

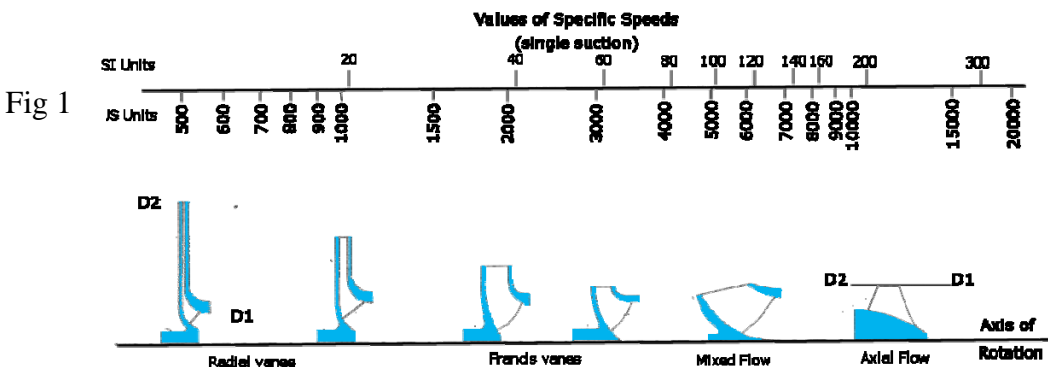
Specific speed (Ns) and suction specific speed(S) are terms that are no longer limited to the interest of pump designers. Most people associated with centrifugal pump evaluation have come to see these terms as valuable tools in pump selection. This month's issue addresses one reader's recent inquiry as to whether there is a relationship between Ns and S.

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An historical relationship and an indirect hydraulic relationship exist between pump specific speed and suction specific speed. Both specific speed and suction specific speed relate to flow through the impeller. Specific speed can be said to describe the impeller whereas suction specific speed describes the impeller inlet. The inlet and outlet of an impeller can be considered independent within certain limits.

Specific speed is a function of a relationship between flow and total dynamic head at any rotative speed (Eq 1). Specific speed will remain constant for a pump design regardless of its rotative speed. To a designer, specific speed is an indicator of impeller geometry. A high specific speed value indicates a high rate of flow in relation to the amount of head developed. For instance, an axial flow (propeller) pump, characterized by high flow and low head, is a high specific speed pump. Conversely, a radial impeller pump, characterized by low flow high head, is a low specific speed pump. Fig.1 shows the relationship between impeller types and specific speed.

Eq. 1
$$N_s = \frac{rpm \times \sqrt{Q}}{H^{3/4}}$$



Suction specific speed is a function of a relationship between flow and net positive suction head required (NPSHR) at any rotative speed (Eq. 2). Similar to specific speed, suction specific speed will remain constant for a pump design regardless of its rotative speed. To a designer, suction specific speed is an indicator of impeller inlet geometry. A difference in suction specific speed, for two pumps with the same rotative speed and capacity, will be physically evidenced by a difference in the inlet diameters.¹

Eq. 2
$$N_s = \frac{rpm \times \sqrt{Q}}{NPSHR^{3/4}}$$

At the beginning of the 20th century, as pumps grew rapidly in size and power, severe problems related to suction conditions began to occur with increasing frequency. Because cavitation was generally associated with head loss, pump engineers felt that there was a relationship between NPSHR and total dynamic head. In 1922, as a result of study conducted in the United States and Germany, L. Moody and D. Thoma independently described a parameter that became known as the Thoma-Moody cavitation factor (sigma) (Eq. 3).

Eq. 3
$$\sigma = \frac{NPSHR}{H}$$

In 1934, M. Tenot² postulated that sigma was related to specific speed. Tests showed that NPSHR varied with the affinity rules for speed changes, but the same did not hold true for impeller trims.³ Engineers knew therefore, that the correlation between specific speed and sigma was false. In 1937, Igor Karassik, an engineer with Worthington Pump Co, was credited with developing the suction specific speed equation (Eq. 2).⁴ Suction specific speed accounts for changes in NPSHR characteristics that are created without a change in specific speed. A designer can develop an impeller with a specific speed identical to that of another impeller, but with a lower NPSHR, simply by increasing the eye diameter and lowering the impeller inlet blade angles.

A change to the outside diameter of the impeller changes the geometry and thereby changes the specific speed. The inlet geometry and NPSHR characteristic will remain unchanged. The suction specific speed value will change because there is a shift in the best efficiency point capacity that resulted from the impeller trim, but discounting any recirculation induced effects, the NPSHR will remain the same for any given flow rate. Recirculation induced effects place a restriction on the extent of diameter reduction that can be practically applied without adversely impacting performance. The range of allowable diameter change diminishes as either specific speed or suction specific speed increases. Subsequently, the allowable impeller trim is always design dependant.

¹ This assumes that there is no inducer. An inducer should be evaluated as a separate impeller.

² Tenot was also a pioneer in photography, taking some of the earliest known photos of cavitation.

³ The Interaction between Geometry and Performance of a Centrifugal Pump, B. Neuman, Mechanical Engineering Publications, Ltd. 1991

⁴ A Map of the Forest...Understanding Pump Suction Behavior: Where Do We Go From Here?, Igor Korassik. Proceedings of the 1st International Pump Symposium, 1984