Separation and Extraction of Hot Particulate from contaminated Perfluorocarbon solution

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Abstract

It was an idea to develop a system to remove the contaminated hot particulate to make clean nuclear research facilities to the clear visibility for researcher. In order to clean micron and sub micron size particulates from used PFC solution as a decontamination tool. Since PFC solution is very expensive so it was a high recommendation to develop the some filtration equipment to purify PFC for next decontamination process, in additionally, reduce the secondary waste. However, we developed an easy and economic filter system to purify the PFC solution. The major advantage of the process operates in closed loop under near ambient conditions, thus minimizing the potential for fugitive TRU emissions and reduces the secondary waste. This has very significant safety and cost impacts. Here we proposed the two types PFC filter systems.

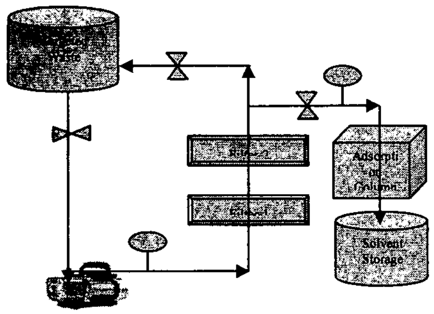

Fig. 1: Schematic Diagram for Hot Particulate Treatment

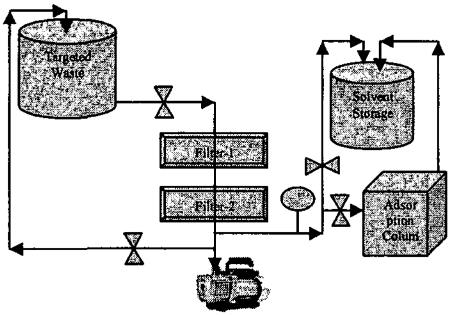

Fig. 2: Schematic Diagram for Hot Particulate Treatment

Introduction

To remove the radioactivity on a metal surface, chemical cleaning reagents have been widely applied. As we know that the cyclones are one of the most common inertial devices and used for a variety of applications. Cyclones, however, have low collection efficiency for small particles due to their reliance on inertial forces to separate particles from gas streams. Particles that are micron size or smaller generally adhere tenaciously due to secondary valence forces with other solid surfaces, and cannot be removed by simple mechanical means. However, contacting particle-contaminated surfaces with a dilute solution of fluorinated surfactant of high molecular weight in an inert perfluorocarbon (PFC) liquid with spraying shear conditions resulted in effective removal of micron or sub-micron sized particles from solid surfaces.

Accordingly, in the present study the particle size distributions and concentrations were mainly uranium, cesium, plutonium etc., which produce hydrogen gas under the alpha radiations in presence of organic constituent.

This work is related to PFC (perfluorocarbon) solution filtration system, which can be easily handled and moved from one place to another and positioned in areas that are cramped for surface. Though there are many filtration systems available to remove hot particulate, but there is no any system available which can be confined areas to purify the PFC solution. Such system that is available requires substantial modification there to by way of long and complicated. In general, the present available system is not good enough to get highly pure PFC after filtration.

Description of the Proposed System

Figure 1 and figure 2 are the process flow diagram or perspective view of our proposed system. Following is a description of the fluid flow through the experimental setup.

Figure 1: Fluid, drawn from the tank (Targeted Waste) by the pump, through a throttling valve, used to control the flow rate of the fluid for the filter, through PG-1, is first pumped through a filter-1, and filter-2, from here, the fluid flows passed another pressure gauge, PG-2, to Adsorption column, through a throttling valve and finally collected in solvent storage.

Figure 2: Fluid, drawn from the tank (Targeted Waste) to filter-1 and filter-2, through a throttling valve. From here this fluid may retentate to again target waste tank or supply to adsorption chamber or directly solvent storage tank by the pump. PG used to control the flow rate of the fluid for the mainly adsorption column.

I case of second proposed system the fluid could be collected without passing through the adsorption column. To use of adsorption column here is an option according to need of pure PFC.

Filters

Filter-1 known as primary ceramic filter consist of 2.0 µm pore size of Al_2O_3 over SiC module, while Filter-2 known as secondary ceramic filter consist 0.2 µm pore size. The purpose of these filters is to remove sub-micron particles suspended in the solution that leaves the cleaning chamber before this solution is returned to storage. Two filters were placed in parallel to reduce the pressure drop to a level that matched the output pressure of the circulation pump.

Why Proposed to Ceramic filters

Ceramic filters are stable in a radiological environment. They do not contain hydrogen in their structure, and thus cannot generate hydrogen gas in the presence of uranium, cesium and plutonium etc. particles. This is in contrast to standard filters made of polymeric materials that will generate gaseous hydrogen when subjected to alpha radiation. Therefore, we have chosen ceramic filter because ceramic filters offer high temperature stability, strength, and compactness. They are available in the form of cylinders or large diameter honeycomb monoliths that contain a large number of 2 mm square parallel passageways extending from one face to the other. Note that in dead-end re-circulating filtration, which is used here, there is no retentate flow. We expect that most of the hot particulates will be collected on the ceramic filters. These filters will be dry when they are removed from the process, and will be treated as TRU solid waste. In additionally, ceramic filters have a high soil loading capacity in a dead-end mode, and can be back flushed, if desired.

Activated Carbon Filter Adsorption Column

The first component of the ACF adsorption column is the ACF cloth wrapped mandrel. The mandrel is composed of a porous metal pipe welded to two sections of pipe on either end. With one end plugged as seen in Figure 3, and the other end welded to the. Which penetrates the column cover, pipe the mandrel is complete.

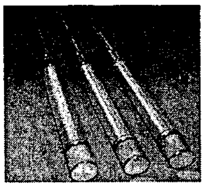

Figure-3

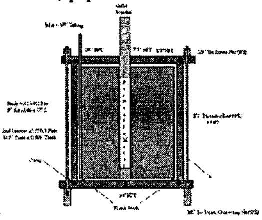

Figure-4

Found in Figure 4 is the variation on this adsorption column setup. The difference between these two setups is that in the second there is an impermeable polyethylene sheet covering both ends. This guards against any of the fluid bypassing the ACF cloth. Without this plastic the fluid could flow through the ends of the carbon and pass through only a small portion of the carbon, exhausting the removal capacity of that small portion quickly.

Conclusion

A Filtration system for the removal of hazardous and radiological particles from a fluorinated solvent has been proposed here which permits the reuse of Perfluorocarbon as a decontamination tools and reduced the secondary wastewater.

Benefits

Cleaning contaminated equipment from the hot cells would drastically reduce the volume of TRU waste that would require characterization, packaging, shipping, and processing. It would also significantly reduce the risk of exposure to people and the environment to TRU waste particles. Depending on the nature of the contamination, more than 97 percent of the radioactivity can be removed using this system, and find the pure PFC for next decontamination. It is simple, safe, highly automated decontamination process and no toxic or oxidizing chemicals are used; no high pressure or temperature needed for processing. Lowered risk for impact to the environment: no gaseous effluent containing TRU particles.