Table 2.01 Maximum permissible tip speed of impeller dependent on materials.

Material	example	$u_{max\ all}$ in m/s
Grey cast iron	EN-JL1040 EN-GJL-250	40
Spheroidal graphite cast iron	EN-JS1030 EN-GJS-400-15	50
Bronze and brass	2.1050 G-CuSn 10	
Stainless steels (normal)	1.4008 GX7CrNiMo12-1	95
Stainless steels (special)	1.4317 GX4CrNi13-4	110

Speed reduction generally gives no problems, but with multistage pumps with axial thrust balance (relief devices) the minimum speed for the full effectiveness of the device must be observed.

2.2.2.5 Pre-rotation control utilises the effect of the pre-rotation of the liquid flowing into a centrifugal pump on the $H(Q)$ characteristic. Positive pre-rotation (i.e. pre-rotation in direction of rotation of impeller) in any type of centrifugal pump results in reduction in the $H(Q)$ characteristic compared to inflow without pre-rotation. Negative pre-rotation (i.e. pre-rotation in opposite direction to rotation of impeller) lifts the $H(Q)$ characteristic. The pre-rotation for this type of control is induced by adjusting the angle of incidence of a cascade of inlet guide vanes upstream of the impeller.

The control range for the application of pre-rotation techniques depends principally on the specific speed of the pump. Whilst in the case of radial flow pumps, the influence of pre-rotation is hardly noticeable, its influence increases with increasing specific speed, i.e. in mixed flow pumps and axial flow pumps. For these pumps the point of optimum efficiency η_{opt} is generally achieved at rates of flow where optimum inflow conditions to the impeller exist. By modifying the inflow conditions, this operating point is changed, whilst at the same time the efficiency drops only slightly, so that control by pre-rotation can be considered a low loss method of control.

The use of a flap guide with variable geometry profile (flap diffuser), in place of the normal inlet guide vanes, holds the efficiency nearly constant over an even wider $H(Q)$ range.

The most advantagous use of pre-rotation control is given by the position and shape of the pre-rotation dependent $H(Q)$ and $\eta(Q)$ curves, when only relatively small changes in flowrate are required for large changes in the system head.