DETECTION OF CAVITATION IN PUMPS

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THE HARMFUL EFFECTS OF CAVITATION

Cavitation often occurs in hydraulic machines, nozzles and control valves (FIG. 1). The consequences range from increased noise nuisance, short-term flow stall and loss of hydraulic efficiency to erosive damage to pump impellers and valve flaps.

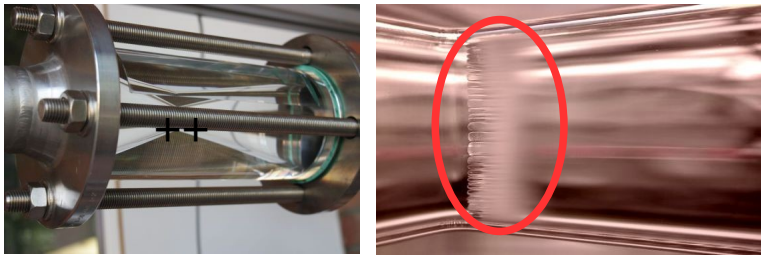

FIG. 1 left: Cavitation at a Venturi nozzle (GMBU test rig). right: Cavitation field at the constriction of the nozzle (red marking).

AVOIDING CAVITATION BY USE OF NPSH-VALUE

To prevent cavitation in pumps, the minimum required **N**et **P**ositiv **S**uction Head **v**alue (NPSH) is specified to ensure that no stall occurs at the impeller. A drop in head of 3% compared to the NPSH design value is specified as a critical value for the onset of cavitation in pumps.

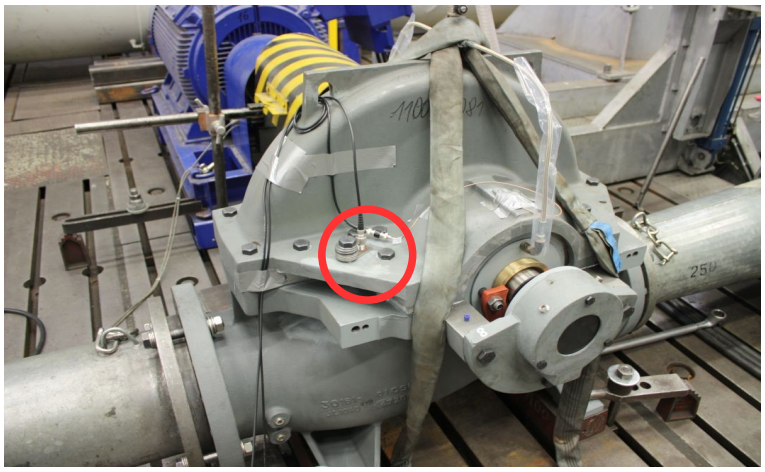

FIG.2 Non-invasive detection of cavitation by sensor (red marking) attached to the cast housing of a dry installed wastewater pump.

DETECTION OF CAVITATION BY AE

With cavitation onset, bubbles are generated on the trailing edges of the impellers forming bubble fields. They are dragged along with the rotating impeller. These bubble fields change the acoustic impedance in the pumped liquid and lead to a dampening of the hydraulic running noise of the pump.

The altered acoustic properties of the pump fluid can be detected using a structure-borne sound (i.e. AE-sensor attached to the outside of the pump housing. The AE sensor has a high frequency bandwidth and signal dynamics. The signals are amplified and can be analysed in both the time and frequency domain. This sensing concept was validated by generating cavitation in a venturi nozzle (Fig. above).

FIG. 3 shows the spectrogram of such a measurement. At the beginning of the measurement, the typical running noises of the pump can be heard. With the onset of cavitation (pump operation at NPSH), there is a drastic drop down in the high-frequency noise (FIG.4) The running noises are absorbed by the cavitation bubble fields. The method is scalable in terms of the frequency bandwidth and acoustic sensivity and can also be expanded as a diagnostic tool for design and development in order to obtain more detailed information not only about threshold but also the nature of cavitating bubble fields.

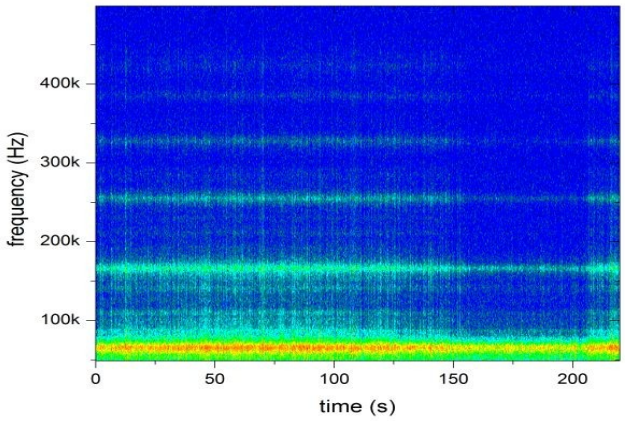

FIG. 3 The spectrogram shows a dip in the high-frequency noise level in the range from 150s to 200s.

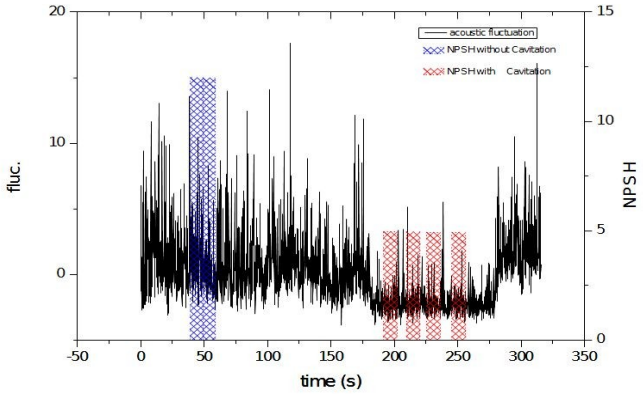

FIG. 4 The evaluation of the signal fluctuations (fluc) synchronised with the calculation of the NPSH value enables to identify the transition form non Cavitation to cavitation (cavitation threshold) (red cross).

CONCLUSION

The AE-based method is significantly more sensitive than determining the NPSH value. It is therefore suitable for tests on the test bench in quality assurance and new project planning as well as pump monitoring during operation.