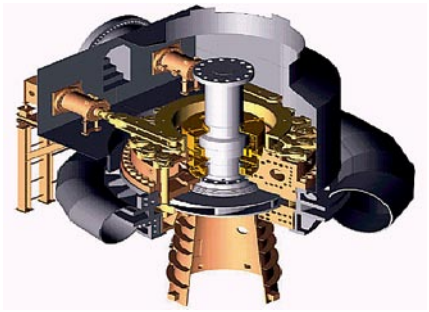

Technical Approach for Hydro Power

KUNIO YASUDA*1 HISAYUYKI SAKA*1

Hydropower contributes to reducing emissions of carbon dioxide (CO_2) to mitigate global warming compared to other electric power generation methods because it is renewable energy and does not produce CO_2. In particular, pumped storage power plants can store the nighttime surplus power generated by nuclear power plants and utilize it to respond to the daytime peak demand. Therefore, with its usefulness in operation and effectiveness at mitigating the global warming, the importance of pumped storage power plants is attracting increasing attention and pump turbines for pumped storage power plants are required to improve performance.

1. Pump turbine configuration and technology for high performance

Mitsubishi Heavy Industries, Ltd. (MHI) is developing and improving the performance of a Francis turbine, which is a typical turbine used in hydraulic power plants, by using the latest computational fluid dynamics (CFD). To optimize the total turbine performance, an entire flow analysis is used. In this CFD analysis, an analysis is made on the entire water passage components from inlet of spiral case to outlet of draft tube which enable to evaluate the total performance of turbines by numerical simulation. As for the runner design, MHI has established a new runner design method to adjust the load distribution on the runner blades by controlling the secondary flow on the blade surfaces to reduce losses.[1] After verifying the accuracy of the results of CFD analysis for these designs in comparison with the model test results, the design method has already been adopted in the design of the prototype turbine and pump turbines.

Fig. 1 Replacing runner
An example where a newly CFD designed runner replaces the existing one.

2. Developing runner with splitter blades

A wide operating range in turbine operation from low to maximum output and from low to high head is required due to the demands of the system and changes in the water flow in rivers.

These needs prompted MHI to research and develop a new runner with splitter blades where performance improvements such as an increased efficiency at partial load, improved cavitation characteristics and reduced pressure pulsation have enabled to extend the operating range. Initially, the runner with splitter blades was applied to high head turbines and pump turbines, and its application has been expanded the medium head Francis turbines. Today, using the latest CFD technology, MHI can produce high performance runners that have a wide operating range with high efficiency at partial load and good cavitation characteristics which are characteristics of runners with splitter blades.[1] The runner also allows the variable speed pump turbines in pumped storage power plants to extend their operating range compared to conventional pump turbines.

3. Conclusion

Hydropower has been used to create hydroelectricity for over 100 years. However, new technology is still being developed as described in this paper, and the development of new runners helps to generate more energy. In addition, the improved convenience and benefits of hydropower promotes total system optimization which enables nuclear and thermal power plants to operate efficiently. This allows the power generation system as a whole to contribute to reducing CO_2. MHI will promote the development of turbines and pump turbines aimed at improved efficiency and a wider operating range to continue contributing to the mitigation of global warming.

Reference

1. Miyagawa, K. et al., Development of High Performance Hydraulic Turbine Contributing to Solution of Global Warming Problem, Mitsubishi Juko Giho Vol.41 No.3 (2004) p.166

Kunio Yasuda

Hisayuki Saka

*1 Takasago Machinery Works