Cesium adsorbent and production method thereof

Cesium absorbent and Method of manufacting the same

Patent title	Method for producing cesium adsorption material in which Prussian Blue is formed on surface of polymer by modifying powdered activated carbon into polymer	**Inventor**	Korea Institute of Civil Engineering and Building Technology / Kim Yong-seok and seven more
Patent application No.	KR 10-2018-0099123(2018.08.24) KR 10-2143645(2020.08.05)	**Authority status**	Registered

Technicality

Technology overview

The technology relates to a high-efficiency cesium removal adsorbent for safe drinking water supply when cesium, which is a radioactive element, is leaked into water. Prussian Blue is needed to remove cesium in synthetic materials. In order to increase the content, through a multi-immobilization method (LBL assembly) technology, nuclear power plant dismantling waste is removed, and disaster safety is secured. Also, the technology can be applied to radiation prevention adsorbents, artificial decontamination agents, and the like in lakes.

Development background and problem to be solved

- Even if only 10 g of cesium, which is a radioactive material, flows into the Paldang Dam, which is connected to the Han River drinking water source, the water exceeds the drinking water standard and cannot be used as a drinking water source. Accordingly, a technology for underwater radiation absorption needs to be developed.
- For more economical removal of cesium ions in water, a cesium adsorbent is provided by modifying the surface of powdered activated carbon with a polymer and forming Prussian Blue on the surface of powdered activated carbon.

Excellence and discrimination of technology

▶ Excellence of technology

- A multi-immobilization method for additionally reacting iron chloride is applied as a method for improving the content of Prussian Blue attached to an adsorbent.
- As the content of Prussian Blue increases, an adsorption capacity is improved. Thus, 99.8% of cesium is removed.
- In the cesium adsorbent, Prussian Blue is synthesized in-situ in the presence of a support to secure binding performance and physical stability.
- The support of a Prussian Blue immobilized adsorbent is a hydrophilic polymer material produced in a hydrogel type.

▶ Discrimination of technology

- Through a synthesis method, a multi-immobilization method, and localization of synthetic reagents, the amount of an adsorbent input is reduced by 25 times compared to CNT series.
- The content of Prussian Blue is 5.5 times higher than that of existing adsorbents, and the cesium adsorption performance is increased by 7.5 times.
- A high-efficiency cesium adsorbent can be mass-produced and reduced by eight times the existing usable production and supply costs.
- The cesium adsorbent can be used as a powder or filter depending on the purpose and function.

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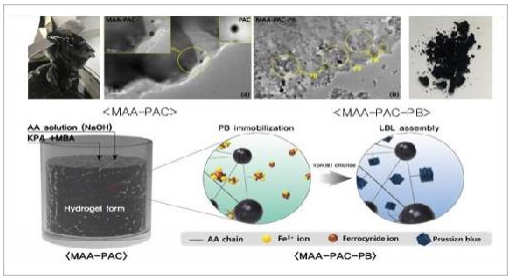
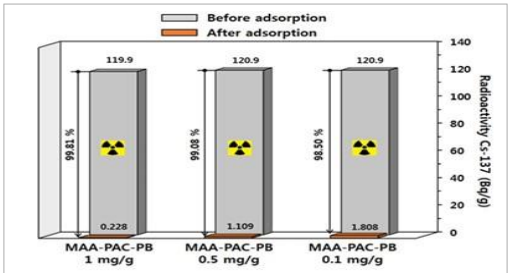
Implementation method

According to the present invention,

- The synthesized COP-PAC is washed with dimethyl sulfoxide, acetone, tertiary distilled water, and ethanol in this order to produce powdered activated carbon (COP-PAC) of which a surface is modified with a covalent organic polymer.
- The produced powdered activated carbon is mixed with iron chloride, and then a precipitate is separated by a centrifuge. The precipitate is mixed with potassium ferricyanide, and the precipitate is separated again and then dried to synthesize Prussian Blue (a cesium adsorbent).



Picture 1 Synthesis schematic diagram



Picutre 2 Underwater radioactive cesium removal rate

Degree of technology completion (TRL)

Degree of technology completion: TRL6 (Full Scale prototype development stage)

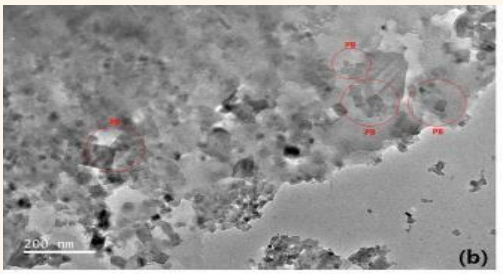
TRL1	TRL2	TRL3	TRL4	TRL5	TRL6	TRL7	TRL8	TRL9
Technical principle presentation	Technology concept setting	Technology concept verification	Lab Scale prototype development	Implementation environment application experiment	Full Scale prototype development	Quasi-commercial product development	Commercial product development	Commercial product implementation

Utilization

Utilization field and applied product

Utilization field

- Radioactive decontamination
- Adsorption fiber
- Hazardous substance absorbent
- Natural mineral adsorbent



Picture 1 Underwater radioactive decontamination

Applied product

- Liquid filter
- Cesium adsorption construction material
- Adsorption fiber for cesium removal
- Natural mineral adsorbent

Picture 2 Adsorption fiber for cesium removal

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Technology trend

- After the Fukushima nuclear accident in Japan in 2011, domestic and international interests in radioactive material purification methods have been highlighted, and the number of patent applications related to absorbents for radioactive removal has increased rapidly.
- As of 2016, The number of applications related to radioactive element adsorption technologies by year has increased by fifteen times compared to 2010. In particular, the adsorption technology for cesium among radioactive elements is 56% of the total applications.
- In Korea, 40% or more of patents have been mainly filed by the Korea Atomic Energy Research Institute and universities and research institutes. In the case of cesium adsorbents, researches on the constituent materials of adsorbents are focused on improving the performance of adsorption materials conventionally studied.

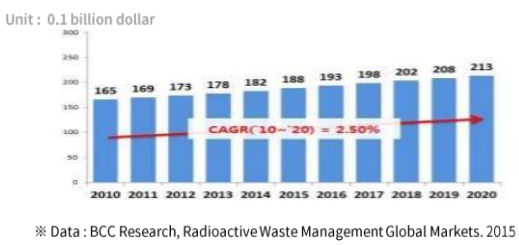
Family patent status

Application nation	Application No. (Application date) / Registration No.	Title of the invention
KOR	KR 10-2018-0099123(2018.08.24) / 10-2143645(2020.08.05)	Method for producing cesium adsorption material using powdered activated carbon as polymer
KOR	KR 10-2018-0099122(2018.08.24) / 10-2152422(2020.08.31)	Method for producing cesium acrylate adsorption material using illite
KOR	KR 10-2018-0099120(2018.08.24) / 10-2143640(2020.08.05)	Method for producing cesium adsorption material using high molecular weight acrylic acid
KOR	KR 10-2019-0136636(2019.10.30) / 10-2126454(2020.06.18)	Cesium adsorbent having network structure and method for producing same
KOR	KR 10-2018-0009638(2018.01.25) / 10-2108353(2020.04.29)	Composite for adsorbing radioactive elements

Market prospect

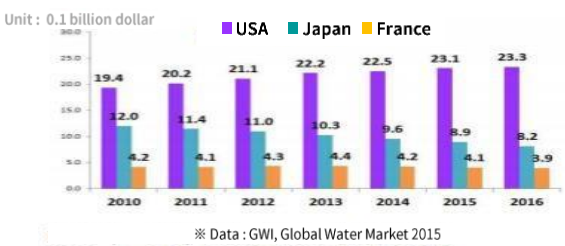
Target market size and prospect

The global radioactive waste management market reached USD 21.3 billion in 2020, growing at an average annual rate of 2.5% from USD 18.8 billion in 2015. In the case of Korea, the market has grown at an average annual rate of 12.1% from 2006 to 2015, and formed a market size of KRW 157.2 billion in 2015, and is showing high growth.



※ Data : BCC Research, Radioactive Waste Management Global Markets. 2015

Picture 1 Global radioactive waste disposal market



※ Data : GWI, Global Water Market 2015

Picture 2 Radioactive waste treatment markets by country

<Data: Korea Atomic Energy Research Institute 2017>

Technology transfer query

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Technology transfer process

Explore promising technologies → Contract consultation → Apply for technology transfer → Negotiate and sign contracts → Follow-up support