DETECTION OF CAVITATION IN TURBINES

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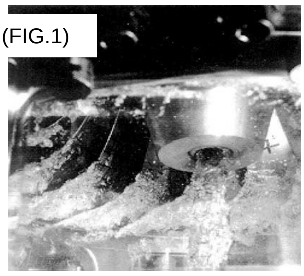
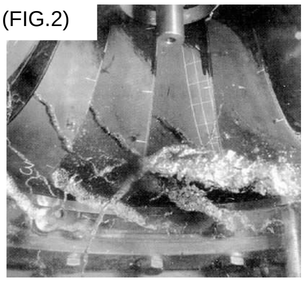
CAVITATION IN TURBINES

Cavitation occurs in turbines in many different forms (FIG. 1 u. 2). The fluid dynamic design of turbines is highly developed. Similar to pumps, there is a key figure that indicates the onset of cavitation (THOMA-number). However, the manifestations of cavitation in turbines are variing much more than those in pumps because of the mechanical design.
Typically accelerometers, which are attached to the turbine housing, are appropriate for identifying cavitating structures (FIG. 3). In this work we use time series recorded with an AE-sensor to evaluate cavitation conditions at turbine blades (FIG 4).

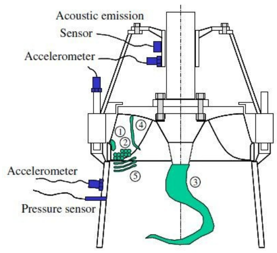
(FIG.1)



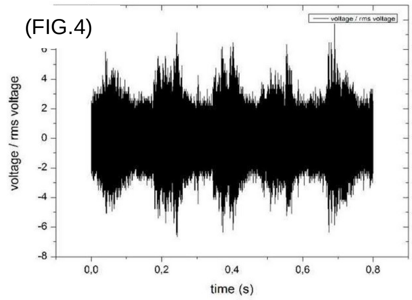
(FIG.2)



(FIG.3)



(FIG.4)



(FIG. 1 u. 2) Cavitation phenomena at a FRANCIS testturbine in various operating points. (FIG. 3) Positioning of accelerometer-sensors. (FIG. 4). Raw data stream (sampling rate 4 MSa/s). .

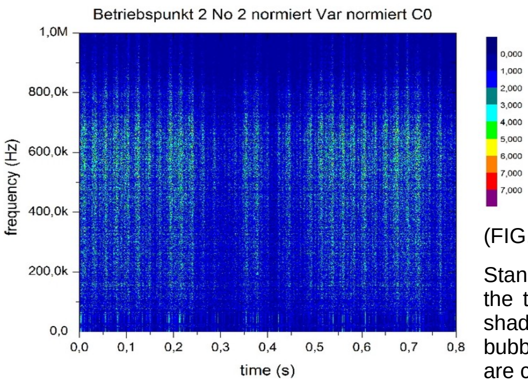
DETECTION OF CAVITATION WITH AE

With the onset of cavitation, cavitation bubbles form at the stall edges of the impellers. This causes bubble fields to form, which adhere to the impeller blades and pass the sensor at the speed frequency.

The sensor has a high frequency bandwidth and signal dynamics. The signals were filtered with a high-pass filter (100 kHz) to create an acoustic window for the high-frequency cavitation noise generated by the bubble implosions. The data is analysed in frequency space (see Fig. 5). The spectrogram shows the acoustic shadows of the bubble fields adhering to the blades. When the cavitation intensity increases, the bubble fields join together.

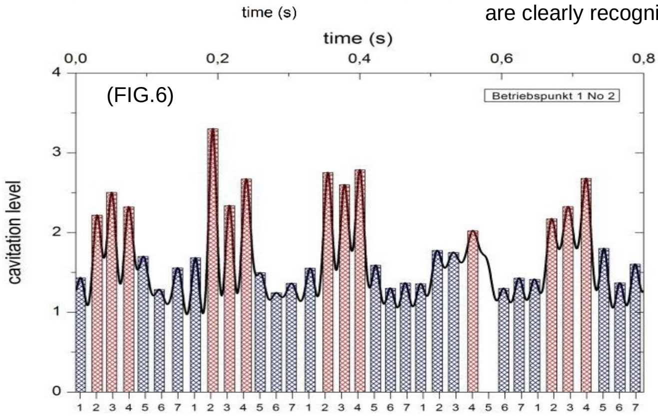
To date, there is no absolute measure of cavitation intensity. Nevertheless, in order to obtain a relative measure of cavitation intensity, the normalised spectrogram data (FIG. 5) were mathematically processed (convolution and averaging) and an effective key figure for the relative quantification of cavitation intensity was formed (FIG. 6 and 7).

The differences in the relative cavitation intensity can be clearly recognised in the two operating points.



(FIG. 5)

Standardised spectrogram of the time signal. The acoustic shadows of the adherent bubbles at the turbine blades are clearly recognisable.



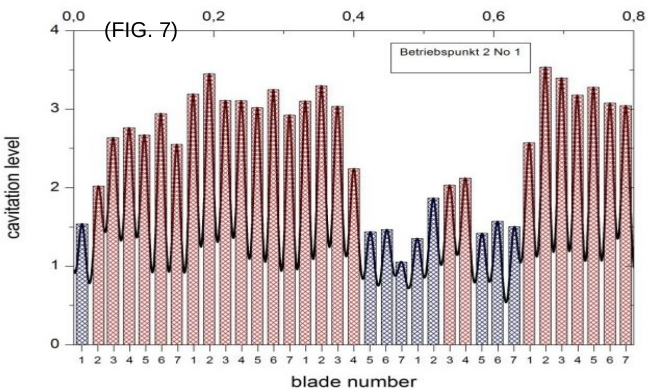


FIG. 6/7 Cavitation intensity level at the turbine blades at two different operating points. FIG. 6 Low cavitation intensity, FIG. 7 High cavitation intensity

CONCLUSION

The acoustic method (AE) offers the possibility of characterising the cavitation intensity in turbomachines, here turbine, with a non-invasive method and thus also being able to make precise statements with regard to cavitation dynamics. The method is equally suitable for development/design purposes and for monitoring turbines during operation.

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