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Spring 2022

Refrigeration & Pressure Circuits for the Test Apparatus on Triaxial Properties of Polymer Foams at Arctic Temperatures

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Ackerman, Nathaniel, "Refrigeration & Pressure Circuits for the Test Apparatus on Triaxial Properties of Polymer Foams at Arctic Temperatures" (2022). *Williams Honors College, Honors Research Projects*. 1428.

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REFRIGERATION & PRESSURE CIRCUITS FOR THE TEST APPARATUS ON TRIAXIAL PROPERTIES OF POLYMER FOAMS AT ARCTIC TEMPERATURES

By
Nate Ackerman

Final Report for 4600:497 Honors Design Project, Summer 2020

Faculty Advisor: **Dr. M. Hoo Fatt**

Faculty/Honors Advisor: **Dr. S. Sawyer**

Faculty/Honors Reader 1: **Dr. G. Nadkarni**

31 July 2020

Executive Summary

The objective of this project is to modify the previous testing apparatus used by Dr. M. Hoo Fatt for exploration of Crushing Behavior of Polymer Foams in Sandwich Structures Operating in Arctic Regions commissioned by the Office of Naval Research and performed under the University of Akron's Mechanical Engineering testing facilities. To do this, it is required to design a system capable of operating at a constant temperature during a testing cycle, reaching down to -60°C . This apparatus must also be compatible with prior equipment, facilities, persons, samples, and media.

Primarily, a copper-tube refrigeration coil design was considered to lead into an ambient-air heat exchanger. This would keep the pressure and temperature operations a single-series circuit where the temperature procedure would facilitate the pressure procedure. After running design calculations, it was determined this preliminary design would be inefficient. The final design made use of the economizing features built into the liquid nitrogen tank that would already be provided for the system by Airgas. This final design was determined to maximize the capital investment in the Airgas liquid nitrogen tank and product within, use product before it boiled off over time, and reduce capital costs needed to upgrade the existing test apparatus developed by Dr. Hoo Fatt's team for the low-temperature test cycles under the specified pressure cycles as well as reduce the apparatus size. Thus, this increased portability, constructability, cost efficiency, and system effectiveness overall. Suggestions were made for other components of the apparatus not explored in this report.