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A PRACTICAL FACILITY FOR TESTING THE PERFORMANCE OF MATERIALS FOR CRYOGENIC INSULATION APPLICATIONS

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ABSTRACT
Cryogenics is concerned with the production and behavior of materials at ultra–low temperatures. The process enables matter to be liquefied transported and stored in a very small volume. Such a system needs efficient insulation to avoid heat exchange with the ambient temperature. Many materials are being developed in the laboratory to serve for such insulation tasks. A practical system was conceived and fabricated to test the performance of such insulation samples. It mimics the real practical system obtainable in the industry and is found promising in evaluating materials for such potentials.

KEYWORD
Materials, Cryogenics, Insulation, Insulation thickness, Insulation performance

INTRODUCTION
Efficient insulation material is an important component of a good cryogenic system, both production, storage, and transportation requires effective insulation to avoid unwanted heat exchange with the ambient environment (Fesmire & Swanger, 2019). Many materials are being developed to serve such a purpose.

Figure 1: A Cryogenic insulation testing facility

The presented system was designed to test the performance of the insulation material developed. It mimics the real industrial condition with the use of simple, safe, and affordable consumables. It uses cryogenics substances that provide the needed cooling effects. The sample to be tested is attached to the facility at ultra-low temperature and then evaluate the temperature gradient. An external temperature recorded determines the material conductivity, practicability as well as stability for use for cryogenic application in the industry, as shown in Figure 1.

MATERIAL AND METHODOLOGY

The facility consists of a 50 mm diameter Austenite 304 stainless steel pipe selected based on standard for ultra-low temperature application (Nayyar, 2000) insulated with 50mm thick polyurethane material. Fabricated in U-shaped form with an open end as inlet connected to the cryogens storage box 1 (as shown in Figure 2), and an outlet side connected to an empty storage 2. A vacuum pump which enables a pressure gradient between the two boxes via the u shaped pipe is attached to box 2. A slot A was provided that accommodates the sample to be tested.
Box 1 will be loaded with cryogen (Dry Ice), when the vacuum pump is energized the cryogen vapor flows down the pipe due to pressure gradient. Exerting a maximum cooling effect on the pipe. Dry ice sublimes (Changes from solid directly to gas) at -78 degrees Celsius. The pipe temperature can be lowered to -75 degrees Celsius. Two thermocouple sensors take and feed in the temperature reading at each minute interval to PicoLOG Software through the computer(Wu, 2018)

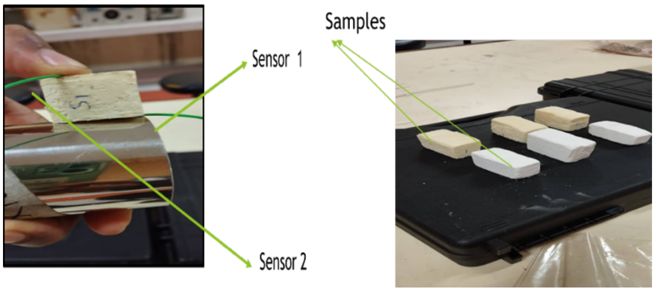

Figure 2: The location of sensor on the specimens.

RESULT AND DISCUSSION

The sample results is presented in table 1 , from the facility a result obtained by two sensors; sensors 1 and 2 are fed to computer via a Data logger connected to computer.

Table 2: Summary results of different sample with external temperature at given insulation thickness

Sample	Internal temperature (Degree C)	External temperature (25mm)	External temperature (35mm)	External temperature (45mm)
SAMPLE A	75.2	15	20	22
SAMPLE B	75.2	17	22	24
SAMPLE C	75.3	18	23	25
SAMPLE D	75.2	20	24	26
SAMPLE E	75.2	23	25	27

CONCLUSION

The facility has a simple device that mimics the real cryogenic insulation conditions.

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