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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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A THERMAL MODEL FOR ANALYSIS AND CONTROL OF DRILLING IN ICY FORMATIONS ON MARS

Abstract

The presence of ice poses a threat to drilling systems acquiring rock or soil samples on Mars. Testing has shown that heat generated by drilling produces water vapor or liquid which may refreeze on the surface of a drill bit. Further experience has shown that the adhesion of ice is sufficient to cause drill bits to stall, resulting in permanent loss of the bit. In addition, heat created during drilling can impact the chemical and physical composition of the sample even at temperatures below the melting point of ice, so restrictions may be imposed upon the allowable heating of a soil or rock formation during a mission. Developing a thermal model of the bit and formation is essential to prevent the loss of scientific data and drill bits, as well as to prevent complete failure of the mission in spacecraft carrying only a single drill string. Using only properties of the formation and drilling system, a computer model has been created to predict temperatures throughout the bit and formation. This model has been shown to be in agreement with preliminary data acquired from tests performed under Mars-like conditions and using a prototype Mars Sample Return (MSR) drill. This model may be used to create schedules for drilling operations by determining the frequency and duration of pauses necessary to let the system cool before drilling may safely resume. This method has advantages over alternative scheduling methods such as monitoring drill parameters (e.g. motor torque) which may only change after ice has already frozen to the bit. The thermal model will be an essential tool in safely acquiring unaltered geologic samples, either for in situ analysis or for return to Earth.