

# Guide vane for an axial kaplan turbine

Reference No: B77046

## CHALLENGE

This invention is related to a tubular Kaplan turbine with short axial extent in low head applications. In this kind of Kaplan turbine the flow velocity distribution for the runner is defined by a straight axial inflow with adjustable guide vanes, that can either be straight or twisted in the spanwise direction. Straight guide vanes have the benefit that they can shut off the flow in the closed position, but they are not able to produce a velocity distribution which is ideal for the energy conversion in the turbine runner. Twisted guide vanes, in contrast, can be optimized for the energy conversion but cannot be completely closed. Thus an additional shutter is required to be able to stop the turbine and to control its speed while synchronizing the turbine with the electrical grid frequency at the turbine start.

## INNOVATION

The innovation consists of a particular configuration of the guide vanes, which improves the velocity distribution in order to minimize losses, while still being able to stop the flow in closed position. This innovative conformation has the following advantages:

- The product of the tangential runner velocity and the tangential flow velocity component is more evenly distributed, leading to a **reduced exit swirl downstream of the runner and consequently to an efficiency improvement**;
- The arrangement of the guide vanes additionally allows **for completely closing the inlet, which avoids the need of incorporating a shutter**. This allows for a **substantial reduction of dimensions and costs of the turbine**.
- For synchronization of the turbine generator during the start-up phase, the guide vanes can be adjusted such that the turbine runs at a stable speed under a non-load condition. This avoids the unstable flow conditions and resulting mechanical fatigue occurring during start-up with a partly opened shutter, thus **permitting an easy and smooth turbine synchronization**.

## COMMERCIAL OPPORTUNITIES

The guide vanes of the present invention can be efficiently used in hydro power plants using low head axial turbines. This type of guide vanes is especially useful in **turbines with a strongly confined axial extension like STRAFLO and S-type turbines**, where it is often difficult to obtain a suitable velocity distribution with straight guide vanes. One possible field of application are **turbines for tidal barrage power plants**. These turbines need to be capable turbine and pump operation in two flow directions, which leads to a number of conflicting hydrodynamic requirements. The present invention solves this conflict to a good extent. Another field of application are **low head turbines designed for refurbishing old river hydro power plants**. To avoid massive intrusion into the civil engineering structure, the new turbine must often be designed to fit into the space available. In some cases this results in a turbine of very small radial and axial extension, for which the application of twisted guide vanes is beneficial.

## DEVELOPMENT STATUS

The optimization of the design was realized based on a CAD model (see picture below). A prototype has been developed and has been successfully tested.

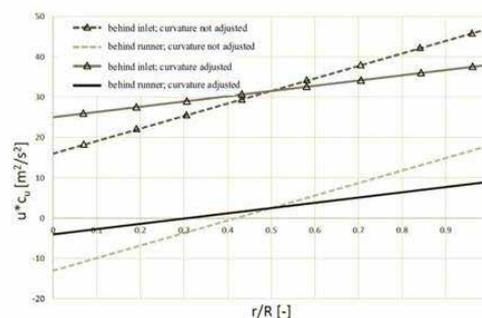
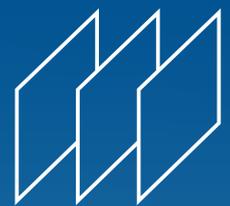


Figure: CAD model of a low head axial turbine (left) and diagram of the product of the tangential flow velocity and the runner velocity ( $u^*cu$ ) over the radial position  $r/R$  for different guide vane designs (right).



BayPAT



Technology from  
TECHNICAL  
UNIVERSITY  
MUNICH

**IP rights:**  
Filed in 2017  
PCT

**Contact:**  
Dr. Tobia Mancabelli  
+49 (0) 89 5480177-11  
tmancabelli@baypat.de

**Bayerische  
Patentallianz GmbH**  
Prinzregentenstr. 52  
80538 München  
[www.baypat.de](http://www.baypat.de)