STERILIZATION OF POLYTETRAFLUOROETHYLENE (PTFE) FILTERS ON PLUMBING VENTS USING A PORTABLE STEAM GENERATOR

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ABSTRACT

The Kansas State University Biosecurity Research Institute (BRI) houses a large biocontainment facility. Drains from the Biosafety Level 3-Agriculture (BSL-3Ag) area connect to a plumbing vent to accommodate gas expansion and release of unexpected pressure in the plumbing. Each vent location has two Pall filter assemblies, in series. These filters prevent aerosols from entering the environment if any inadvertently pass through drain traps and enter the plumbing vent. A method was needed to decontaminate Pall filters before evaluating filter integrity by conducting water intrusion tests or before filter change out. A portable Lattner electric boiler was used to develop this procedure. Biological indicators (BIs) were placed inside the Pall filter assembly and on the inlet and outlet ports. The assembly was isolated by closing appropriate valves. Hoses were attached to the top and bottom valves of the housing and to the valve on the inlet side to drain condensate. A gauge was placed on the top side of the assembly to monitor pressure. Outer surface temperature was monitored using a Fluke thermocouple device. Steam was slowly introduced through the outlet side of the housing until the temperature reached 120°C. Air within the system was bled out through the valve on top of the assembly. Pressure was adjusted using the bottom valve of the housing. Condensate was collected into a bucket containing CaviCide® disinfectant. Steam was applied for a minimum of 30 minutes at 120°C and 15 psi. All BIs came back negative. This is a practical method for Pall filter housing sterilization.

OBJECTIVES

- Describe a polytetrafluoroethylene (PTFE) filter assembly design
- State how infectious aerosols from a biosafety level 3-agriculture (BSL3-Ag) room could reach a plumbing vent
- Successfully validate the parameters required to use steam as a PTFE filter housing sterilization method

INTRODUCTION

The BRI was constructed to meet or exceed BSL-3 and BSL-3Ag standards. The BMBL specifies that HEPA filters must be installed on all atmospheric plumbing vents serving plumbing traps in BSL-3Ag containment spaces. During original construction, standard HEPA caissons were installed on the atmospheric plumbing vents. Once the building became operational, condensation accumulation in the HEPA cabinets associated with the plumbing vents was noticed on several occasions. As standard HEPA filters do not function well in wet environments, the decision was made to remove the HEPA caissons and install Pall filter assemblies instead, as Pall PTFE filters perform well in a wet environment. Once installed, a reliable method of decontamination using steam, was developed for the Pall filter assemblies. The BRI BSL-3Ag containment spaces function as primary containment. These rooms house large livestock species which are often challenged with high consequence pathogens. Infectious materials (urine, feces, water, etc.) are washed down the drains in these rooms, and are subsequently treated in the Effluent Decontamination System (EDS) tanks before leaving the facility. All of the plumbing from these rooms is vented to allow for escape of gases and pressure in the plumbing system. If any infectious aerosols were to pass through the drain traps and enter the plumbing vents, they would be captured by the Pall filters.
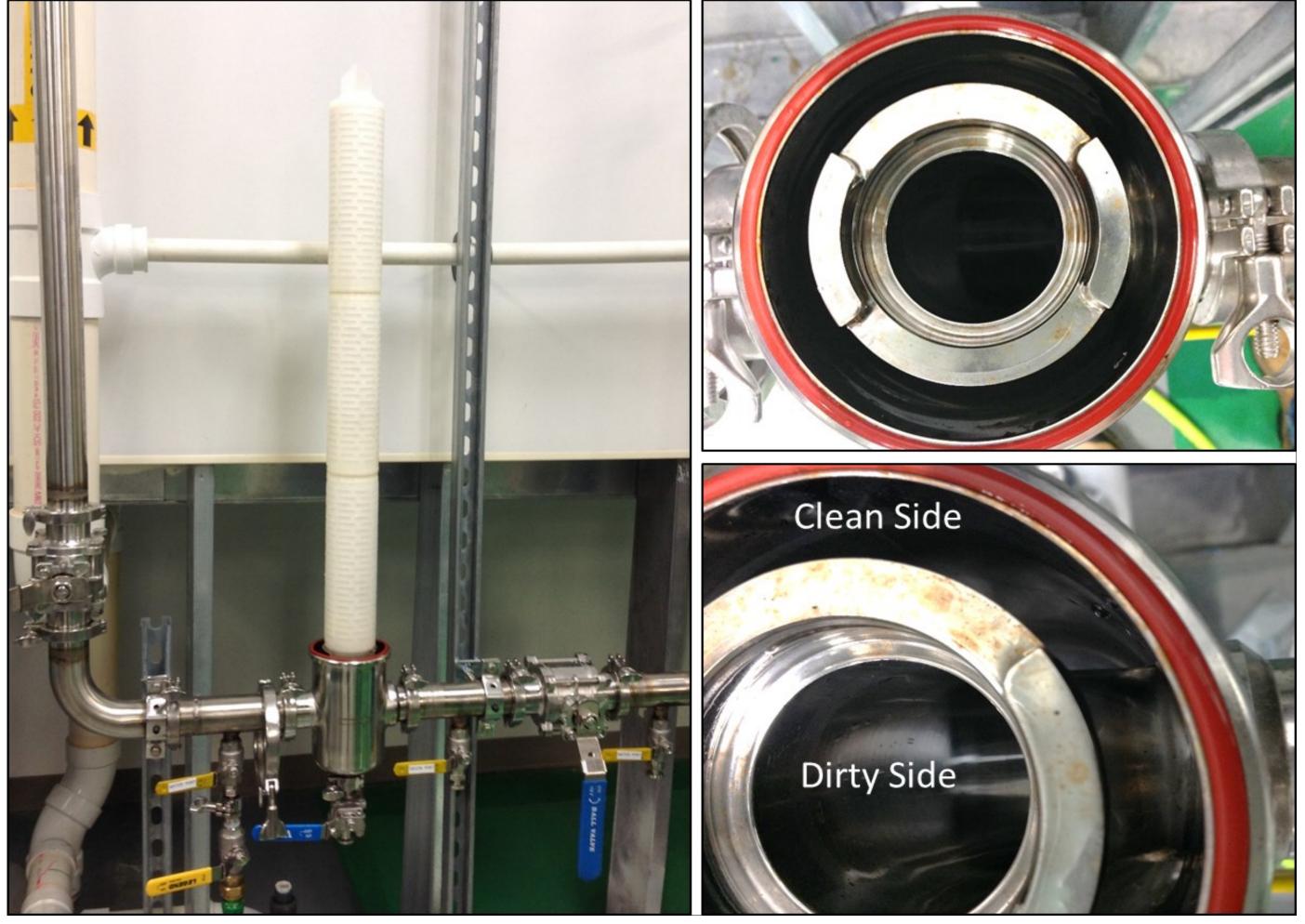

Figure 1: <u>Left</u>: Pall filter assemblies, in series, shown with valves in normal operating positions. <u>Middle</u>: Pall canister removed with filter exposed. <u>Right</u>: Views of the pluming vents with the filter removed. The bottom photo shows the inner (dirty) side of the vent and the outer (clean) side after going through the filter.
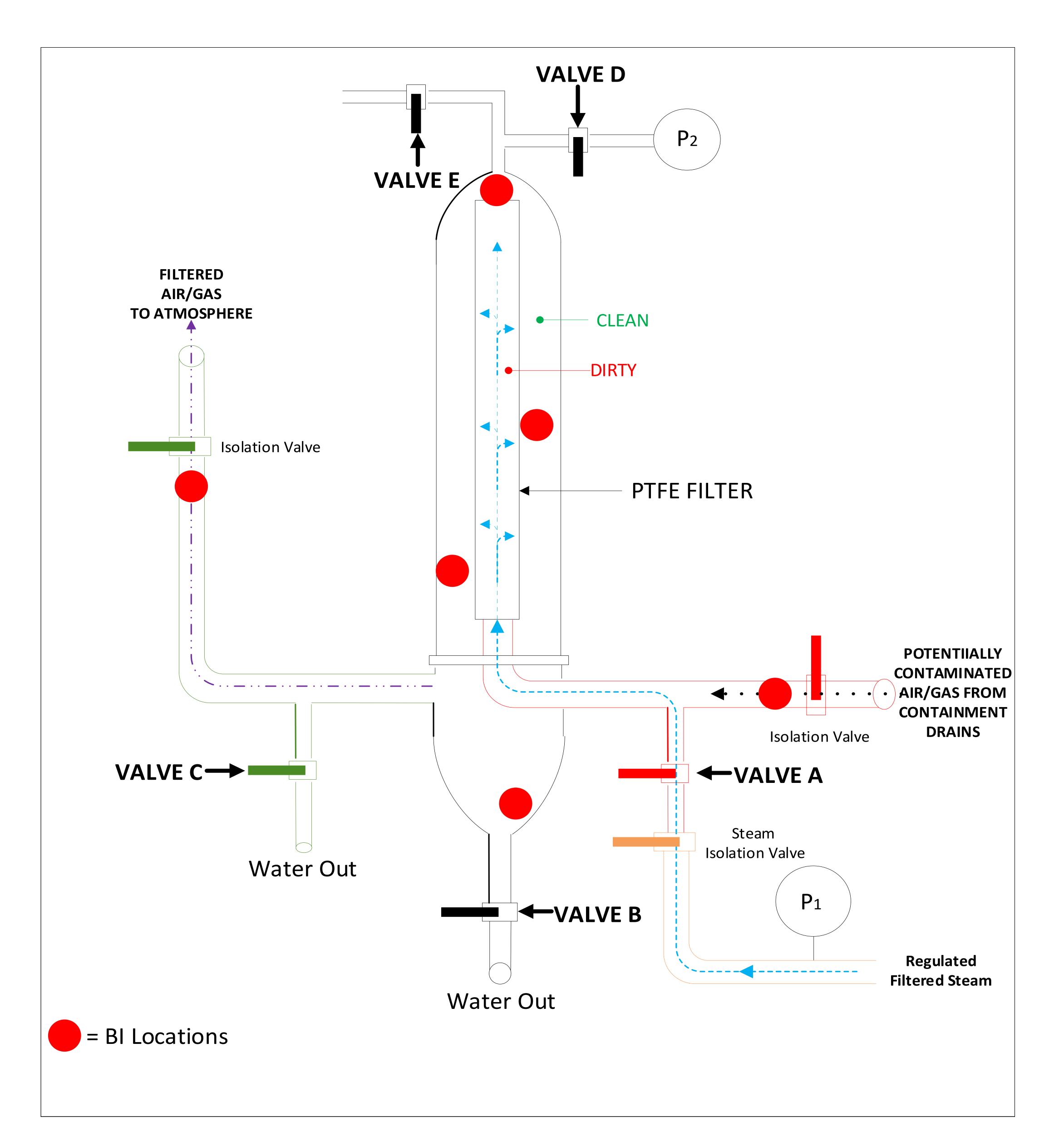

Figure 2: <u>Left</u>: Steam decontamination setup. <u>Middle</u>: Portable Lattner electric boiler. <u>Right</u>: Temperature monitoring using a Fluke thermocouple monitoring device.

Figure 3. Pall filter housing diagram depicting the flow of air and steam through the system. For validation, BIs were placed throughout the housing, locations shown as red dots.

MATERIALS & METHODS

A portable Lattner electric boiler was used to produce regulated, filtered steam (Figure 2). Hoses were connected to valves B, C, and D to allow condensation to drain from the system (Figure 3). A bucket containing disinfectant was used to collect condensation.

<u>Preparation</u>: Eight Pall housings—two housings per manifold—were installed in the mechanical space (aka penthouse) on the upper floor. Two Pall housings were installed in the mechanical space on the lower floor (EDS room). When installed, there were no electrical outlets available in the mechanical spaces to power the steam generator. Five 208 VAC/60 Amp, 3 phase outlets were installed to accommodate the generator. A hose bib was installed in the penthouse to provide domestic water to the steam generator. An existing hose bib was used in the EDS room.

<u>Experimental Design</u>: Before the Pall filter units were put into service, the housing was opened and six BIs (*Geobacillus stearothermophilus*) were placed throughout the housing. The BIs were affixed to the housing using autoclave tape. The housings were closed, and steam was applied as described below at 15 psi, 120°C, for 30 minutes. BIs were retrieved after the housing returned to room temperature and incubated for 24 hrs at 60°C.

<u>Replication</u>: Three separate steam decontamination runs were used for validation.

<u>Order of Operations</u>: **1.** Ensure all valves, including isolation valves, are fully closed. **2.** Connect steam line to valve A, leaving valve A closed. **3.** Ensure that boiler pressure is 30 psi. **4.** Slightly open valves B and C, (ensuring hoses are submerged in CaviCide®). **5.** Slowly open valve A to allow steam into the system. **6.** When steam flow is evident from valve B, close valves B and C. **7.** Partially open vent valve E. (ensuring hoses are submerged in CaviCide®) **8.** Permit steam to flow through the system until the steam pressure is stabilized. **9.** Adjust valve A and valve E as necessary until the validated temperature is achieved. (120° C) **10.** Monitor the temperature for the necessary sterilization time. (30 min.) **11.** When sterilization is complete: **(a)** Close valve A, housing drain valve C, and vent valve E. **(b)** Close the vessel steam supply valve. **(c)** Open valve E to compensate for any differential between the pressure within the assembly and ambient pressure. **(d)** Allow the assembly to cool to ambient temperature, drain condensate, if any. **12.** The filter assembly is now ready for use.

RESULTS & DISCUSSION

For each of the three validation runs, the results of all BIs were negative. The configuration of the Pall filter housings at the BRI is illustrated below (Figure 4). There are two housings in series for each plumbing vent. The first filter should capture any aerosols, and the second filter is redundant. For our purpose, the filter housing nearest the research space (A) is isolated and steam decontaminated first. The integrity of the filter is then tested using a water intrusion test. If the filter integrity is good, the second filter housing (B) is considered "clean" and the integrity may be tested without steam decontamination of the housing. If the first filter does not pass, it is replaced and retested. The second housing then would be considered potentially contaminated and undergo steam decontamination before integrity testing.
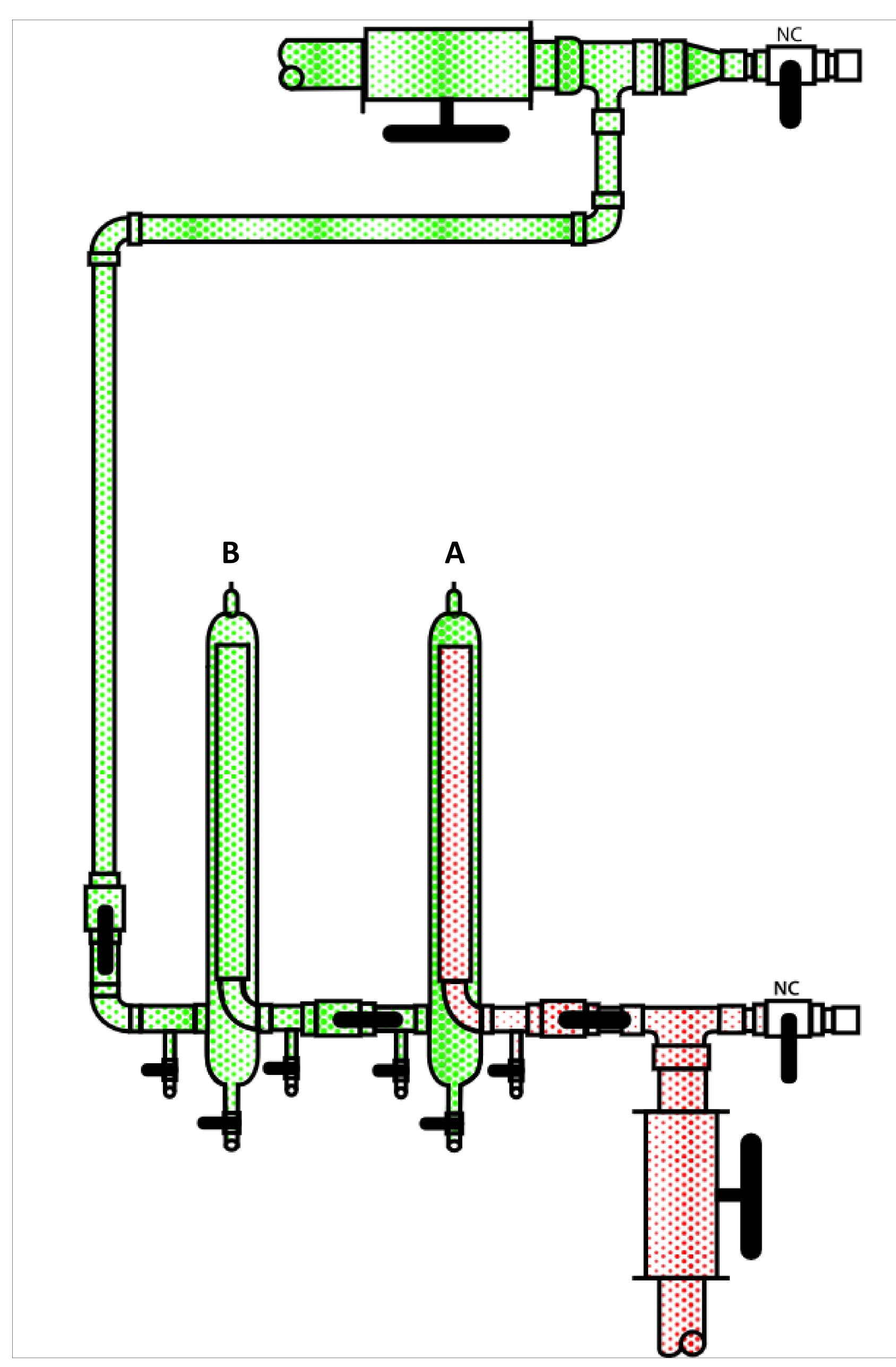

Figure 4. Pall filter housing setup depicting potentially contaminated areas under normal operating conditions (red dots). The first filter captures any aerosols that may be present. The second filter provides redundancy but is considered 'clean' (green dots) if the first filter passes the integrity test.

CONCLUSION

Steam, when applied for a minimum of 30 minutes at 120°C and 15 psi, is an effective method to decontaminate the PTFE filter housings. Any infectious aerosols (from agents that we currently study) from the BSL-3Ag spaces that reach the housing would be effectively inactivated using this method.

ACKNOWLEDGEMENTS