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Zero Gravity Pump

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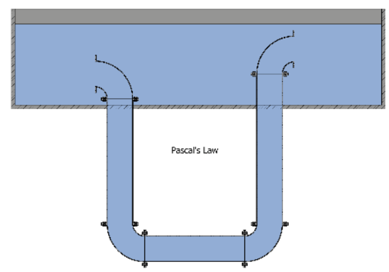
The Switching Siphon

A Zero Gravity Pump

The switching siphon is based on Pascal's law.

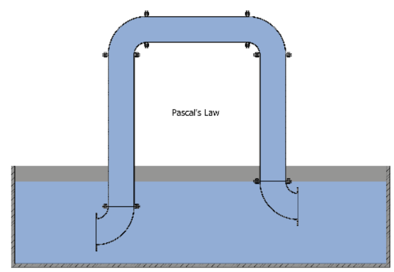
If you have a pipe horizontally in a tank, you will not have any circulation, because the system is in equilibrium, defined by the level in the tank.

Applying pressure will enable circulation through the pipe, where only friction is influencing the circulation. Gravity has no effect.



The siphon work in a similar manner if it is extended upwards from the tank and filled with water.

Again, this siphon will not have any circulation due to gravitational equilibrium, unless you insert a circulation device.

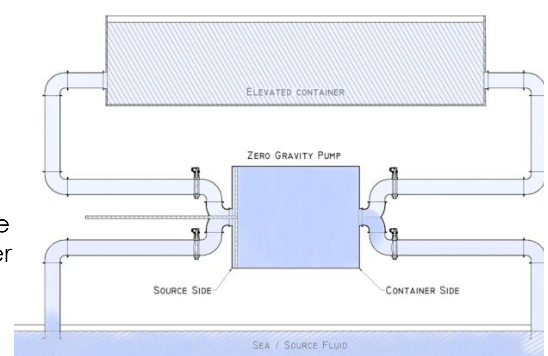


The patented technology, is a dual siphon extended with four valves, a tank, and a circulation mechanism (piston).

The tank is operating as the exchange mechanism, and the valves switch between the two siphons.

When the lower siphon is operating the tank is filled with source fluid, and when the upper siphon is operating, the source water moved up, and the tank is filled with elevated container fluid.

This process circulates water upwards, with the purpose to replace water in a elevated container.



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Pressure and energy

The Zero gravity pump's efficiency can best be described with two examples comparing how friction and gravity will influence energy consumption.

This is a simple example, but the difference is huge, and the most important thing is that gravity cannot be manipulated, but that is possible with pressure drop due to friction.

Friction and gravity for a Zero Gravity Pump

Let's say we want to move 1000 m3/hour (1000 tons every hour), up 30 meters.
We assume straight and vertical pipes. For a Zero Gravity Pump, the pipe length is duplicated and equal 60 meters.

If we use an online pumps power calculator with a 0,8 efficiency, and an online pressure drop calculator, we will get these results for a Zero Gravity Pump:

Pressure Drop – DN500 (60m)	15.25 mbar
Pressure from Gravity	NA
Total Pressure	0,01525 bars
Total Differential head	0,1525 meters
Energy Consumption	**0.52 kW**

Friction and gravity for a normal pump

Let's say we want to move 1000 m3/hour (1000 tons every hour), up 30 meters.
We assume straight and vertical pipes.

If we use an online pumps power calculator, and an online pressure drop calculator, we will get these results for a normal pump:

Pressure Drop – DN500 (30m)	7,63 mbar
Pressure from Gravity	3 bars
Total Pressure	3,00763 bars
Total Differential head	30,0763 meters
Energy Consumption	**102.45 kW**

The examples are theoretical but accurate results. The friction can be adapted, and with a DN600, the pressure drops to 6,28 mbar (0,21 kW), where the power consumption can be optimized by changing the pressure drop from friction.

Compared to any other pump, the energy is wasted in the drain, and you need to repeatedly lift water.

Note that for pressure drops at 1 meter, the 100 millibar pump head is comparable with 10-20 millibar of friction, and the pump-efficiency will be around 80% or lower, when adding valve energy-usage.

Valve pulse energy

The only difference from a normal pump is the valve operation, switching between the two siphons.

This requires energy, but the valve is patent pending, and will operate without any pressure. A non-pressurized operation is unique for the Zero Gravity Pump, since it has two synchronously operated valves.

Solenoid operation

The solenoid has one function, and that is to equalize pressure over the valve. If the pump is moving water to 10 meters, the solenoid will equalize a pressure at 1 bar.
But since water is a non-compressible fluid, we are using solenoids designed for very low flow (zero flow).

Solenoid valve energy	< 2 Watt
Solenoid speed	1-7 ms
Solenoid voltage	24V
Dual solenoid energy usage	< 4 Watt

Valve motor operation

Due to the valve's operation, it will only move after the solenoid have equalized the pressure on both sides of the valve. The motor operating the valve is a servo motor with excellent torque.

Valve torque	6,4 Nm
Valve open/close speed	>= 100 ms
Motor pulse energy	75 Watt (for 100 ms)
*Motor average energy usage	7,5 Watt
*Dual valve energy usage	< 20 Watt

Energy usage

By looking at the energy usage for lifting water, the example above gives us an indication that we can use 10kW for valve operations, and still get a 90% energy efficiency in the pumping operations. Our current estimation with this pump, you need to run multiple pumps in parallel (7-9), but will still have a lot of energy left if our valve energy estimates require us to increase the motor energy to 500 Watt or more.

*Valve energy usage is an optimistic estimation based on current motor-specifications, and the energy usage can be important for low elevations (1-2 meters) and on low flow rates. It is recommended to calculate the energy-efficiency of your current pump if your elevation and flow is low. A dual pump setup at low volumes and low elevations can still be 50% efficient compared to a traditional pump.

The valve operations are expected to be running at maximum 60 RPM, and at this speed the flow will have an interruption-time at approximated 200-300 ms, when switching siphon. Parallel pump-operation is recommended.

The valve is under development, and we hope that we can optimize both speed and energy-usage, but the above specifications may change!