Contribution ID: **172** Type: **Poster Presentation (120m)**

Research on transient measurement of thermal conductivity of ultra-low temperature frozen soil

Thursday 25 July 2024 14:00 (2 hours)

This paper designed a detachable cryostat. The cooling capacity is obtained by GM refrigerator and transferred to the test chamber through the copper cold chain. The test chamber is filled with low temperature helium, and the sample is installed in the test chamber. Finally, the temperature of the sample is controlled by adjusting the temperature of the helium atmosphere. The cryostat above has the advantages of flexible sample changing and no need to repeat vacuum pumping, which result in short sample changing time. By recording the temperature change of the plane heat source probe with time, the transient plane heat source method (hotdisk) can measure the thermal properties of the tested sample, and has the characteristics of accuracy and efficiency. Here, the cryostat is combined with the transient plane heat source method to measure thermal conductivity of frozen soil, and the temperature test range of hotdisk method is extended to the liquid hydrogen temperature range of 20K. The thermal conductivity of 304 stainless steel and epoxy resin G10 has been measured in 20K-300K. The values are in good agreement with the thermal conductivity values provided in the literatures, thus verifying the reliability of the measuring device. On this basis, the thermal conductivity of different kinds of frozen soil under 70K has been measured, and the variation rule of thermal conductivity values has been obtained: frozen soil with 3.8% salt content and 19% water content > frozen soil with 20% water content > frozen soil with 9% perlite content and 45% water content > frozen soil with 77% water content, 17% peat content and 6% perlite content > frozen soil with 37% water content and 11% peat content. Finally, the calculation model of thermal conductivity of frozen soil was given. The thermal conductivity of frozen soil can be predicted by temperature and water content of frozen soil. The thermal conductivity of cryogenic frozen soil in this study can provide data support for cryogenic liquid underground storage projects.

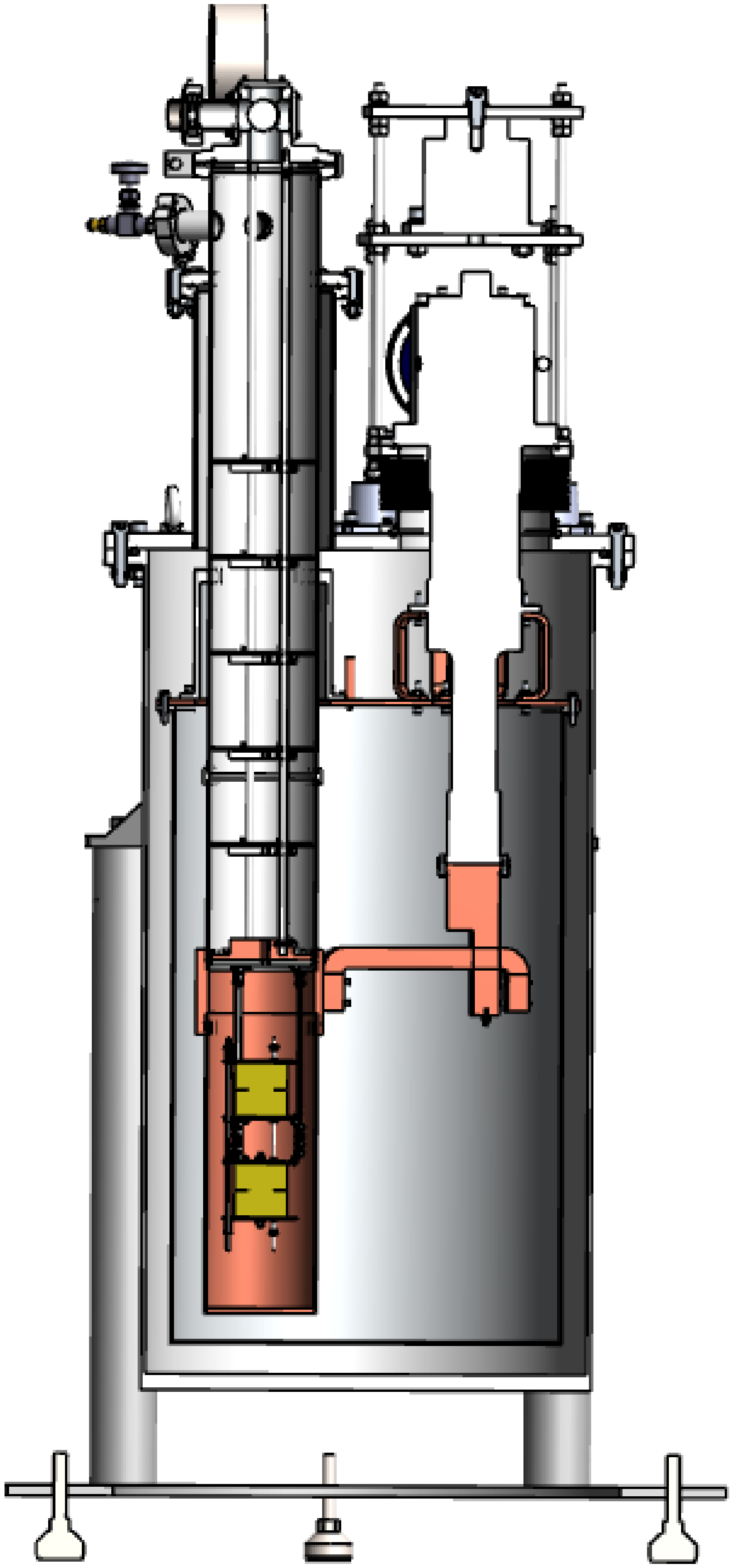

Figure 1: diagram of experimental device

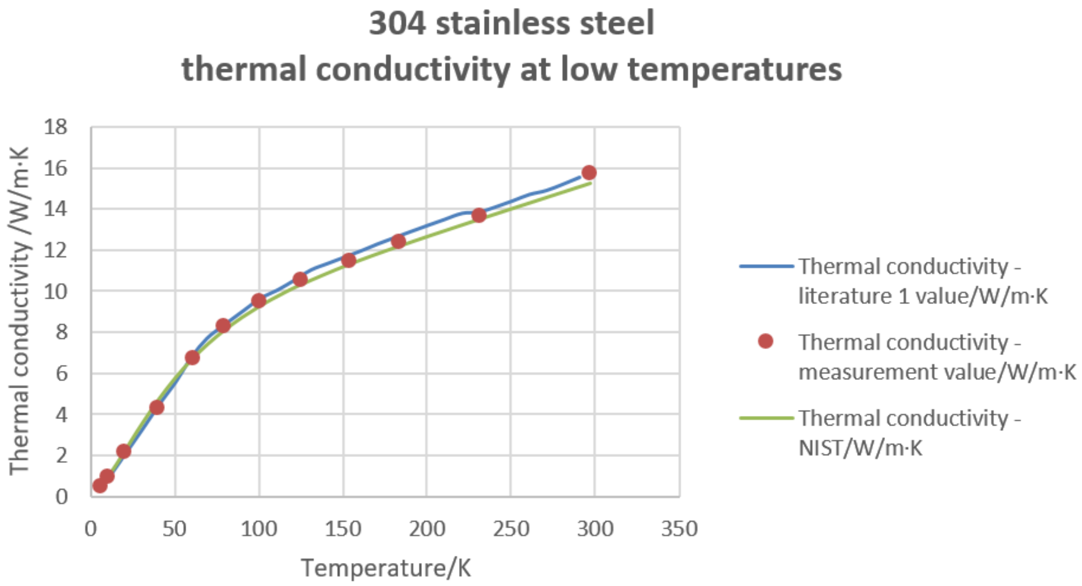

Figure 2: 304 stainless steel thermal conductivity at low temperatures

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Session Classification: Thu-Po-3.4

Track Classification: Tracks ICEC 29 Geneva 2024: ICEC 12: Thermal properties and numerical studies