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Many centrifugal pump applications involve the transfer of viscous fluids. This month's newsletter provides an overview of how viscosity impacts centrifugal pump selection and performance.

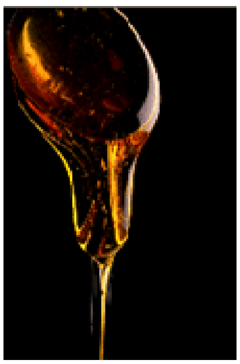


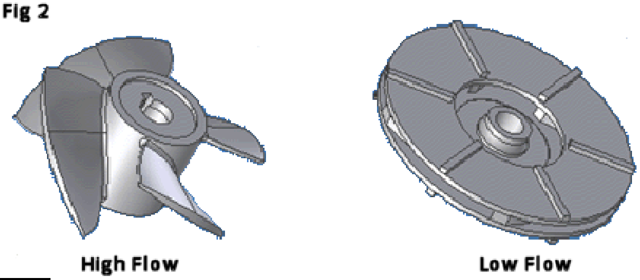
Fig 1

Solids exhibit elasticity when exposed to a shearing force. Provided that the solid's yield strength is not exceeded, a solid will return to its original position once the shearing force is removed. This is a characteristic that separates solids from liquids. Liquids are inelastic. When a shearing force of any magnitude is applied to a liquid, it will shear. The amount of shear for any given force is dependent on a liquid's viscosity. Viscosity is a measure of a liquid's resistance to a shearing stress from an applied shearing force. This internal fluid resistance to shear may be thought of as fluid friction[1].

Viscosity negatively impacts pump performance by causing an increased resistance to flow throughout the pump. We are all familiar with how well honey adheres to the surface of a spoon (Fig 1). It streams off the spoon in a long strand, resisting separation from either itself or the spoon. The action separating the fluid stream from itself and the spoon surface is fluid shear and the shearing force at work is gravity. Similarly, the centrifugal action of a pump impeller generates shearing forces acting on the liquid as it moves through the pump. Viscosity increases the resistance to shearing forces generated by the impeller action and the pump's internal surfaces. The result is a loss of capacity and head and increased power consumption.

Most pumped fluids are classified as Newtonian in that resistance to shear is directly proportional to the shearing force applied. The amount of performance loss from viscous effects is dependent on pump geometry, speed, and the viscosity of the fluid pumped. 3000 cSt is often given as the practical limit of centrifugal pump under viscous conditions, but the actual limit is geometry dependant and the pump manufacturer should be consulted. High flow pumps move very large flows relative to impeller and casing surface areas and thereby are the least effected by viscosity. Low flow impellers have narrow fluid passages that have large surface areas resulting in high frictional forces relative to the amount of fluid pumped (Fig 2).

Fig 2



[1] Our February 2007 newsletter has some additional information on how viscosity is defined.

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Pumps are classified based on their water performance. International standards institutes have published standards for derating a pump's water performance when handling Newtonian fluids at elevated viscosities[2]. The viscous corrections are based on empirical data derived from a large body of pump tests. For a viscous application the performance of the pump must be adjusted by the pump manufacturer to account for the viscous condition before making the pump selection. The head, flow, and efficiency of the manufacturer's curves are adjusted based upon viscosity correction and a pump is selected that will have good performance at the rated viscous duty point. (Fig 3)

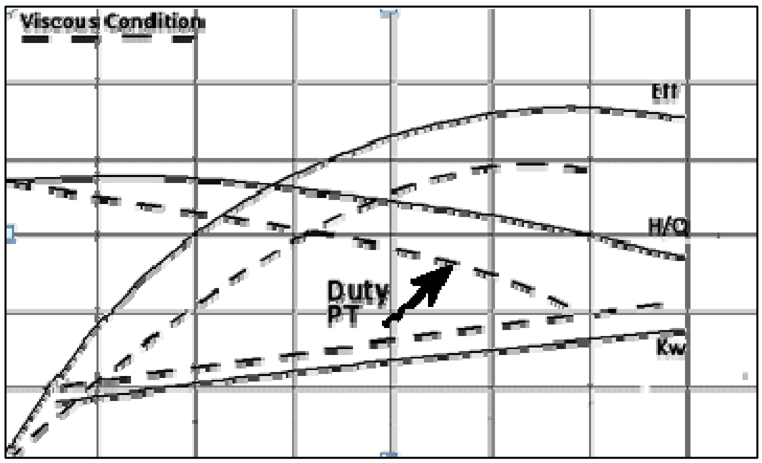

Fig 3

As mentioned above, viscous effects are dependent on the specific geometry of a given pump. Because viscosity corrections are based on empirical data there will be variance in predictive accuracy between pumps of different manufacturers. Nevertheless the correction factors are a functional tool and tend to be conservative enough so that pumps perform well when adjusted in accordance with the guidelines.

[2] American National Standards Institute (ANSI)/Hydraulics Institute(HI) 9.6.7, ISO 17766