Cleaning of PORAL® sintered metal filters

Sintered metal filters have many advantages such as:

- High resistance to corrosion,
- High resistance to temperature, stability over a wide temperature range,
- High mechanical strength,
- Easy to implement in any installation design.

And they are also **easy to clean**, allowing them to be reusable and to have a longer life if the cleaning techniques used are appropriate and the filters are handled with care.

1. The sintered metal filters

The sintered metal filters are characterized by a sinuous porosity with irregular size and shape (Figure 1). The interconnected pores allow the passage of the fluid from one side to the other side of the filter media. The passages generated by the open porosity differ in size, shape and length.

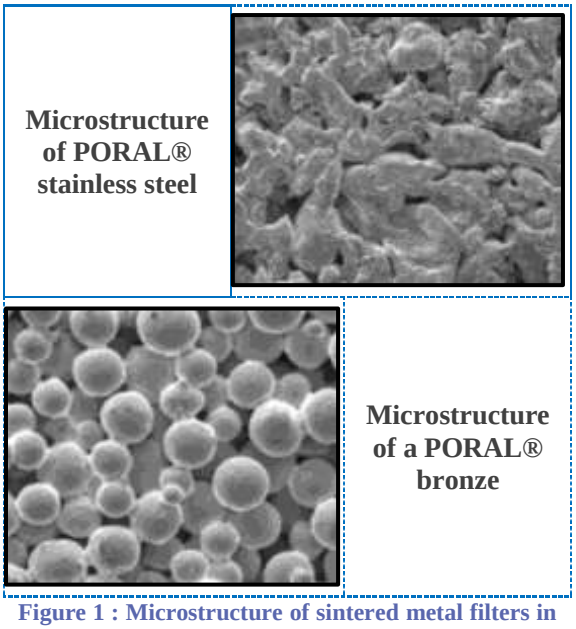

Figure 1 : Microstructure of sintered metal filters in stainless steel and bronze (SEM).

Sintered metals filters can thus be used for "barrier" or "in-depth" filtration (Figure 2).

When pore size is smaller than particle size, particles are retained on the surface of the filter. Back flush cleaning is readily performed. This corresponds to "barrier" filtration (Figure 2.a).

"In-depth" filtration uses one of the features of filters obtained by sintering: the sinuosity of capillaries enabling fluid flow. When particle size is smaller than pore size, particles tend to penetrate in the sinuous porosity of the filter media. Particles meet a lot of obstacles, and are then retained on the pore walls. This allows retaining particles having a size smaller than pores (Figure 2.b).

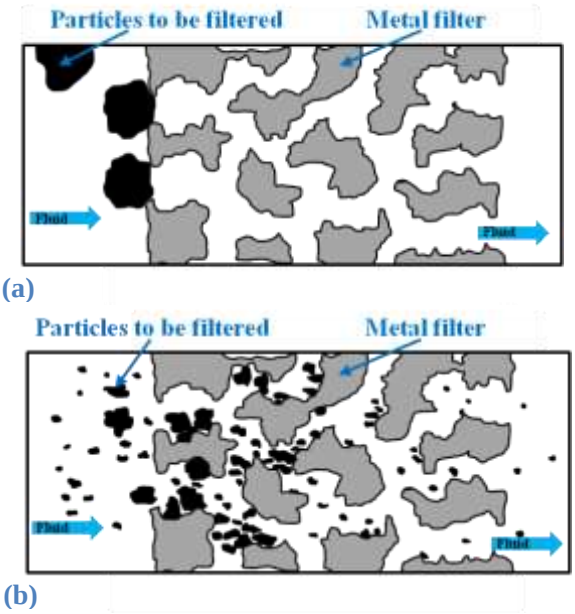

Figure 2 : 2D schematic representation of "barrier" filtration (a) and "in-depth" filtration.

Whatever the type of filtration used (barrier or in-depth filtration), after a period of operation, it is necessary to clean the filter in order to avoid a too high resistance to the flow of fluid. Indeed, Figure 2 illustrates how filters may become clogged in use.

To establish an effective cleaning process, it is important to know whether the particles are retained on the surface or in the thickness of the media, how they are maintained and finally their nature (or chemical composition).

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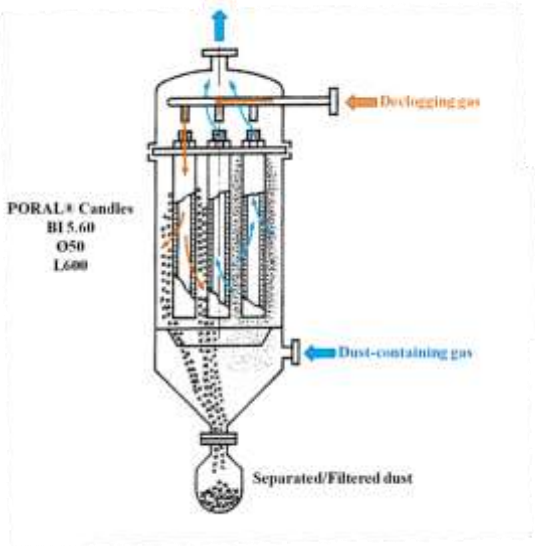
2. Cleaning techniques

- *Backwash cleaning using a clean gas or liquid (see example below):* This process is perfectly satisfactory whenever all the particles are retained on the filter surface. If the particles clinging to the porous surface need to be gently brushed off, this should be done at the same time as the reverse flushing so that there is no risk of embedding the particles into the porous surface. The brush used should be soft (ex.: nylon).



The fluid used for backflushing may be filtered fluid itself, or any other clean fluid. However, it is advisable to gas flush in the case of gas filtration and to liquid flush if a liquid is being filtered. If contamination is high, or if the impurities are very fine, backflush cleaning will be more efficient if it is carried out at very frequent intervals.

- *Cleaning by hydroblasting*: it is a technique that can avoid the use of other cleaning methods if the polluting particles are weakly bonded to the support surface.
  The disadvantage of this technique is that it does not enable in-depth cleaning of the filter.

With time, and whatever the filtration efficiency, a small amount of fine particles tend to penetrate into the wall thickness, where they will be stacked. The filtration media can then be generally (depending of the pollutants) be regenerated though a flow of solvent, a chemical attack or a calcination.

- *Chemical cleaning* :

This method requires a complete cleaning system with a pump, allowing a cleaning solution to flow through the filtration media (more efficient that only a dip treatment) till complete cleaning. Ideally let the cleaning solution circulate backwards. That method allows to dissolve the pollutants into the cleaning solution and to maintain the filtration media integrity. It is then imperative to add a complete rinse process, with a flow of a clean & neutral fluid though the wall thickness (till 3h) and a drying process (generally in a drying oven at 120°C – 10h minimum).

- *Heat treatment in an oven:* that treatment allows to easily remove all organic or biological compounds trapped into the filter wall thickness by incineration/combustion or volatilization. Polymers can easily be removed as well. But it is preferable to apply that method for compounds which will not leave residues, or an additional cleaning process will have to be added.

- *Ultrasonic cleaning*: often used for a final cleaning of filtration media but reserved for a big amount of parts as it requires a specific equipment.

Remark: Despite all that different methods, it is possible after a certain number of cleaning cycle, the filters still need to be changed (too important clogging, mechanical resistance deterioration because of too many treatments, etc…)

3. Cleaning efficiency

After performing the procedure of filter cleaning operations, the effectiveness of the unclogging could be assess by testing the filters. A standard first bubble test and then a general bubble test can reveal non-cleaned areas. The measurement of the pressure drop can also confirm recovery of permeability.

4. Examples of cleaning procedures

- *Chemical cleaning :*
  - Bronze PORAL®:
    - All common solvents
    - Acetic acid at 25%, 30 to 60 min.
    - Hydrochloric acid at 10%, 30 min. max.
  - Stainless steel PORAL®:
    - All common solvents
    - Nitric acid at 20%, at 50°C max., 30 to 120 min.
    - Sodium hydroxide solution: 50%, until 50°C

The cleaning solution should be selected depending on the pollutant to be removed to get the desired results. Some examples are listed below:

- Inorganic compounds: diluted acids that would not attack the filtration media material itself (as nitric, phosphoric, citric or oxalic acids sometimes associated with detergents or caustic agents.
- Organic compounds: some caustic agents can be used, giving often the best results, as well as solvents, soaps or detergents. In case or mixed pollutants, caustic agents can be used to remove oils, then acid agents to remove the mineral or scale deposits.
- Biological compounds: strong oxidizers can be used (as bleach, peroxides or caustic agents or acids).

- *Thermal cleaning currently used*:
  - Stainless steel PORAL® :
    - Air calcination till 450°C, 1h in a homogenous oven then a reduction cycle.
    - Heat treatment under H_2, at 1100°C maximum during 1h to 1h30min.
  - Bronze PORAL®: possible thermal treatment, maximum temperature to be adapted.

Example of a complete cleaning process :
Regeneration of clogged PORAL grade 05 stainless steel cartridges with a Raney nickel catalyst powder, used in the chemical industry.
Recommanded regeneration process in that case :

- Washing with water and a wetting agent (Teepol, 0,01% vol.) ;
- Chemical cleaning with a 10% nitric acid solution at 50°C during 1h;
- Water rinsing, back flushing during 25min (300cm3/cm2);
- Drying.