3M Selective Separations

Cesium Removal Demonstration at Battelle Columbus Laboratories Decommissioning Project

Project Plan
and
Operational Procedure

Background

3M has developed, with support from the United States Department of Energy National Energy Technology Laboratory (NETL), technology for selectively removing dissolved contaminant materials from liquids using systems operating at flow rates up to 50 gallons per minute. This technology combines active particle chemistry with the advantageous features of membrane science to achieve a new medium for liquid waste processing – a spiral wound filter cartridge that offers the benefits of simplified installation, convenient replacement, and clean, easy disposal of a concentrated waste. By incorporating smaller, higher surface area particles into a sturdy yet porous membrane, greater separation efficiencies of even trace contaminants can be realized at higher flow rates than with conventional column systems. In addition, the captive-particle medium prevents channeling of liquids and insures uniform flow across the sorbing particle surface. The cartridges fit into standard, commercially available housings, and whole system capital costs are substantially lower than those of column or reverse osmosis systems. Selective separation of specific targeted contaminants from mixed waste streams is made possible by utilizing a variety of chemically active particles. Today this family of recoverable materials includes cesium, strontium, cobalt, technetium, radium, lead, copper, and certain organometallic species. Developmental work for selective capture of other elements is ongoing.

Project Scope

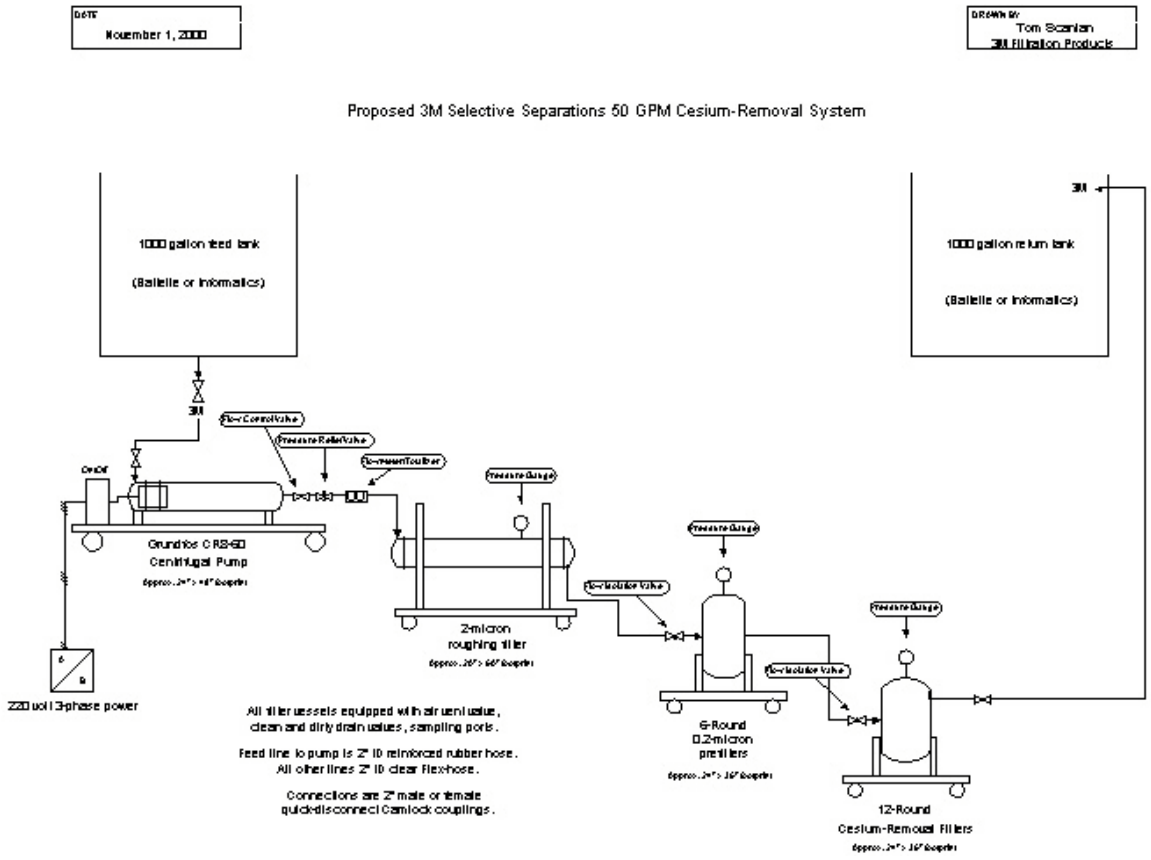
Under the current phase of its contract with NETL 3M has proposed to demonstrate removal of a target radionuclide at a flow rate of 50 gallons per minute (GPM). The Battelle Columbus site was identified as having available water contaminated with a radionuclide (cesium) in volume sufficient to allow for processing at this flow rate. Working in conjunction with Informatics' Well Injection Depth Extraction (WIDE) project, 3M will take groundwater that has been pumped into holding tanks and process it through a set of prefilters and cesium-removal cartridges before returning it to holding tanks for reinjection into the ground. 3M will provide the equipment required to take water from the influent holding tanks and to return it to the effluent holding tanks. (See schematic drawing for description of components.) 3M will also provide personnel for assisting in setting up the equipment, start-up of operations, and training of operators. In addition, 3M may provide assistance in monitoring the performance (removal rate and efficiency) of the cesium cartridges using the 3M Rapid Liquid Sampler (RLS).

Project Objective

The primary objective of the 3M project is to demonstrate the capability to remove cesium from groundwater at a process flow rate of 50 GPM. This technology has previously demonstrated the capability to capture radionuclides, including cesium, at flow rates up to 20 GPM. Performance parameters of concern are pressure drop across the system, cesium removal efficiency, and total cartridge capacity for cesium capture. It is also intended to show that effective prefiltration is afforded by the arrangement of a 2-micron roughing filter in front of 0.2-micron filters. The cesium removal cartridges are not designed to pass solids and therefore incoming water must be prefiltered to avoid premature plugging of the cartridges.

It is anticipated that the 50 GPM flow rate will exceed the flow rate provided by the WIDE system, and that intermittent operation of the 3M system will be necessary. This should not present a problem as the 3M system can be operated in a start/stop mode as water becomes available. For instance, a 3000 gallon volume of water can be processed through the 3M system in about one hour, which may represent the total volume available in one day. While a specific total process volume has not been established for this

demonstration it would be most useful to run the system until the cesium removal cartridges exhibit breakthrough of the target analyte.



System Components

The components of the 3M Selective Separations 50 GPM Cesium-Removal System should be connected to influent and effluent holding tanks as shown in the schematic drawing. A 2” ID reinforced rubber hose connects the Grundfos CR8-60 centrifugal pump to the influent holding tank. The pump then connects to the 2-micron filter housing by means of 2” ID clear Flex-hose. A flow control valve is provided to control process flow rate. An adjustable pressure relief valve is provided along with a 150 PSI maximum pressure relief valve corresponding to the pressure ratings of the prefilter and cartridge vessels. A flowmeter/totalizer is also provided to monitor flow rate and volume processed. The Grundfos CR8-60 requires a 220 volt, 3-phase power supply. (Battelle to provide.)

The 2-micron filter vessel is equipped with 2” male Camlock quick-disconnect fittings for the inlet and outlet port connections, a pressure gauge with air bleed valve on the inlet side, air bleed valve on the outlet side, and drain valve. The vessel opens on one end by means of three wing bolts, two of which swing free allowing the vessel hatch to pivot on the third. The 3M 743B High-Flow filter cartridge is installed over a support tube onto a cup at the bottom of the vessel. The O-rings on the 743B cartridge should be greased with a silicone lubricant (provided) prior to installation of the cartridge.

The 2-micron filter vessel is connected to the 0.2-micron filter vessel by means of a 2” ID clear Flex-hose. The 0.2-micron filter vessel is equipped with 2” male Camlock quick-disconnect fittings, flow isolation valve, pressure gauge, air bleed valve, and drain valve. The vessel lid is secured with wing bolts and is mounted on a swivel. The vessel holds six 2.5” diameter by 20” long filter cartridges which mount into cups at the bottom of the vessel. Spacers are provided between the filters and vessel lid to insure proper fit within the closed vessel. Prefilter O-rings should be greased with silicone lubricant prior to installation.

The 0.2-micron filter vessel connects to the cesium-removal cartridge vessel by means of a 2” ID clear Flex-hose. The cesium-removal cartridge vessel is equipped with 2” male Camlock quick-disconnect fittings, flow isolation valve, pressure gauge, air bleed valve, and drain valve. The vessel lid is secured with wing bolts and is raised and lowered using a crank assist. The vessel holds twelve 2.5” diameter by 20” long cesium-removal cartridges which mount into cups at the bottom of the vessel. Spacers are provided between the cartridges and vessel lid to insure proper fit within the closed vessel. Prefilter O-rings should be greased with silicone lubricant prior to installation.

Effluent water from the cesium-removal cartridge vessel is returned to the effluent holding tank by means of a 2” ID clear Flex-hose. The final return connection will be determined at the time the equipment is set up.

System Operation

Note: It is recommended that clean, non-contaminated water be used for starting up and leak-checking the system prior to processing any groundwater. A volume of about 100 gallons should be sufficient for this purpose.

Install prefilters and cesium-removal cartridges. Use spacers and vacuum grease as necessary.

Open air bleed and flow isolation valves on the prefilter and cartridge vessels. Close all drain valves. Open the terminal gate valve.

The Grundfos CR8-60 centrifugal pump must be primed with water before start-up. If the connection to the influent holding tank draws from the bottom (preferred) gravity will be sufficient to push water to the pump. An air purge valve is provided to vent air out of the pump while water is coming in. Open purge valve until water is observed coming out, then close the valve. Open the flow control valve about one eighth turn. (Total rotation is 90 degrees so open between 10 and 15 degrees.) Activate flowmeter/totalizer by pressing the display button. It should read 0.0 and indicate 'FLOWMETER'. Pressing the display button again will show a number representing the total volume that the pump has processed and indicate 'TOTAL 1'. Pressing the display button a third time will give an indication of 'TOTAL 2' which may be a lower number than the first one because it can be reset to zero by holding it down for several seconds. Pressing display again will return to the 'FLOWMETER' mode. (If the system is operating the display will remain on. If it is idle for several minutes the display turns itself off to conserve battery power and must be turned on again when processing is resumed.) With the display in 'FLOWMETER' mode, turn on the pump. Observe flow rate on flowmeter. Adjust valve to between 5-10 GPM. Air will vent from each vessel as it fills with water. Close air bleed valves after water is observed coming out. Water flow may be directed with a short length of tubing if desired. When water has filled all the vessels and is observed entering the effluent holding tank, the flow control valve may be adjusted to raise flow rate to 50 GPM. Check and record pressure readings on each of the vessels.

System Leak Check:

The system can be checked for leaks as follows. With the system completely filled with water, shut the pump off and close the terminal gate valve. Restart the pump and observe pressure reading on the closest vessel. When pressure reaches 30 psi, shut off pump and close the flow control valve. Pressure on vessels should equalize and be between 20 and 40 psi. Keep system deadheaded for 30 minutes and monitor pressure. A drop in pressure indicates a leak in the system. Visually monitor for water drips at connection points. Leaks may be addressed by tightening connections or applying additional pipe sealant.

Sampling

Influent and effluent water will be monitored for cesium concentration throughout the demonstration. A precise sampling schedule has not been determined at this time. The 3M Rapid Liquid Samplers for cesium may be used for some of the monitoring. Sample analysis may be performed on site (Battelle), at 3M, or both.

Project Conclusion

It is uncertain how long the demonstration will run or what total volume will be processed through the cesium-removal cartridges. While it would be beneficial to run until the cartridges are close to full capacity for cesium capture this may not be possible (or practical) within the timeframe of the overall decommissioning project at Battelle. The primary objective for 3M, as stated previously, is to demonstrate capture of cesium from a contaminated water source at a process flow rate of 50 GPM.

The system components and all filters and cartridges are the property of the United States government. It is understood that the equipment will remain on site until the demonstration is concluded, at which time a decision will be made on what to do with it.