CHEMPUMP
A DIVISION OF TEIKOKU USA INC.

Technical Data Sheet TDS-012

NPSH & Regenerative Turbine Pumps

Regenerative turbine pumps are designed to optimize head rise at relatively low flow conditions. Regenerative turbine pumps are categorized as low specific speed pumps and offer users better head rise and efficiency when compared to standard centrifugal pumps in similar applications.

This is accomplished by adding energy to the fluid as it passes around the periphery of the impeller. By repeated action of the impeller on the fluid, head is added around the entire circumference of the impeller from the suction nozzle to the discharge. The suction nozzle is designed to minimize head losses of the fluid entering the impeller and features a relatively small low pressure space as compared to conventional centrifugal pumps. The fluid must be accelerated to impeller tip speed to fill the inlet chamber and begin adding the regenerative head.

Because of this acceleration, the local static pressure is reduced, causing a minimal amount of vapor to be generated in the form of very small bubbles. As head is added and pressure increased, the bubbles collapse in the region of the impeller tip and condense to mix with the pumped fluid. Experience has shown that these collapsing bubbles are in a region of high pressure and therefore, no damage to the rotating or stationary components will result. One effect of these vapor bubbles is to fill a portion of the pump chamber with vapor, which reduces capacity and characteristic head rise.

To evaluate the effect of low NPSH available on regenerative turbine pump performance, laboratory test data has been analyzed for successively lower values of pump suction pressure (vacuum suppression tests). A single stage regenerative turbine pump was run, designated PT-10. For these tests, NPSH available was defined:

$$NPSH_A = P_{SUCT} - P_{VAP} + \frac{V_1^2}{2g} \quad \text{where:}$$

P_{SUCT} = Pump suction pressure expressed in feet of head absolute
P_{VAP} = Fluid vapor pressure in feet absolute
V_1 = Inlet velocity measured at the gage point
g = Acceleration due to gravity

Results of these tests are graphed as follows in Figure 1:

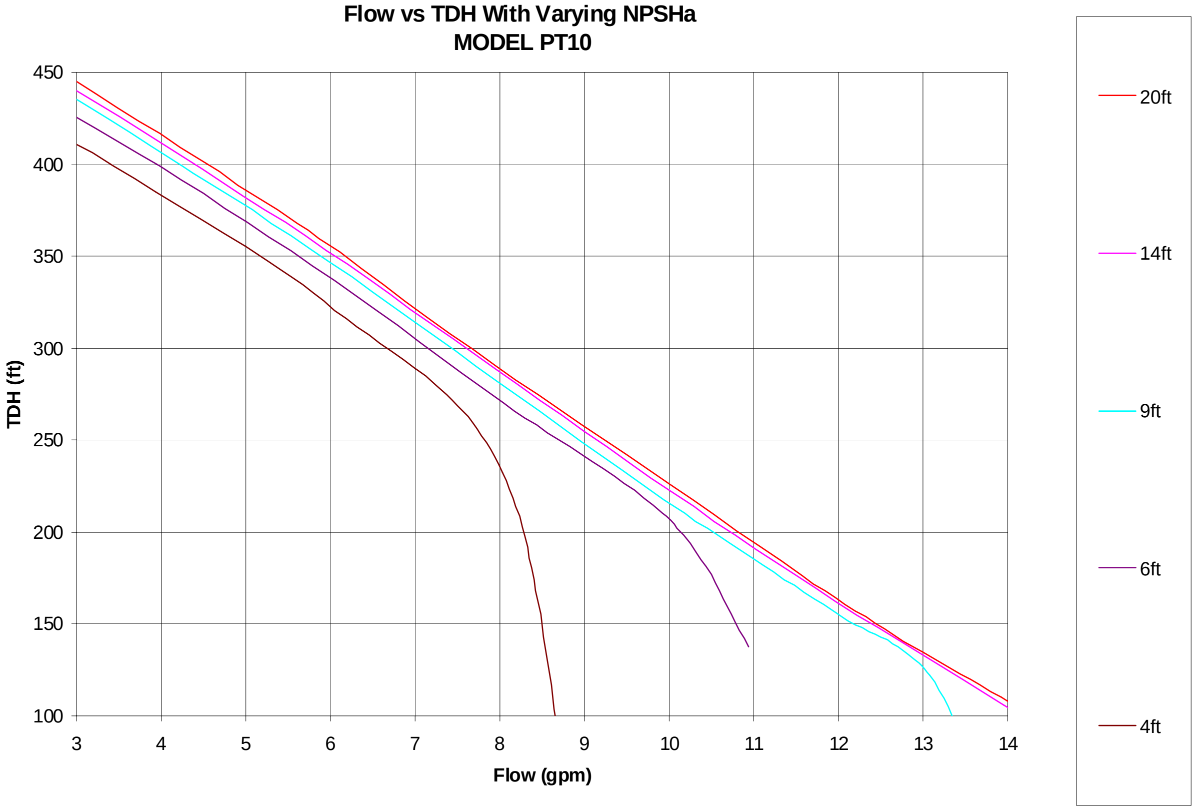

Figure 1

As suction pressure is reduced, a measurable change in capacity and head rise is observed. The effect of this phenomenon is minimally and increasingly suppressed performance with each increment of reduced suction pressure. The maximum flow rate of the pump is also limited based on the amount of suction pressure reduction. Both of these effects are shown in Figure 1. The erosive and mechanical damage and erratic performance associated with centrifugal pumps operating under cavitation do not occur with regenerative turbine pumps. At each suction condition measured, regenerative turbine pumps operate with no pronounced vibration or audible noise, even when the pump was run with a minimum $NPSH_A$. No indication of typical centrifugal pump type erosive or mechanical cavitation damage is exhibited on the impeller or in the pump casing.

Operating regenerative turbine pumps at low $NPSH_A$ conditions is completely acceptable, but conditional upon pump sizing and operation at a capacity and head consistent with the $NPSH_A$ in the operating system and both the suppressed and limited performance range associated with that system $NPSH_A$.

NPSH limits as suggested by the Hydraulic Institute (i.e., 3% head reduction at rated capacity) are not directly applicable to regenerative turbine pumps. These limits were established for typical centrifugal pump impellers having a large region of reduced suction pressure at the impeller eye. Cavitation produced in the eye of the impeller leads to increasing lengths of cavitation sheets, which have the potential of causing significant damage to both impeller and pump casing as pressure is increased through the stage and the vapor generated collapses on metal surfaces. In addition, as cavitation progresses, a relatively small amount of vapor in a centrifugal impeller causes an immediate reduction in pressure and limitation of capacity that produces a very sharp break in the head-capacity curve. This condition cannot exist in a regenerative turbine pump and operation with reduced capacity and head as detailed herein will not diminish life expectations or performance for these pumps.

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