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ADVANTAGES AND DRAWBACKS OF USING PULSATION DAMPENERS EITHER WITH OR WITHOUT SEPARATOR ELEMENT BETWEEN FLUIDS (GAS / LIQUID)

As we already know, the volumetric or dosing pumps manage to supply a constant volume in time, but produce an oscillating and variable flow in pumps with a crankshaft movement.

As already exposed in our article *"Technical and practical considerations on the use of pulsation dampeners in circuits with volumetric or dosing pumps"*, this oscillating flow supply effect is more significant in the case of single-piston pumps; and it is in this type of pumps where the installation of a pulsation dampener becomes more useful and necessary, both at the discharge and the suction.

In some cases there is the tendency to install at the suction a dampener without a separator element between the pumped liquid and the atmospheric air inside the dampener. We understand that this solution creates a major problem that we will try to explain.

When the dampeners without separator are used at the discharge, the problem gets reduced in part.

Let's see which are the main problems of installing such a pulsation dampener at the suction of the pump:

I) It must be always mounted upright and must be filled with the pumped liquid at least to half of its volume, leaving the remaining volume for atmospheric air. This is a hazardous operation if the liquid is corrosive, as it must be performed on site.

II) The usual problem, but even more pronounced at the suction: The atmospheric air gets dissolved as time goes by, so it becomes necessary to proceed as in (I). But, ABOVE ALL, the dissolved air reduces the dosing of the liquid the pump is providing. The pump chamber gets full of liquid and dissolved air bubbles. These bubbles, which on entering the pump have a non-negligible size, as they could be slightly below the atmospheric pressure, when the pump starts the discharge and the pressure rises get compressed, what reduces the volume of the pump head and consequently an effect akin to CAVITATION happens (*).

(*): The volume freed by the reduction of the size of the air bubbles, is filled by the pumped liquid vapour and if this circumstance does not occur the problem gets worse.

III) Comparative analysis of volumes and costs of the dampeners with and without a separator between fluids (air / liquid):

DATA OF A HYPOTHETICAL CASE (simple-effect membrane pump)

Q = 5 L/min. at 100 r.p.m.
Pumping pressure: 4 bar-g
Suction pressure: 1 bar-g
Residual pulsation admitted at the discharge: +/- 6%
Residual pulsation admitted at the suction: +/- 3%

THEORETICAL CALCULATIONS ON THE VOLUME OF THE DAMPENER AT THE DISCHARGE

With separator (bladder, membrane, bellows):

∂V = (5 / 100) / 2 = 0.025 litres ≡ 25 c.c. (this is the volume that gets in and out of the dampener in each pump cycle.

$V_0 = (\partial V \times P_2) / [0.8 \times 0,8 \times (P_2 - P_1)] = (25 \times 4.24) / (0.64 \times 0.48) \approx$ 345 c.c. (this is the total volume of the dampener).

P_2 = Working pressure plus percentage of residual pulsation = = 4 + (6 x 4 / 100) = 4.24 bar

P_1 = Working pressure minus percentage of residual pulsation = = 4 – (6 x 4 / 100) = 3.76 bar

Without separator:

$V_0 \times 1\text{ at} = V_1 \times P_1 = V_2 \times P_2$

V_2 = Volume of atmospheric air inside the dampener when compressed at P_2 pressure

$P_0V_0 = 1\text{ at} \times V_0 = P_1V_1 = P_2V_2$;

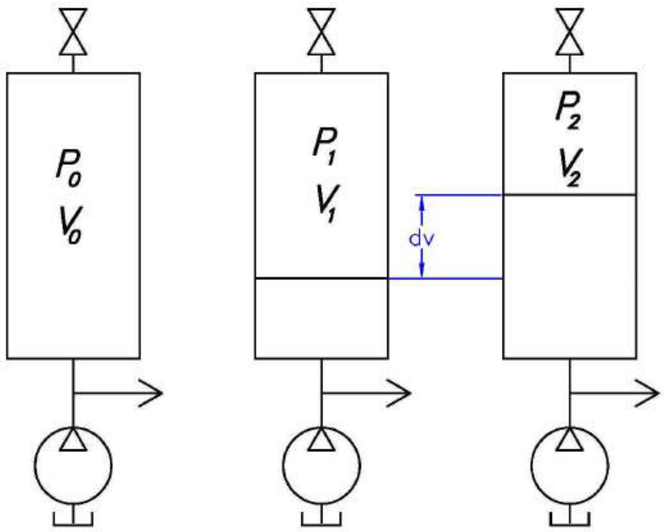
$V_1 - V_2 = \partial V = 25$ c.c., $V_1 = 25 + V_2$;

$P_1 \times (25 + V_2) = P_2 \times V_2$;

$(3.76 \times 25) + 3.76 \times V_2 = 4.24 \times V_2$;

$V_2 \times (4.24 - 3.76) = 3.76 \times 25$;

$V_2 = 94 / 0.48 \approx 195.8$ c.c.



$V_0 \times 1\text{ at} = P_2 \times 195.8 = 4.24 \times 195.8$;

$V_0 = (4.24 \times 195.8) / 0.8 \approx$ 1,038 c.c.!!;

1,038 / 345 = 3 times the volume of the dampener without separator compared to the dampener with separator!!!

NOTE: The higher the working pressure, the bigger the size of the dampener without separator.

CALCULATIONS OF THE DAMPENER AT THE SUCTION

With separator:

$V'_0 = \partial V \times P'_2 / (0.8 \times 0,8 \times (P'_2 - P'_1)) = (25 \times 1.03) / (0.64 \times 0.06) = 670.58$ c.c.
$P'_2 = 1 + [(3 \times 1) / 100] = 1.03$
$P'_1 = 1 - [(3 \times 1) / 100] = 0.97$

Without separator:

$P'_1 \times (25 + V'_2) = P'_2 \times V'_2$;
$(0.97 \times 25) + 0.97 \times V'_2 = 1.03 \times V'_2$;
$0.06 \times V'_2 = 0.97 \times 25$;
$V'_2 = (0.97 \times 25) / 0.06 \approx 404.16$
$V'_0 \times 1$ at $= P'_2 \times 404.16$;
$V'_0 = (1.03 \times 404.16) / 0.8 = 520.36$ c.c.

The volume of the dampener must be at least twice the calculated value in order to get the initial level of the liquid as far from the dampener connecting port as possible. Therefore, this volume would be 520.36 x 2 = 1,040.72 c.c.

Summarizing:

The main drawback of not using pulsation dampeners with separator, either at the suction or the discharge, is the dissolving of the air inside the dampener into the liquid and the need for stopping the pump regularly to refill the dampener with atmospheric air; with the recurrent hazardous exposure in case of pumping corrosive chemicals.

But above all, in the application of the dampener without separator at the suction of the pump, the dissolving of air into the liquid can create cavitation and a deficient dosing.

The use of dampeners without separator, either at the suction or the discharge, will require dampeners with a bigger size than those needed if fitted with a separator.

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