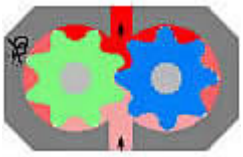
Some of the more popular pump types in Finland; an overview.

The pulsation characteristics, and so the choice of an appropriate dampener, are different according to the: A) Type of pump. B) The compressibility, viscosity, and specific gravity of the liquid pumpage. C) Length and diameter of the pipe through which the liquid it being pumped.

I. Positive Displacement "PD" Pumps

A. Rotary Pumps
In general positive displacement pumps of the rotary pump types, (except the peristaltic - hose pumps), are less pulsatious than the reciprocation group of pumps.

1. External Gear Pumps Finland

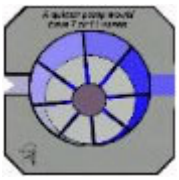


Perhaps the most common of pumps in Finland, except for the centrifugal pump, to be found lubricating car engines and providing power steering oil force, is driven at high RPM and with 5, 7, or 11 teeth per gear, is pumping at typically above 150 Hz and above pulsation.

2. Internal Gear Pump

Usually is run slowly, and by design does not shear the liquid. It is often used for pumping viscous liquids in the Finland paper industry up to moderate pressures.

3. Vane Pump

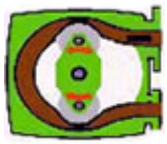


There are many varieties of vane pump. Those with the least number of vanes may cause some pulsation, but generally the source of pulsation from vane pumps is from the final cut-off of the outlet slot. When their pumping at RPM shaft speed as with fluid power applications, at up to 3000 psig / 207 bar, the frequency of pulsation has been measure at 500 Hz and above.

4. Lobe Pump

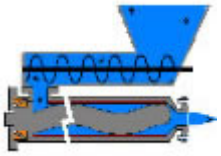
Also known as the "rotary piston pumps". Lobe pumps tend to be limited to below 340 RPM, because of suction conditions with the less fluid substances for which they are used. With 2 or 3 lobes only, their characteristic pulsation frequency is rarely above 18 Hz. Although pumping at this low frequency, The use of a single connection accumulator to provide flow smoothness can rarely work efficiently because of the pressure change necessary to force viscose mass up and down a "T" piece, so the flow through Pump Guards are normally specified for 3" through 12" lines.

5. Hose / Peristaltic Pumps Finland



Displace liquid by squeegee action sweeping the outside of a flexible tub containing the liquid. The pump shoes, or wheels compress the tube, creating a sealed section which is rotate forward. This part of the pumping action is very smooth; however when the shoe lifts off the tube a void is created, into which some liquid must flow back. At that moment the back flow occurs, flow must continue forward. To flow smoothly, back flow and forward flow are required from the damper. As Hose pumps from Finland are used for thick and solids containing liquids the damper needs to be a flow through type, inlet connection providing the momentary back flow and the outlet port providing the pumped forward flow.

6. "PC" aka Progressive Cavity Pumps

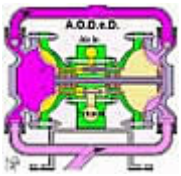


A very Flow Smooth pump type for pumping high viscosity - non Newtonian - fluids. Low RPM and only moderate head generation.

B. Reciprocating Pumps

1. Air Driven Pumps

i. AODD Pump

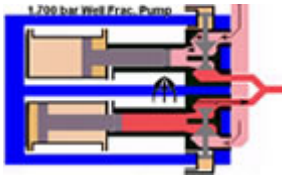


Air Operated Double ended Diaphragm Pumps"AODeD"s are characterized by a hesitation between pumping their left stroke and the pumps right stroke. To produce flow smoothness it is necessary to take in part of the volume from each pumping stroke, so that in the monetary hesitation between displacements, as the pressure falls, the stored volume may come out and fill the valley in the pumped flow pattern.

ii. Intensifier Pump

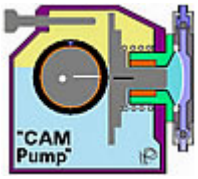
Air operated metering pumps EG/EX - Williams Milton Roy. Air cylinders of these pumps are available from 5 to 100 times the area of the liquid end pumping plunger, providing 500 psi to 10,000 psi metered pumpage. The stroke rate is set at the air supply, and the shot volume is controlled by setting the plunger length of stroke. Ideal for explosive atmosphere hazard environments, methanol and chemical injection on oil and gas production platforms.

2. Hydraulically Driven Intensifying Pumps



This pump type is used from Hydro test apparatus, thru. to pumping huge flows in gas well rock fracturing. It is also of the packed plunger pump type. The pumps hydraulic drive cylinder is usually long stroking and a multiple of the pumpage cylinder diameter; from a typical 3,000 psi to 5,000 psi / 350 bar drive system producing 10,000 to 25,000 psi pumping. These hydraulic intensifier pumps are normally of simplex or duplex configuration. The extreme versatility of this pumping method has caused this pumping market segment to be served by many "made to order" sources.

3. Cam / Offset Lobe Driven Dosing Pumps



A most economical dosing / metering pump, simple volume control with slight disadvantage that pumping volume control results in suction side lost motion makes a discharge shock which requires in-line flow-through to catch on the pump outlet.

4. Solenoid Driven Dosing Pumps

For lower pressure dosing pump application, simple flow control by digitally timed pumping action, with turn down ratios as high as 800:1. To provide continuous flow a damper is used, and to also catch the low pressure shot spikes. Major market segment water and wastewater treatment.

5. Crank Linkage Driven Pumps

i. Fixed Speed Fixed Stroke / Power Pumping

Pumps also known as simply Triplex, Quintuplex, and Septuplex which is the smoothest of them all, often do not need pulse dampeners, but the response characteristics of the piping systems into which they pump may exhibit resonance, which needs to be addressed acoustically by a Wave Guard - no moving parts damper.

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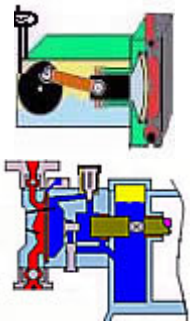
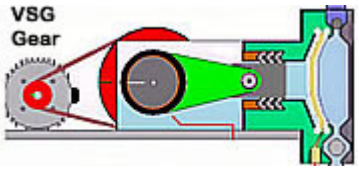
ii. Variable Stroke Membrane / Process & Metering Pumps



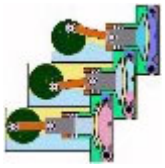
The original 1960s development from the WWII era packed plunger metering pump "instrument". Introduced to overcome leakage from the plunger packings, are all characterized by a hydraulic oil chamber providing reciprocating fluid to the non process drive side of the membrane. Typically the pressurized volume of the fluid in this type of pump is 4.5 times the volume per per maximum stroke displacement. When pumping heated of cold compressible liquids the volumetric efficiency falls to a point at which the major pulse pressure is from a velocity jump shock.

iii. Variable Speed Pumps



The cost of pump gear box linkage stroke length control has lead to popularity of VSG frequency drives. This method of providing rate of mass transfer control is now prevalent. Smaller displacement pumps running at well above the 173 SPM norms, have proved equally reliable when supplied with process liquid by a flow-through suction stabilizer, at 300 SPM at up to 6000psi 400bar.

iv. 674 / 675 Process Multiplex Pumps



Pumping the major process liquid flow at high pressure into reactors without packing leakage, has lead to the need for pumps that are a cross between API 674 power pumps and API 675 metering pumps. This has been achieved by banking multiple diaphragm heads together driven from one shaft on which the head drive boxes are angularly "phased" of each other.

II. Non Positive Displacement Pumps

A. Centrifugal Pumps

More specific tailored variations of the centrifugal pump type exist than can be mention. They span form only 2 blade designs for pumping sand slurry from dredging, to very high speed machines with multiple stages that produce huge pressure on particulate free thin liquids. Many centrifugal pumps have their rotating parts diameter machined down to produce very specific delivery / pressure curves.

B. Turbine Pumps

Very high rotational speed machines, capable of generating very high pressure and enormous flow rates at lower heads. Generally have shaft sealing pressurized from outside with lube oil from an accumulator system in accordance with API 614 "LOSA" systems.

C. Pushing / Flex-Vane Pumps

The flexible rotor of this pump acts in part like a vane pump but as pressure rises the positivity of the displacement fall away by by passing the "vanes". It is and it is not a PD pump.