2018 Mo-99 TOPICAL MEETING ON
MOLYBDENUM-99 PRODUCTION TECHNOLOGY DEVELOPMENT

SEPTEMBER 23-26, 2018
HILTON KNOXVILLE HOTEL
KNOXVILLE, TN

Evaluating All-Metal Diaphragm Valves for Use in Tritium Environments

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ABSTRACT

In a tritium gas processing system, it is desired to minimize polymer components due to their degradation from tritium exposure (beta decay). One source of polymers in the tritium process are valve components. A vendor has been identified that manufactures a valve that is marketed as being made from all-metal construction. This manufacturer, Ham-Let Group, manufactures an all-metal diaphragm valve (3LE series) for wetted components.

SRNL procured these diaphragm valves for characterization and evaluation. The Ham-Let diaphragm valves were initially characterized by pressure and burst tests. The leak rate used as the acceptance criteria was 4.0×10^{-9} STD cc He/sec based on typical leak rates from manufacturers. A baseline leak test was performed on all initial valves. All but one of the valves passed the initial leak test, the valve that failed the initial leak test leaked out of the connection from the body to the actuator. Seven valves were then cycled in a nitrogen and/or vacuum environment. The manufacturer's life for these valves is stated at 100,000 cycles. The valves have been cycled 750,000 times to date, with one valve failing prematurely at 20,000 cycles due to particulates in the line. Another valve failed at 500,000 cycles, the cause of failure of this valve is under investigation. Five additional valves were cycled in a hydrogen environment. To accelerate the effects of hydrogen on the metal diaphragm, the valve bodies were heated during cycling to replicate 10 years of hydrogen exposure in one month of testing. Five valves were cycled for 125,000 cycles. One valve failed at 100,000 cycles while another failed at 125,000. The other three valves exceeded leak rate required after completed 125,000 cycles. These valves exceeded performance expectations in both the nitrogen and hydrogen cycling conditions. Future research will investigate these valves in a tritium environment.

SRNL-STI-2018-00203-X