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Mechanical ice drilling

Poster

ICE CORE DRILL HEAD CUTTING POWER DIRECTLY MEASUREMENT AND EVALUATION OF SLOTTING CUTTER

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Antarctic ice sheets contain important records of climate change, atmospheric environment evolution, and biological and chemical processes. Studying these records helps us understand the past, present, and future of the Earth system, and obtaining ice core samples is the prerequisite of these studies. During ice core drilling, the cutters directly contact and break the circular ice layers beneath them. Reasonable cutter design can help improve drilling speed, simplify the ice chips transportation, and reduce the power needed at the bottom of the hole. To study cutter performance, we built an ice core drilling test stand, equipped with a dynamic torque sensor connected to the output shaft of the drive motor, which can directly measure the cutting torque and power consumption of drill head. By replacing the cutter heads, we compared and evaluated the drilling effects of cutters with 30°, 40°, and 50° rake angles. Test result showed that the cutter with 40° rake angle performed best, which produce cutting torque around 9N·m at 100rpm, and the power during the drilling process stabilized at approximately 100W. By changing the height of the cutting shoes, we try to clarify relationships between the drilling power, ice chips particle size, ice core quality. In addition, different parameters of pitch and the corresponding minimum WOB was explored. The preliminary result showed when the cutting depth was 3mm or more, the size of ice debris significantly increased, a large spiral appeared on the core surface but within an acceptable range, and there were significant fluctuations in torque during the cutting process. We also designed a slotted cutter inspired by the ice-carving serrated tools, experiment verified that it can reduce energy consumption effectively and achieve better cutting performance. In this study, we present design, calculation, simulation, and laboratory test of ice core drill head cutting process. The results can provide a reference for the design and selection of drill head and cutter.

References

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