

GLOSSARY OF PUMPS AND PUMPING SYSTEMS

Absolute Pressure: Expressed as kPa (or Bara) Is the pressure above absolute zero which is equal to the barometric (also local atmospheric) pressure plus the indicated gauge pressure (kPag or Barg). Gauge pressure is essential to determine as a pressure above or below the barometric pressure and which is ultimately the actual reading on the gauge.

Air Lock: A condition occurring when a centrifugal pump body is filled with air and a vacuum can no longer be formed allowing water to flow into the pump.

API pump: The American Petroleum Institute has published a set of standards (see API 610 to ensure pumps meet minimum safety, reliability and maintainability standards. A pump that conforms to these standards is said to be an “API pump”.

A.P.I. Specifications: Specifications recommended by the American Petroleum Institute. These specify many safety features of pumps and piping involved in pumping flammable or dangerous substances.

API 610: A standard for pumps used in the petrochemical industry published by the American Petroleum Institute. API 610 ensures that safe, reliable pumps are used in a dangerous industry.

Back pull-out pump: A pump design that allows the entire power end of the pump to be removed for maintenance/replacement while the wet-end of the pump remains in place.

Back-to-back: In the case of impellers, an arrangement where two impellers are placed back-to-back on a single shaft sharing the same backplate. This arrangement provides almost double the flow of a single impeller design.

Back-to-back double seal: A mechanical seal configuration typically used when the process fluid is toxic, flammable, or hazardous. This seal is used to prevent the process fluid or its vapour from leaking into the environment.

Back Vane: Part of the design scheme in impellers used to balance axial thrust on an impeller.

Balance Holes: Another impeller feature that helps to balance axial thrust.

B.E.P.: Best Efficiency Point. The kinetic energy that a pump produces is never converted with 100% efficiency to pressure energy. There are always losses due to friction in the seals/bearings, friction of the pumped fluid over the impeller, etc. The BEP is the volumetric flow rate of the pump for which the pump was designed to convert the most kinetic energy into pressure energy.

Canned pump: A pump in which the armature, and shaft of the motor are in a can, used for pumping clean lubricating fluids.

Cantilevered pump: Centrifugal pumps often used in sump pump applications where it's not desirable to have the bearings/motor under water. The impeller is at the end of a shaft which is cantilevered from the bearing housing assembly. Also known as an

overhung pump.

Capacity: The amount of liquid pumped per unit time. Measured in gallons/min, cubic meters per sec, etc.

Case, Casing: The part of the pump that is the volute chamber, encloses the impeller(s). The case can be split radially or axially

Cavitate: Formation of cavities (bubbles) in fluid flow applications in areas of low pressure, causing a collapse in the high-pressure area of the pump and loss of capacity, excessive noise and possibly damage.

Centre line design: A pump design where the pump is attached to feet that are attached to the sides of the volute instead of the bottom. Commonly used in high temperature pumping applications.

Centipoise: A unit of dynamic viscosity.

Centistoke: A unit of kinematic viscosity. The kinematic viscosity in centistokes is equal to the dynamic viscosity in cP divided by the liquid density.

Centrifugal pump: A pump that transports fluids by conversion of rotational kinetic energy into hydrodynamic energy of fluid flow. Typically, fluid enters the pump near to the rotating axis, and is accelerated by an impeller, flowing radially outward to a volute chamber where it exits the pump.

Close coupled: The situation when the pump impeller is mounted directly on the rotating drive shaft. There are no separate bearings.

Close-coupled pump: A pump in which the impeller is mounted on the drive shaft. Close-coupled pumps have the advantage of being compact, but are limited in size.

Closed or open impeller: In a closed impeller, the impeller vanes are contained within a shroud, causing the fluid to always be in contact with the impeller. An open impeller lacks this shroud. Closed impellers are more efficient, but can also clog easier if the process fluid contains solids.

Closed impeller: An impeller whose vanes are completely enclosed by two shrouds, one on the front and one on the back.

Drain Plug: Removable plug used to drain water from the pump during periods of inactivity or at service intervals.

Efficiency: The measured power out of a piece of equipment divided by the power produced by the piece of equipment. Shown as a percentage.

Equivalent length: A way to calculate the friction of fittings, like bends, tees, returns, and valves, in straight run equivalents. Measured in length.

Expeller: A type of gland seal that reduces the bypass pressure from the pump into the gland or rotary sealing area of the pump. Used in applications pumping slurries. Achieved through a combination of centrifugal force and component tolerances.

Extrusion: Displacement of an O-ring into a gap due to the fluid pressure.

Eye of the impeller: The centre of the impeller, where the process fluid begins its journey outwards to the outlet or discharge.

Flooded suction: If the pump is below the liquid source, and the suction is fed by

gravity. This is a preferred method for centrifugal pumps.

Flow: The measurement of the liquid volume capacity of a pump. Often given in litres per minute (L/min), litres per second (L/sec) and metres³ an hour (m³/hr).

Flowrate: (Q) see Q following.

Foot Valve: A check valve placed in the liquid (water) source below a surface pump to prevent loss of liquid and loss of prime in the pump

Friction Pipe: The loss in head due to the friction between the process fluid and the walls of the pipes and joints.

Friction Head: The force (pressure) required to overcome the friction that is solely due to the inside of the pipes/fittings/pumps in a system.

Foot Valve: A valve that prevents loss of priming in centrifugal pumps when the source of process fluid is lower than the pump.

Friction Head: The force (pressure) required to overcome the friction that is solely due to the inside of the pipes/fittings/pumps in a system.

Friction factor 'f' (pipe): The friction factor of piping is a measure of how much frictional force is produced per length of pipe. This will be specific for each type of pipe and will depend also on whether the flow is laminar or turbulent. This factor is required to calculate the friction loss in a run of pipe.

Friction loss (pump): Friction between the pump and the process fluid results in loss of pressure. Different parts of the pump are more or less susceptible to this force.

Friction (pipe): The force produced as the process fluid flows through the pipes of a system. Caused by movement of the fluid internally as one fluid layer moves against another. Also caused by movement of the fluid against the pipe wall. Rougher pipes will lead to higher friction.

Gauge Pressure: See Absolute Pressure.

Gland: A component of a packing seal type stuffing box. Also, as Packed Gland.

Gland follower: In a mechanical seal, it is a part of the stuffing box that is forced against the packing rings to increase the radial sealing force.

Head: A term in fluid mechanics to represent the energy stored in a fluid due to the pressure exerted on its container. Measured as a length of fluid where a standard of 10m is equal to one atmosphere, or 14.7 psi.

Head Total: The sum of the head produced by the pump. It can be calculated by subtracting the suction head from the discharge head. Also referred to as Total Dynamic Head.

Housing: The pump body or casing. Depending on the design may be made of plastic, aluminium, cast-iron, stainless steel, or constructed as a steel shrouded plastic body (plastic-lined housing).

Impeller: A device that attaches to a rotating shaft and converts the energy of motion, into the liquid or fluid being pumped.

Impeller eye: The centre of an impeller, also the point at which the liquid enters.

Impeller eye diameter: The diameter of the opening where the liquid enters.

Impeller shroud: Plates located on either side of impeller vanes to prevent solids from entering and damaging the impeller .

Impeller vane: A mechanical component of the impeller that directs the flow of liquid from the eye to the discharge, located at the outer diameter of the impeller.

Jockey pump: A second, smaller pump found mainly but not only in sprinkler systems.

Key: A small square piece of metal that is used to secure a rotating part onto a shaft, preventing the part from rotating independently of the shaft.

Keyway: A slot in the shaft that will accommodate the key.

K factor: A coefficient that provides the friction loss from fittings in a system. Tables exist that list the fittings and their K factors.

Lip Seal: Also known as a radial shaft seal. They are used to seal rotary elements such as a shaft or rotary bore.

Lobe pump: Similar to gear pumps in operation; the lobes do not make contact.

Magnetic drive: A seal-less pump that uses a motor coupled to the pump by magnetic linkage. There is no direct mechanical linkage.

Magnetic seal: Seals that use magnetic force rather than springs to provide sealing pressure.

Mechanical seal: A device that joins fluid-mechanical systems together by preventing leakage between the systems.

Minimum flow: See “low flow”. A condition which causes excessive heat to build up inside the pump casing.

Minimum NPSH_A: The minimum net positive suction head available. This quantity should be larger than the NPSH_R or the NPSH required.

Motor frame: NEMA (National Electrical Manufacturers Association) publishes standards for sizes of electrical motors. The Motor frame is a quantity that comes in the published sizes.

Multistage pump: Any pump with more than one impeller. Typically pumps with two impellers are referred to as two stage pumps.

Newtonian fluid: A fluid that behaves without changing its viscosity as a function the rate of flow.

Non-Destructive Examinations (NDE): A process which pumps or pump components are examined for defects without resulting in the destruction of the component being examined. A.k.a. Non-destructive testing (NDT).

Normal operating point: This is the set of conditions at which the pump normally operates. It could be the same or different than the best efficiency point, or the rated operating point.

Nozzle head: The part of a pump where the fluid is discharged. Commonly reduced diameter causes the fluid to exit the system faster than its flow through the system.

NPSH Available: (NPSHA). The net positive suction head available that can be used to prevent cavitation within the pump. It is defined as static head plus surface pressure head minus the vapour pressure of the process fluid minus the friction loss due to the piping, valves and fittings. To avoid cavitation the NPSHA has to be $>$ the NPSHR.

NPSH Required: (NPSHR) is determined by the pump design and the operating condition selected and is provided by the pump manufacturer. To avoid cavitation the NPSHA has to be greater than the NPSHR. Net positive suction head is the head required to keep a pump from cavitating. A characteristic of the pump. Calculated by the manufacturer with cold water.

Open impeller: An impeller with vanes attached to the hub with no front or back shrouds; the impeller may have small web in-between vanes for structural support.

Operating length: The length of a seal when it is in operation, i.e., while it is under compression.

Operating point: The point on the pump performance curve at which a pump operates. It corresponds to the flow rate and total head sustained by the pump.

Operating region: Refers to the range in pump performance curve in which the pump operates.

Overhung pump: A pump whose impeller shaft is supported by bearings on one side only. Also known as a cantilevered pump.

Packing: A manner in which to stepwise reduce the pressure from the pump so that by the time the fluid gets to the last step, the amount of leaking is acceptable. Usually implemented as a set of rings to produce the pressure gradient.

Packing ring: A seal composed of a set of rings that prevents leakage of the fluid into the atmosphere.

Parallel operation: As opposed to Series operation. Two pumps are connected to the same head and thereby provide twice the flow rate as a single pump.

Performance curve: A graph depicting the plot of total head versus flow rate for a specific pump, with a specific impeller and set of characteristics.

Pipe friction loss: The loss in head due to the friction between the process fluid and the walls of the pipes and joints.

Pipe roughness: A measurement of how rough the inside surface of a pipe system is. Many measurements are taken and averaged. It is the average size of peaks that are on the internal surface of the pipes producing friction.

Piping pressure (maximum): Pipe systems have a maximum pressure rating to which they may be subjected. Otherwise, they may burst due to excessive pressure. This also includes joins and flanges. The ASME pressure piping code B31.3 provides the maximum stress for pipes of various materials.

Pilot pump: A pump that contains a rotating casing that causes the fluid to rotate. At one point within the rotating cylinder of fluid, there is a pitot tube, or pick up tube that captures a small amount of the rotating fluid and sends it to the discharge under high pressure.

Pitting: Erosion at the surface of a material as pits due to corrosion, erosion or

cavitation.

Positive displacement pump: A type of pump that causes a fluid to move by trapping a fixed amount of the fluid and moving it into the discharge pipe.

Pressure gradient: The pressure drop, when referring to mechanical seals, across the mechanical seal faces.

Pressure head: The pressure at the pump exerted by atmospheric and other additional pressure that might be in the vessel.

Prime: In a centrifugal pump, if the source is lower than the pump, a small amount of process fluid is infused into the pump to start the suction process.

Priming: The process of initially filling the suction pipe and intake of a surface mounted pump. Priming is generally necessary when a pump must be located above the water source. To prime, a suction line will require the installation of a foot valve.

Progressive cavity pump: A positive displacement pump. Ideal for fluids with high viscosity (e.g., grease, pastes, etc.) They are also known as eccentric screw pumps.

Propeller pump: A.k.a. axial flow pump. A pump in which the impeller imparts lift to the fluid propelling it along due to the impeller's shape.

Pump curve: A graph supplied by the pump manufacturer depicting the relationship between the head and the capacity of a particular pump. Usually contains different curves for different sized impellers.

Q: Commonly used as a symbol for flow rate (quantity). Units may be expressed as any volume per unit time.

Radial flow pump: A centrifugal pump designed so that the pump has medium head and medium flow, or high head and low flow.

Rated operating point: The point on the pump efficiency curve at which the pump vendor guarantees the pump's performance.

Recessed impeller pump: Sometimes known as vortex pump. A pump design which reduces contact between the impeller and the process fluid by recessing the impeller. Ideal for slurries containing solids or fibres.

Seal-less pump: A specially designed pump that is used to pump dangerous liquids. It prevents them escaping into the atmosphere because the internal rotor is assembled with the impeller and does not extend outside the casing.

Seal life: The life expectancy of a mechanical seal. Seals should last until the sacrificial (usually carbon graphite) is worn away.

Seal only pump: A pump that contains only seals and no soft packing, due to the fact that it has no conventional stuffing box.

Self-align: Some seals are designed to align with the shaft exactly by built in mechanisms.

Self-priming pump: A pump that contains a reserve amount of process fluid that helps to create an initial vacuum and lift fluid from the source.

Self-venting pump: A pump in which the suction and discharge control valves can be opened to flush trapped gas during or prior to the start-up sequence. API Standard

610 considers a pump to be self-venting *"if the nozzle arrangement and casing configuration permit adequate venting of gases from the first-stage impeller and volute area to prevent loss of prime during the starting sequence."*

Semi-open impeller: An impeller with no front (suction) shroud. Used typically when pumping particle containing fluids.

Series operation: As in electricity, this is the case when two pumps are connected such that the discharge of the first pump feeds into the suction of the second pump. Care must be taken to match the discharge of pump 1 with the intake of pump 2, otherwise overheating or cavitation can occur.

Shaft: The component of the pump that transmits the radial force from the motor to the impeller.

Shaft packing: Seals are expensive, so manufacturers supply their pumps with soft packing to seal the shaft. Mechanical seals then replace the shaft packing.

Shaft sleeve: A thin cylindrical, metal sleeve placed around the shaft to prevent wear and tear.

Shore "A": A scale used to measure hardness of materials. Defined by Albert Shore in the 1920s.

Shut-off head: The shut off head is the head (pressure) delivered by the pump with the discharge valve closed (shut off).

SIC: Silicon carbide. Very hard and durable, therefore commonly found in seal faces.

Side channel pump: Is a specially designed pump that provides high head at low flows. Ideal for liquefied gases.

Sludge pump: A pump that prevents solids in a liquid from settling in the pump.

Slurry: A mixture of liquid and solid.

Slurry pump: A heavy duty pump designed to withstand the corrosive or abrasive effects of particles in the process fluid. Achieved by lining the pump with extra material that can withstand the assault.

Spalling: Damage to bearings caused by improper lubrication, mechanical damage, defect or fatigue.

Specific Gravity (SG): The ratio of the density of a substance compared to the density of a reference (usually water at 4°C).

Specific speed: A dimensionless number used to characterize turbomachinery. Normalises impellers to a speed in revolutions per minute to that of a geometrically similar impeller if it were to deliver 1 gallon per minute against 1 foot of hydraulic head.

Speed-torque curve: A graph of a pump's speed versus its torque.

Static head: The maximum height (pressure) that a pump can deliver.

Stationary seal: Refers to a mechanical seal where the spring-loaded portion of the seal does not rotate with the shaft.

Strainer or Filter: A metal screen installed at the inlet of a pump to prevent foreign bodies from entering the pump.

Stuffing box: An assembly of mechanical components that houses a gland seal. Prevents leakage.

Stuffing box pressure: Pressure in the stuffing box. Varies widely depending on pump design.

Standby service: A service where a piece of equipment is in a state from which it can be immediately used for operation, either replacing a faulty component or sharing the load.

Static balancing: A.k.a. *single plane balancing*. The process of balancing an impeller in a single plane only.

Submersible pump: A pump that operates when it is completely submerged. Must have waterproof electrical circuits and is usually liquid cooled.

Submersion: Submersion refers to the height difference between the surface of the intake reservoir and the opening of the pump intake pipe.

Suction head: Suction head is the term for the head when the source of the pump is above its centreline.

Suction lift: Opposite of suction head. Occurs when the source for the pump is below the pump's centreline.

Suction line: The suction line of a pump system is piping which transports fluid material from its source to the pump itself.

Suction static head: The height difference between the surface of the inlet reservoir and the centreline of the pump. If the tank is pressurized, this pressure is also included.

Suction static lift: Also known as suction static head. Only occurs when the pump is above the inlet reservoir.

System: The total set of components is referred to as the system. In a pumping system, this would include piping and mechanical equipment from the inlet point to the discharge. as in pump system.

System requirements: The set of conditions (velocity, elevation difference, pressure, etc) that define or determine the total head.

Thixotropic fluid: A fluid whose viscosity decreases with agitation.

Total head: The sum of the head produced by the pump. It can be calculated by subtracting the suction head from the discharge head.

Total Static Head: The discharge pressure minus the suction static head – including the difference between the surface pressures of the two (discharge & suction) tanks, if they are pressurized.

Turbulence: In fluid dynamics, this is non-laminar flow.

Two-stage pump: A pump design containing two impellers operating in series. The discharge of the first stage is the input of the second stage.

Undercut, or undercutting: Reducing the effective diameter of an impeller by trimming the vanes, while leaving the shroud intact.

Vapor pressure: If a liquid is in a chamber that is below the liquid's vapor pressure, then the liquid will vaporize.

VSD, Variable Speed Drive: Can be used to control flow in the system by varying the impeller speed.

Velocity head: The energy contained in a flowing fluid. Its kinetic energy. Calculated by the term $(\text{velocity})^2 / 2$ (acceleration of gravity).

Vent: To remove air or gas from a system.

Venturi (Bernoulli's law): A pipe that has a section in its middle of smaller diameter than either end. The pressure in this area will be less than the pressure in the area of piping with the larger diameter.

Vertical pump: Any pump where the shaft is mounted vertically.

Vibration Damping: Important in mechanical seal design to prevent seal faces from opening and leakage occurring.

Viscosity: Resistance to gradual deformation of a fluid by shear or tensile stress.

Volute Housing: A spiral shaped container that houses the impeller. Its function is to collect and direct the flow of liquid coming out of the impeller.

Volute pump: A pump design where the casing is shaped like a volute (spiral).

Vortex: A mass of liquid in rotary motion around an imaginary axis.

Vortex Pump: A pump used in applications where a very large percentage of solids are contained within the fluid. Operates by having a recessed impeller that is out of the flow path.

Water hammer: Occurs in a piping system due to rapid fluctuations in pressure. Usually caused by change in pump conditions, or the opening or closing of a valve too rapidly.

Wear Plate: A replaceable steel insert that fits inside the volute or suction cover of a pump. Helps to form a vacuum with the impeller and reduce the cost of replacement.

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Engineers for Africa.