Improved understanding of two phase flow phenomena based on unsteady blade pressure measurement

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ABSTRACT

Impeller blade and side wall pressure measurements deliver additional informations of the energy transfer in a centrifugal pump under two phase flow conditions. These informations are used to improve the phenomenological understanding as well as to calibrate numerical two phase flow CFD-codes.

This paper gives an introduction into the measuring technique, based on subminiatur pressure transmitters with telemetric data transmission and gives a choice of results, obtained with this method.

INTRODUCTION

Two phase flow phenomena in centrifugal pumps are an important research subject still today.

This paper concerns two phase flow of two different types:

- with phase transition: cavitation
- without phase transition f. e. water plus undissolved air

The reason to combine both fairly different types in one paper is the fact that basically the same test technique and the same test pump has been used for investigation on two phase flow with and without condensation.

Cavitation causes noises, deterioration of efficiency and what is most important, damage by erosion to impeller and other components of the pump. CFD codes normally do not have problems to predict the inception of cavitation, but it is much more difficult to precalculate the NPSH for a head drop of 3%, which is the most common cavitation criterion for pumps in industrial applications. At a head drop of 3%, cavities are extended, unsteady, cloud cavitation may occur. Pump engineers are knowing very well, that the change in pump head is not a reliable indicator for the actual type of cavitation and for the pump wear.

Cavities for example may produce an extra lift, that means an increase of the pump head as long as the cavities are attached [1], other phenomena like fluctuations or rotating cavitation may cause an extra head drop. For a better understanding it is necessary to get a correlation between the type of cavitation on one hand and on the change of pump head and on erosive attack on other hand.

Though the flow with extended and unsteady cavities is very complex, the development of numerical codes showed large progress in the last few years - but of course there is a strong demand for detailed experimental results for validation.

In a wide range of pump applications f. e. in the chemical industry or in the offshore oil production the liquid to be pumped contains certain contents of undissolved gas. It is well known, that the performance of standard centrifugal pumps decreases rapidly in liquid/gas two phase flow - the deterioration starts from a gas void fraction of 2-3% - the total breakdown of pumping can be expected at gas contents of 8-15% (see Fig. 1).