Inducer Performance

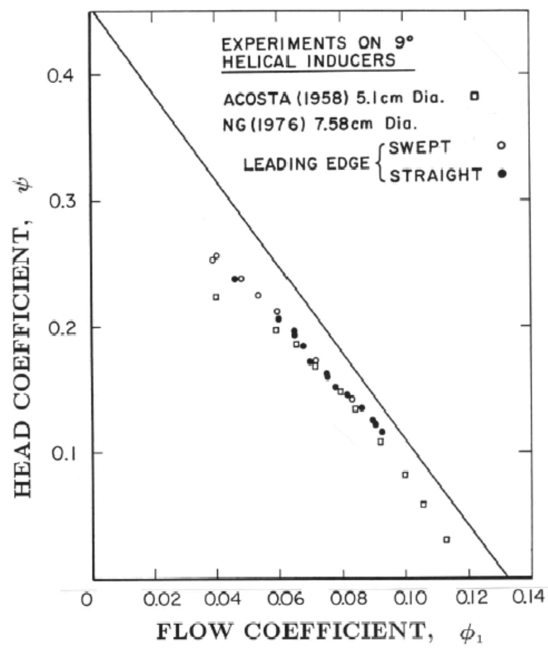

Figure 1: Non-cavitating performance of 9° helical inducers of two different sizes and with and without swept leading edges (the 7.58 cm inducers are Impellers III and V). Also shown is the theoretical performance prediction in the absence of losses (from Ng and Brennen 1978).

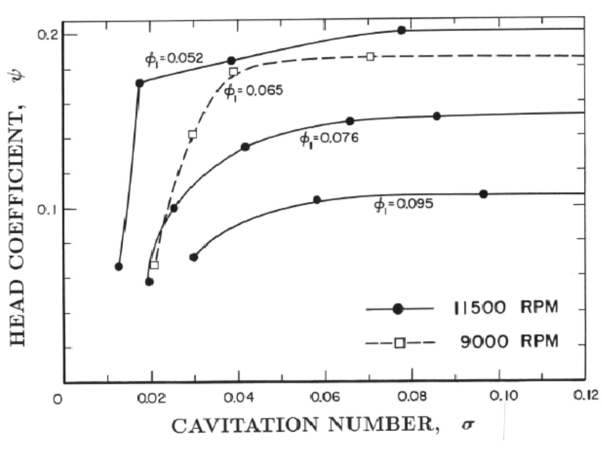

Figure 2: Cavitation performance for Impeller V at various flow coefficients and rotating speeds (from Ng and Brennen 1978).

Typical inducer performance characteristics are presented in figures 1 to 4. The non-cavitating performance of simple 9° helical inducers (see section (Mbbi)) is presented in figure 1. The data for the 5.1 cm and 7.6 cm diameter models appear to coincide indicating very little Reynolds number effect. Furthermore, the non-cavitating performance is the same whether the leading edge is swept or straight. Also included in the figure are the results of the lossless performance prediction of equation (Mbdc4). The agreement with

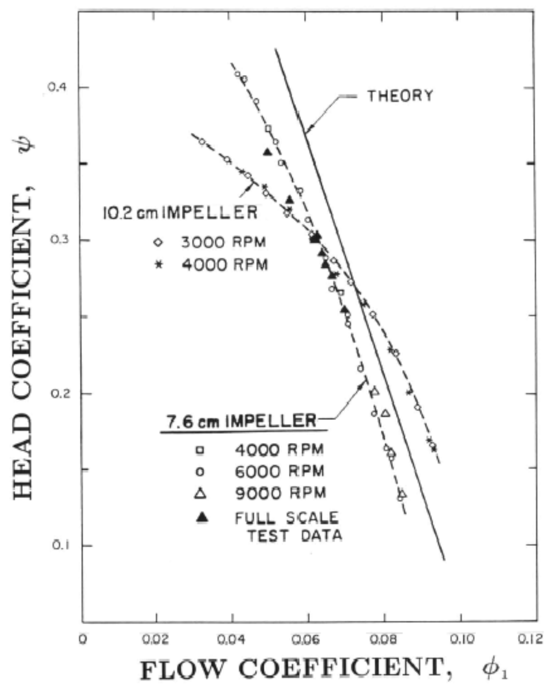

Figure 3: Non-cavitating performance of Impeller IV (7.58 *cm*, with stator) and Impeller VI (10.2 *cm*, without stator) at various rotational speeds. Also shown are full scale test data from Rocketdyne and a theoretical performance prediction (solid line) (from Ng and Brennen 1978).

the experiments is about as good as one could expect. It is most satisfactory close to the zero incidence flow coefficient of about $0.09 \rightarrow 0.10$ where one would expect the viscous losses to be a minimum. The comparison also suggests that the losses increase as one either increases or decreases the flow from that zero incidence value.

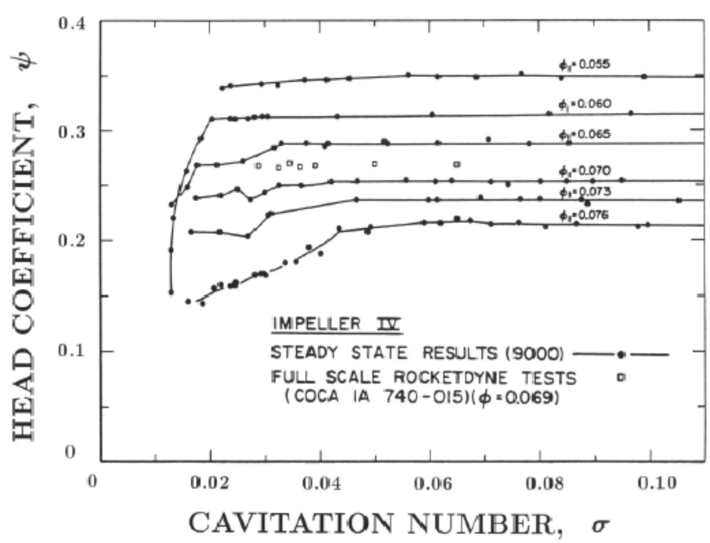

Figure 4: Cavitation performance of Impeller IV at 9000 *rpm* and various flow coefficients. Also shown are full scale test data from Rocketdyne (from Ng and Brennen 1978).

The cavitation performance of the 7.58 *cm* model of the 9° helical inducer is presented in figure 2. These curves for different flow coefficients exhibit the typical pattern of a more gradual head loss at the higher flow coefficients. Notice that the breakdown cavitation number is smaller for non-zero incidence (for example, $\phi = 0.052$) than it is for zero incidence ($\phi = 0.095$). One would expect the breakdown cavitation number to be a minimum at zero incidence. The fact that the data do not reflect this expectation may be due to the complications at low flow coefficients caused by backflow and the prerotation which backflow induces (see section (Mbde)).

Another example of inducer performance is presented in figures 3 and 4, in this case for the SSME low pressure LOX pump model designated Impeller IV (see section (Mbbi)). In figure 3, non-cavitating performance characteristics are shown for two models with diameters of 7.58 *cm* and 10.2 *cm*. The difference in the two characteristics is not related to the size as much as it is to the fact that the 7.58 *cm* model was tested with a set of diffuser (stator) vanes in the axial flow annulus just downstream of the impeller discharge whereas the 10.2 *cm* model was tested without such a diffuser. Note the substantial effect that this has upon the performance. Below the design flow ($\phi_1 \approx 0.076$) the stator vanes considerably improve the diffusion process. However, above the design flow, the negative angle of incidence of the flow encountering the stator vanes appears to cause substantial loss and results in degradation of the performance. Some full scale test data (with diffuser) obtained by Rocketdyne is included in figure 3 and shows quite satisfactory agreement with the 7.58 *cm* model tests. The results of the theoretical performance given by equation (Mbdc4) are also shown and the comparison between the lossless theory and the experimental data is similar to that of figure 1.

The cavitation performance of Impeller IV in water is shown in figure 4 along with some data from full scale tests. Note that the head tends to be somewhat erratic at the lower cavitation numbers. Such behavior is typical of most axial flow inducer data and is probably due to hydraulic losses caused by unsteadiness in the flow.