Scaling of Cavitation Inception

The complexity of the issues raised in the last section helps to explain why serious questions remain as to how to scale cavitation inception. This is perhaps one of the most troublesome issues that the developer of a liquid turbomachine must face. Model tests of a ship's propeller or large turbine (to quote two common examples) may allow the designer to accurately estimate the noncavitating performance of the device. However, he will not be able to place anything like the same confidence in his ability to scale the cavitation inception data.

Consider the problem in more detail. Changing the size of the device will alter not only the residence time effect but also the Reynolds number. Furthermore, the nuclei will now be a different size relative to the impeller. Changing the speed in an attempt to maintain Reynolds number scaling may only confuse the issue by also altering the residence time. Moreover, changing the speed will also change the cavitation number, and, to recover the modeled condition, one must then change the inlet pressure which may alter the nuclei content. There is also the issue of what to do about the surface roughness in the model and in the prototype.

The other issue of scaling that arises is how to anticipate the cavitation phenomena in one liquid based on data in another. It is clearly the case that the literature contains a great deal of data on water as the fluid. Data on other liquids is quite meager. Indeed the author has not located any nuclei number distributions for a fluid other than water. Since the nuclei play such a key role, it is not surprising that our current ability to scale from one liquid to another is quite tentative.

It would not be appropriate to leave this subject without emphasizing that most of the remarks in the last two sections have focused on the inception of cavitation. Once cavitation has become established, the phenomena that occur are much less sensitive to special factors, such as the nuclei content. Hence the scaling of developed cavitation can be anticipated with much more confidence than the scaling of cavitation inception. This is not, however, of much solace to the engineer charged with avoiding cavitation completely.