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SIZING AND WORKING PRINCIPLES FOR A SUCTION PULSATION DAMPENER INSTALLED IN METERING PUMPS WHEN THE SUCTION PRESSURE IS BELOW 1 BAR ABSOLUTE

The pulsation dampener for these applications is necessary in order to:

- ✓ Maintain flow velocity in the suction piping constant, while avoiding the possible cavitation effect.
- ✓ Achieve a practically constant suction pressure. According to HIDRACAR experience this pressure variation shall be lower than ±0,1 BarA.

Example of sizing and dampening optimization in a real client case:

PROCESS CIRCUIT DETAILS AND EXISTING END USER ISSUE

Pump: Peristaltic pump with a flow of 4.000 lph and 25 strokes per minute.

Piping: 2” suction pipe diameter

The pump suctions grey water from an underground sewage pit. A special submerged filter has been installed in the sewage pit. The filter has been installed in order to re-use the water after filtering for a golf course irrigation system.

The end user installed an electronic sensor between the filter and the pump suction port in order to detect the loss of head across the filter. It was established that when the suction pressure falls below +0,7BarA, the filter ought to be cleaned. The pressure oscillated from +1,1BarA to +0,45BarA without the Suction Pulsation Dampener and with the filter in clean conditions. Therefore the electronic sensor wasn’t able to detect the increase of loss head across the filter (with the fixed pre-set value of +0,7BarA) due to the exiting pressure oscillations.

HIDRACAR was asked to resolve the suction pressure pulsations issue in order to obtain a stabilized suction pressure that allows the sensor to detect and increase of loss head across the filter.

Our client requested us to determine the dampener optimum size and design to reduce the pulsations till reaching oscillation amplitude of 0,15BarA. It means pressure oscillations from +0,95BarA to +0,8BarA with the filters in clean conditions.

PROBLEM RESOLUTION

HIDRACAR proposed the installation of a IN-LINE bladder suction pulsation dampener to solve the suction pressure fluctuations issue. The solution was based on our standard plastic units where we introduced a transversal threaded hole with the same diameter of the suction piping (2”) as evidenced in the next photo.

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The efficiency of the Suction Pulsation Dampener is guaranteed thanks to its special in-line disposition described below:

- ✓ the two ports of the Dampener are aligned with the suction piping.
- ✓ the diameter of the Dampener's transversal threaded hole is the same as the suction piping.
- ✓ the bladder is in direct contact with the vein flow.
- ✓ The hole passage to the inlet of the dampener has section four times larger than standard dampeners

Another important point is to determine adequate size for the dampener and the required pre-set of the bladder before delivery. In the following sections, we will describe the methods we use for its determination and implementation.

SUCTION PULSATION DAMPENER SIZING

The dampener size is obtained in the same manner as for the pump discharge sizing. For more information, please read HIDRACAR Technical Article.
The sizing calculations data are described below:

Pump: Peristaltic with 2 impellers
Flow: 4.000 lph
SPM: 25
Admissible pressure oscillation (customer requirement): P1(max)-P2(min)= 0,15BarA
where:
P2(max)= +0,95BarA
P1(min)= +0,8BarA

For the determination of the dampener required Volume (Vo), we will use the following formula:

$$V_0 = \frac{P_2 \times \partial V}{P_2 - P_1}$$

δV= C /5 (Conservative assumption. We assume the volume fluctuation inside the dampener in a peristaltic pump is similar than in a 2 pistons single acting pump). See HIDRACAR Technical Article.

We haven't considered the thermal effect of quick expansion and contraction of gases for this example because of the low pressures in place.

C(cm3)= flow (lph) x 1000 / (spm x 60 x 2 impellers) = 1.333 cm3

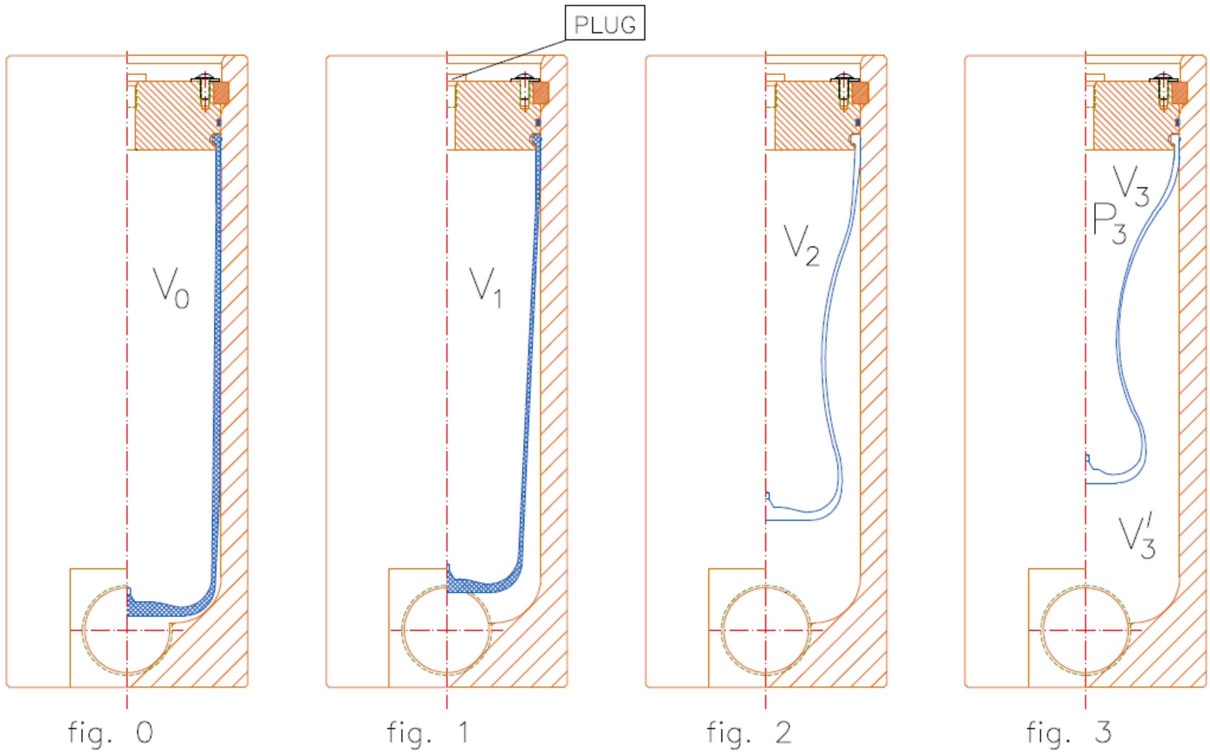
δV= C /5= 267 cm3

and therefore **Vo= 1688cm3= 1,7 liters**

HIDRACAR selected the standard size immediately larger than the volume obtained from the sizing calculations.

U030 with Vo= 2,6 liters

DETERMINATION OF V3 (bladder gas volume in delivery conditions)



Figures 0 to 3 represent the 4 compression states of the bladder inside the suction pulsation dampener.

V1 = V2 + δV; P3= Atmospheric pressure

HIDRACAR deliver the suction pulsation dampeners with the bladder compressed at V3

In the Fig.0, the bladder is completely elongated occupying all the volume inside the pulsation dampener body. The total volume Vo= 2,6 liters.

In the Fig.1, the bladder is slightly elongated and the gas volume in its interior is V1. For this gas volume corresponds a pressure of P1= +0,8BarA.

In the Fig.2, the bladder is slightly compressed and the gas volume in its interior is V2. For this gas volume corresponds a pressure of P2= +0,95BarA.

In working conditions the bladder gas volume is fluctuating between Fig.1 and Fig.2, and the volume fluctuation is δV= V1-V2 = C /5 = 267 cm3.

In the Fig.3, the bladder is more compressed and the gas volume in its interior is V3. V3 is the volume that has to be pre-set in delivery conditions and we shall calculate it for dampening optimum performance. In delivery conditions the bladder is compressed with a gas volume V3 and atmospheric pressure 1Bara.

From the equality provided by Boyle Mariotte formula below:

$$Po \times Vo = P1 \times V1 = P2 \times V2 = P3 \times V3$$

We have:

Vo= 2,6

P1= 0,8BarA

P2= 0,95BarA

P3= 1BarA

δV= V1-V2 = 267 cm3

Therefore, we can deduce:

V1 = P2 x δV / (P2-P1) = 1.691 cm3= 1,7 liters

And then:

V3 = P1 x V1 / P3 = 1,36 liters

The suction pulsation dampener is delivered by HIDRACAR with compressed bladder at the value "V3" and the atmospheric pressure.

PRE-SETTING OF V3 (bladder gas volume in delivery conditions)

In the figures, you can see that instead of a gas charging valve, in the dampener top lid has been installed a ¼"BSP threaded plug. During the dampener pre-setting (compression of the bladder till reaching V3 at atmospheric pressure), the plug ought to be unscrewed permitting the air go out the dampener till reaching the required pre-set volume V3.

One of the process connection ports ought to be closed. Using a low pressure pump a certain volume of water "VL" has to be introduced inside the pulsation dampener. For that purpose we use a pump which suctions water from a calibration pot. Once "VL" has been introduced inside the dampener, the

VL= V0 – V3 = 2,6 – 1,36 = 1,24 liters

VL is the amount of liquid that has to be introduced in the pulsation dampener in the external part of the bladder and that will be determined registering the height in the calibration pot. Pay ATTENTION in order to not have occluded air.

Once VL of water has been introduced in the pulsation dampener, proceed to close the plug in the threaded connection of the top lid ¼" BSP. Then the water inside the dampener can be drained. The volume of gas V3 has already been pre-set.

PRE-SETTING IN THE SITE WITH OUR VACUUM KIT

HIDRACAR will deliver the suction pulsation dampener with its bladder in normal relaxed position.

In the top lid threaded connection ¼"BSP or Vg8, we have available a vacuum kit (*REF. BV-VAC)* with a venturi valve + air flow regulating valve and a vacuum pressure gauge.

Proceed to install the pulsation dampener in the circuit and start the pump. Slightly open the air flow regulating valve until there are no pressure oscillations on the vacuum gauge. Read the instructions of our Vacuum Kit (*REF. BV-VAC)* ATTENTION, stop purging air when there are no oscillations in the vacuum gauge.

In practice, we recommend to precharge at between -0,2 to -0,4 barG using our Vacuum Kit.

PRESSURE OSCILATIONS RESULTS AFTER THE SUCTION PULSATION DAMPENER INSTALLATION IN THE EXAMPLE

The **blue line** shows the variability of pressure with the filter clean without the HIDRACAR Suction Pulsation Dampener. In these conditions, the electronic sensor was not able to detect the head loss across the filter and therefore provide an electrical signal to clean the filter due to the oscillating pressures.

In the **red line**, once the Suction Pulsation Dampener was installed, the pressure variability was significantly reduced between +0,95BarA and +0.8BarA; and the sensor was successfully calibrated at +0,7BarA.