dimension D to define a "specific speed" given by

$$\overline{N} = \frac{\left(\dfrac{Q}{ND^3}\right)^{1/2}}{\left(\dfrac{g\Delta H}{N^2D^2}\right)^{3/4}} = \frac{N\sqrt{Q}}{(g\Delta H)^{3/4}} \tag{2.31}$$

The specific speed is a combination of operating conditions. Holding this constant ensures (within the limits of the assumptions made) similar flow conditions in geometrically similar machines. Equation 2.31 is a nondimensional combination, only when consistent units are used (e.g., N is radian/sec, Q is cubic feet per second or cubic meter per sec, H is feet or meter). But in practice, g is assumed to be constant, providing

$$S = \frac{N\sqrt{Q}}{(\Delta H)^{3/4}} \tag{2.32}$$

This is a dimensional number, and the most commonly used units are (rpm, gallons per minute, feet) or (rpm, m^3/sec, m).

Turbine designers usually prefer to work with a parameter called "power specific speed." This is derived by eliminating the size of the turbine through the following combination:

$$\overline{N}_p = \frac{C_p^{1/2}}{C_H^{5/4}} = \frac{N\sqrt{\text{BHP}}}{\sqrt{\rho}\,(g\Delta H)^{5/4}}$$

This is a dimensional number.

The specific speed ($\overline{N}$) is a significant parameter in the initial selection of turbomachinery. There is a wide variation in specific speed for turbomachinery with appreciable compressibility effect. The range is somewhat better defined for hydraulic turbines and pumps. The concept of "specific speed" is widely used by liquid handling turbomachinery designers but is much less useful for modern gas compressors and turbines. The concept of "power specific speed" and "specific speed" is extremely useful in model testing. For example, a prototype with a prescribed N, Q, ΔH, and BHP can be modeled by keeping these nondimensional parameters constant to achieve dynamically similar flow.

The suitability ranges, based on specific speed are given in Fig. 2.8. The initial design of turbomachinery depends on the parameters $\overline{N}$ and $\overline{N}_p$. Each achieves maximum efficiency in a certain range of values of $\overline{N}$ as shown in Fig. 2.9. For example, if $\overline{N}$ is between 2 and 4, an axial compressor is superior to a centrifugal compressor.

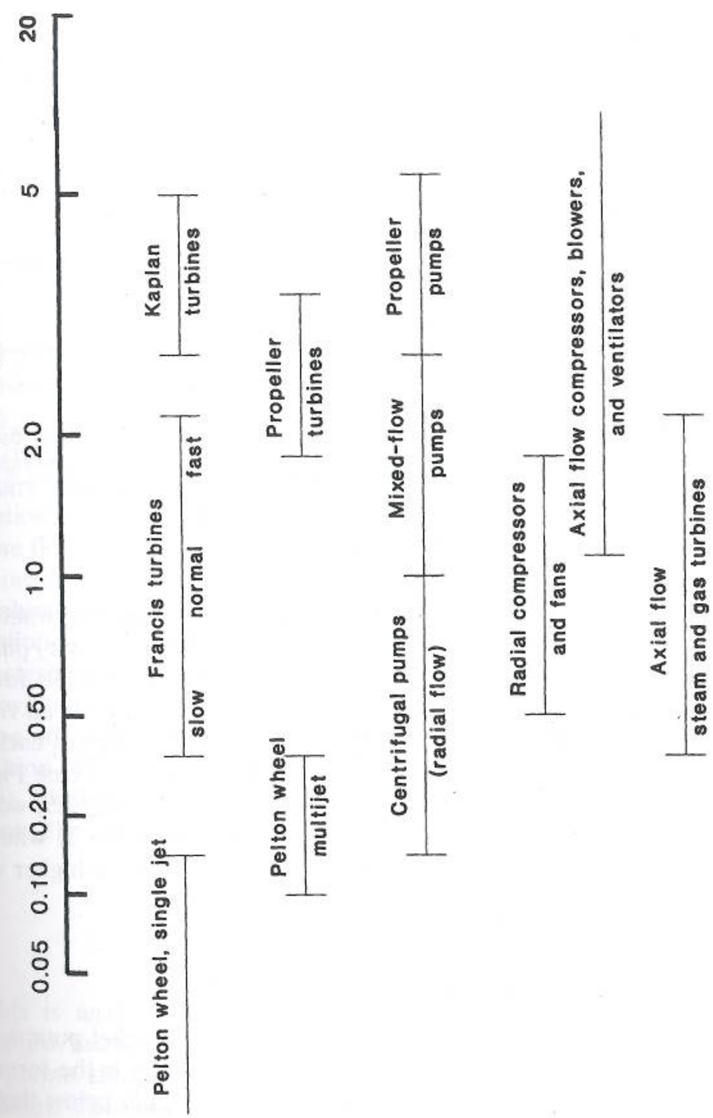

Figure 2.8 Correlation of rotor design and specific speed suitability ranges of various designs (Csanady, "Theory of Turbomachinery" 1964; reprinted with permission from McGraw-Hill.)