# Self Cleaning HEPA Filtration without Interrupting Process Flow - 9054

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## ABSTRACT

The strategy of protecting the traditional glass fibre HEPA filtration train from it's blinding contamination and the recovery of dust by the means of self cleaning, pre-filtration is a proven means in the reduction of ultimate disposal volumes and has been used within the Fuel Production Industry.

However, there is an increasing demand in nuclear applications requiring elevated operating temperatures, fire resistance, moisture resistance and chemical composition that the existing glass fibre HEPA filtration cannot accommodate, which can be remedied by the use of a metallic HEPA filter media.

Previous research (Bergman *et al* 1997, Moore *et al* 1992) suggests that the then costs to the DOE, based on a five year life cycle, was $29.5 million for the installation, testing, removal and disposal of glass fibre HEPA filtration trains. Within these costs, $300 was the value given to the filter and $4,450 was given to the peripheral activity.

Development of a low cost, cleanable, metallic, direct replacement of the traditional filter train will the clear solution. The Bergman *et al* work has suggested that a 1000 ft^3/min, cleanable, stainless HEPA could be commercially available for $5,000 each, whereas the industry has determined that the truer cost of such an item in isolation would be closer to $15,000. This results in a conflict within the requirement between 'low cost' and 'stainless HEPA'.

By proposing a system that combines metallic HEPA filtration with the ability to self clean without interrupting the process flow, the need for a tradition HEPA filtration train will be eliminated and this dramatically reduces the resources required for cleaning or disposal, thus presenting a route to reducing ultimate costs.

The paper will examine the performance characteristics, filtration efficiency, flow verses differential pressure and cleanability of a self cleaning HEPA grade sintered metal filter element, together with data to prove the contention.

## INTRODUCTION

Initial results from Work in Progress at the Microfiltrex facility of the Porvair Filtration Group has shown both the efficacy and long term stability of Pulsed Jet self cleaning HEPA grade (>99.97% @ 0.3 microns).

The existence of such a technology brings solutions to a number of intractable problems in the Nuclear Industry and beyond, thus allowing point of use HEPA protection in environments where this was previously impractical. This obviates the need for scrubbers, diluters or heat exchangers downstream of the process to allow contaminant removal to take place.

**Contention**

A research programme was developed to determine:

1. Is the concept feasible?
2. Was the HEPA efficiency reliable over the long term?
3. Was a stable operating regime (DP plateau) achieved?
4. Was the operating DP within the parameters of the typical process requirement?

The work continues to be conducted on the test rig (see Fig. 1)

**Fig. 1. Test Rig.**

The test filter is based upon a Microfiltrex standard range 'M086000' element utilising the company's designated Sinterflo F3 stainless steel sintered fibre media to achieve a 99.97 @ 0.3 microns efficiency. The effective filtration area of the element is 0.3 $m^2$. Using a typical face velocity of 3 cm/s for HEPA filtration, a test flow rate of 32.4 $m^3$/h (19.2 cfm) was determined. The element passed a 0.3 µm Ondina challenge test at 32.4 m3/hr giving an efficiency of 99.992%.

The Pulsed Jet Vessel is supplied with a calibrated airflow, commensurate with its filtration area, by a centrifugal fan, whilst the dust is fed into the system by a precision syringe pump via a rotary brush, at a dust rate of 105.8 g/hr. We have chosen to explore the concept using a high dust load in the first place, as this is more typical of the process requirements our clients have asked us to explore. Low dust loads and a wide range of media velocities will also be explored, as will efficiency at the MPPS (Most Penetrating

Particle Size) as the research programme proceeds in the future. Results of this work will be presented in a subsequent paper.

Initially, we determined that the tangential inlet imparting angular momentum to the heavier particles (i.e., acting as a low efficiency cyclone) drops out a substantial fraction of the test dust (a Red Iron Oxide powder in the range 0 to 5 microns). That being the case, a preferentially selected fine fraction is thought to be reaching the filter element.

Initial observation of the filter performance, with a clean DP of 612 Pa (2.5” wg) and a Pulsed Jet initiation set point of 1212 Pa (4.8” wg) showed that the filter ran for 8.5 hours without reaching the DP set point (see Fig. 2).

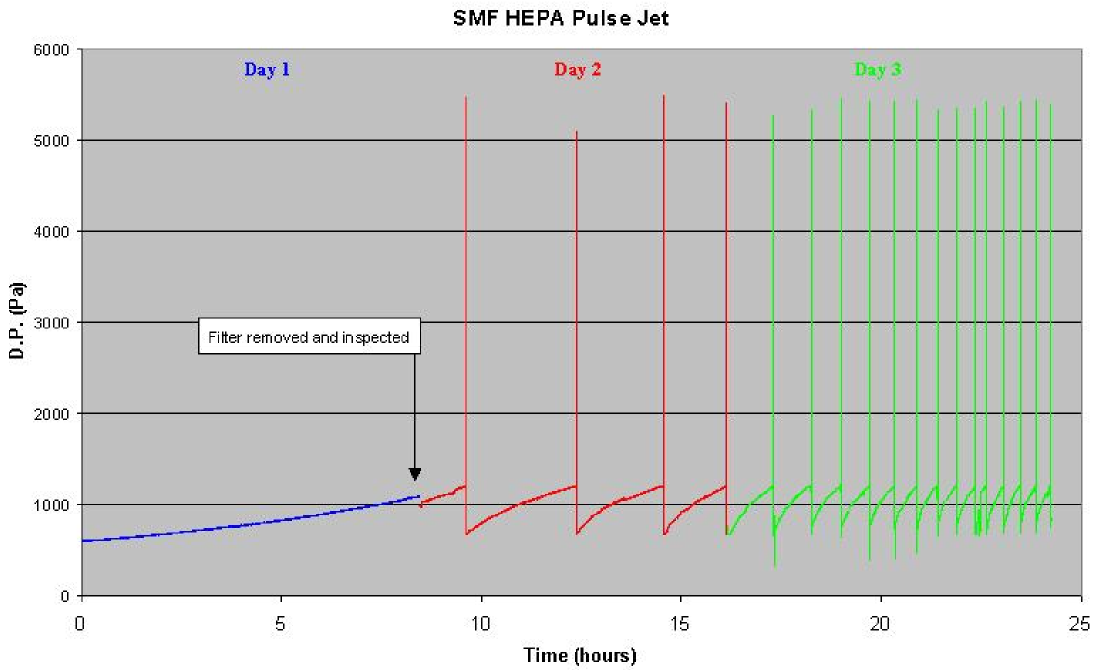


**Fig. 2. Filter performance, with a clean DP of 612 Pa (2.5” wg) and a Pulsed Jet initiation set point of 1212 Pa (4.8” wg).**

The Pulsed Jet initiation set point was reduced, allowing the Pulsed Jet system to operate, and the data suggests that a stable operating regime was reached (see Fig. 3). The data records time between pulses at a constant PJ initiation DP.

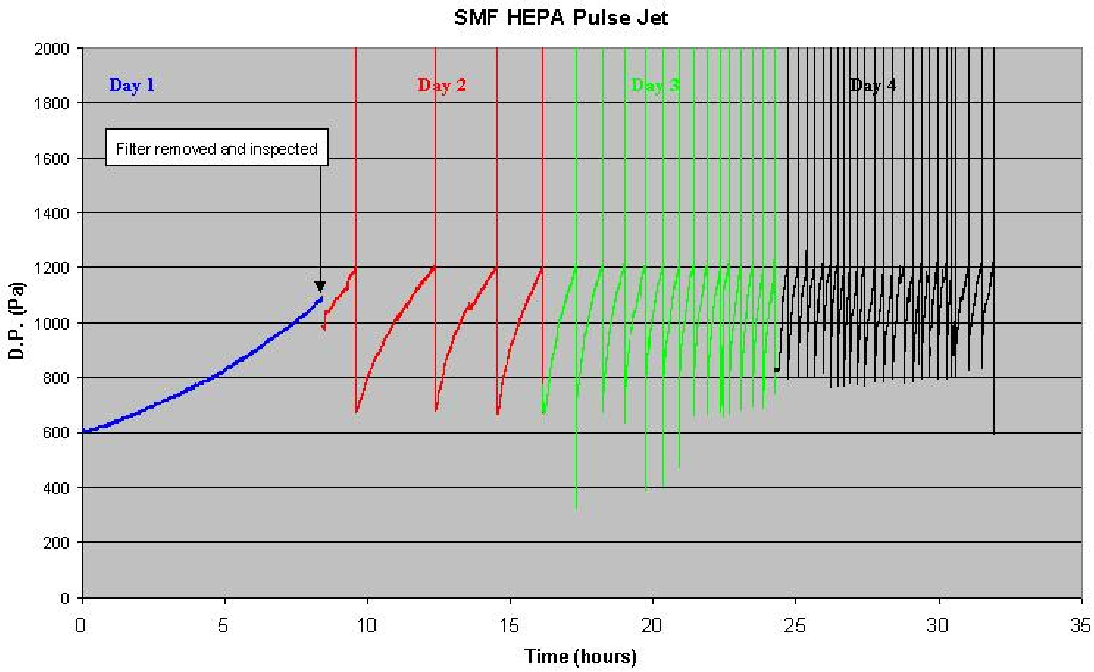


**Fig. 3. Illustration of stable operating regime.**

Fig. 4 shows a synthesis of that data, indicating that, over time, the Pulsed jet HEPA self-cleaning system reaches a stable operating plateau and stays there.

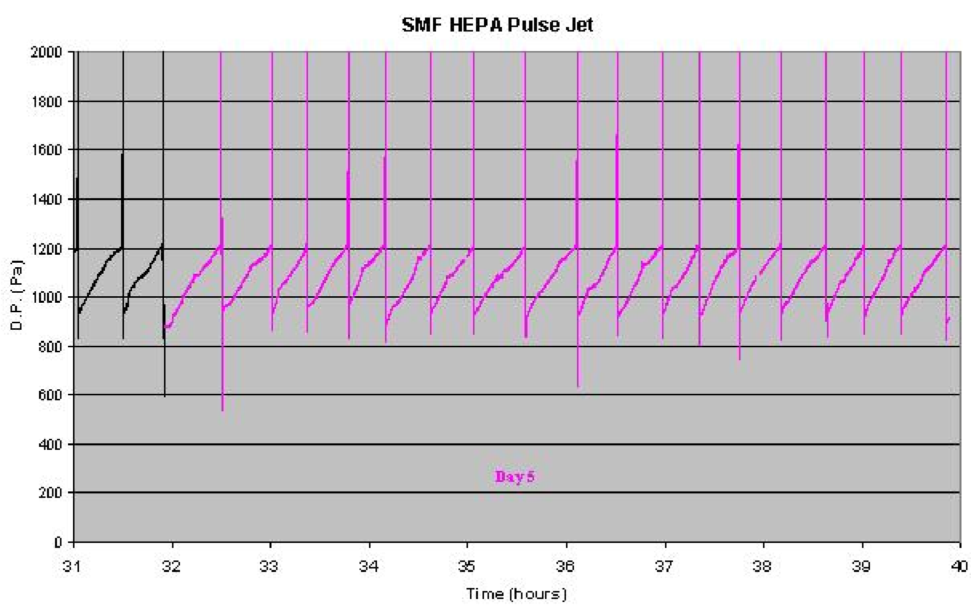


**Fig. 4. Stable operating plateau of the Pulsed jet HEPA self-cleaning system.**

Having achieved an indication of a stable regime, the initiation set point was raised to a higher level of 1812 Pa (7.3" wg), to determine if elevated DP would have the effect of choking flow, compressing the cake or increasing penetration to compromise the operating of the equipment in real, process applications. (see Fig. 5).

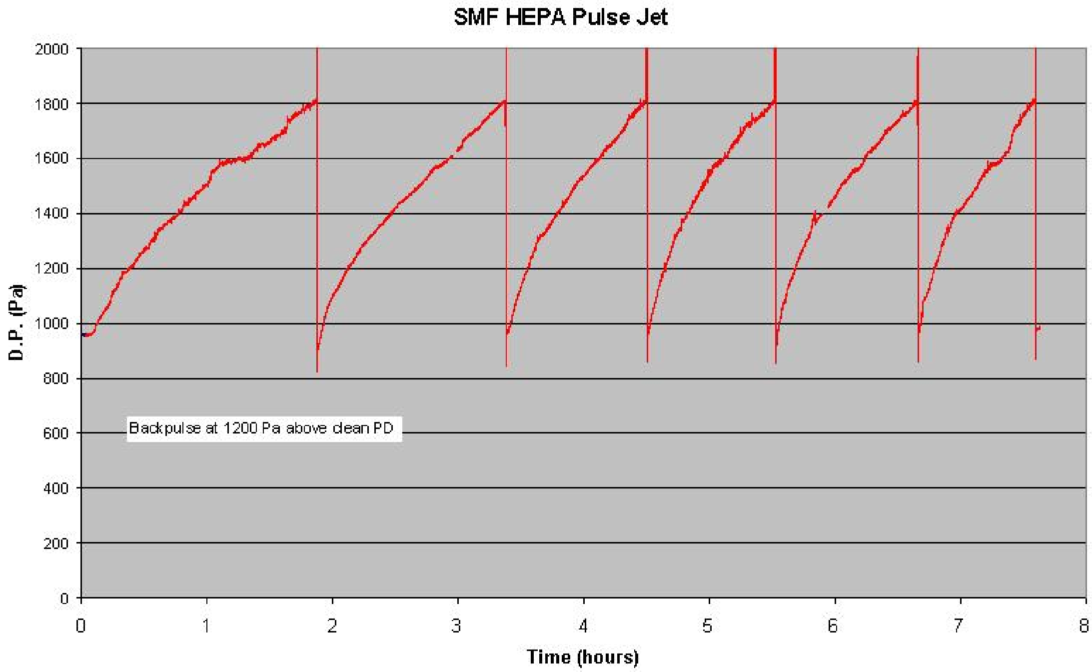


**Fig. 5. Illustration of the initiation set point was raised to a higher level of 1812 Pa (7.3" wg).**

The filter was removed from the vessel and thoroughly rinsed in water and then soaked in 15 % Nitric acid for 20 hours. It was then again rinsed in water and dried in an oven for 2 hours at 110 °C. A taint of the red iron oxide powder was still visible after this process.

The filter was then subjected to a 0.3 µm Ondina challenge test at 32.4 m3/hr giving efficiency of 99.978 % was measured. This is somewhat lower that the 99.992% measured before testing but still within the HEPA specification. The filter was then installed back in the pulse jet test rig and the PD at 32.4 m3/hr measured as 609 Pa which is very similar to the pre-test clean PD of 612 Pa suggesting that the cleaning had been successful despite the tainted appearance of the filter.

## CONCLUSION

The on-going development programme gives confidence that it is possible to achieve stable, long term, self-cleaning HEPA filtration, which can operate continuously without interrupting the process flow. The importance of this development is difficult to calculate, but it is clear that there are several applications in the nuclear industry and beyond, particularly in waste treatment or destruction.

Further work will continue to define precisely the pressure loss, stability of filtration performance and the applicability/stability of the process to very high and very low flows, to upset conditions (for instance, explosion mitigation) and both low and very high solids challenges.