Width-variable Francis Turbine

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The goal of this project was to develop a new technology that would allow us to operate a Francis turbine at part load without having a great loss of efficiency. The main concept consists of a turbine runner with height- adjustable covering disc, which is used for generating a variable inlet width. Our CFD- simulations showed with clear evidence, that the solely adjustment of this covering disk does not generate the desired effect of reducing the volumetric flow rate, but leads to an increase of the water's velocity when streaming through the turbine runner. This increasing velocity has the effect that the volumetric flow rate does not decrease noticeably, while in return the efficiency dumps rapidly because of emerging friction losses. Therefore we decided to equip the turbine with an additional height- adjustable stay vane ring. This stay vane ring consists of fixed, immobile guide vane blades (therefore they are called stay vane blades) being attached to a solid ring which can be adjusted in height to reduce the volumetric flow rate. By simulating various operating points of the turbine we got data to generate the turbine's characteristic curve. This curve was compared to the curve of a conventional Francis turbine with similar nominal power. The graph shows clearly that using our newly developed turbine generates a by far better output when operating at part load.