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論　文　内　容　要　旨

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学位論文題目	Study on Internal Flow Condition of Contra-Rotating Small Hydroturbine with Spoke (スポークを有する二重反転形小型ハイドロタービンの内部流れに関する研究)		

内容要旨

In recent years, there are strong requirements to change the fossil fuel into renewable energy because of the terrible environment pollution. Renewable energy, such as hydropower, wind power, solar power, is alternative energy and can be used circularly. To suppress the greenhouse effect, the renewable energy is paid on more and more attention. Among these kinds of renewable energy, the small hydropower is not widely used now and has great potential. There are so many places that can provide the hydropower energy all over the world, and most of the small hydropower energy is not been used yet. Small hydropower facilities that generate about 100kW-1000kW is widely spread, however, it causes environmental destructions by a foundation construction and a setup of a draft tube.

On the other hand, there are a lot of places that can generate about 100W-1kW in agricultural water and a small stream. Small hydropower installations are expected to have lower environmental impacts because it will be operated near the living environment, such as agricultural water, small stream and so on. Therefore, Darrieus and gyro-type turbines, which are suitable for design specifications of a low head in agricultural water and a small river, are investigated and the performance characteristics and the optimum design parameters are discussed. Internal flow of a spiral water turbine with wide flow passage, which had small environmental impact, is investigated. Furthermore, a small-cross flow turbine used for a small stream as an environmentally friendly pico-hydroturbine and a Savonius turbine with low cost are suggested, and the performance improvement by installation and selecting the optimum position of shield plate are reported. Efficiency of small hydro-turbine is lower than that of large one, and these small hydro-turbine's common problems are easy to be out of control when there are foreign materials in the fluid media. Then, there are demands for small hydro-turbine to keep high performance and wide flow passage. Therefore, we adopt the contra-rotating rotors, which could be expected to achieve high performance and enable to use low solidity rotors with wide flow passage, in order to accomplish high performance and stable operation. In this study, a significant compact hydro-turbine is named as a small hydro-turbine. Final goal on this study is development of a small hydro-turbine like electrical goods, which has portability and makes an effective use of the unused small hydropower energy resource.

Till now, some of the small hydropower energy resources in Tokushima prefecture are inspected and evaluated. The parameters, including the head, flow rate, water quality and the capacity of utilization, are investigated. As the result of the investigation and evaluation, some of the water supplying system in the farm land have great potential and can be used as the small hydropower energy resource. Therefore, the casing of the water supplying system in the farm land is assumed as the working environment of this contra-rotating small hydro-turbine. In addition, the investigation result shows that the flow rate in the casing changes in a wide range, then the small hydro-turbine has to adjust the wide range of the flow rate, and taking advantage of this unused small hydropower energy resource is necessary.

The first step of designing this kind of contra-rotating small hydro-turbine is referring to the existed design methods of the small hydro-turbine, and these methods force on the designing of the low flow rate hydro-turbine which is only several liters per second. Based on the references, we can design the rotors and blade of the contra-rotating small hydro-turbine. After the designing, we can make the numerical analysis on the designing to predict the performance of the new hydro-turbine, and then we can make the performance experiment to prove the numerical simulation.

In the previous research, because of the large loss between the front and rear rotor, we changed the geometry of the spoke from cuboid to cone. The performance and internal flow condition of this small hydro-turbine was highly improved by this modification.

In this research, a new kind of cylinder spoke is designed to replace the previous cone spoke, and numerical analysis of contra-rotating small hydro-turbine with cylinder spoke is conducted. The cylinder spoke is designed to increase the efficiency of this contra-rotating small hydro-turbine and improve the internal flow condition between front and rear rotor. It seems that it is the cone spoke which limits the increasing of efficiency and improvement of internal flow condition.