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# AUTOMATIC FILTER CLOGGING DETECTION TO TRIGGER MAINTENANCE ROUTINE

HP INC

# *Automatic filter clogging detection to trigger maintenance routine*


## *Abstract*

All printheads include a filter to filter out particles present in the ink or generated upstream of the filter from reaching the nozzles and causing IQ defects.

In some printers, an additional filter located in the Ink Delivery System is used to capture the particles before reaches the printhead, increasing the printhead life. Typically, these filters are replaced based on time or number of liters of ink that has gone through the filter, based on experimental data.
However, depending on the ink type and conditions, the filter may be replaced prematurely when it has not reached its end of life. In other cases, the filter may be replaced too late, which could end up in IQ defects or printhead starvation if the flowrate provided to the printhead does not met the requirement of the print job.

This invention describes a process to trigger the filter replacement based on the ink pressure drop related to the filter, which is related to the effective area of the filter, thus the clogging of the filter.


## *Invention*

Monitoring the ink pressure loss along the filter at a certain flowrate provides information about the effective area of the filter. By knowing the actual state of the filter, it helps to trigger its replacement when it is actually needed, not replacing the filter based on experimental data that may be affected by the testing or ink conditions. The invention avoids replacing the filter prematurely, when the filter has not reached it End of Life, or too late, which could end up in IQ defects or printhead starvation.

Prior solutions consist of triggering the filter replacement based on time or the amount of ink that has gone through the filter based on experimental data. The main disadvantages of this solutions is the high dependence on the testing conditions, which could differ from the reality. Additionally, a safety factor is included, reducing the life usage of the filter.
For instance, in one project there was an issue with the yellow ink that has an issue with age induced particle growth. Due to that, the filter of the printhead was clogged when a few numbers of liters had gone through it. A filter located on the Ink Delivery System will face the same issue, in which the filter would be clogged before than expected and the printhead would face issues related to IQ or printhead starvation.

The solution described is able to detect when the filter is clogged in order to trigger the maintenance routine. For the issue of the yellow ink, it could detect that the filter is being clogged before than expected and trigger the maintenance routine. Furthermore, it provides information to Customer Assurance and R&D team to detect possible issues.

Other solution may consist of a Break and Fix strategy. When the issues related to the clogging of the filter appears, such as printhead starvation, the customer would replace the filter. The main disadvantage of this solution is a direct impact on the perception of robustness and the experienceof using the printer.

Typically, the ink pressure sensors are located on the Ink Delivery System to monitor the ink pressure to detect some specific events, such as the End of Refill of the Intermediate Tank or the Out of Ink event of the main supply.

By locating an ink pressure sensor upstream, the filter and another downstream the filter, the pressure loss of the filter can be measured. The pressure loss of the filter directly depends on the effective area and the flowrate. Since the flowrate required can be estimated by the print mode, the expected pressure loss can be calculated.

Note: depending on the printer architecture (with or without Intermediate Tank) and the location of the filter (upstream or downstream the Intermediate Tank), the flowrate may be also estimated by using:

- Flowmeter: installing it in line with the filter
- Volumetric ink pump: if the filter is located upstream the Intermediate Tank, the flowrate can be estimated based on the time to refill a certain ink volume.
- Weighting the main supply: if the filter is located upstream the Intermediate Tank (or there is not an Intermediate Tank), the flowrate can be estimated based on the weight evolution of the main supply.

The following schematics corresponds to a Recirculation Ink Delivery System, which includes a filter located upstream the Intermediate Tank to capture particles from reaching the printhead. It includes two ink pressure sensors (1 and 2) located before and after the filter to measure the pressure losses.

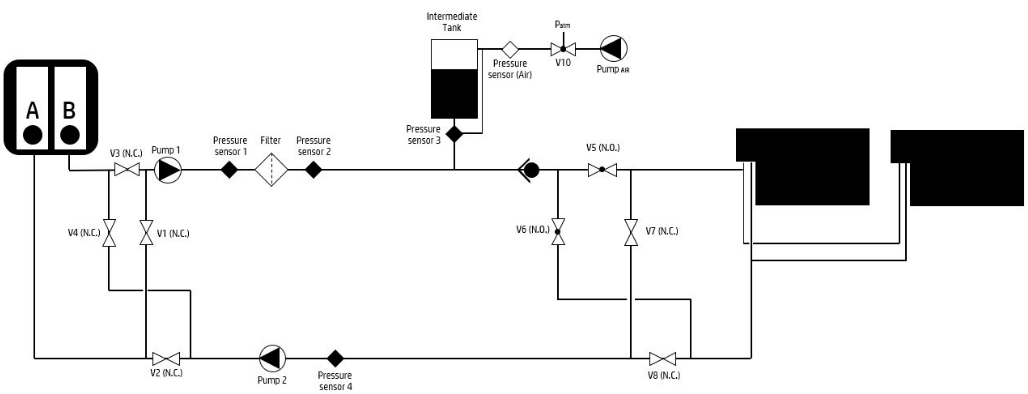


Figure 1. Recirculation IDS that uses 2x ink pressure sensors to measure the pressure drop of the filter

By comparing the theoretical pressure loss along the filter based on the measured ink flow against the actual pressure loss measured with the ink pressure sensor, it can be detected the status of the filter in terms of effective area of the filter (clogged area).
If the effective area of the filter reaches a certain threshold, the filter is detected as clogged and an alert to the customer is triggered to replace the filter.

The following setup was used to have a better understanding of problem with the yellow ink that has an issue with age induced particle growth in the mentioned project. Due to that, the filter of the printhead was clogged when a few numbers of liters had gone through it.

Note that the Setup, the ink pump is located downstream the filter.

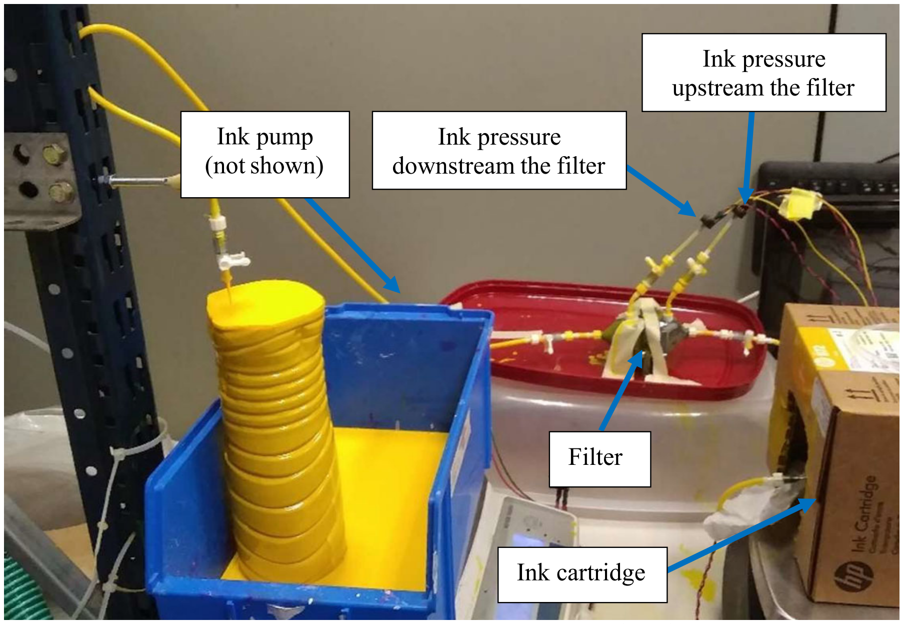


Figure 2. Setup to measure the pressure loss of the filter

The following experiments were conducted:

1. The pressure loss of the filter was measured at a certain flowrate using a batch of ink that shown heavier ink particles due to chemical interaction (bad ink formulation). It can be seen that the pressure loss rapidly increases when a certain amount of ink has gone through the filter. This is due to the fact that the effective area of the filter is being reduced due to the ink clogging.

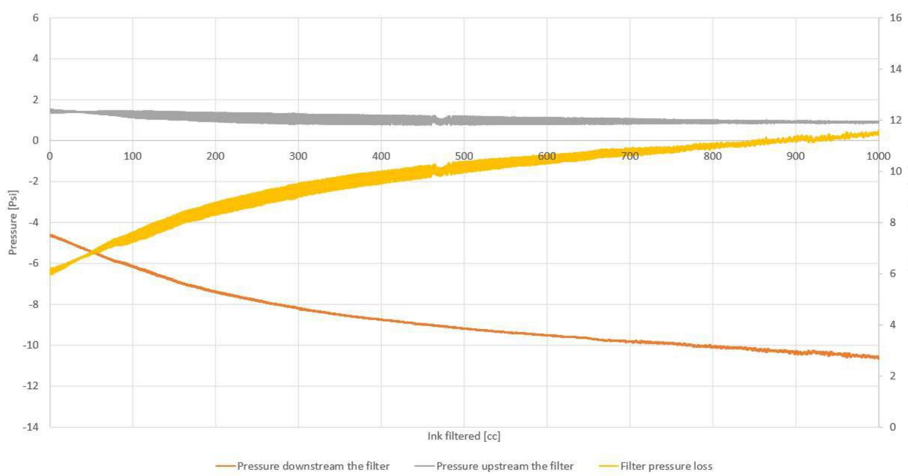


Figure 3. Filter pressure loss using "Bad" ink

2. In this case, the batch of ink used was good (no heavier ink particles). It can be seen that the pressure loss remains constant for the amount of ink filtered.

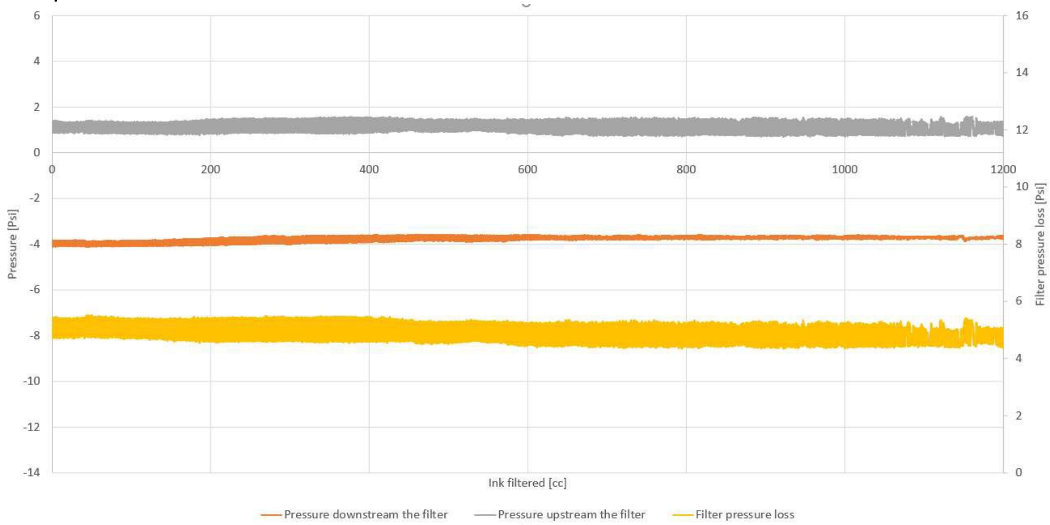


Figure 4. Filter pressure loss using "Good" ink

The advantages that the invention provides are:

- Printhead starvation: the maintenance routine of the filter is triggered when a certain threshold is reached, avoiding issues related to printhead starvation due to having the filter clogged.
- Total Cost Operation: the maintenance of the filter is not triggered before than required, which will increase the total cost of the operation of the printer.
- Robustness: the solution prevents hardware damage, such as an excessive ink pressure during an ink refill due to a filter clogged (filter located between the ink pump and the Intermediate Tank).
- Automatic detection: the printer automatically triggers the maintenance routine of the filter based on the ink pressure loss of the filter.
- Flexible solution valid for multiple ink types: the solution can be adapted to different ink formulations.

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