Thermodynamic Terms

Some definitions given here are not as all-inclusive as general thermodynamics might require, but cover the ground necessary for reciprocating compressor applications. There are some items where "authorities" differ in definition and approach. In such cases, a certain amount of judgment has been applied.

SPT means standard pressure and temperature. As used herein it is 14.696 psia and 60° F in the English system of units.

STANDARD Conditions, in the SI System, are 1.01325 barA and 15 C. These conditions are used in Canada, South America, and New Zealand

NORMAL Conditions, in the SI System, are 1.01325 barA and 0 C. These conditions are used primarily in Europe.

DENSITY is the weight of a given volume of gas, usually expressed in lb/cu.ft. at SPT conditions.

SPECIFIC VOLUME is the volume of a given weight of the gas, usually expressed as cu. ft./lb at SPT conditions.

SPECIFIC GRAVITY is the ratio of the molecular weight of a given gas to the molecular weight of dry air, both measured at the same specified conditions of temperature and pressure usually 14.696 psia and 60° F. It should also take into account any compressibility deviation from a perfect gas.

BOYLE'S LAW states that if the temperature of a gas remains constant, its volume varies inversely with the absolute pressure. It is expressed by the formula: $P_1 V_1 = P_2 V_2$

CHARLES' LAW states that if the pressure of a gas remains constant, its volume varies directly with the absolute temperature. It is expressed by the formula: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

IDEAL GAS LAW is created by combining Boyle's and Charles' Laws. It is expressed by the formula: $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

COMPRESSIBILITY is a volume ratio that indicates the deviation (as a multiplier) of the actual volume from that as determined by the perfect or ideal gas laws. When compressibility is applied, the equation is the real gas law. Compressibility is designated by the term "z", and is a function of pressure, temperature, and gas composition.

$$\frac{P_1 V_1}{z_1 T_1} = \frac{P_2 V_2}{z_2 T_2}$$

TEMPERATURE is the property of a substance that gauges the potential or driving force for the flow of heat.

ABSOLUTE TEMPERATURE is a temperature measurement relative to an absolute scale. The absolute scale in English units is degrees Rankine; Temp Rankine = T F +460. The absolute temperature scale in SI units is degrees Kelvin Temp Kelvin = T C +273. Zero degrees in both absolute temperature scales reference the temperature when a substance contains no heat.

ISOTHERMAL PROCESS is one during which there is no change in the temperature. This is impractical, as it would require all heat to be continuously removed from the process.

ISENTROPIC (ADIABATIC) PROCESS is one during which there is no heat added to or removed from the system. All the heat of compression is contained in the gas and shown as a temperature increase. Although not attained in practice, adiabatic compression is a good model for most positive displacement compression.

ADIABATIC HORSEPOWER is the power required to adiabatically compress a gas delivered from one pressure to a higher one. The power is calculated at the face of the compressor piston.

ADIABATIC EFFICIENCY is the ratio of the adiabatic horsepower required to compress a given amount of gas to the actual horsepower expended in the compressor cylinder The adiabatic efficiency is dependent upon factors such as gas preheat and valve horsepower losses.

MECHANICAL EFFICIENCY is the measure of the power lost due to mechanical friction of the piston rings, packings, and bearings. A value of 95% mechanical efficiency is used for the compressor cylinders in addition to specific frame losses that include bearing and oil pump losses.

BRAKE HORSEPOWER is the measured horsepower input to the compressor. It is the adiabatic horsepower divided by the adiabatic efficiency and the mechanical efficiency.

POLYTROPIC PROCESS is one in which changes in gas characteristics and properties are allowed for throughout the process.

HEAT is energy transferred because of a temperature difference. There is no transfer of mass.

WORK is energy in transition and is defined as Force times Distance. Work cannot be done unless there is motion.

ENTHALPY (Heat Content) is the sum of the Internal and External energies.

ENTROPY is a measure of the unavailability of energy in a substance.

SPECIFIC HEAT (Heat Capacity) is the rate of change in Enthalpy with temperature. It may be measured at constant pressure or at constant volume. The values are different and are known as cp, and cv respectively. For a perfect gas, Cp= Cv + R. R is the universal gas constant.

RATIO OF SPECIFIC HEATS (k) is the ratio of Cp over Cv. It may vary considerably with temperature and pressure levels.

SATURATED VAPOR PRESSURE is the pressure existing at a given temperature in a closed vessel containing a liquid and the vapor from that liquid after equilibrium conditions have been reached. It is dependent only on temperature and must be determined experimentally.

SATURATED PRESSURE is another term for Saturated Vapor Pressure.

SATURATED TEMPERATURE is the temperature corresponding to a given saturated vapor pressure for a given vapor.

DEW POINT of a gas is the temperature at which the vapor (at a given pressure) will start to condense (or form dew). Dew point of a gas mixture is the temperature at which the highest boiling point constituent will start to condense.

BUBBLE POINTof a gas is the temperature at which the liquid (at a given pressure) will start to boil (or form vapor). Bubble point of a gas mixture is the temperature at which the lowest boiling point constituent will start to boil.

RELATIVE HUMIDITYis the amount of water vapor entrained in a gas, expressed as % of saturation.

PARTIAL PRESSURE of a constituent in a mixture is the absolute pressure exerted by that portion of the mixture. Calculated by multiplying the absolute pressure of the system by the mole fraction of the constituent in the mixture.

DRY GAS is any gas or gas mixture which contains no water vapor and also in which all of the constituents are substantially above their respective saturated vapor pressures at the existing temperature. Note: In commercial compressor work a gas may be considered dry (even though it contains water vapor) if its dew point is low at the

inlet condition (say -50° F to -60° F.) Note: In commercial compressor work a gas may be considered dry (even though it contains water vapor) if its dew point is low at the inlet condition (say -50° F to -60° F.)

WET GAS is any gas or gas mixture in which one or more of the constituents is at or very close to its saturated vapor pressure. The constituent at saturation pressure may or may not be water vapor.

CRITICAL TEMPERATURE is the highest temperature at which a gas can be liquefied.

CRITICAL PRESSURE is the saturation pressure at the critical temperature. It is the highest vapor pressure the liquid can exert. Note: Critical conditions must be experimentally determined for each pure gas. When calculated for a mixture, they are called pseudo critical conditions. Pseudo critical conditions are a mole % (volume %) weighted average of critical conditions for each constituent of a mixture.

REDUCED TEMPERATURE is the ratio in absolute units of the actual gas temperature to the critical temperature. Pseudo - reduced temperature is the ratio in absolute units of a gas mixtures actual temperature to pseudo - critical temperature.

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