very efficient way.

2) The extractant mixture is recyclable: the complexed metal(s) can be fully recovered and the extractant mixture can be used in new extraction cycles.

3) The extractant mixture has a low affinity for the metals of the s-, d- and p- series of the periodic table, so that the metals of these series are extracted with a low or zero percentage.

4) The recovery rate of the extractant mixture is at least 95%, so it is possible to reuse it in new extraction cycles.

5) The extraction process is environmentally friendly.

6) The procedure is carried out under mild reaction conditions (temperature between 0°C-25°C and atmospheric pressure).

7) Both the TSIL compound and the CYPHOS NTf2 solvent are commercially available, or easily prepared by simple ion exchange.

8) The procedure is feasible on an industrial scale.

In summary, the new extractant mixture is a revolutionary technology that significantly improves on current methods for the extraction of inner transition metals (lanthanides and actinides) in complex matrices.

Innovations:

This novel chemical composition allows the selective and efficient extraction of the inner transition metals of the f-series (lanthanides and actinides) from other metals of the s-, d- and/or p-series of the periodic table. In this sense, the main interaction of the inner transition metals with TSIL, which acts as a selective chelator, takes place via the 1,3-dicarbonyl site.

Moreover, once the extracted metals have been separated, the original extractant mixture is recovered with a yield of more than 95%, which allows it to be recycled and subsequently used in new extraction cycles, making it a sustainable and environmentally friendly procedure. There is no other extraction system with these characteristics on the market that is recyclable.

Technical specification or expertise sought

Stage of development

Lab tested

Sustainable Development goals

- **Goal 9: Industry, Innovation and Infrastructure**
- **Goal 13: Climate Action**
- **Goal 7: Affordable and Clean Energy**
- **Goal 6: Clean Water and Sanitation**

IPR Status

IPR applied but not yet granted

Partner Sought

Expected role of the partner

APPLICATION MARKETS

This novel composition is able to selectively extract the inner transition metals from the other metals of the periodic table at pH=6.

The main application sectors of this novel technology are:

- Mining.
- Nuclear chemistry.
- Nuclear medicine.
- Nuclear waste treatment.
- Scientific research.

This technology solves the problem of the selective separation of the chemical elements belonging to rare earths (lanthanides and actinides), some of which are used as fuels in nuclear power plants.

The selective separation of these metals (f-block) from the rest of the metals listed in the periodic table is crucial both in the process of extracting the starting minerals and in the treatment of nuclear waste products.

Its application in different industrial sectors can have a positive impact on the environment and can contribute to improving energy sustainability worldwide.

COLLABORATION SOUGHT

Companies interested in acquiring this technology for commercial exploitation through patent licensing agreements are sought.
Company profile sought:
Mining.
Chemical industry.
Nuclear industry.
Nuclear medicine.
Nuclear waste treatment.

Type of partnership

Commercial agreement with technical assistance

Investment agreement

Research and development cooperation agreement

Type and size of the partner

- **SME <=10**
- **R&D Institution**
- **SME 11-49**
- **Big company**
- **SME 50 - 249**
- **Other**

Dissemination

Technology keywords

- **04004 - Nuclear Fission / Nuclear Fusion**
- **10003005 - Radioactive Waste**
- **04005010 - Integrated waste-energy processes**
- **03004010 - Special chemicals, intermediates**
- **03008 - Mining Technologies**

Market keywords

- **09006 - Mining (non-energy related)**
- **06002002 - Nuclear**
- **08003003 - Mining machinery**
- **05002004 - Nuclear imaging**

Targeted countries

- **World**

Sector groups involved

Media

PDF documents

Detailed Technical Description
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