# Off-Gas System for K-MSR

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***Keywords : Molten Salt Reactor, Off-Gas System, Radioactive Fission-Product Gases**

## 1. Introduction

The Molten Salt Reactor(MSR) is one of the most advanced reactor types (Generation-IV) under investigation in many countries, including the United States, Russia, and Japan [1]. This type of reactor has potential advantages over traditional light water reactors, where fission products of primary fuel salts can be continuously removed through the off-gas system. Therefore, the system should provide facilities safely to process radioactive gases emitted from the fuel salt vessel, tanks, etc. In this paper, several off-gas system designs are reviewed to develop the off-gas system of the Korea-Molten Salt Reactor(K-MSR).

## 2. Review of Off-Gas System Design

### *2.1 Molten Salt Reactor Experiment(MSRE)*

The 8-MW Molten Salt Reactor Experiment(MSRE) was performed by Oak Ridge National Laboratory to demonstrate the efficiency, reliability, and safety of the molten salt reactor concept in the 1960s. The MSRE off-gas system mainly treated the off-gases [2]:

(1) continuously discharged, the helium containing highly radioactive fission-product gases, from the fuel salt circulating pump bowl and

(2) intermittent discharged, relatively large flows of helium containing, significant amounts of radioactive gases and particulates, during salt transfer operations.

It should be noted that this paper focuses on fuel salt off-gas but does not take into account non-radioactive gases such as atmospheric gases ejected to maintain reactor and drain tank cells.

Figure 1 shows a schematic diagram of the off-gas system for MSRE. After the gases leave the pump bowl, the gases are held in the two volume holdup loops for approximately two hours (one hour each) for the short-lived isotopes to decay. The first holdup loop is cooled by atmosphere gas (95% $N_2$ and 5% $O_2$), and the other is cooled by the water flow. Then the gases enter the one of the charcoal beds which are filled with water and cooled by the water flow. After retaining xenon for at least 90 days and krypton for 7-1/2 days or more in the charcoal beds, the off-gas is vented through the stack with the blower fan.

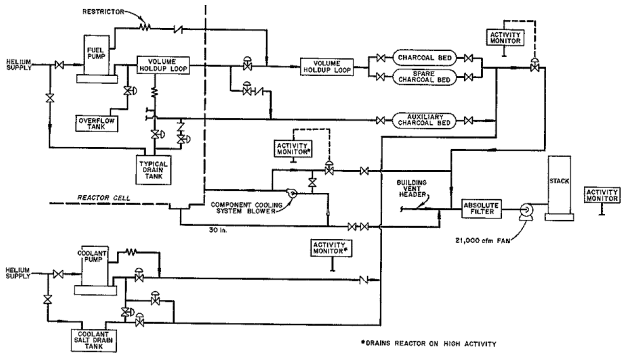


Fig. 1. Off-Gas System for MSRE [2]

### *2.2 Molten Salt Demonstration Reactor(MSDR)*

The 300-MW Molten Salt Demonstration Reactor (MSDR) was introduced based on the technology of MSRE [3].The off-gas system is a closed system. The system is specialized by a bubble generator, a bubble separator, and the use of a fuel-salt drain tank for gas holdup and cooling. The drain tank is designed to hold gases for approximately six hours with the natural convection cooling system.

Figure 2 shows a flowsheet for the MSDR. After the gases leave the drain tank, they go to the particle trap to remove solid particles. The downstream gas line is divided into two branches:

(1) approximately 1 cfm of gas is recirculated to the bubble generator (the gas is highly radioactive and held for 6-1/2 hours in the loop) and

(2) the other gas goes to charcoal beds (not shown in the flowsheet) for cleaning (the gas is held up for 90 days and stored in the tank for purge, pump seals, etc.).

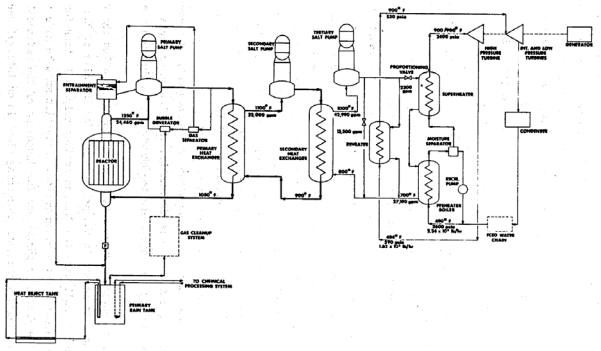

Fig. 2. Flowsheet for MSDR [3]

### *2.3 Molten Salt Breeder Reactor(MSBR)*

A preliminary design of the 1000-MW Molten Salt Breeder Reactor (MSBR) was first described in 1966, and extended designs of a two-fluid reactor (i.e., fuel salts and blanket salts) were developed in 1971 [4]. The MSBR off-gas system is also a closed system. The system provides a bubble generator, a bubble separator, and a fuel salt drain tank. The off-gas hold-up time is ~2.3 hours in the drain tank.

Figure 3 shows a schematic diagram of the off-gas system for the MSBR. In the study, it's assumed that about 15% of the gaseous fission products are short-lived and decay in the fuel-salt system and the others are either stable or have half-lives, meaning long enough for them to be removed at the gas separator. The nonvolatile fission products are removed in the drain tank and the additional particle trap. The gases are held up in the 47-hr Xe holdup system to decay radioactive noble gases. Then, the 80% of gas is recycled from Xe holdup system to the bubble generator, and the others move to the long-delay Xe holdup loop for ~90 days. After leaving the holdup loop, the off-gas enters the gas cleanup system and is then compressed and recycled to the reactor purge system.

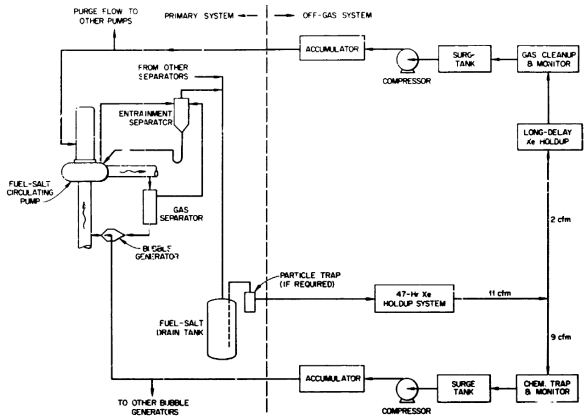


Fig. 3. Off-Gas System for MSBR [4]

### *2.4 Korea-Molten Salt Reactor(K-MSR)*

The 100-MW K-MSR will be developed based on the successful operation of the MSRE and design concepts of MSDR and MSBR. The off-gas system will consist of the decay tank or holdup loop, the halide/particulate/ acidic species/aerosol trap, the $H_2O/O_2$ trap, the short-lived Xe and Kr holdup, the long-delay Xe holdup, and the He storage tank as shown in Fig. 4.

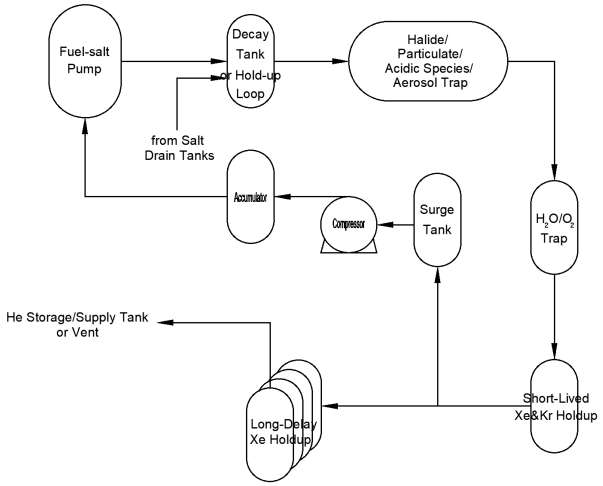


Fig. 4. Preliminary Design of Off-Gas System for K-MSR

## 3. Conclusions

In this study, the concepts of the MSRE, MSDR, and MSBR off-gas system are reviewed and we introduced the preliminary design of the K-MSR off-gas system. The goal of the K-MSR off-gas system is to develop the most efficient, reliable, and safe system. To do so, the design of the off-gas system will be continuously upgraded and optimized.

## ACKNOWLEDGEMENTS

This work was supported by the National Research Foundation of Korea(NRF) grant funded by the Korea government(MSIT) (RS-2023-00259713).

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