ELIMINATION OF THOSE EXPLOSIVE STARTS IN THE BACKWASH SEQUENCE

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ABSTRACT

The majority of filter cells in Gippsland Waters' 18 Potable Water Treatment Plants incorporate a system of in floor nozzles direct into a plenum or in floor laterals. The primary function of the nozzles is to collect filtrate after it has passed through the media. The secondary and equally important function the nozzles perform is distribution of air and water during the backwash process to remove entrapped particulate matter from the filtration media. During normal filtration operation it became apparent that things were not going as expected during the backwash sequence. The signs of bed disturbance were there and so the quest for a solution began. Our solution involved the separation of the air scour and water wash sections of the backwash process. This involved some clever design of prefabricated sections of each air scour system so they could be manufactured and installed with minimal fuss.

The subject of filter bed inspections is not covered in this paper, but some of the issues highlighted during these inspections are mentioned. This presentation is an insight into what changes were made to our systems, which has led to improved air and wash patterns of those filters that have been modified to date.

KEY WORDS

Gippsland Water (GW), Water Treatment Plant (WTP), Free Air Delivery (FAD), Variable Speed Drive (VSD).

1.0 INTRODUCTION

Gippsland Water (GW) operates 18 Water Treatment Plants (WTP's) to supply treated water to communities large and small. The WTP flow rates range from 5 L/s at the smaller package plants to around 300 L/s at the larger ones. The WTP's have in total 51 high rate multi media filter cells. These range from small self-contained freestanding stainless steel units at the smaller plants, to larger concrete units, which are integral to the building structure at some plants and purpose built freestanding structures at others.

Prior to the introduction of Drinking Water Guidelines very little attention had ever been focused on filter operation. As long as they worked and were washed when required, then all was fine. Because filters are typically the last physical barrier for removal of suspended particulates, closer monitoring of the filtration process was undertaken. This of course resulted in closer monitoring of the filter backwash operation and cleaning process, and involved Technicians watching the performance of the backwash sequence more closely. During this monitoring, there were signs the backwash process was not as good as it could be. One such sign being the volcanic type eruptions in the bed when the air scour sequence began.

The treatment plants' filters used a common filter nozzle for filtration, air scouring and washing during the backwash process. A means of improving the reliability and effectiveness of the air scour sequence was required. If the repeatability of the air scour pattern could be established, then filter performance could be expected to improve by removing these disruptive random eruptions.

<u>Figure 1</u>: ***Eruption at the start of an air scour sequence***

2.0 DISCUSSION

Poor air scouring and backwashing had been observed in a number of filters across several treatment plants, and was reducing the effectiveness of the filtration process. Air scouring is the process of fluidisation of the filter media to allow efficient washing, and not the destruction of the filter media as was occurring. Effective backwashing of filter media is critical to the performance of any filter. Uneven air scour and backwash patterns can disturb the interface of the media layers or in some cases cause severe mixing which leads to water short circuiting.

At one of our larger WTP's, one filter was the first to be selected for the newly re-designed air scour system as the start of the backwash sequence was violent and spasmodic. The process involved a complete re-design of the air scour pipe work. The design needed to be:

Flexible - able to be installed around existing infrastructure. One issue observed was that the filter cell floor was not level, with unevenness of greater than 25mm in some areas. The air scour system had to be level, not just attached to the existing floor.
Durable - designed for long life using stainless steel pipe work and fittings.
Easily installed and maintained - reduces filter down time, time spent in the cell as they are confined spaces, and welding within the cell is kept to a minimum.

In addition, the sizing of holes for the pipe work was based on existing plant blower rates, and was to have an air scour lateral in between each row of filtrate nozzles. The re-design also needed to consider the removal of the existing air scour header and dropper assemblies, and effective sealing of the all the holes that were left.

2.1 Removal of the old system.

With the decision to rebuild the air scour system made, work on removal began. Removal of the old air scour system required cutting the 97 droppers and also the old header supply pipe where it came in through the wall.

The droppers were cut off approximately 25mm above the floor. Each stub then had the inside and outside edges cleaned of all burrs left by the cutting process. The stubs into the laterals and the header supply hole in the wall had to be sealed against leakage. To seal the header supply hole through the wall, a stainless steel plate disc was inserted into the old pipe end from inside the filter and was fully welded in place. The external entry was already flanged so a modified blank flange was bolted in place. The blank flange had two drilled lugs welded on opposite sides. A stud on each side of the flange would be anchored back into the filter wall to stop any outward movement of the sealed inlet. The material of the header and droppers was PVC so the filter was put through a number of water wash cycles to remove any swarf and fine sand from the laterals. After the washes all waste was vacuumed out and the 97 dropper butts had caps glued in place to complete the sealing.

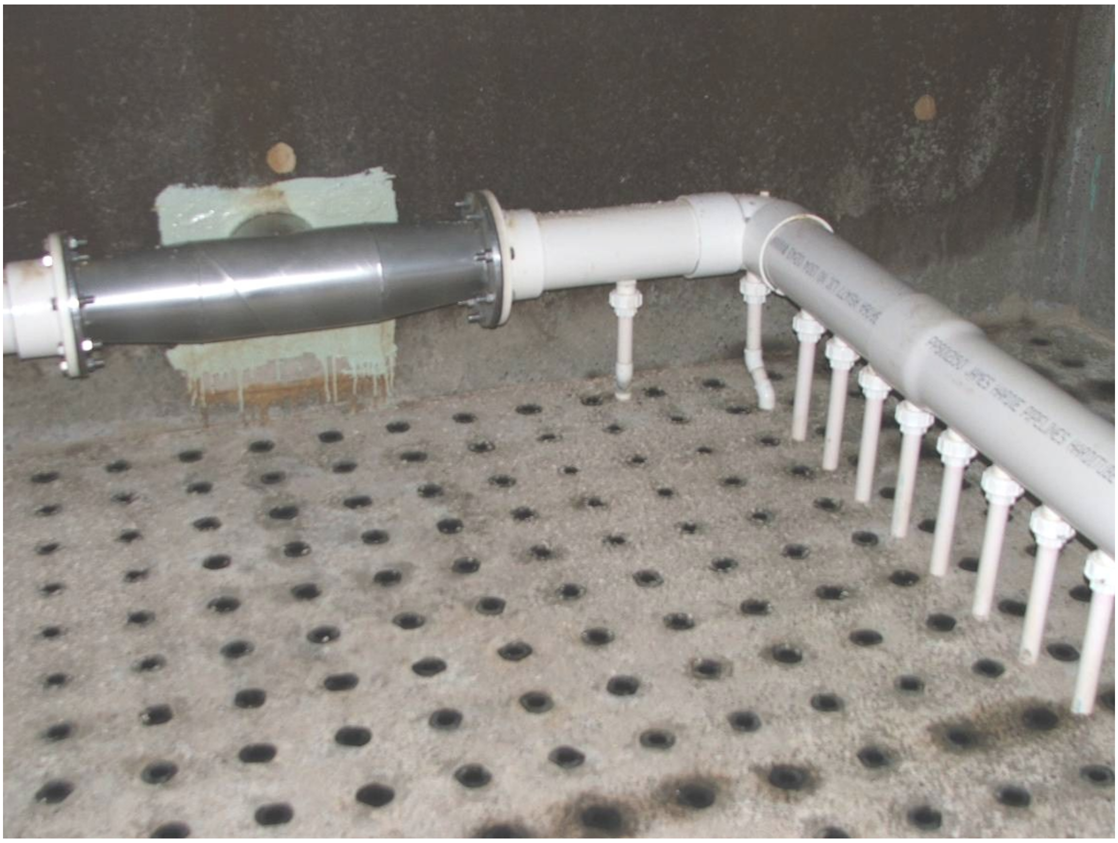


Figure 2: ***A section of old air scour headers and droppers prior to removal.***

After the sealing work was completed, the 1222 filtrate nozzle sockets were plugged, to prevent entry of foreign material into the laterals. The cell was then washed and grit blasted to remove loose or flaking particles from all surfaces. Following vacuuming it was coated with an approved product to protect, reduce leaching, and make operational cleaning easier. While the preliminary work was being done, the new air inlet supply was being connected to the existing anti-siphon section of the original line. This allowed the other filters to continue normal service while the new line was fitted, isolated and blanked off for future extension.

2.2 Prefabrication of air scour arrays

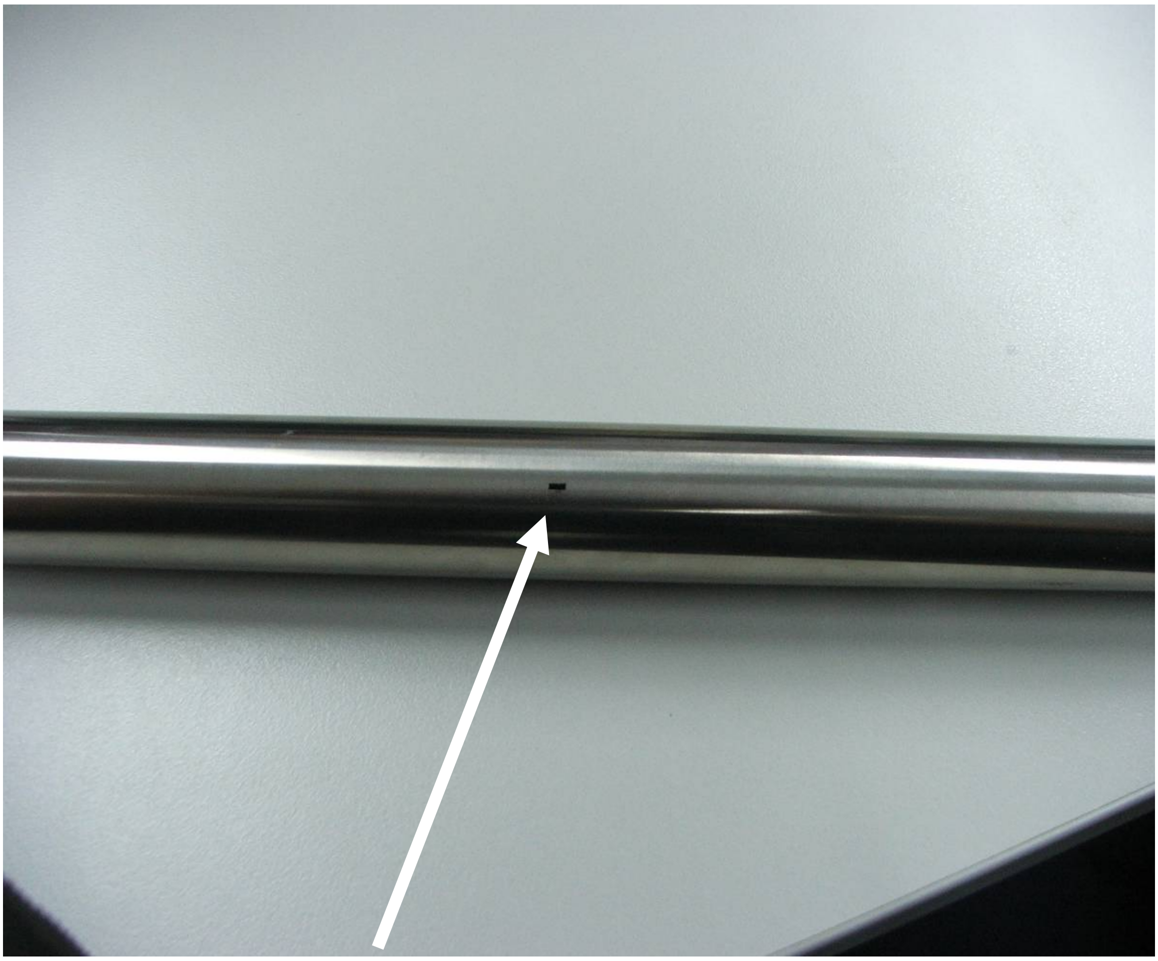
During the onsite works the manufacture of the new air scour pipe work was underway. The system was designed so that an air scour line was laid between each row of nozzles. The complete setup was built in arrays that were flanged to allow them to be easily installed or removed around the internal infrastructure with minimal disruption in the cell. Air to the header would be supplied from the top of the filter rather than from the bottom. This would also allow easy access to pipe work for future maintenance as it was all visible. Because the air scour pipe work was being built on the factory floor, accurate measurements of the filter cell were critical. Each cell has minor differences in measurements and these needed to be accounted for to be confident the new system would fit into the cell when installed onsite.

<u>Figure 3</u>: ***Arrays in flanged sections for easy installation.***

Prefabrication at the factory meant that all the necessary equipment and machinery was available and only incidental equipment would be required for installation onsite. The arrangement of the pipe work arrays made transporting to the site and assembling in the cells very easy. The advantages of this design method was appreciated when working in the smaller cells that measure around 2.0 m x 2.5m x 2.5m deep. Very tight and confined working areas where less time required working in the space would always be the desired outcome.

2.3 Slots replaced round holes

The new air laterals for the system used slots instead of holes as the thought was the air would be spread rather than be a jet form. The slot size in the first system built was 1mm x 8mm positioned on the bottom at 45^{o} off center and opposed at 150mm centers. The end slot in each lateral was positioned centrally on the bottom. This ensured complete discharge of water from within the lateral to assist with quick dispersal of air to end of each lateral in the system. There were a number of rejected laterals due to incorrect slots before the desired result was achieved. If one slot in the lateral didn't pass the lateral was not accepted.



<u>Figure 4</u>: ***Laser cut air slot in the later systems. 1mm x 3mm.***

The critical requirements for the slots in the air laterals were:

- Correct and uniform shape.
- Accurate dimensions and correct position on the lateral.
- Free from any burrs with sharp edges both internally and externally.

The air scour rates we use are typically below what would be considered industry standard, so the above requirements were essential to achieve the calculated pressure losses and flows across the system.

Air flows ranged between 0.67 and 0.8 $m^3/m^2/min$ (FAD), with 0.72 $m^3/m^2/min$ being the target flow rate. In light of this in later systems the dimensions of the slots were reduced to 1mm x 3mm (Figure 4) at 75mm centers. The installation of flow meters in each of the re-designed systems has allowed blower output performance to be monitored as well. Improving the air scour of the backwash process has improved filter performance in those units that have been upgraded.

3.0 CONCLUSION

Separating the air and water cycles of the backwash process has led to much smoother, more even air distribution of the air. The air scour starts and rapidly covers the bed to the ends of each of the air laterals (Figure 5).

The systems are custom made to fit each cell accurately. This has reduced the need for excessive onsite modifications and plant down time. Our next project will to be install VSDs' on blowers. This via the PLC program, should allow blower speeds to be adjusted to suit each individual system at each plant.

In summary, we have found that separating the air and water backwash system has the following advantages over our original backwashing systems;

- Improved smoother air scouring of the media.
- Less stress on blowers, associated pipe work and the structure.
- Easy maintenance on air scour pipe work system.
- More efficient scouring of the media with no mixing.

Figure 5: ***Resulting air scour pattern from new system.***

4.0 ACKNOWLEDGEMENTS

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