WANNER INTERNATIONAL LTD

TECHNICAL BULLETIN

# System Design Consideration for

# Hydra-Cell pumps used in Reverse Osmosis application

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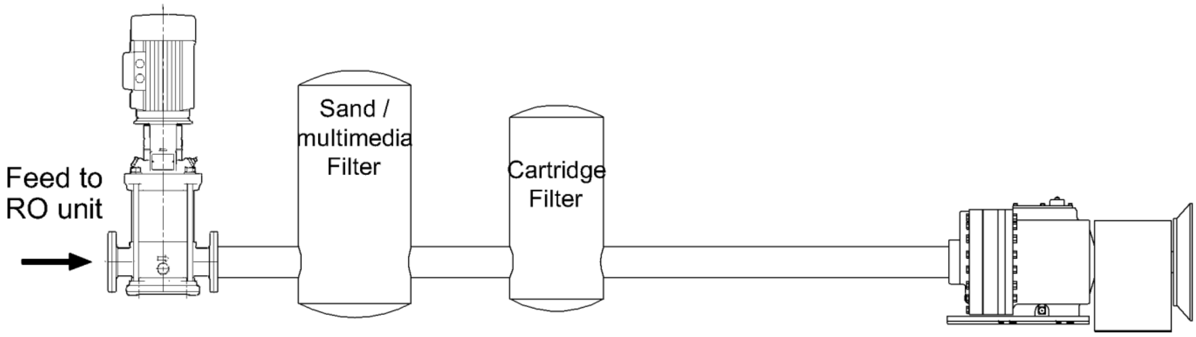
Elements which can be present on the inlet system to the Hydra-Cell Pump




Any elements between the feed pump and the Hydra-Cell inlet have to be taken into account, including the pipe work!

Why do we have to take care about the inlet conditions to the Hydra-Cell pump?

The Hydra-Cell pump is a reciprocating positive displacement pump; in this respect it is similar to piston type pumps. Consideration has to be made for the acceleration and deceleration of the liquid in the inlet piping as the pump diaphragms are stroking and the inlet check valves are opening and closing.

Having high acceleration head losses can result in a pump which is cavitating, causing excess vibration in the system, also hydraulic vibration of the system pipe work.

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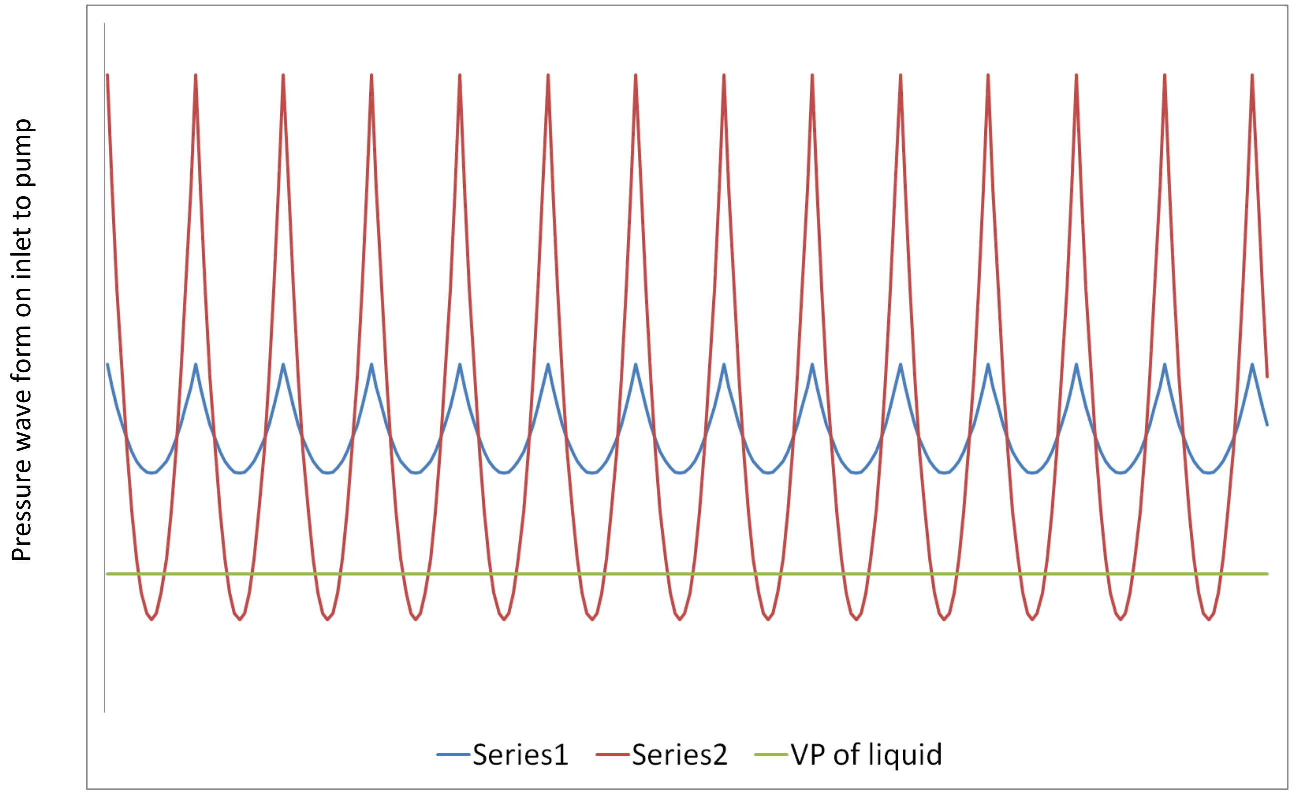
Hydra-Cell Seal-less Pumps

<u>Why do I have a problem when the gauge on the inlet to the Hydra-Cell is reading 2 bar?</u>

The gauges used are often dampened needle gauges. These will only read average pressure.

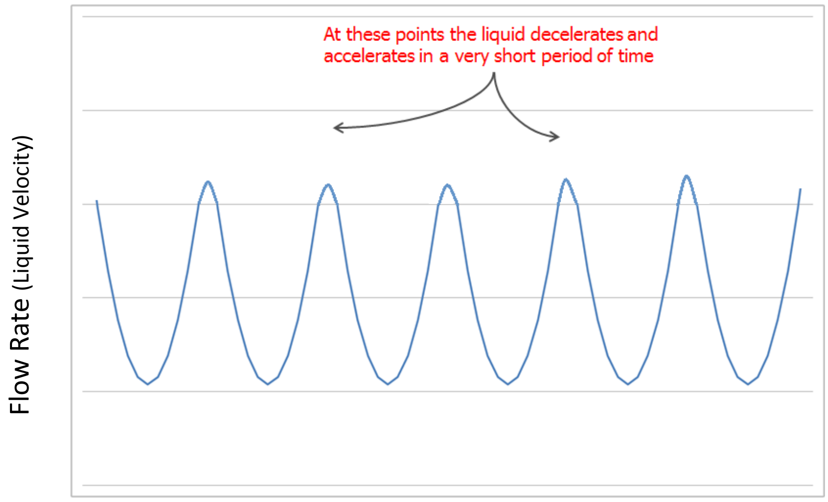



The chart shows 2 different pressure wave forms for 2 different inlet systems. The average value is approximately the same. However series 2 with the higher peak to peak pressure variations will result in the pump cavitating.

To get a better indication of what is happening at the inlet to the pump a recording of a pressure trace is required.

## Acceleration of liquid in the inlet pipe

The diagram below shows the flow rate on the inlet to a reciprocating positive displacement pump.



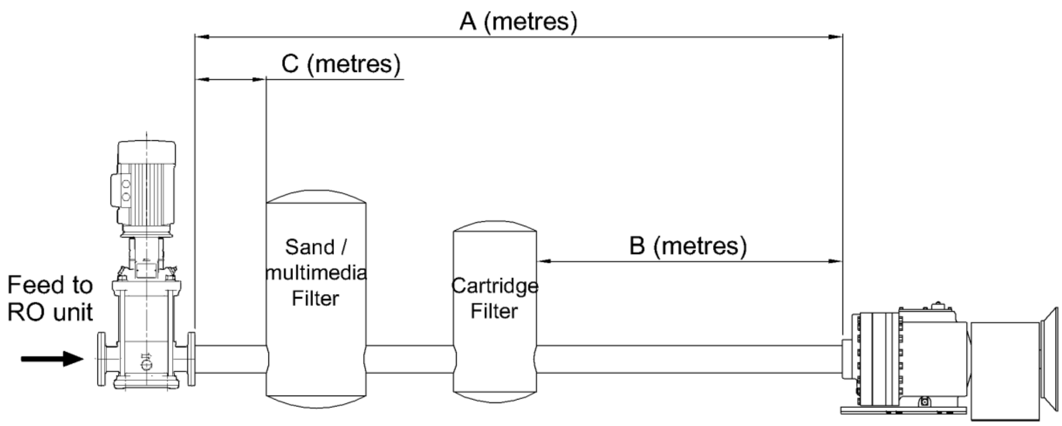

These changes in flow rate, liquid velocity, will result in pressure changes on the inlet of the pump.

If the changes in flow rate are high, the changes in pressure will be high. Resulting in high acceleration of the liquid will result in high pressure swings.

Appendix A describes why the effect of pipe diameter is important.

## Sizing the pipe Work

The total pipe work from the centrifugal pump to the Hydra-Cell pump needs to be considered, diameter of the pipe as well as the length of pipe.




Appendix A describes the effect of piping diameter on acceleration head.

Please see NPSH spread sheet calculator for calculating pressure losses due to acceleration head losses.

**Rule of thumb**

| Guidelines for pipe dia. | | |
|---|---|---|
| Pump | inches | MM |
| G10 | 1.5” | 35 |
| G25 | 2” | 50 |
| G35 | 3” | 75 |

| Guidelines for total pipe length from Centrifugal pump to Hydra-Cell pump (Shorter is better) | |
|---|---|
| Pump | Total Length in Meters (A) |
| G10 | 6 M |
| G25 | 6 M |
| G35 | 6 M |

| Guidelines for minimum distance B | |
|---|---|
| G10 | 0.5 M |
| G25 | 1 M |
| G35 | 1 M |

## Sizing the Centrifugal feed pump

Sizing the centrifugal fed pump is very important as it must have enough flow capacity to keep the Hydra-Cell pump supplied with liquid, not only for the steady state conditions, but also for the instantaneous demands created be the reciprocating pumping action.

Be careful not to oversize the centrifugal pump so that the pump does not run at a duty point which is within the "hunting" part of the performance curve causing the pump to run rough. This is when the centrifugal pump curve has a maximum point at low flows which results in two points of potential operation of flow rate for a given pressure. The pump becomes unstable trying to jump from one operating point to another. Best practice is to have between 20% and 50% of the BEP flow rate.

Select the centrifugal pump with a 4 pole motor. High speed running can release more air/gas from the liquid which can build up in the system.

Make sure that the correct seals are chosen for the liquid being pumped so that excessive air is not pulled through the seals aerating the liquid.

An analogy

A car has a 12V battery to start it. A mobile radio needs a 12V set of batteries to work. The 12V batteries for the radio will not start a car engine. The car battery has a larger capacity to supply high levels of current instantaneously to start the engine.

**Rule of thumb**

Centrifugal pump should be sized 1.2 to 1.5 times the flow rate of the Hydra-Cell Pump.

| Pump | Flow rate |
|---|---|
| G10 | 2.2m3/hr |
| G25 | 5.2m3/hr |
| G35 | 9.4m3/hr |

## Sizing the pre-filters

There are three main types of filter you may find

1. Sand filter – For removing suspended particles.
2. Cartridge filter – For fine suspended particulate filtration, 10 - 5 micron.
3. UV filter – For removing bacterial contamination.

Sand, Multimedia and Cartridge Filters

The condition of the filter is often monitored by measuring the pressure drop across the filter. As the solids build up in the filter the pressure drop increases, but also the flow rate capacity though the filter becomes restricted. The filter capacity needs to be higher than the actual so that the liquid flow does not become restricted.

UV Filter

These are only occasionally used. If they are present on the inlet to the pump be careful of internal diameters and mounting. They are often mounted vertically! And can have a very large effect on the acceleration head Ha.

**Rule of thumb**

Multimedia, Sand and cartridge filters should be sized 3 times the flow rate required.

| Pump | Flow rate |
|---|---|
| G10 | 5.4m3/hr |
| G25 | 12.6m3/hr |
| G35 | 23.4m3/hr |

## Air/Gas contained in Liquid

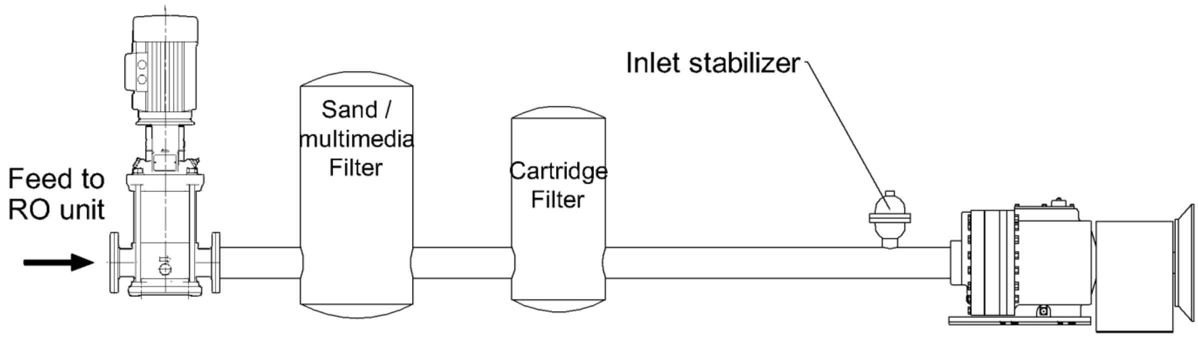
If large pockets of gas or air are contained in the liquid this can lead to hydraulic imbalance setting up heavy vibrations in the pump and eventually damage.

Air or gas can be pulled into the liquid by

1. Waterfall effect when filling a tank
2. Pulled in through poor seals on a centrifugal pump

Liquids can have dissolved air or gas inside them which is “evenly” spread out. When a liquid’s velocity is increased there is a corresponding pressure drop in the liquid. This reduction of pressure can cause the dissolved gas/air to be released and collect into larger pockets. The high the increase in velocity, the lower the pressure drop the more gas/air is released.

## Reducing acceleration head with an inlet stabiliser




Once all the improvements to the pipe work have been made as much as possible to the guidelines above, if there is still an acceleration head issue then an inlet stabiliser can be used to reduce the acceleration head.

Please see Pulsation dampener product sheet.

**Are pulsation dampers on the discharge needed?**

G03,G10,G25 pumps

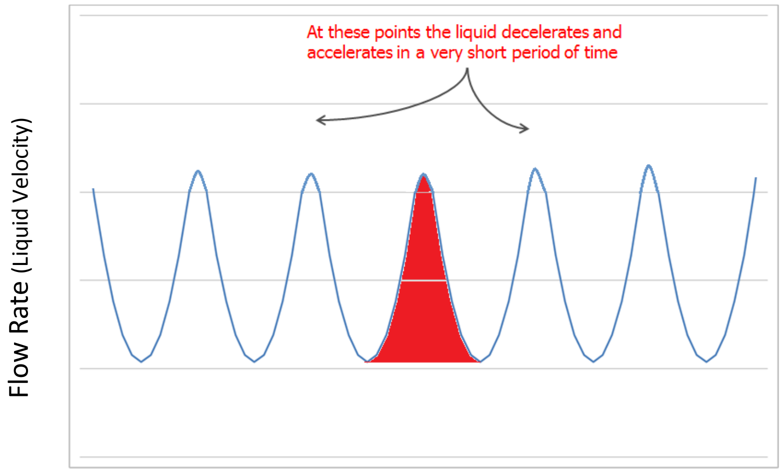
In general it is found that pulsation dampers on the discharge are not required for RO systems. However in some cases due to discharge pipe diameter and geometry a pulsation damper maybe needed. It is not easy to calculate this or predict.

G35 Pumps

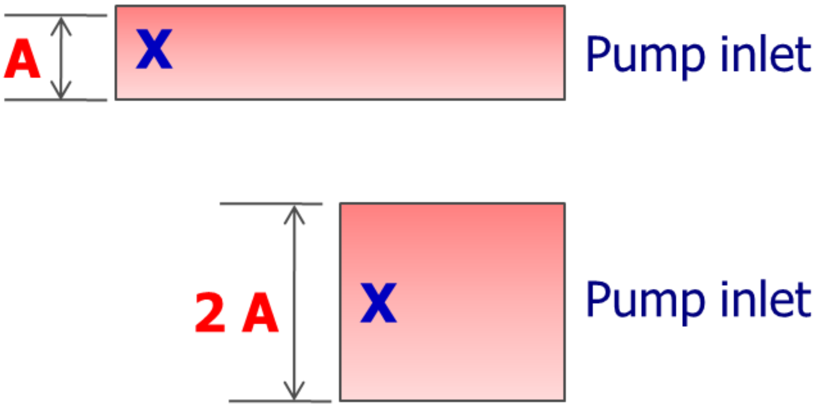
A pulsation damper is recommended for single pump systems and is very necessary for multiple pump systmes.

# Appendix A

<u>Effect of pipe diameter on the acceleration Head</u>




The diagram below shows 2 different diameter pipes. The shaded area represents the total volume of liquid needed to supply the pump during the shaded red area of the inlet wave form.




During the diaphragm stroke, liquid at point X has to travel to the pump inlet in a fixed time, time for the diaphragm to stroke. The point X for the A dia. pipe has to accelerate to a higher velocity to get to the pump inlet in the same time. So the acceleration head losses and vibration will be higher for pipe A than for pipe 2A.

Please see NPSH spread sheet calculator for calculating pressure losses due to acceleration head losses.