

9-2 Development of Decontamination Technique for Radioactive Wastes Using Supercritical Fluid

— Reverse Micelle Formation in Supercritical Carbon Dioxide —

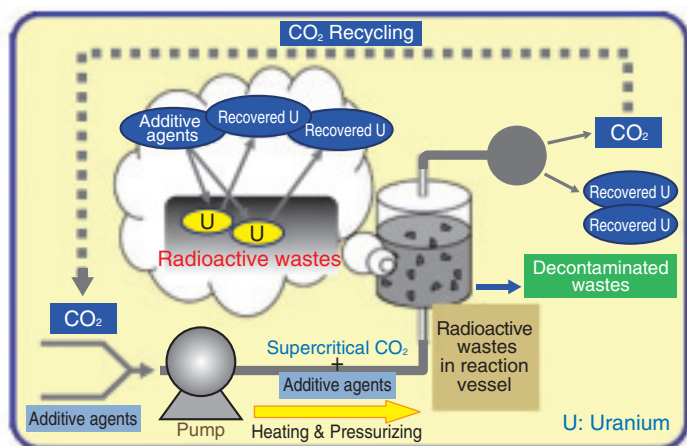


Fig.9-4 Process of decontamination using supercritical fluid Uranium in radioactive wastes is reacted with an additive agent and carried by supercritical CO₂ in a reaction vessel, and the reaction leads to uranium being dissolved in supercritical CO₂. Uranium is collected by extracting and depressurizing the supercritical CO₂.

In order to reduce the cost of radioactive waste management and improve the safety of radioactive waste disposal, it is necessary to reduce the quantity of radioactive waste. Therefore, we develop a technique to remove radioactive nuclides from the waste.

One of the requirements for a decontamination technique is that it should be possible to control the generation of secondary wastes produced during decontamination. We transform carbon dioxide (CO₂) into the supercritical state from the gaseous state by pressurizing and heating it and use the supercritical CO₂ as the separation medium. If supercritical CO₂ is transformed to gaseous CO₂, it almost loses its capability to dissolve a substance, and decontaminated substances are easily separated from the CO₂. In this process, CO₂ does not add to the waste, and the amount of secondary wastes can be greatly reduced. We have already succeeded in decontaminating uranium by using the CO₂ soluble complex of tri-*n*-butyl phosphate and nitric acid as an additive agent (Fig.9-4). However, additive agents, especially those with high reactivity, that can dissolve in supercritical CO₂, are limited, and therefore, it is difficult to apply this technique to the decontamination of plutonium oxide, which is a very stable compound.

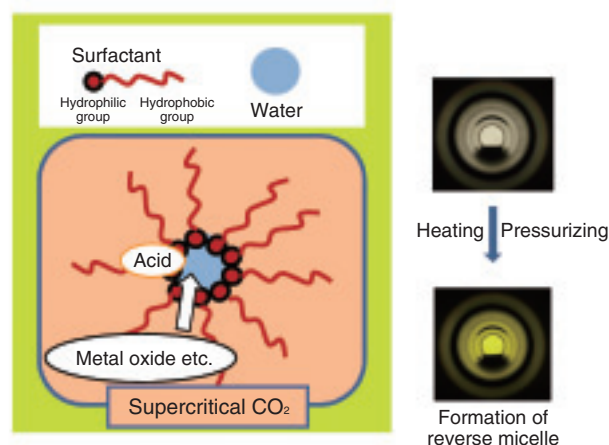


Fig.9-5 Diagram of a reverse micelle in supercritical carbon dioxide

Reverse micelles enclosing water are formed in supercritical CO₂ by using a surfactant. An acid in the water reacts with a metal oxide. The right-hand side photographs show the dissolution of a water soluble indicator (methyl orange) in supercritical CO₂ when reverse micelles are present.

We developed a technique to form reverse micelles in supercritical CO₂. The technique involves the use of a surfactant and increases the reactivity of the supercritical CO₂ by introducing the additive agent. Here, the reverse micelle has a spherical structure containing a small water particle wrapped by the hydrophilic group of the surfactant molecules, and the hydrophobic group is located far from the water particle (Fig.9-5). We examined several surfactants and succeeded in forming reverse micelles containing water, which dissolved nitric acid and metal salts, in supercritical CO₂. Moreover, it was found that the polarity of the hydrophilic group of the surfactant and the size of the hydrophobic group are important factors influencing the formation of stable reverse micelles. We succeeded in dissolving europium oxide in supercritical CO₂.

It was thus observed that the new decontamination technique, in which reverse micelles in supercritical CO₂ were used as a reaction field, showed promise. We shall continue to improve the technique by performing detailed investigations of surfactants and experimental conditions so that it can be used for decontaminating radioactive wastes contaminated with plutonium.

Reference

Kurahashi, K., Tomioka, O. et al., Phase Behavior and Reverse Micelle Formation in Supercritical CO₂ with DTAB and F-Pentanol for Decontamination of Radioactive Wastes, Proceedings of the ASME 13th International Conference on Environmental Remediation and Radioactive Waste Management (ICEM2010), Tsukuba, Japan, 2010, ICEM2010-40257, 4p., in CD-ROM.