Насоси та насосні станції

Pump and pumping station

Main pumping stations which supply water to the **distribution system** will be located near the **water treatment facility** or a **potable water storage facility** and will pump directly into the piping system. These pump stations may be a part of these other structures. Pumps which pump directly into transmission lines and distribution systems are sometimes called **high lift pumps**. **Booster pumps** may be located anywhere in the system to increase the pressure in the pipeline. **Booster pump stations** are usually located remote from the main pump station, as in hilly topography, where pressure zones are required. Booster pumps may be needed to handle peak flows in a distribution system which can otherwise handle the normal flow requirements.

distribution system – розподільча система
water treatment facility – споруди водопідготовки
potable water storage facility – споруда зберігання питної води
high lift pumps – станції високого тиску
Booster pump stations – станції підкачки води.

FACTORS FOR DETERMINING DEMANDS.

- Annual Average Daily Consumption (ADC) – середньодобова норма води

• Annual Maximum Daily Consumption (MDC) – норма в добу максимального водопостачання

• Peak Hour Consumption on Annual Maximum Day (MDC/Peak-Hour) – норма в годину максимального водопостачання

• MDC plus Simulated Fireflow – норма в добу максимального водопостачання плюс витрата на гасіння пожежі

• Maximum curb pressures (70 psi) – максимальний тиск

• Minimum curb pressures at any point on the distribution network (usually 30 psi) – мінімальний тиск в будь-якій точці розподільчої мережі

• Residual curb pressure to be maintained at a point of simulated fire flow (20 psi minimum) – залишковий тиск, який повинен бути забезпечений в точці уявної пожежі)

PUMP TYPES.

There are generally two types of pumps used for potable water pumping applications: **the vertical turbine pump**, **line shaft** and **submersible types**, and the **centrifugal horizontal double suction split casing** or **cantilever pump** designed for water-works service:

Axial flow pump – осьові насоси

Radial flow centrifugal pumps - Радіальні відцентрові насоси

End Suction Pumps – кінцеві насоси

Horizontal Split Case Pumps – горизонтальні кінцеві насоси

Multistage Pumps – багатоступінчасті насоси

Vertical Turbine Pumps - Насоси вертикальні турбінні

Submersible pumps - занурювані насоси

Chopper pumps- насос з подрібнювачем

Grinder Pumps – насос з перемеленням

Circulator Pumps – циркуляційний насос

Fire Pumps - пожежні насоси.

Jet Pumps – струменеві насоси

Vertical Well Pumps – вертикальні свердловинні насоси

Regenerative Turbine Pumps - Генеративні турбінні насоси

Slurry Pumps – мулові насоси

Self-Priming Pumps - само всмоктувальний відцентровий насос

Trash Pumps - насоси для сміття

Vertical Sump Pumps – вертикальні дренажні насоси

Positive Displacement Pumps - об'ємні насоси

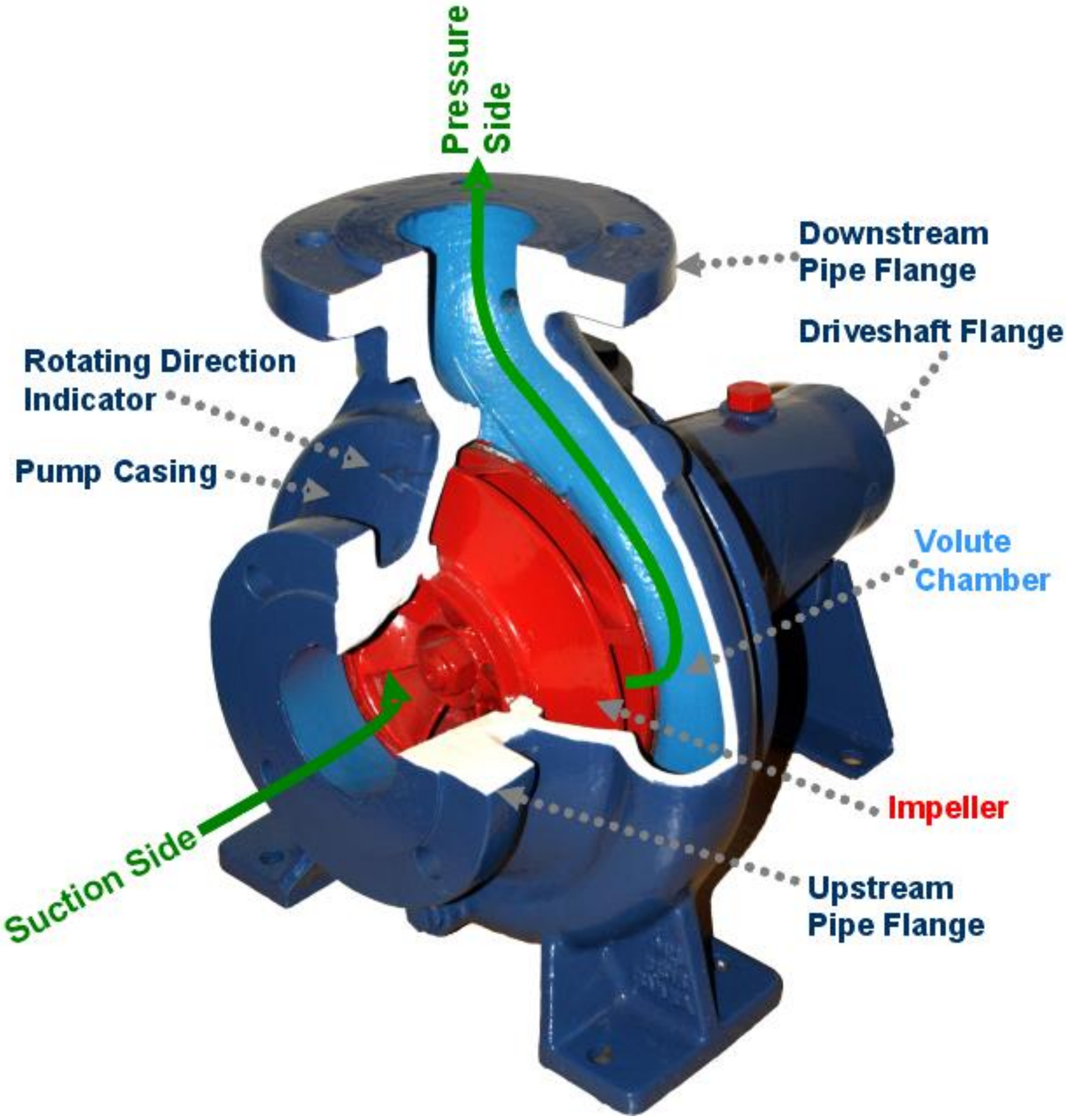
Rotary Pumps – роторні насоси

Gear Pumps - шестеренні насоси

Screw Pumps - гвинтові насоси

Vane Pumps - пластинчасті насоси

Reciprocating Pumps – поршневі насоси



Pump casing – корпус насоса
Rotating Direction Indicator – показник напрямку руху
Suction side – всмоктувальна сторона
Upstream pipe flange – верхній фланець
Impeller - крильчатка
Volute chamber – спіральна камера
Driveshaft flange – карданний фланець
Pressure side – напірна частина
Downstream pipe flange – нижній фланець труби

For standard waterworks design for portable systems, pump casing will be **cast iron** and impellers will be bronze. Base for pump and **driver** will be cast iron or **fabricated steel**. Pump impeller and casing may have wearing **rings** depending upon manufacturers' recommendations and consideration of the cost of replacing the rings. Pumps will have **mechanical seals** or **packing seals**, **ball** or **roller bearings**, and **lubrication system**. Pumps which may operate under extreme conditions such as at the ends of **pump curves** or under **frequent on-off operation** will have packing seals in lieu of mechanical seals.
Lubrication for horizontal pumps will be **oil bath** or **grease**. Vertical **dry pit pumps** will be grease lubricated. Vertical **wet pit pumps** will have oil or water lubrication.

cast iron – чавун
driver – двигун
fabricated steel – фабрична сталь
rings – кільця для ущільнення
mechanical seals – механічне ущільнення
packing seals – сальники
ball or roller bearings - кулькові або роликові підшипники
lubrication system – змащувальна система
pump curve – крива насоса
frequent on-off operation – частотне керування
oil bath – масляна ванна
grease – мастило
dry pit pumps - сухі насоси
wet pit pumps – мокрі насоси

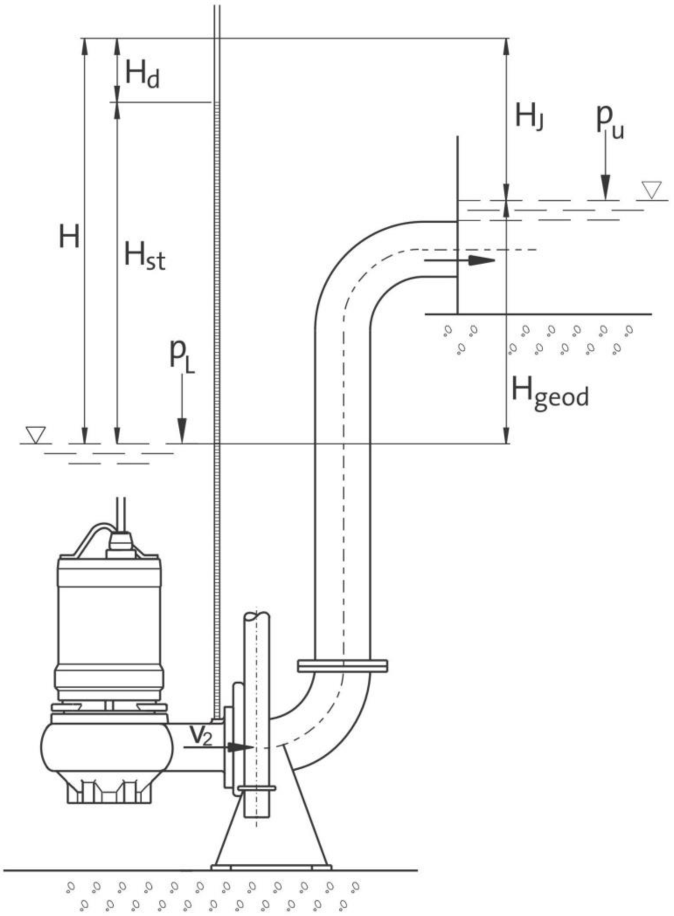
Pump Performance

Pump Head – напор насоса

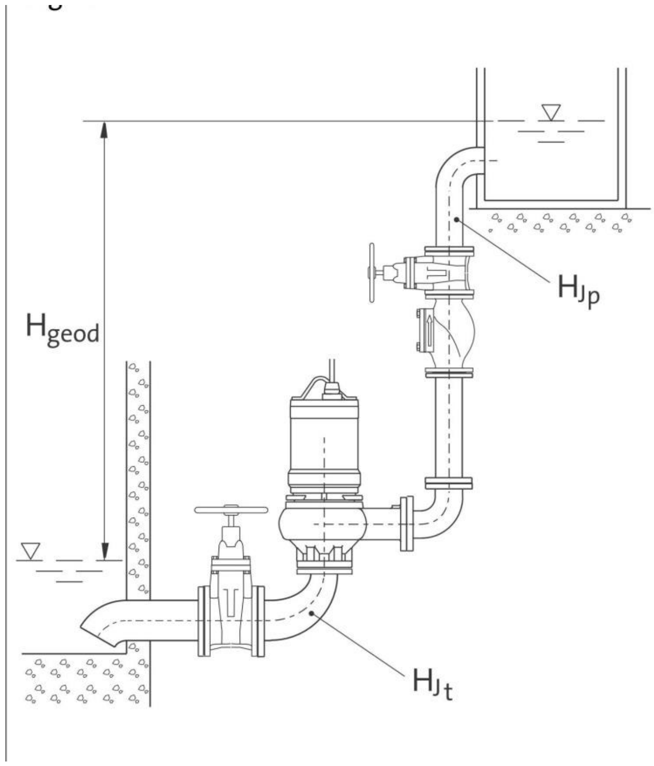
Submersible Pumps

H - pump total head (m) – Повний напір
H_{st}- = pump static head (m) – статичний напір
H_d = pump dynamic head (m) – динамічний напір
H_{geod}= geodetic head (m) – геодезичний напір
H_J= pipeline losses (m) – втрати в трубопроводі
p_L= atmospheric pressure in pump well – атмосферний тиск в колодязі
p_U= atmospheric pressures in upper container – атмосферний тиск у верхній ємності
v_2= flow velocity at outlet (m/s) – швидкість на виході

g = acceleration of gravity (9,81 m/s^2) – прискорення вільного падіння



Dry-installed Pumps



Pump Performance Curves

Centrifugal pump characteristics are normally presented as a set of curves, where the data has been established through the testing of the pumps or assessed by the manufacturer for e.g. a special impeller diameter. For submersible pumps the following important information is normally plotted as curves against the flow rate Q:

- H head curve
- η efficiency curve(s)
- P power curves
- Net positive suction head required (NPSHR) - допустимий кавітаційний запас

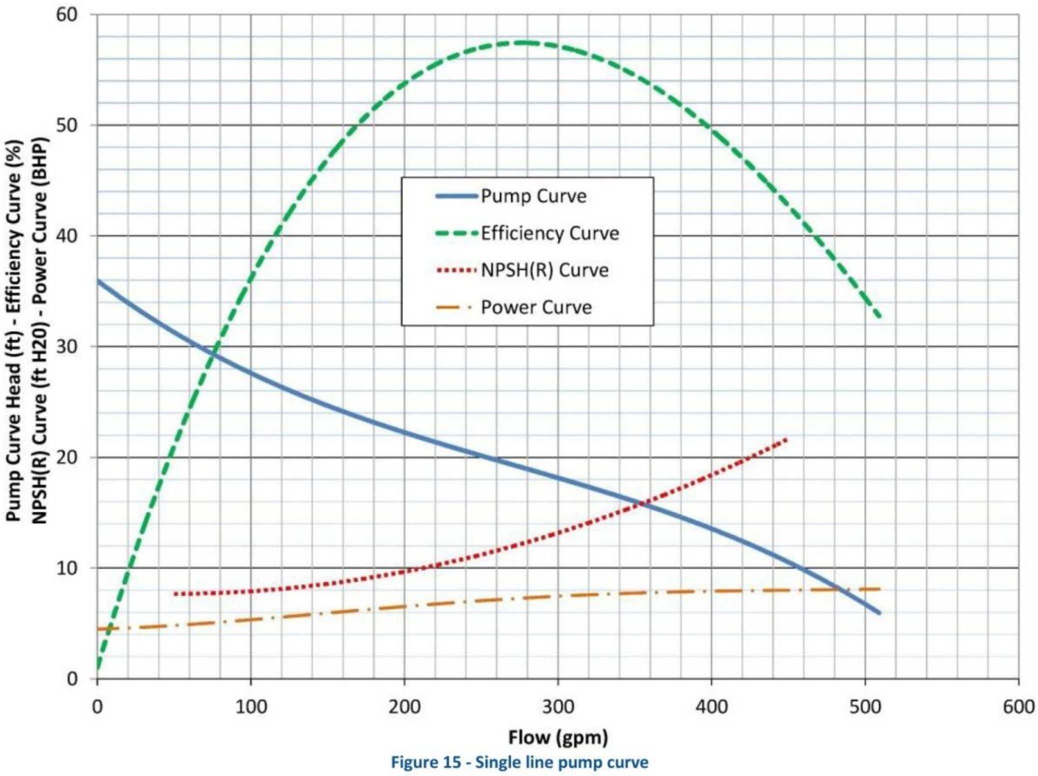


Figure 15 - Single line pump curve

1.4. Cavitation and NPSH

Cavitation is caused by the formation and collapse of **vapour bubbles** in a liquid. Vapour bubbles form when the local static pressure in a flowing liquid decreases to or below the **liquid vapour pressure** at **ambient temperature**. When the bubble, or **void**, moves with the flow to an area with a higher pressure, it will rapidly collapse. The implosion causes a **transitory**, extremely high local shock wave in the fluid. If the implosion takes place

near a surface, the pressure shock will, if occurring repeatedly, eventually erode the surface material. The cavitation **phenomenon** will typically occur in centrifugal pumps at a location close to the **impeller vane** leading edge. Cavitation may also lower the pump Q/H curve and efficiency. A cavitating pump **emits** a typical **rattling noise**, like sand being pumped through the pump. No pump material will completely withstand cavitation, so care should be exercised if the pump operating conditions present a risk of cavitation. Wear marks from cavitation typically occur locally and consist of deep **pittings** with sharp edges. The **pittings** can be several millimetres deep. Normally pump curves published for submersible pumps are drawn so that a pump in normal submerged installation will not cavitate as long as the duty point is on the **allowed section** of the Q/H curve.

vapour bubbles - бульбашки пари
liquid vapour pressure - тиск пари в рідині
ambient temperature –температура навколишнього середовища
void - недійсний
transitory - тимчасовий
phenomenon - явище
impeller vane – лопасті колеса робочого
emits - випускати
rattling noise - стукіт
pittings - каверни
allowed section- допустима ділянка

Water Hammer

Oscillating pressure waves are generated in a liquid being pumped through a pipeline during starting and stopping of the pumps. This phenomenon is called **water hammering**, and, if severe, may lead to pipeline and equipment **damage**. The **severity** of the phenomenon is dependent on a number of **variables**, such as change of velocity during the **reflection cycle**, pipe material characteristics as well as liquid characteristics. When the liquid is **accelerated** or **decelerated**, a transitory pressure wave oscillates back and forth until **dampened**.

Water hammer can be analyzed by two different **approaches**—**rigid column theory**, which ignores **compressibility** of the fluid and **elasticity** of the walls of the pipe, or by a **full analysis** that includes elasticity. When the time it takes a valve to close is long compared to the **propagation time** for a pressure wave to

travel the length of the pipe, then rigid column theory is appropriate; otherwise considering elasticity may be necessary.

Oscillating pressure waves – хвилі коливання тиску
water hammering - гідравлічний удар
damage- пошкодження
severity – строгість
variables - змінні
reflection cycle – відбивання циклу
accelerated or decelerated – прискорення або гальмування
dampened - загасаючий
approaches - підходи
rigid column theory – теорія жорсткої колони
compressibility - стисливість
elasticity - еластичність
full analysis – повний аналіз
propagation time – час поширення

Avoiding Water Hammer

If water hammer occurs in sewage installations, the situation can be **alleviated** with one or several of the following measures:

- Preventing of simultaneous stopping of two or more pumps.
- Installing automatic valves with closing times of 20…30 seconds instead of regular check valves. Pump stops after valve has closed.
- Stopping pumps slowly with **frequency control**.
- Using soft start equipment also for stopping of the pumps. Complete control of **stopping sequence** not always possible.
- Installing automatic air relief valves at points where negative pressure occurs.
- In cases of cavitation in pump during the stopping cycle, the installation of a **bypass suction line** with check valve from the wet well to the rising main will prevent the pressure from dropping inside the pump. Dimension of bypass pipe should be selected one size smaller than pump pressure flange size.

- Using heavier pipe components that will **withstand** water hammer pressure.

Vacuum transients may be more critical to the pipeline and equipment than **pressure surges**.

Alleviated - пом'якшити

frequency control – регулювання частоти
stopping sequence – послідовність зупинки
bypass suction line – обвідна всмоктуюча лінія
withstand – витримувати
Vacuum transients – вакуумні переходи
pressure surges – скачки тиску

Video
https://www.youtube.com/watch?v=2HF_Z64OfQE&feature=youtu.be

https://www.youtube.com/watch?v=uP1ZiZ4khDM&feature=youtu.be