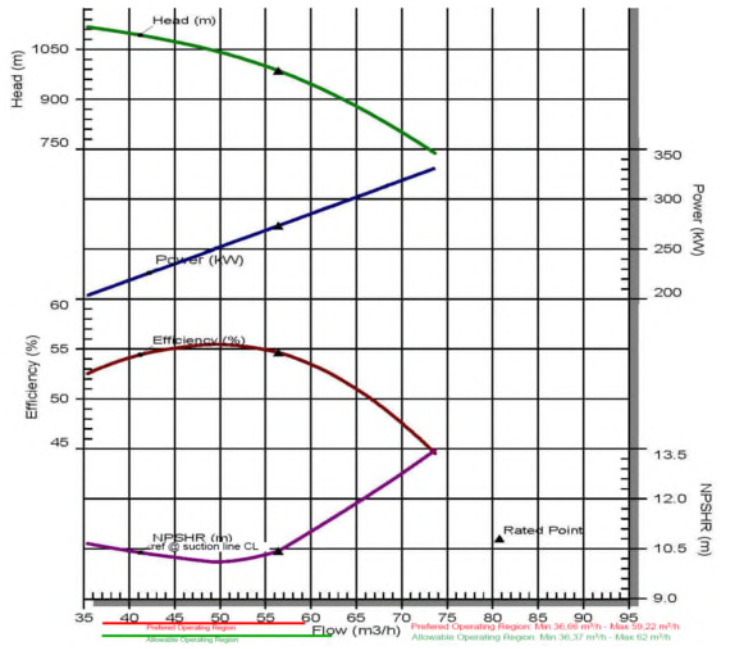
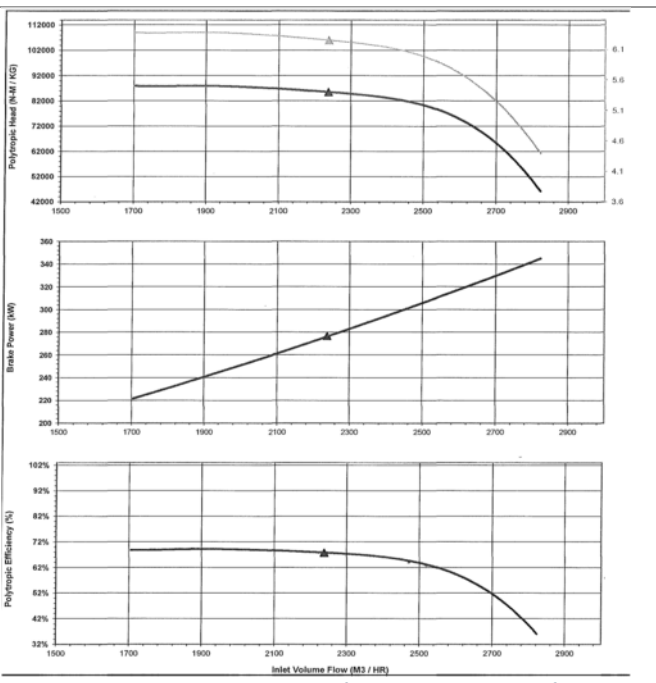
Centrifugal pump Vs Centrifugal Compressor

Parameter	Centrifugal pump	Centrifugal Compressor
Working principle	Kinetic energy of the impeller is imparted to the liquid, to raise hydraulic energy, combination of kinetic energy (Flow) and pressure energy (Head).	Kinetic energy of the impeller is imparted to the gas, to raise aerodynamic energy, combination of kinetic energy (Flow) and pressure energy (Head).
Volume of fluid	Liquid being incompressible fluid, Volume remains the constant.	Gas being compressible in nature, Volume gets compressed, reduced.
Parameters required for selection	→ Capacity in volumetric flow → Total differential head → NPSH available → Fluid properties; density, viscosity, vapor pressure, operating temperature → Nature of fluid: clean, solid content, corrosiveness	→ Inlet volume in Actual volumetric flow → Available Suction pressure and temperature → Discharge pressure required → Gas mixture properties; Molecular weight, Specific hear ratio, Compressibility → Nature of Gas
Performance curve	 It is mainly graphical representation of volumetric flow Vs Head, also include → Volumetric flow Vs Efficiency → Volumetric flow Vs NPSH required → Volumetric flow Vs Power	 It is mainly graphical representation of actual volumetric flow Vs Adiabatic or Polytropic Head, also include → Actual volumetric flow Vs Discharge pressure → Actual volumetric flow Vs Power → Actual volumetric flow Vs Efficiency
Control method	→ Discharge control → Speed variation	→ Suction Throtlling / Variable inlet (IGV) → Speed variation → Discharge control
Significance of Head	It is static height of liquid. Pump develops fixed head at given flow, Hence all the friction loasses and pressure diffrences across the system are to be convrted in to head. $H \propto \frac{P}{SG}$ and $H \propto V^2$	Energy required to move unit mass of gas from one point to another. Work performed on unit mass of gas. $H_{ad} = \frac{zRT_s}{Mw}\left(\frac{k}{k-1}\right)\left(\left(\frac{P_d}{P_s}\right)^{\left(\frac{k-1}{k}\right)} - 1\right)$
Temperature rise	Temperature rise within the casing is negligeble. $\Delta T \propto \frac{Head}{Specific\ heat}$	Substantial increase in discharge temperature due to gas compression. $T_d \cong T_s\left(\frac{P_d}{P_s}\right)^{\left(\frac{\eta-1}{\eta}\right)}$
Low flow instability	**Terminology:** MCF Static and MCF Thermal **Effect:** Unbalanced Hydraulic load on rotor, Excessive shaft deflection, Internal recirculation, Heat generation, High vibration **Consequences:** Low flow cavitation, Seal and bearing failure **Protection:** Recirculation line with automatic recirculation valve or flow orifice or control valve	**Terminology:** Surge **Effect:** Stall, Back flow of gas from discharge to suction, flow reversal and oscillation, fluttering noise, Very high vibration **Consequences:** Failure of Seal, bearing or impeller, too many surge cycles is detrimental to the compressor and auxiliaries **Protection:** Recirculation line with anti-surge control system or control valve or Inlet guide vane or VFD
High Flow instability	**Terminology:** High flow, Run out flow **Effect:** Cavitation, Excessive radial load on rotor, Discharge re-circulation, High vibration, mild or high-pitched whining sound **Consequences:** Cavitation, pitting / erosion mark on impeller, bearing failure, Shaft bent or sheared off, Driver overload **Protection:** Operation within preferred operating range, High flow alarm / trip setting, VFD	**Terminology:** High flow, Choke flow, Stonewall **Effect:** would not have serious issue if gas velocity is well within sonic speed except driver overload **Consequences:** Gas velocity close to sonic speed may lead to damage compressor internals **Protection:** High flow alarm / trip setting, VFD, Anti-choke valve
Applicable API standard	API 610: Centrifugal Pump API 685: Sealless Centrifugal Pump	API 617: Centrifugal and Axial Gas Compressor API 672: Integrally Geared Air Compressor API 673: Centrifugal Fan
Co-efficient to determine flow / head characteristic	Sp. Speed < 70 → Radial impeller (High/medium head, low flow) 70 < Sp. Speed < 160 → Mixed Flow (Medium flow, Medium head) Sp. Speed > 160 → Axial Flow (High flow, low head) Specific speed in SI unit, m-m3/s	Pressure ratio > 1.2 → Compressor 1.11 < Pressure ratio < 1.2 → Blower 1.11 > Pressure ratio → Fan Pressure ratio = Discharge pressure /Suction pressure
Shaft Sealing types and standards	Shaft sealing system for Centrifugal pump (API 682), Old method – Gland packing	Dry Gas sealing system (API 614 / API 692), Contacting wet seal, Labyrinth Seal

Kirit Domadiya