# Development of low speed self-rotating nozzle system for drilling

**Taro KOYANO**

**Abstract**

In recent years, methane hydrates which include methane gas have attracted attention as next-generation energy sources. However, for the purpose of the degradation of the methane hydrate, effective development methods have not been established. For this problem, a branch drilling with waterjets has been proposed as a possible solution. Since waterjets require a minimum weight on bit for drilling, this method may provide a light weight drilling system with low cost. To drill through rock masses, we need to rotate nozzle system to obtain a borehole diameter larger than the outside diameter of the nozzle system. Although self-rotating nozzle systems which use reaction force by waterjet as driving force have been used for cleaning, their rotational speed is too high to drilling. Therefore, Yokoi (2010) adopted a vane pump as a brake system and developed a low speed self-rotating nozzle system. To clarify fundamental characteristics of this nozzle system, Yokoi (2010) measured rotational speed of the nozzle system. However, the developed nozzle system could not rotate under high ambient pressure due to small rotational torque.

In this study, I aimed to improve the nozzle system developed by Yokoi (2010) to enable the rotation of the nozzle system under high ambient pressure. For that purpose, modification of the waterjet nozzle design, measurement of the rotational speed of the nozzle system using weight and confirming the rotation of the nozzle system under atmosphere pressure and high ambient pressure were conducted. Main results obtained in this study are summarized as follows: (1) Rotation of the nozzle system under atmosphere pressure was achieved by the use of modified waterjet nozzles. (2) Low speed self-rotation of nozzle system under high ambient pressure was confirmed. (3) Rotational speed of nozzle system under high ambient pressure was much smaller than that obtained by using weight. The reason of this result is considered that brake effect increased under the high ambient pressure, since air remained inside the vane pump was compressed by the ambient pressure. To confirm reproducibility, more experimental data under high ambient pressure are required.