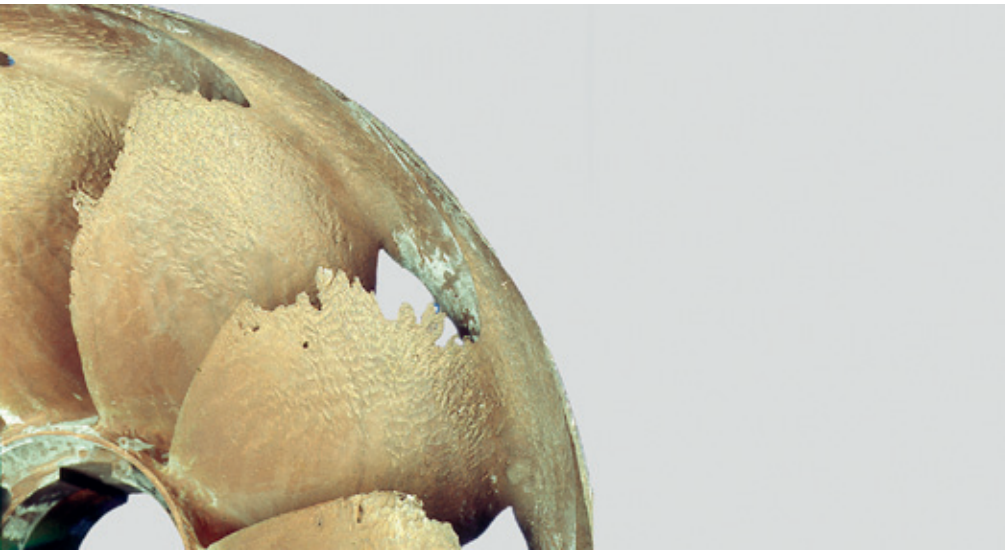
HyCon MD
Cavitation Monitoring and Diagnosis



The HyConMD cavitation monitoring module provides reliable online information about the cavitation state inside the hydraulic machine. Cavitation is an undesired hydraulic phenomenon that potentially limits the operational range of hydraulic turbines. It causes noise, vibrations and can even erode the surface of turbine components. However, a cavitation free operation – i. e. no cavitation occurrence at all – is not always the best economical approach, especially for axial turbines like Kaplan or Bulb turbines. Therefore, an "admissible" amount of cavitation is in many cases accepted.

At a glance

- optimization of the operation range
- flexibility to operate the unit in off-design conditions with limited risk
- support of flexible maintenance strategies
- reliable online information about the cavitation state inside the hydraulic machine
- clear classification of the cavitation behavior
- robust and reliable ultrasonic sensors in industrial quality
- advanced filter techniques and signal evaluation
- powerful high-speed signal processing unit
- easy installation without calibration

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The traditional approach to determine the “admissible” amount of cavitation is based in general on visual observation of the cavitation state during model tests. However there are some deficiencies in this technique due to:

- geometrical deviations between model and prototype, also caused by wear of the turbine
- deviations in physical boundary conditions between model tests and prototype conditions like water temperature, dissolved air content, or cavitation nuclei content
- a model test is not always available

This causes uncertainties in the border areas of the operation range whether or not cavitation is present and if yes, it is in many cases not clear whether it is “admissible”. On the other hand, especially in times of high dynamics in the electrical grid combined with ambitious demands on availability and flexibility of the power generation a reliable evaluation of the cavitation behavior can generate a real economic benefit for the operator. However this advantage can only be achieved by means of an appropriate monitoring device.

Therefore Voith Hydro developed the HyCon MD cavitation monitoring module which is specially designed to provide reliable online and historical information about the cavitation state of the unit. Thus, this device is able to offer the above mentioned added value to the plant owner.

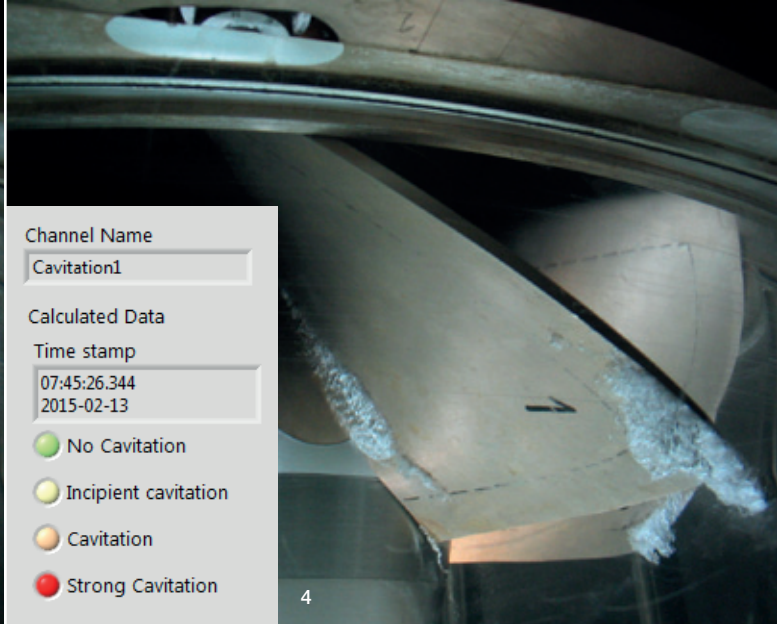
In particular the module

- helps to optimize the plant operation
- provides flexibility to respond to rapidly changing grid demands – a requirement which is getting more and more important for grid operators. Being able to safely operate the turbine in the border areas of the operating range contributes to maximize the output and profit
- supports flexible revision intervals based on reliable information on the accumulated cavitation “history” of the unit. For this purpose a variety of online monitoring and archiving functions are available.

The method used by the HyCon MD cavitation monitoring module to detect cavitation is the measurement of acoustic emissions caused by the cavitation process. These acoustic emissions are analyzed in the ultrasonic frequency range and a characteristic value is derived which is able to clearly classify the turbine‘s cavitation state in 4 categories:

- no cavitation
- incipient cavitation
- slight (admissible) cavitation
- strong cavitation

Sensor and digital signal processor in industrial quality



1 + 2 Examples of cavitation damages

3 + 4 Cavitation phenomena with corresponding user friendly representation

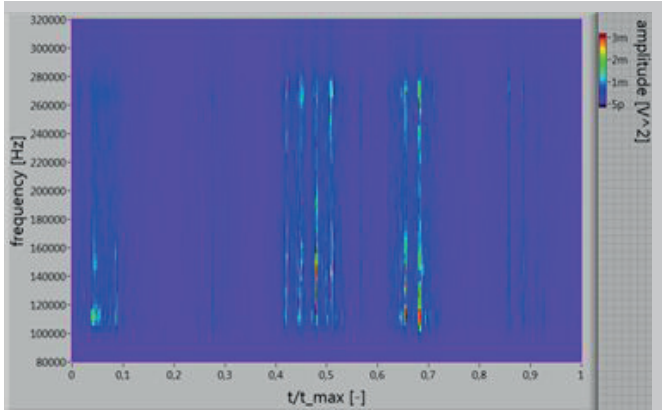
The monitoring system consists of a set of robust high-frequency sensors and amplifiers, a high-speed data acquisition and signal processing unit as well as an analysis software module. The sensors can be attached outside the turbine. Based on the measured acoustic emissions and additional machine data like rotational speed the software module calculates the above mentioned characteristic value.

A key advantage of the method is the fact, that no individual calibration of the system is necessary. This allows the user to assess the cavitation in different machines independent of machine size, speed and – most important – without prior knowledge of machine characteristics.

Both, long-term and short-term observations are possible, each giving important insights into the machine behavior and providing directions for the operation of the machine. The instantaneous or short-term data can be used for an optimization of the operating range while a long-term evaluation of the signal supports an individual, condition based adjustment of the revision intervals.

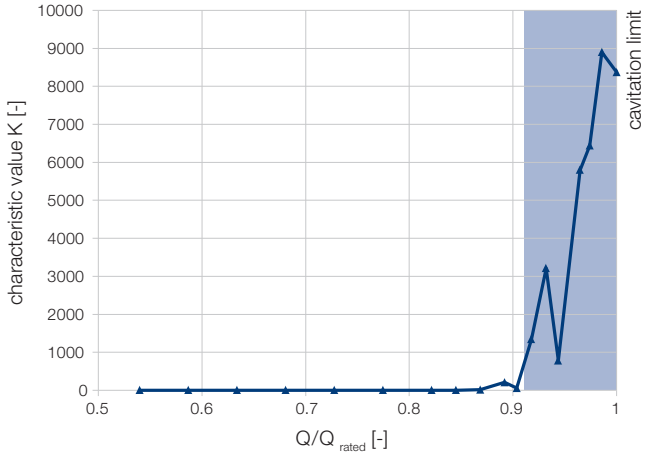
Advanced filter techniques in the time

and frequency domain presented in the expert view



Characteristic value with clear indication

of beginning cavitation



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