

# Self-Rectifying Turbines for Wave Energy Conversion

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## INTRODUCTION

Several of the wave energy devices being studied under any wave energy program make use of the principle of an oscillating water column. In such wave energy devices an oscillating water column due to wave motion is used to drive an oscillating air column which is converted into mechanical energy. The energy conversion from an oscillating air column can be achieved by using a system of nonreturn valves for rectifying the air-flow, together with a conventional turbine. But such a system is complicated and difficult to maintain, and the average cycle efficiency in an oscillating air-flow is likely to be considerably smaller.

The nonreturn valves can be eliminated by the use of a self-rectifying air turbine which inherently provides a unidirectional rotation for an alternating air-flow. The Wells turbine (Inoue et al., 1988; Kaneko et al., 1986; Raghunathan et al., 1982, 1989; Setoguchi et al., 1986) is of this type and is one of the simplest and probably the most economical turbine for wave energy conversion. On the other hand, a number of other self-rectifying air turbines with different configurations have been patented and improved over the last decade. However, the comparison of characteristics of all these has not been made so far.

This paper reviews the present state of the art of the self-rectifying air turbines, those that could be used for wave energy conversion. The types of turbine included in the review are summarized as follows (refer details to Kaneko et al., 1991).

### Wells-type turbines:

- (a) Wells turbine without guide vanes (g.v.)
- (b) Wells turbine with guide vanes
- (c) Turbine with self-pitch-controlled (s.p.c) blades
- (d) Biplane Wells turbine without guide vanes
- (e) Biplane Wells turbine with outer guide vanes (o.g.v.) (Fig. 1)
- (f) Biplane Wells turbine with outer and inner guide vanes (i.g.v.)
- (g) Biplane turbine using cambered blades
- (h) Biplane turbine with preset blade incidence
- (i) Triplane Wells turbine

### Impulse turbines:

- (a) Impulse turbine with self-pitch-controlled guide vanes (Fig. 2)
- (b) McCormick counterrotating turbine

### Radial turbine

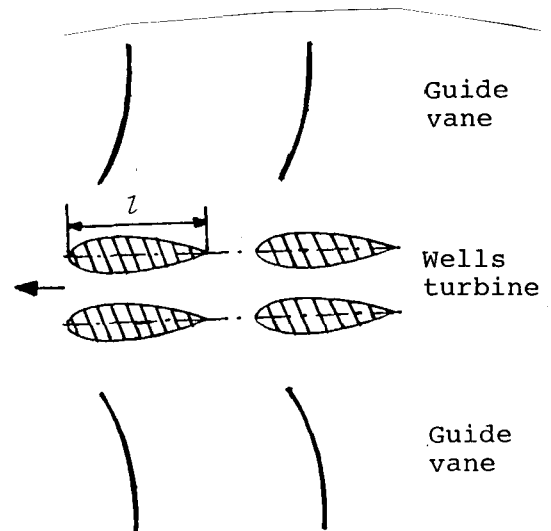


Fig. 1 Biplane Wells turbine with outer guide vanes (o.g.v.) (Setoguchi et al., 1990)

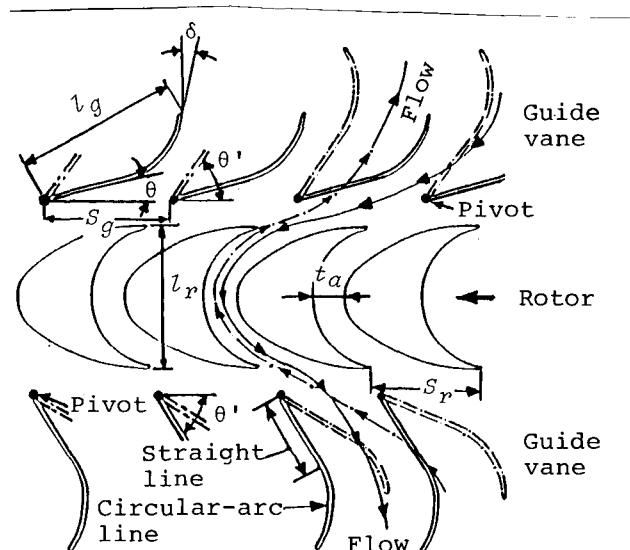


Fig. 2 Impulse turbine with self-pitch-controlled guide vanes (Kim et al., 1988)

Received December 7, 1990; revised manuscript received by the editors June 24, 1992. The original version (prior to the final revised manuscript) was presented at The First International Offshore and Polar Engineering Conference (ISOPE-91), Edinburgh, United Kingdom, August 11-16, 1991.

KEY WORDS: Wells turbine, self-rectifying turbine, impulse turbine, wave energy.