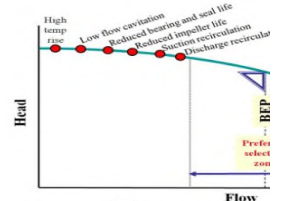
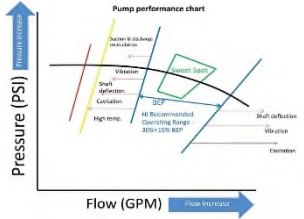
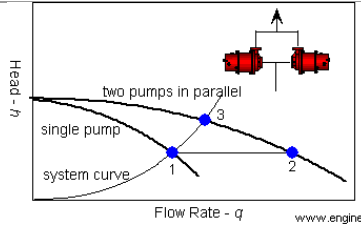


Centrifugal Pump : Key Operational issues and remedies to optimize reliability

How it affects pump reliability?	Possible counter measure	More details
A. Pump Operation below or close to minimum continuous flow		
- Operation close to MCF Stable → Unbalance hydraulic load on rotor → excessive Shaft deflection → High vibration Wear ring seizure, Bearing or seal failure - Operation close to MCF → Excessive internal recirculation → Erosion and heat generation - Operation close to MCF Thermal → Internal recirculation → heat generation → Cavitation	✓ Re-circulation line with orifice, ARC or control valve ✓ Use of Non-metallic wear ring (it minimizes the effect) ✓ Interlock on low flow ✓ Re-rate the pump for lower flow (if such requirement is regular)	 Fig 1 Courtesy PFA, Australian Pump Test
B. Pump operation on extreme right of the performance curve / High flow operation		
- Operation at very high flow → Higher and unbalance hydraulic load on rotor → excessive Shaft deflection → High vibration Wear ring seizure, Bearing or seal failure, Shaft breakage - Operation at very high flow → Higher NPSH_r → Cavitation → Impeller or Seal failure	✓ Set interlock on high flow ✓ Rerate the pump if requirement is high ✓ Provide adequate NPSH_a at higher flow ✓ Provide Inducer, Upgrade metallurgy of Impeller, Inducer to provide more resistance against possible cavitation ✓ Upgrade to double volute or double diffuser design to balance higher radial load	
C. Insufficient NPSH_a		
- Insufficient NPSH_a → Cavitation → High vibration, sound, Wear ring seizure, Impeller, seal failure → dynamic unbalance of rotor → Pump catastrophic failure - Vapor lock inside the casing → Dry running of mechanical seal, Dry running of bearings in case of Sealless pump - NPSK_a is not merely an absolute value, but it is dynamic in nature, varies with operating suction level or pressure, temperature and vapor pressure	✓ Ensure adequate NPSH margin over the complete operating range ✓ Use PG in suction for monitoring. In case of higher DP across strainer or air / vapor ingestion gauge will sharply hunt. ✓ Startup vent, Increase suction pressure, Lower temperature ✓ Improve SOP. Attach vapor pressure curve with the operating procedure for light HC or sub-zero operating temp. service. ✓ Use of Inducer, upgraded design and metallurgy of Impeller, Inducer to provide more resistance against upset condition ✓ Upgrade to Double seal with pressurize barrier ✓ Optimize strainer size	$NPSH = \frac{p_0 - p_v}{\rho \times g} + \Delta Z - h_L$ Where, p_0 = Pressure at water surface p_v = vapour pressure ρ = density of fluid ΔZ = difference of height at point 0 and point 1 h_L = head loss between point 0 and point 1 Velocity head is negligible, unless high flow pump
D. Unbalanced Parallel Operation		
- Unbalanced Parallel Operation → One pump may deadhead the other or continuous pulsation or recirculation - In the case of dead head, one pump operates at very high flow and the other is at below MCF. Both would be at risk	✓ Both the pump should be hydraulically identical. Most importantly, discharge pressure should be the same ✓ Provide individual re-circulation line and flow meter ✓ Discharge check valve should not be passing ✓ Must have individual control valve and identical suction piping ✓ More precaution - parallel operation of non-rising curve	
E. Change in process parameter or process fluid characteristics		
- Specific gravity or viscosity ↑ - Bearing load ↑ Power ↑ - Operating Temp ↑ - Vapor Pr ↑ - NPSH_a ↓ - Operating Temp ↑ or ↓ - Suitability of elastomer - Contamination → Corrosion or erosion → Dynamic unbalance of rotor → High vibration, seal failure - Solid in process → impeller clog → Pump failure - Solid in process → Strainer choke → cavitation	✓ Always ascertain actual fluid process data in accordance with process data sheet ✓ Upgrade pump design or MOC of parts, if required ✓ Inspect suction strainer on regular interval or provide DP gauge or transmitter across the strainer ✓ Assess performance at regular time interval to detect any issue related to density or viscosity	