3-15 R&D of New Detritiation System Using Bacteria

－Incubating Tritium Oxidizing Bacteria from the Forest Soil－

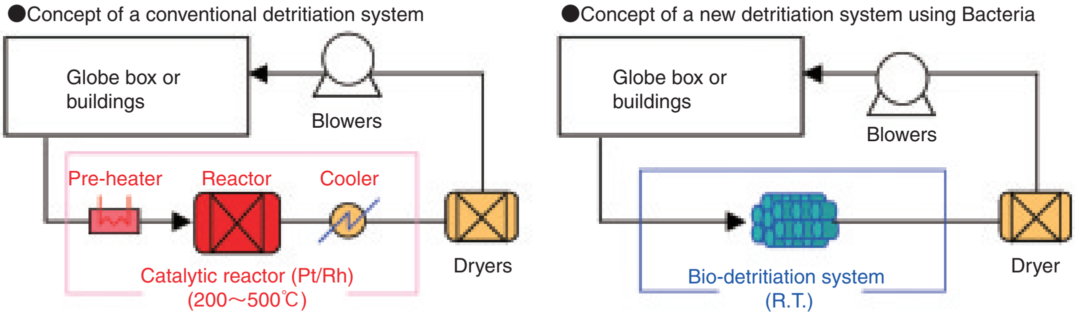

Fig.3-32 Comparison of detritiation system concept using catalyst and bacteria
The conventional system requires catalytic reactor to always be at high temperature, so capital & operation cost is high, and the replaced catalyst becomes tritiated waste. The new system can be operated at room temperature. The bio-reactor cost will be about 1/10 that of the catalyst set. Bio-reactor can be burnt for waste minimization.

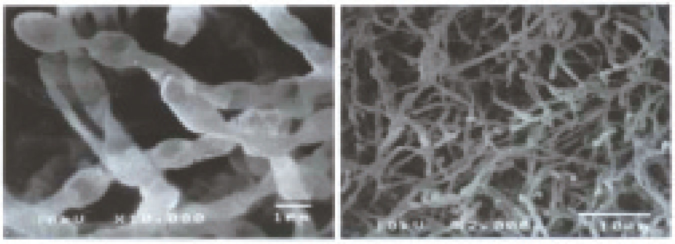

Fig.3-33 Typical tritium oxidizing bacteria (by SEM)
Left:x 10000, Right:x 2000 (*Kitazatospora*)

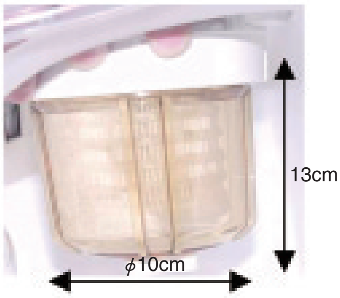

Fig.3-34 Bio-reactor for detritiation
The bacteria was incubated under 307K for 10 days on a filter in the reactor cassette.

A fusion reactor uses deuterium and tritium (^{3}H) as a fuel. ^{3}H is a radioisotope, emits a weak β-ray, and decays to ^{3}He with a half-life of 12.3 years. It can be handled safely in a multiple confinement system, because it has characteristics similar to hydrogen. In fusion facilities like “ITER”, the confinement functioning is always checked. Also, even if some ^{3}H leaks into the buildings, that ^{3}H is oxidized by a high temperature catalytic reactor and the tritiated water vapor is recovered by a dryer, in order to avoid ^{3}H release to the environment as much as possible. This conventional detritiation system has been used extensively, but it requires keeping an expensive catalyst bed at high temperature (Fig.3-32). Therefore, R&D has been continuing at JAEA to develop a more efficient system. In this study, we took notice of research at Ibaraki Univ. (Prof. Ichimasa et al.), in which the almost all the hydrogen in an environment was oxidized by ordinary bacteria in the soil at room temperature. Recently, for the first time in the world, we succeeded in efficient atmosphere detritiation using bacteria which can be an alternative detritiation technology.

Traditionally, bacteria have been used extensively for fermentation in food, and medical products industries, but here we investigated the original idea that the special function of bacteria can be used for fast oxidation of hydrogen in atmosphere. We succeeded in finding and incubating bacteria with high ^{3}H oxidation ability from the forest soil (Fig.3-33), and identifying the conditions making this bacteria active. Using this bacteria, a bio-reactor was fabricated (Fig.3-34), and tested it by connecting it to the Caisson Assembly for Tritium safety Study (CATS). We developed a bio-reactor that could oxidize atmospheric ^{3}H in the same way as the catalytic reactor, with a detritiation factor of more than 85%. The ITER requirement of 99% should be attainable using multiple bio-reactor connection series. Further, the bacteria maintained about 70% of their ^{3}H oxidation activity even after one year storage under 4℃. From the above accomplishments, we see a good possibility that the bio-reactor can be used for an alternative detritiation system. If this technology is used, a high temperature catalytic reactor would not be required, and the fabrication & operation cost and waste volume would be decreased. For the future practical use of bio-reactors, we will investigate their long-term performance, and also attempt using bacteria for processing of gas other than tritium.

Reference
Ichimasa, M. et al., Tritium Elimination System Using Tritium Gas Oxidizing Bacteria, Fusion Science and Technology, vol.48, 2005, p.759-762.