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Development of tritium removal technology from large amount of contaminated water using a hybrid process.

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Tritium is a radioactive beta emission isotope of hydrogen with a mass of 3.0 and is mainly present as tritiated water(HTO) in wastewater discharged from nuclear facilities.
However, since HTO and H2O have very similar physical and chemical properties, it is very difficult to separate a trace amount of HTO mixed in a large amount of water (H2O). There is a commercialized isotope exchange and hydrogen distillation technology that can remove tritium, but this technology is a process to remove HTO from pure water quality of D2O, so it is impossible to apply to large amounts of contaminated water such as contaminated water in Fukushima, tritium contaminated water generated when decommissioning nuclear power plants, and contaminated environmental water.
In the case of Korea, tritium was detected higher than that of residents of other regions in urine samples of residents near Wolsong Nuclear Power Plant, a heavy-water nuclear power plant, and was reported in the media. Therefore, in preparation for the generation of tritium contaminated water, it is essential to develop a technology that is larger in capacity and more efficiently capable of removing tritium than the current level of tritium removal technology. However, at the current technology level, it is very difficult to remove tritium from large amounts of contaminated water such as Fukushima contaminated water.
Elim-Global Research Institute and a research team from four universities in Korea are developing different tritium removal technologies separately and developing large-capacity tritium removal technologies through a hybrid complex process based on the characteristics of the developed technology.
Pre-treatment technologies consisting of MF(Micro-Filtration), UF(Ultra-Filtration), RO(Reverse Osmosis), CDI(Capacitive Deionization), and EDI(Electro Deionization) were developed and configured to operate flexibly according to the water quality of the target contaminated water. Particulate impurities and ionic impurities in contaminated water are removed through the developed pre-treatment process and only the unremoved tritium and pure water is introduced into the tritium removal device. Currently, research is being conducted to confirm the mass balance through the analysis of the tritium concentration in incoming, treated, and concentrated water during the operation of each pre-treatment process, and research on the behavior of tritium in each process.
Multi-stage zeolite membranes showed 60% of tritium removal efficiency and metal oxide & electrochemical technologies showed 30% removal efficiency. When a hydrophilic inorganic adsorbent was used, it was confirmed that the tritium removal efficiency was 43%, the functional ion exchange resin may be removed up to 8%, and research for increasing the removal efficiency for each technology is continuously being conducted.
In this research, in order to obtain maximized tritium removal performance, it is designed as a hybrid process in consideration of the advantages and characteristics of the four processes, and it is expected that tritium removal performance could be obtained better than a single process. In addition, a process for treating tritium concentrated water discharged from each tritium removal technology is also being developed, and a hybrid type tritium removal system with a 10 L/hr, 70% tritium removal efficiency is planned to be developed by combining pre-treatment, tritium removal technology and concentrated water treatment technology.

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