The Development of Runner with Splitter Blades

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1. Abstract

Pumped-storage power plants (PSPPs) produce the energy needed for peak demand periods in the daytime, by utilizing power generated by thermal and nuclear power plants at night. For the past few decades, many ultra high-head PSPPs have been constructed in Japan in the pursuit of cost economy. And the liberalization of electric power leads to the demand of added value with more efficient operation, the wide adjustable operating range and the stable system . In order to solve these problems, a runner has been developed with splitter blades, commonly referred to as a "splitter runner".

2. Development of the splitter runner

The total number of blades of conventional pump-turbine runner is usually 6 or 7. According to our research, it was proved that multi-blade runners decrease secondary flow loss. However, usual multi-blade runners cause decrease in the efficiency at the high water operation and the difficulty in manufacturing/ maintenance work. In order to solve these problems, a runner has been developed with main blades and splitter blades in circumferentially alternate positions, which is called a "splitter runner" (see Figure 1).

Figure 2 shows the expected prototype turbine performance converted from model test results of the pump-turbines with the splitter runner and the conventional runner. The advantages of the splitter runners are as follows:

- Improvement in turbine efficiency throughout the operating range
- Decrease in pressure fluctuation at part-load operation
- Improvement in cavitation characteristics at the inlet runner blade

The splitter runner was applied to the first unit of Tokyo Electric Power Co. (TEPCO) Kannagawa PSPP. It was possible to increase turbine output from the original 450MW to 470MW due to the high hydraulic performance of the splitter runner.

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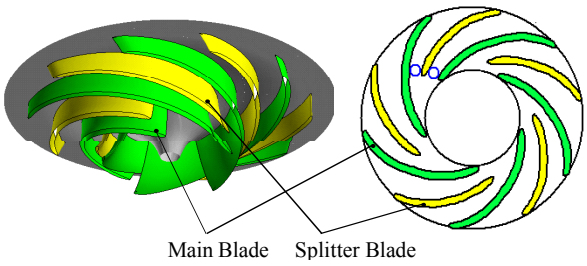

Figure 1 Pump-Turbine Runner with Splitter Blades

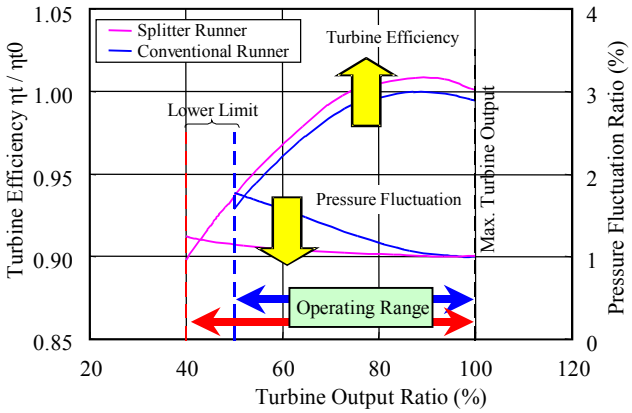

Figure 2 Hydraulic Performance

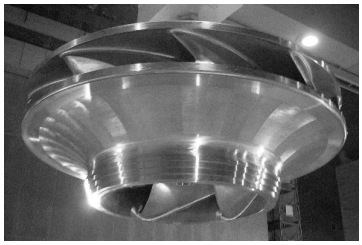

Figure 3 Splitter Runner for Kannagawa PSPP

3. Conclusion

TEPCO's Azumi pump-turbine with maximum pump net head of 138.2m and turbine output of 103MW has been refurbished using the splitter runner. Thus, the splitter runner can be applied to not only an ultra high-head constructed pump-turbine, but also a low-head refurbished pump-turbine. The high hydraulic performance of the splitter runner contributes to reduction in environmental load due to reduction in CO2 emissions and the fuel of the thermal power plants.