

Safety Venting (SVEN) System

Background

In severe accident conditions such as core meltdowns, the containment building may provide the final barrier to a significant release of fission products to the environment. During a severe accident, containment integrity may be jeopardized due to slow pressurization from steam formation or non-condensable gas generation. In such conditions, a containment filtered vent system (CFVS) can relieve pressure and capture radioactive aerosols and iodine at a very high efficiency, thus mitigating the consequences of a severe accident to the environment. Building on our current CFVS scrubber experience, Westinghouse has enhanced and qualified the next generation scrubber system, the safety venting (SVEN) system, to exceed existing global standards in CFVS products.

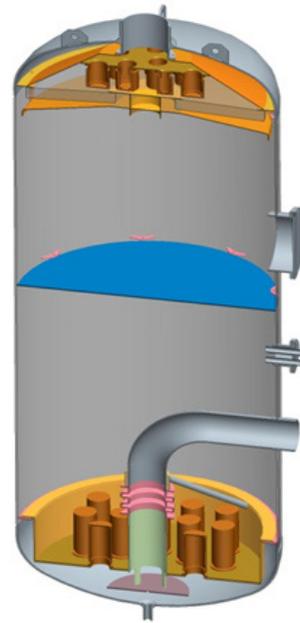
Description

The Westinghouse-patented SVEN CFVS is based on a well-known and proven filter separation technique that uses sintered metal fiber filters (MFFs) to remove micro-size radioactive particles. Submerging the MFF cartridges in liquid makes them suitable as a primary containment ventilation system since the filter efficiency meets the highest global standards today. The captured fission products in the cartridges will be cooled since they are retained in liquid. The filters have a deep structure that can retain a large amount of aerosols without getting clogged or exhibiting a large pressure loss. The liquid in the system is well proven as a highly efficient gas scrubber for elemental iodine removal. The liquid and the MFFs are housed in a stainless-steel tank. In the upper part of the tank, above the scrubber liquid, a splash shield and a demister are installed to remove moisture from the vent flow. Downstream of the demister, a set of fine MFFs in the tank top remove smaller aerosols.

The system is sized for plant-specific vent conditions following a severe accident. The SVEN system is a compact unit and is connected to the primary containment vessel by the containment vent piping. If required, organic iodine can be retained in a separate molecular sieve that uses a bed of zeolite material.

The SVEN system is a passive system that requires no external power source to function. Depending on the customer requirements, the system can be made self-sufficient for 24 hours or longer; thereafter, it may require the addition of plain water to recover level. No chemical needs to be added post-operation.

The SVEN system is sized based on customer requirements, and the system can be split into multiple tanks to more easily fit into existing buildings.



SVEN filter design

Testing and Verification

The SVEN design has been verified by an extensive test program that covers the range of parameters under which it will operate. The test program considered all the conditions that can occur during ventilation of a pressurized containment with a damaged reactor core inside. A wide variation of pressure, temperature, gas composition and aerosol combinations were covered in a test matrix. The test results clearly show that the total efficiency of the system is above 99.99 percent (e.g., decontamination factor, or DF, of 10,000) for all vent conditions and the most conservative test aerosol, BaSO₄ powder with 0.3 μm mass median diameter. The full evaluation of the integrated system DF is available in a test report.

Regarding iodine retention, testing shows that a minimum efficiency of 99.9 percent (DF of 1,000) can be obtained for elemental iodine retention for all postulated conditions determined at the time of testing.

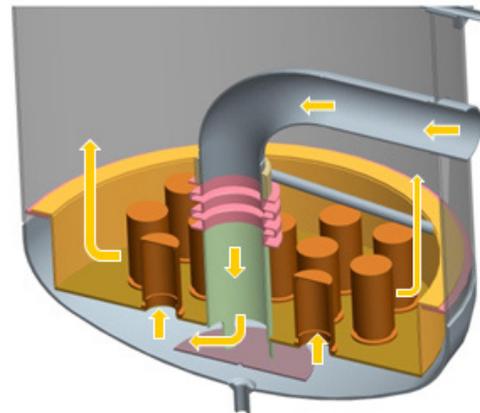
The SVEN test program is considered state of the art because it incorporates lessons learned from the Fukushima Daiichi event and years of severe accident test research. This provides significant benefits over scrubber systems that were tested to global standards established in the late 1980s and 1990s. Test improvements include:

- Aerosol sizes (previously limited to 1 to 2 microns; codes now predict sizes down to 0.3 micron).
- The use of insoluble test aerosols versus previous testing that was done with soluble aerosols, which artificially increased tested retention efficiencies.
- Liquid testing to a pH of 13 to account for buffering in case of chloride presence in the vent gas due to cable burning in containment (previous testing was only done to a pH of 10).
- Testing at higher temperatures and pressures to simulate a delayed venting strategy.
- Adding swell testing to scrubber water levels to confirm the expected two-phase water level is able to remove fission products.

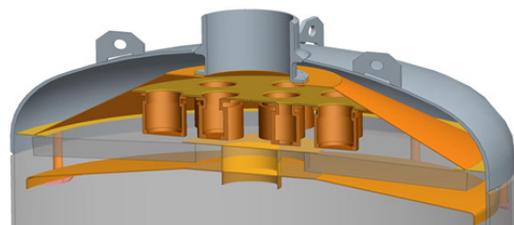
Benefits

In summary, the SVEN scrubber provides the following benefits:

- The system can be scaled to fit into existing buildings.
- The filter media used is readily obtainable, which results in a short overall system lead time.
- Manufacturing of the equipment (e.g., tank and other components) can be localized, when necessary.
- SVEN testing is state of the art and exceeds the testing done on systems many years ago.
- Additional testing can be supported, as necessary, with a full-scale test loop.
- The SVEN system can provide a very high-quality, cost-effective solution to global CFVS requirements.



Flow through bottom of SVEN filter



Top of SVEN filters