

# Glossary of Popular Pump & Process Engineering Terms

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## A

**Absorbed Power:** The actual amount of power being consumed by the pump at a specific flow and head.

**Adapter (or Support Head):** Connects and aligns the power (bearing) end of an ANSI pump to the wet end.

**A.N.S.I. B73.1 Standard:** American National Standards Institute. A set of specifications (envelope dimensions) for centrifugal pumps.

**Absolute pressure (normally in kPaA) :** Atmospheric pressure added to gauge pressure.

**Affinity laws:** They are used to determine changes in capacity, head and power due to changes in shaft speed. The same laws can be used to estimate changes in capacity, head and power due to changes in impeller diameter.

**Air ingestion:** Air is coming into the stuffing box because of a negative suction pressure.

**Alignment:** The centreline of the pump is perfectly aligned with the centreline of the driver (usually an electric motor).

**Ambient temperature or pressure:** The environmental temperature or pressure in the area where the equipment is located.

**Atmospheric pressure:** At sea level, atmospheric pressure 101.3 kPaA.

**API Standards:** Standards produced by the American Petroleum Institute for various pieces of equipment applied in the oil and gas industries. Various API codes are applicable for pumps dependent on the type of pump. Examples are API610, API685 etc.

**Axial Thrust:** The resultant of all axial forces (i.e. in direction of the pump shaft) acting in the pump rotor.

**Axial Thrust Balancing:** Methods by which the axial thrust is balanced to minimize bearing loads.

## B

**Back to Back Impellers:** In multistage pumps, some impellers are located on the shaft facing opposite directions. This is one method of achieving axial thrust balancing.

**Back plate:** Used in some centrifugal pumps to position the stuffing box and provide an impeller wear surface.

**Back Vane:** A radial narrow vane located on the back shroud of an impeller and is designed to balance axial thrust.

**Back pull out pump:** A design that allows the wet end of the pump to be left on the piping yet allows the power end and adapter to be removed. A.N.S.I. pumps are designed this way.

**Back to back double seal:** Two mechanical seals located in a pump with the rotating seal faces in opposite directions.

**Balance Holes:** Holes in the back shroud of an impeller designed to balance axial thrust.

**Balanced seal:** A design in which the seal face closing area is reduced to lower the closing force, and reduce the heat generation between the faces.

**Ball bearing:** Consists of an inner race, an outer race, and a series of balls between them. Often called a precision or anti friction bearing.

**Bar:** Metric unit for pressure and is equal to 100 kPa.

**Barrier fluid:** The high-pressure fluid that is circulated between the two seals in a double mechanical seal. The fluid should enter the bottom and leave the top to prevent air pockets.

**Base plate:** The pump and motor are mounted on this unit.

**Bearing:** Supports the rotating shaft and allows it to turn with a minimum amount of friction. Could be either sleeve or anti-friction type.

**Bellows:** A component of a mechanical seal that can be manufactured from metal or non-metallic materials to eliminate flexing, rolling or sliding.

**Belt Drive:** A combination of belts and pulleys that transfers torque from the driver to the pump.

**B.E.P (Best Efficiency Point):** The best efficiency point on a pump curve for a specific impeller diameter. It is the point where the power coming out of the pump (water power) is the closest to the power used by the pump (absorbed power) from the driver. This is also the point where there is no radial deflection of the shaft cause by unequal hydraulic forces acting on the impeller.

**Buffer fluid:** The low pressure fluid that is circulated between the two mechanical seal in a tandem seal.

**Buna N:** Sometimes called *Nitrile*. A common elastomer used in the sealing of oil or water.

**Bushing:** A close fitting support device used to restrict flow between two liquids, thermally isolate a hot liquid, support the rotating shaft or break down pressure.

**Bypass line:** Used to either re-circulate fluid from the pump discharge to the stuffing box, the stuffing box to the pump suction, or the pump discharge to a lower pressure point in the system. This can also be used as a manual means of flow control.

## C

**Canned pump:** A seal/less pump with the shaft, bearings and rotor contained in a can to prevent product leakage. These are generally limited to pumping clean lubricating liquids.

**Capacity:** Volumetric flow of liquid measured in, litres/sec, m<sup>3</sup>/hr etc.

**Cartridge seal:** A self-contained assembly containing the seal, gland, sleeve, and both stationary and rotating seal faces. Usually needs no installation measurement. Must be used in a pump with impeller clearance adjustments are made.

**Cavitation:** Cavities or bubbles form in the fluid low-pressure area and collapse in a higher-pressure area of the pump, causing noise, damage and a loss of capacity.

**Centreline design:** The pump is mounted to the base plate by feet attached to the sides of the volute instead of the bottom. These are used in higher temperature pumping applications e.g. API applications and allows thermal expansion to occur in without the necessity of re alignment.

**Centipoise:** One unit for dynamic viscosity of a liquid.

**Centistoke:** One unit for the kinematic viscosity of a liquid. Dynamic viscosity divided by the liquid specific gravity at the same temperature gives kinematic viscosity.

**Centrifugal pump:** A pump that imparts energy to a liquid with centrifugal force.

**Centrifugal separator (or cyclone separator):** Equipment that utilises centrifugal force to separate solids out of the fluid. In pumping, they are used in seal flush lines.

**Change of state:** This defines a change in phase for any material e.g. liquid to vapour, liquid to solid, solid to vapour.

**Close-coupled:** A close-coupled pump is characterised by a common or rigidly-coupled motor and pump shaft. These pumps do not have a flexible coupling. There are no pump bearings and all thrust is carried by the motor bearings.

**Concentricity:** When the parts share the same centerline they are concentric to each other.

**Condensate:** This defines the change on phase of a vapour to liquid e.g. steam to water.

**Constant Level Oiler:** This is used to maintain the oil level in a bearing housing to the correct level as oil is used.

**Cooling jacket:** Cooling jackets can be located on the pump casings and /or the stuffing box of the pump to control the temperature of the fluid. Cooling jackets can be part of the component casting or separate bolt on items.

**Corrosion:** This is a chemical or electrochemical reaction on material surfaces that changes the profile and/or composition of the surface.

**Corrosion resistant:** An arbitrary term that indicates a corrosion rate of less than 0.05 mm per year.

**Coupling:** This is used to connect the pump to the driver. It transmits torque between the driver and pump. It can be a flexible coupling that allows some axial and radial misalignment or rigid which does not allow for any misalignment. Allowable misalignment is determined by manufacturers of the coupling.

**Critical speed:** Any object made of an elastic material has a natural period of vibration. When a pump rotor or shaft rotates at any speed corresponding to its natural frequency, minor unbalances will be magnified. These speeds are called the critical speeds.

**Cryogenic Pumping:** This generally refers to pumping liquid gases at very cold temperatures.

**Cutwater:** A part of the pump casing that directs the pumped liquid to the pump discharge.

## D

**D.I.N. standard:** This is a German standard that defines various industrial products.

**Deflection:** Movement or displacement of the shaft in a radial direction.

**Density:** Measured in kg/m<sup>3</sup> or lb/in<sup>2</sup>. This is the ratio of the mass of a liquid in a given volume to the magnitude of that volume. Refer to Specific Gravity.

**Design Duty Point:** This is generally defined for a pump as a capacity at a head or pressure of the liquid being pumped, ideally the design duty point on a centrifugal pump as at BEP.

**Dilatant liquid:** A liquid whose viscosity increases with increased shear rate e.g. agitation.

**Differential Pressure:** The difference between the outlet pressure and the inlet pressure. Differential pressure is sometimes called the Pump Total Differential Pressure.

**Discharge Head:** The outlet pressure of the pump converted to head of liquid.

**Double seal:** An outdated term describing two seals in a pump. The latest terminology is “dual seals”, back-to-back double seals or tandem seal. In the past the term was used to describe a higher-pressure barrier fluid between dual seals.

**Double suction pump:** A pump with an impeller where liquid enters the impeller on both sides. The rotor is generally (but not always) suspended between two bearings. These pumps are generally of higher capacities.

**Double volute:** A centrifugal pump design that incorporates two cut waters to decrease radial loads and minimise shaft deflection when the pump is operating away from the B.E.P. Lowers the efficiency of the pump and therefore seldom used on smaller size impellers.

**Dry running:** Operating a pump without liquid in the pump and therefore in the seal area.

**Dual Seal:** Two seals running in various configurations: back to back, tandem, face to face, or concentric.

**Ductility:** The property of a metal that allows a great deal of mechanical deformation without cracking.

## E

**Efficiency:** In centrifugal pumps, this is the useful power in the liquid to the expended power. That is power out of the pump divided by power into the pump.

**Elastomer:** A rubber-like material that, when compressed and then released will basically return to its original shape in less than five seconds.

**Electrolysis:** A process involving chemical change caused by the passage of an electric current through a liquid.

**E.P.D.M or E.P.R:** Ethylene propylene rubber. This is a common elastomer used in the sealing of water based and higher pH materials. Cannot be used in petroleum products.

**Erosion:** This is wear caused by mechanical action of the liquid on the surface of the materials. It is obviously more prevalent if the liquid contains solids.

**Eye of the impeller:** The center of the impeller where the fluid enters.

## F

**Face combination:** The materials chosen for the two lapped seal faces. An example is carbon graphite running on silicon carbide.

**Face-to-face seals:** Two seals running against a common seal face. The barrier fluid pressure is always lower than stuffing box pressure.

**Face lubrication:** The fluid or vapor that exists between lapped mechanical seal faces.

**Face pressure:** The sum of all the loads on the seal face including the spring load, hydraulic load and shaft axial thrust, divided by the area of the seal face. This face load is reduced by friction between the sliding elastomer and the shaft or sleeve.

**Flashing:** A rapid change in phase from a liquid to a gas.

**Flooded suction:** This refers to a situation where the liquid level on the suction side of a pump is higher than the pump centerline and the liquid flows to the pump by gravity.

**Fluorocarbon:** This is a generic term for an elastomer of which Viton (a Dupont product) is a typical example. The material has good compatibility with hydrocarbons, has high temperature capability but poor mechanical life.

**Flush:** Putting an outside liquid into the stuffing box of the pump at a pressure higher than stuffing box pressure. All of this liquid mixes with and dilutes the pumped fluid.

**Foot Valve:** A type of check valve with a built-in strainer. Used at the point of the liquid intake to retain liquid in the system, preventing the loss of prime when the liquid level is below the pump centerline.

**Free length:** The uncompressed axial length of a seal.

**Friction Head:** This is the head loss due to friction as liquid flows in pipes and fittings.

## G

**Gasket:** This is used between two static surfaces to provide a seal. Made from a variety of deformable materials.

**Gland:** The part that holds one half of the mechanical seal and attaches to the stuffing box.

## H

**Hard face:** A seal face either rotating or stationary. The most common materials are silicone carbide, ceramic, tungsten carbide, Stellite, Ni-resist. The hard face must be the wider seal face.

**Hastelloy "C" (also known as Alloy C):** A nickel-rich, corrosion-resistant and very hard alloy.

**Head:** The equivalent height of the liquid that will produce a particular pressure. Can be calculated from  $H$  (metres) = pressure in kPa / (9.8 x specific gravity).

**Horizontally Split Pump:** This is a pump where the casing is split into two sections in the axial plane. This means there is a top and bottom-half casing. Connections are normally on the bottom-half casing to allow removal of the top casing for pump inspection without needing to disconnect pipework.

**Hydraulic balance:** A method of reducing mechanical seal face loading by reducing the seal face closing area.

**Hydrocarbon:** A petroleum product consisting of hydrogen and carbon.

## I

**I.D.:** Inside diameter.

**I.S.O.:** International Standards Organization. Sets pump and seal standards for the metric community.

**Impeller:** The rotating component of a centrifugal pump that imparts energy to the fluid being pumped. Available in open, semi-open and closed design.

**Impeller eye:** The centre of the impeller or the point where fluid enters the impeller.

**Impeller shroud:** The plates located on one or both sides of the impeller vanes. Prevents solids from penetrating behind the vanes.

**Impeller vane:** Located between the eye and the discharge side of the impeller. Directs the flow of the liquid to the outside diameter of the impeller.

**Inducer:** A small axial flow vane that attaches to the impeller of a centrifugal pump that reduces the N.P.S.H. required by a pump. This improvement occurs across a narrow capacity range and the impact can be detrimental outside of this range.

**Induction motor:** The most common type used in industry. Has a slippage of 2 to 5 percent compared to synchronous motors.

**Inline pump:** Mounted in the piping generally between two flanges. No base plate or alignment required.

## J

**Jacket:** Usually refers to the heating/cooling jacket surrounding the stuffing box on some pumps.

## K

**Kalrez®:** An “elastomer-like” material manufactured by E.I. Dupont that is used to seal most solvents and other aggressive fluids. It is available in several different grades.

**Kilowatt:** One thousand watts. The normal unit for power in the metric system.

**Kpa (kilopascals):** A metric unit of pressure.

## L

**Labyrinth seal:** A non-contacting seal utilising a tortured path for the escape of the fluid. Utilises a series of pressure drops to reduce the leakage.

**Lantern Ring:** A device used to supply lubricant to packing. Usually located in the middle of the packing ring set.

**Line bearings:** These position the rotor or shaft radially and are normally of the sleeve type. Generally used in vertical pumps.

**Liquefied Natural Gas LNG:** This is liquefied gas from natural sources

**Liquefied Petroleum Gas LPG:** This is liquefied petroleum gas which is a by-product of the refining of crude petroleum oil.

## M

**Magnetic drive:** A type of seal less pump that utilises permanent magnet technology to provide the rotation of the impeller.

**Mating ring:** Another name for the hard face in a mechanical seal. It can be either rotating or stationary.

**Mechanical seal:** A positive sealing device used to seal all fluids (liquids and gases). The primary seal is a set of lapped seal faces that are installed perpendicular to the shaft.

**Metal bellows:** Used in mechanical seal designs to eliminate the need for a dynamic elastomer and springs.

**Metal fatigue:** A breakage of the metal caused by the bending and flexing of a metal part beyond its endurance limit.

**Minimum flow:** The minimum capacity of a pump to prevent thermal and/or mechanical damage.

**Moment of inertia:** This represents a magnitude of the inertia in respect of the rotation around the axis of the pump and drive rotor.

**Multistage Pump:** This defines a pump that has more than one impeller on the shaft.

## N

**Negative pressure:** A pressure below atmospheric pressure.

**Newtonian Fluid:** A Newtonian liquid is one whose viscosity does not change with increasing shear rate e.g. when agitated.

**Non Overloading Power:** This refers to the maximum power absorbed by a pump with a specific impeller diameter and liquid. Motors are generally sized at the next size above this power.

**N.P.S.H.A:** The net positive suction head available to prevent cavitation of the pump. It refers to the suction side of a pump installation and is defined as the head acting on top of the liquid + static head - vapor pressure head – friction head loss in the suction piping.

**N.P.S.H.R.:** Net positive suction head required to prevent cavitation of a pump and is dependent on impeller and pump design. The pump manufacturer determines the NPSHR by testing. In all cases, it is imperative that  $NPSHA > NPSHR$  to prevent cavitation

## O

**O.D.:** Outside diameter.

**Operating length:** This measurement is set by manufacturers to provide the correct closing pressure on the two mechanical seal faces. The measurement can be made in a number of ways dependent on manufacturer. One measurement is from the face of the stationary face to the location screws for the rotating part of the seal.

**Orifice Plate:** A plate with a hole smaller than the pipe diameter in which it is located

**Over hung impeller:** Not supported with bearings on either side of the impeller.

## P

**Packing:** The soft rings that a mechanical seal replaces to stop leakage. Packing must have a small leak because it works on the theory of a series of pressure drops to reduce the stuffing box pressure to the point where the leakage is acceptable. Generally, a minimum of five rings of packing is required to do this.

**Parallel operation:** This refers to two or more pumps that are discharging to a common header. It is important that the impeller speed and outside diameters are the same or one of the pumps may cause other pumps to operate at shut off.

**pH:** A measure of the acidity or the alkalinity of a fluid. The scale ranges from 0 (acid) to 14 (alkali) with 7 considered neutral.

**Pipe strain:** The strain on the pump volute caused by the piping. It will cause excessive mechanical seal movement and can cause contact between rotating and stationary pump and seal components. It can also cause serious misalignment with resultant damage to bearings and couplings.

**Pitting:** Surface voids caused by corrosion, erosion or cavitation. It is possible for the three to occur at the same time.

**Positive Displacement Pumps:** This is a collective definition of all pumps that operate according to the positive displacement principle. That is, the liquid being pumped is displaced by a body which periodically increases and decreases the working volume.



**Power end:** The end of the pump that attaches to the power source and is not wetted by the liquid. The bearings are in this part.

**Precision bearing:** Ball or roller bearing as opposed to a sleeve bearing.

**Pressure gradient:** The pressure drop between the seal faces.

**Priming:** This refers to the filling of a pump with liquid prior to operation.

## Q

**Quench:** The introduction of a fluid outside the seal to cool the product, dilute any leakage across the seal faces or isolate seal faces from atmosphere.

## R

**Radial Bearing:** This bearing handles most of the radial loads put on the impeller. In an end-suction centrifugal pump it is the bearing located closest to the stuffing box.

**Radial Thrust:** This is the thrust produced in the radial direction i.e. at 90 degrees to the centerline of the shaft, by forces acting on the impeller when operating at points other than BEP.

**Radially Split Casing:** A pump casing with the casing joint at 90 degrees to the shaft axis.

**Rated Operation:** This is the basis of selection of both pump and driver. When rated operation is specified, it generally exceeds the requirement of the design operation.

**Ring Section Pumps:** These are multistage pumps with several identical stage casings arranged in tandem behind each other. The stage casings are radially split.

**Rockwell "C":** The scale used to define hardness of materials.

**Run out:** Twice the distance that the centre of the shaft is displaced from the axis of rotation.

## S

**Saturation Pressure:** Same as vapour pressure.

**Seal faces:** The lapped faces that provide the primary seal in a mechanical seal.

**Self Priming Pump:** These pumps are capable of pumping liquids on a suction lift by being able to remove air from the suction line of its own accord. Most self-priming pumps need to be filled with liquid (primed) before the initial start, however their design means that subsequent starts do not require priming. Pumps that can self-prime from dry are limited to diaphragm and peristaltic type pumps only (both are positive displacement pumps).

**Series operation:** Two or more pumps connected with the discharge of the first pump discharging to the suction of the other etc. Rarely used these days.

**Shaft packing:** The soft packing located in the stuffing box to provide a shaft seal for pumps.

**Shaft Power:** The mechanical power absorbed at the pump shaft.

**Shut off head:** This is the maximum head that the pump can generate with a given impeller outside diameter. It is normally at zero capacity.

**Sleeve bearing:** A non-precision or anti-friction bearing. It is usually manufactured from carbon, teflon, brass, white metal, other synthetic bearing materials.

**Slurry:** A slurry is a liquid in which solids are present in suspension.

**Solubility:** This defines the ability of a liquid to dissolve with another liquid. For example, ethanol will fully dissolve in water whereas oil will float on water.

**Specific Gravity (SG):** This is the ratio of the mass of a liquid for a known volume to the weight of water for the same volume. The reference is water at 4 degrees C with an SG of 1.0. If the liquid you are questioning will float on water the specific gravity is less than one. If it sinks, it is higher than one. **Note** that this is based on the liquid **not** being soluble in water.

**Specific Speed:** Specific speed of a pump is determined by the geometry of a pump impeller. The higher the specific speed the less N.P.S.H. required.

**Stainless steel:** Alloy steels containing a high percentage of chromium and/or nickel.

**Static head:** The height of a liquid above a reference point e.g. pump centerline.

**Stationary face:** The seal face that does not rotate with the shaft.

**Stuffing box:** The portion of the pump that held the packing and now holds the mechanical seal.

**Stuffing box pressure:** The pressure in the stuffing box and generally between suction and discharge pressure but closer to suction pressure.

**Submersible pump:** A pump/motor pumpset that operates only when totally submersed in the fluid which is being pumped.

**Suction lift:** Pumping application where the liquid level on the suction side of the pump is below the pump centerline.

**System resistance Curve:** A graphed representation of how total dynamic head varies with capacity. A pump will operate where the system resistance curve intersects the pump performance curve.

**System head:** The head caused by friction in the piping valves and fittings.

**Tandem seals:** The seals are facing in the same direction with a low-pressure barrier fluid circulating between them.

**Thermal conductivity:** A measure of the material's ability to conduct heat. This is a very important factor in the selection of mechanical seal faces.

**Thixotropic fluid:** The viscosity of the fluid decreases with agitation. Non-drip paint is an example of such a fluid.

**Throttling:** This means closing of a valve on the discharge side of a pump to increase friction loss. This steepens the system resistance curve with a resultant decrease in flowrate. Opening the valve results in an increase in flowrate.

**Thrust bearing:** This locates the rotor or shaft axially and is designed to handle any excess axial thrust load. In an end-suction pump, it is normally located close to the coupling.

**Thrust:** In a centrifugal pump it refers to the axial movement of the shaft. The thrust can be towards the wet or power end of the pump and at start up it thrusts in both directions.

**Total Discharge Head:** This is equal to the pressure at the pump discharge connection converted to head of liquid.

**Total Dynamic Head:** Total dynamic head is equal to total discharge head minus total suction head

**Total Suction Head:** This is equal to the pressure at the pump suction connection converted to head of liquid.

**Tungsten carbide:** A common hard face seal material available in several grades depending upon hardness and corrosion resistance. Cobalt and nickel are the two most common types.

**Turbulence:** This refers to disturbance of fluid as it enters the suction connection and /or the impeller. This can cause cavitation problems in a centrifugal pump. This is often caused by an insufficient length of straight pipe before the pump suction inlet.

## U

**Unbalanced seal:** A mechanical seal not designed to balance the closing force between seals. Refer to **Balanced Seal**.

## V

**Variable speed motor:** This is used to control flow in a system by varying the frequency of the motor. A better system than throttling as it reduces power consumption significantly.

**Vacuum:** This is a pressure less than atmospheric.

**Vapor pressure:** Below this pressure, the liquid at this temperature will vaporise.

**Vaporisation:** The fluid passes from a liquid to a gaseous state. If this happens at the seal faces the seal faces will be blown open.

**Velocity:** A measurement of the speed of the liquid in the system. This is measured in metres per second.

**Velocity head:** This is part of the total head calculation. This is calculated from the formula  $H = v^2/2g$ .

**Vent:** This removes air or gas from the system. It is important to vent the stuffing box in vertical pumps to prevent the seal faces from running dry.

**Viscosity:** This is defined as the property of a liquid that offers resistance due to the existence of internal friction between layers within the liquid.

**Viton®:** An E.I. Dupont Dow manufactured fluorocarbon elastomer widely used in the sealing industry. Refer to **Fluorocarbon**.

**Volute casing:** This derives its name from a spiral-shaped casing surrounding the pump impeller. It converts velocity energy to pressure energy.

**Vortex Pump:** A type of pump used to handle liquids with entrained solids, particularly stringy solids. The impeller is recessed into the volute. A very low efficiency design, but practical in many applications.

**Vortexing liquid:** Creating a “whirlpool affect” that can draw air into the suction of the pump. Vortecies can form both from the surface of the liquid and in vertical pumps, from the floor of a pit or channel in which they are located.

## W

**Water hammer:** This occurs in a closed piping system as a result of the pressure being rapidly increased when the liquid velocity is suddenly changed. This damaging effect is usually the result of sudden starting, stopping, change in pump speed, or the sudden opening or closing of a valve. Water hammer can usually be controlled by regulating the valve closure time, surge chambers, relief valves or other means.

**Water Power:** The calculated power coming on water at an efficiency of 100%.

**Watt:** A measure of power.

**Wear ring:** This is used with closed impeller pumps to seal leakage from the high-pressure side of the pump to the low-pressure side. This may need to be replaced as it wears when the recommended clearance is doubled or when reduction in pump performance can no longer be tolerated.

**Welded metal bellows:** A seal design used to eliminate the use of elastomers. Excellent for cryogenic and hot applications. Not as effective for hot petroleum applications because of “coking” problems.

**Wet end:** The part of the pump that gets wet from the pumping fluid. Includes the volute, stuffing box, impeller wear rings, and shaft or sleeve.