The treatments generally used for water supplying technical systems can be divided into:

<table>
<thead>
<tr>
<th>EXTERNAL TREATMENTS</th>
<th>CHEMICO-PHYSICAL TREATMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>Chemico-physical</td>
</tr>
<tr>
<td>filtration</td>
<td>softening</td>
</tr>
<tr>
<td>deaeration</td>
<td>demineralisation</td>
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<tr>
<td>dirt separation</td>
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</tbody>
</table>

The external physical treatments most used in closed circuit systems are filtration and dirt separation. The impurities contained in suspension in the technical water of the circuits can cause a series of problems that should not be underestimated:

**Differential aeration corrosion**
Such corrosion is due to the fact that, in the presence of water, a layer of dirt on a metal surface leads to the formation of two areas (water/dirt and dirt/metal) with different oxygen concentrations; this is why localised cells are activated with current flows that lead to the corrosion of the metal surfaces. This corrosion can lead to components such as boilers and radiators being weakened and even rupturing.

**Blocked and seized pumps**
This can be caused by dirt that circulates between the pumps and can accumulate in them either because of the particular shape of the pumps, or as a result of the magnetic fields generated by the pumps.

**Irregular valve operation**
This is due to dirt that can stick tenaciously to their seats and cause regulation differences and leaks.

**Lower output from heat exchangers**
Dirt deposits can significantly reduce the flow rate of fluids and the surface areas that exchange heat.
Filtration is a physico-mechanical process in which a liquid in motion is separated from the solid particles dispersed in it as a result of their being retained by a porous filter media through which the liquid passes.

Traditionally, in closed circuit heating systems, Y-strainers are used: they are made from a metal mesh basket that functions as a filter element and a dirt collector. The flow typically proceeds (for mechanical resistance reasons) from the inside to the outside of the strainer basket. The particles are thus trapped inside it. The strainer is generally installed on the return line before the heat generator to protect the exchanger.

Cleaning the strainer
To clean the strainer, it is sometimes sufficient to have installed a valve in the lower part of the strainer, facing downwards in order to collect the impurities at the bottom. Note that particles can often stick to the basket; for effective cleaning, the strainer screen needs to be removed from the body so the strainer must be fitted with two shut-off valves at its ends.

Strainer cartridge
The basic element of a Y-strainer is the cartridge inside it. It is characterised on the basis of the main characteristics of the metal mesh making it up: strainer mesh size, mesh, gross area, open area, open percentage and open area ratio.
**Strainer mesh size (filtration capacity)**
Indicates the maximum diameter of the particles that can be retained by the mechanical action of the strainer. The distinctive value is usually expressed in mm or μm.
For example, a strainer with a mesh size = 0.40 mm (or 400 μm) retains impurities bigger than that size.
Their limit lies in the fact that they cannot intercept, and therefore remove from circulation, dirt particles smaller than 400-500 μm.
The minimum diameter of particles intercepted by the strainer is also known as the filtration capacity.
There are strainers on the market with filtration capacities that decrease as the nominal diameters of the valves increase in order to have reasonable head loss values:

<table>
<thead>
<tr>
<th>Size</th>
<th>1/2&quot;</th>
<th>3/4&quot;</th>
<th>1&quot;</th>
<th>1 1/4&quot;</th>
<th>1 1/2&quot;</th>
<th>2&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strainer mesh size [μm]</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>470</td>
<td>470</td>
<td>530</td>
</tr>
</tbody>
</table>

**Mesh**
Number of openings in the strainer screen per linear inch.

\[
\text{Mesh} = \frac{25,40}{\text{OPENING} + \varnothing \text{wire}}
\]

**Gross area**
This is the outer surface of the strainer cartridge, the sum of the open area and the strainer screen.

**Open area**
This is the total area of the openings in the screen.

**Open percentage \( (A_o) \)**
Ratio as a % between open area and gross area.

\[
A_o = \left( \frac{\text{OPENING}}{\text{OPENING} + \varnothing \text{wire}} \right)^2 \times 100
\]

**Open area ratio (OAR)**
Ratio, expressed as a proportion, between the open area of the strainer and the nominal diameter of the pipe in which the strainer is installed.

**Kvs**
The Kvs value is calculated with the strainer completely clean and the openings free of impurities.
The table below shows the average Kvs values valid for the types of Y-strainers currently on the market.

<table>
<thead>
<tr>
<th>Mesh size of 400 μm</th>
<th>1/2&quot;</th>
<th>3/4&quot;</th>
<th>1&quot;</th>
<th>1 1/4&quot;</th>
<th>1 1/2&quot;</th>
<th>2&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kvs</td>
<td>4.1</td>
<td>7.3</td>
<td>11.0</td>
<td>17.4</td>
<td>25.0</td>
<td>37.0</td>
</tr>
</tbody>
</table>

For strainers of this type the open area ratio (OAR) usually varies between 2.5:1 and 3:1.
You can increase this parameter by:
A) Oversizing the gross area of the strainer cartridge, and consequently of the chamber that contains it, keeping the mesh size unchanged: this causes obstacles and costs more.
B) Increasing the mesh size, keeping the dimensions the same and reducing the filtration capacity.
Head losses from a Y-strainer fitted in a closed circuit

A 1” brass Y-strainer is installed in a central heating system, as shown in the diagram above. From the corresponding head loss diagram we can deduce that for a project flow rate of 1500 l/h, the strainer in the system causes a head loss of:

$$\Delta p \text{ STRAINER (no clogging)} = 180 \text{ mm w.g.}$$

This corresponds to a head loss calculated with a completely clean strainer and a screen free of obstructions, so with no clogging.

As already mentioned, Y-strainers need to be cleaned regularly; particles tend to stick to the inner surface of the screen and only a fraction of them falls into the lower part where the impurities are collected. This causes clogging of the screen and a drastic reduction in the open area ratio. Taking an open area ratio (OAR) of 2.5:1, an increase in clogging leads to an increase in the strainer’s head losses: for clogging of 70%, the head loss increases by a factor of 4.5 (experimental data).

$$\Delta p \text{ STRAINER (clogging 70%)} = 810 \text{ mm w.g.}$$
Dirt separation is a physical treatment similar to filtration but is more efficient as it is based on the combination of several actions: the particles colliding against the internal mesh element are separated and the large internal volume encourages them to fall into the dirt collection chamber, reducing the fluid speed.

The dirt collection chamber has the following features:
- It is located at the bottom of the device, at such a distance from the connections that the collected impurities are not affected by the swirling of the flow through the mesh.
- It is large enough to increase the dirt collection capacity, which means emptying/discharging procedures are required less often (in contrast to strainers, which need to be frequently cleaned).
- Unlike strainers, the mesh inside the dirt separator does not clog up and rarely needs to be removed or cleaned. This is why shut-off valves do not need to be installed at the ends of the device.

The dirt collection chamber has a drain cock to drain off the impurities which have collected at the bottom of the dirt separator, while the system is still running.

Dirt separator head losses

In the diagram of the system a 1” dirt separator is used: this device removes particles of impurities effectively with very low head losses regardless of the quantity of impurities collected.

Δp DIRT SEPARATOR = 29 mm w.g.

<table>
<thead>
<tr>
<th>DIRT SEPARATOR</th>
<th>Nominal diameter</th>
<th>70% clogging</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DN 25 (1”)</td>
<td>25% clogging</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50% clogging</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70% clogging</td>
</tr>
<tr>
<td></td>
<td>0.005 mm=5 μm</td>
<td>0.01 mm=10 μm</td>
</tr>
<tr>
<td></td>
<td>Kvs</td>
<td>28.1</td>
</tr>
</tbody>
</table>

A normal Y-strainer has an initial head loss that increases as the degree of clogging increases.
Separation efficiency
The separation capacity of a dirt separator basically depends on three parameters:
1) It increases as particle size and mass increase. The larger and heavier particles drop before the lighter ones.
2) It increases as the speed decreases. If the speed decreases, there is a calm zone inside the dirt separator and the particles separate more easily.
3) It increases as the number of recirculations increases. The medium in the circuit, flowing through the dirt separator a number of times during operation, is subjected to a progressive action of separation, until the impurities are completely removed.

The dirt separator limit is therefore the number of passages that the heating medium must make through the device to obtain the separation efficiency stated.

To eliminate the impurities contained in the technical water of the circuit, the best solution is to use a combination of Y-strainer and dirt separator. In this way a strainer screen with a larger mesh size than the standard commercial size (400 μm) can be used thus reducing head losses due to gradual clogging. The strainer is effective during the first passage, blocking particles bigger than the mesh size, while in subsequent passages, the dirt separator completely removes the impurities present up to the minimum nominal size (5 μm).

Technopolymer dirt separator
Using a technopolymer dirt separator makes it possible to combine optimal technical and functional characteristics with flexibility and compact construction. The adjustable locking nut also makes it possible to use the device on horizontal (1) and vertical (2) pipes, making installation easy.

The main features of the technopolymer are:
- High strain strength
- Good resistance to crack propagation
- Very low humidity absorption
- High abrasion resistance
- Performance maintained over temperature variation
- Compatibility with glycols and additives used in circuits.

Separation of ferrous impurities
Dirt separators fitted with a magnet offer greater efficiency in the separation and collection of ferrous impurities. The impurities are trapped inside the dirt separator body by the magnetic field created by the magnets inserted in the special outer ring.

The outer ring can also be removed from the body to allow the decantation and subsequent expulsion of sludge while the system is still running.

Since the magnetic ring is positioned outside the dirt separator body, the hydraulic characteristics of the device are not altered.