OPTIMIZATION TESTS OF CLASSIC KAPLAN TURBINES

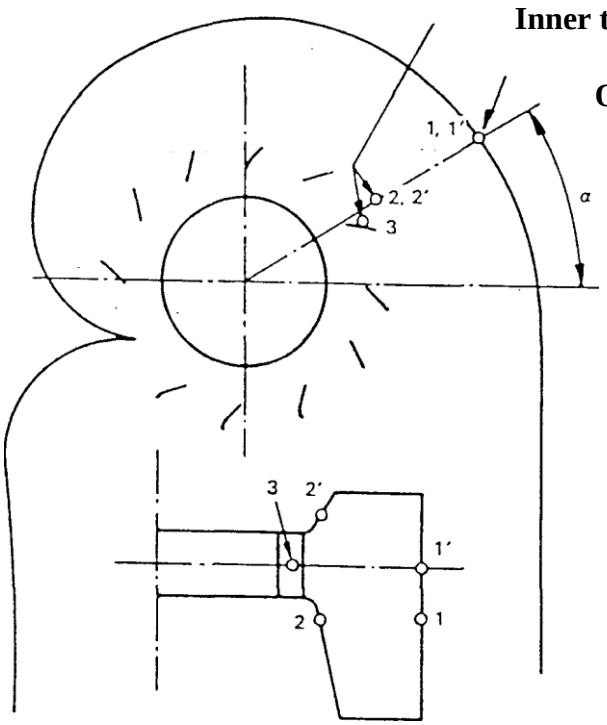
Key words: optimization of double regulated water turbine, optimization of Kaplan turbine, optimal cam dependence, index flow rate measurements, Winter-Kennedy method, spiral pressure difference method

Optimization of Kaplan turbines consists in determining such the optimal dependence between the opening angles of both the guide vanes and the runner blades (optimal CAM) that the turbine will be operated with maximum efficiency at a given head and flow rate.

For execution of optimization tests of classic Kaplan turbines, the Winter-Kennedy method of relative discharge measurements which are based on measuring the pressure difference in turbine spiral case is very strongly recommended. The basic feature of such method used is that it does not require any time-consuming and expensive measurements of the absolute discharge through the turbine.

Implementation of the optimal CAM dependence can be directly interpreted as measurable benefits, not only connected with maximization of energy production from a disposable hydro-potential, but also with extension of the lifetime of the hydrounit structural components because of reducing dynamic loadings of turbine structure components.

The advantages of optimizing the hydrounit operation, in comparison with the relatively low costs of the tests and programming the optimal CAM dependence in the digital turbine governors, is the most important virtue of the offered approached.



Inner taps (pressure p_2)

Outer taps (pressure p_1)

$\alpha = 20° - 120°$

Discharge:

$$Q = K\,(p_1 - p_2)^n$$

Fig.1 Location of taps for Winter-Kennedy method of discharge measurement through a turbine equipped with concrete semi-spiral case - Recommended by IEC 60041

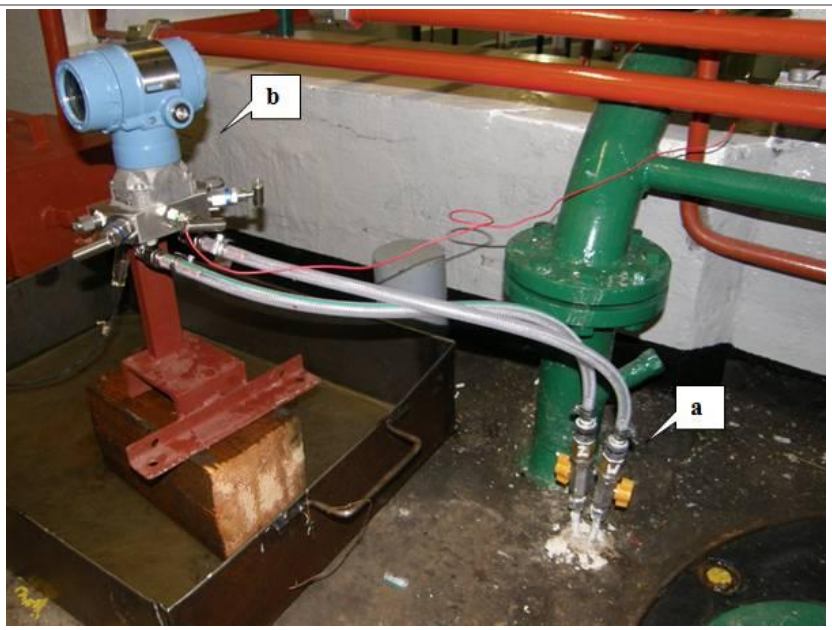


Fig.2 The measurement of differential pressure for the Winter-Kennedy method:
a) exit of manometric tubes from the spiral turbine
b) differential pressure transducer.

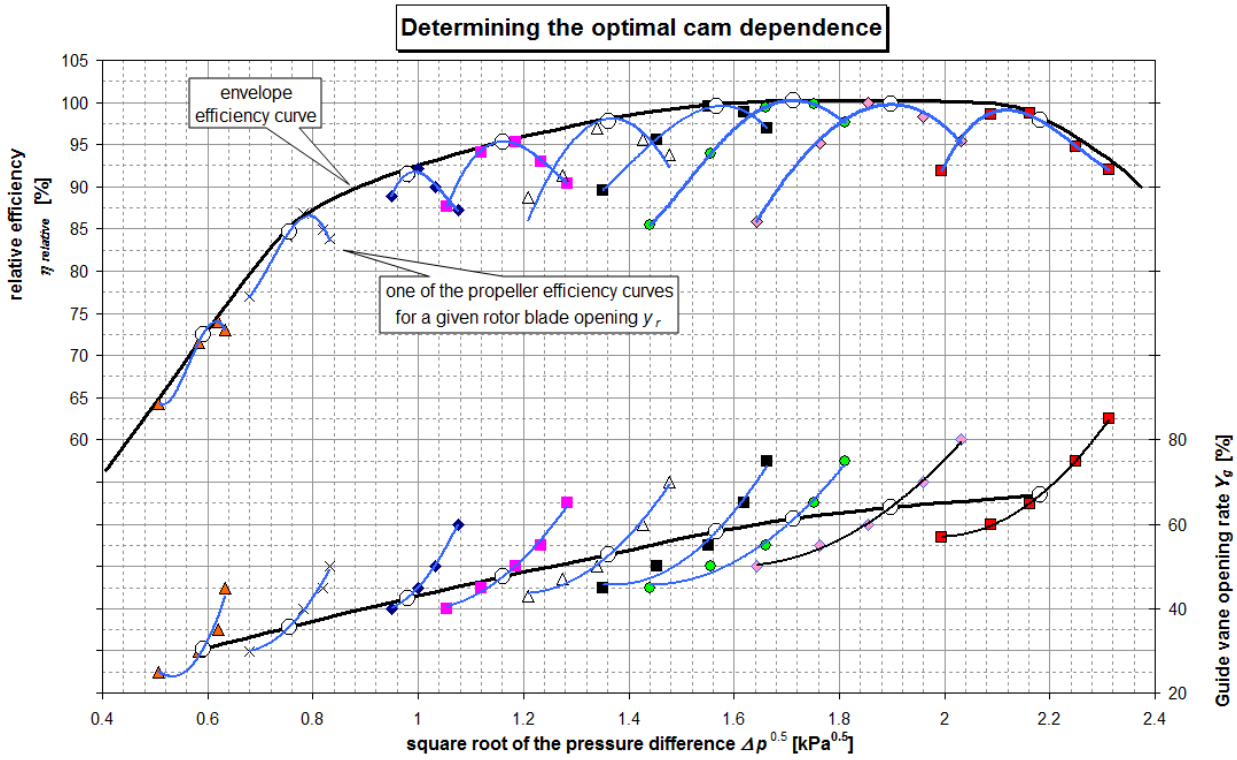


Fig.3 Example of propeller curves with their envelope curve defined using the relative flow measurement using Winter-Kennedy method (determined as the square root of pressure difference in the turbine spiral case $\Delta p^{0.5}$)
and used to determine the optimal cam dependence $y_r = f(Y_g)$

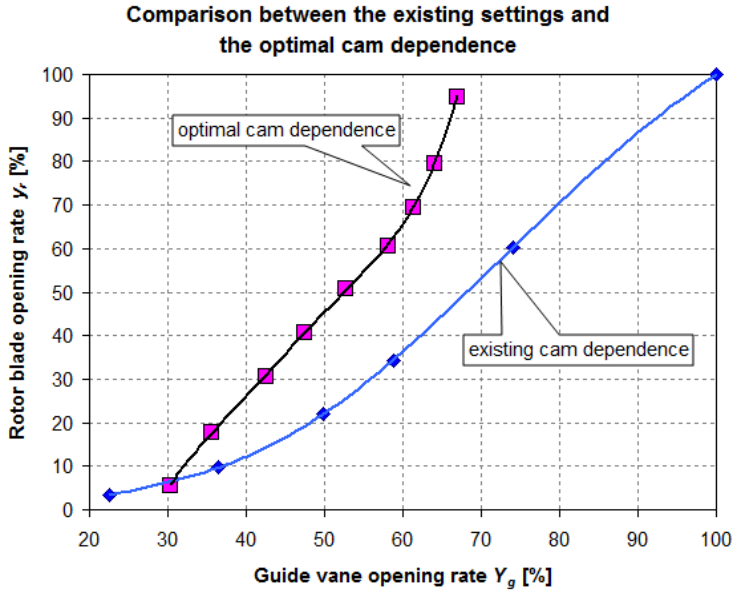


Fig.4 Example of optimal and factory cam dependence $y_r = f(Y_g)$

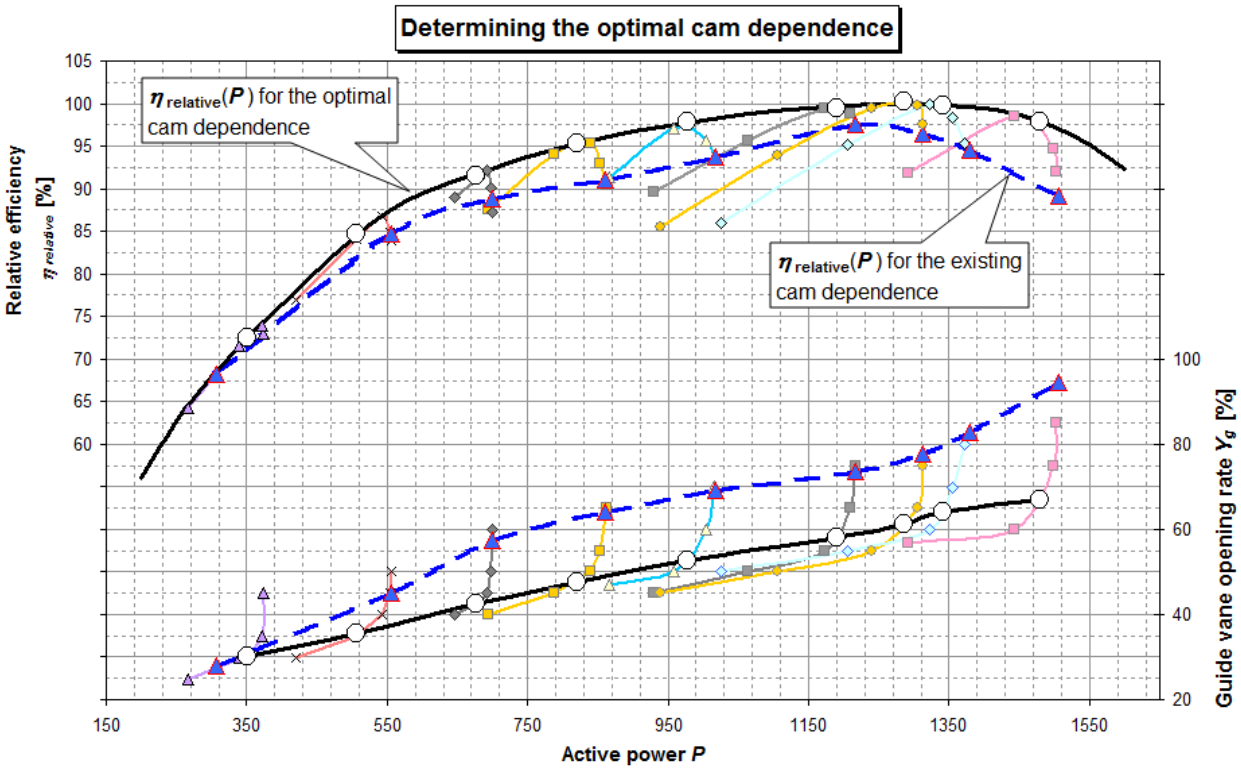


Fig.5 Example of efficiency curves for hydrounit operated at factory settings and at optimal settings of the turbine governor

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