

Nitrous Oxide Cooler for DanSTAR



Introduktion til køle- og varmepumpeteknik

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Motivation

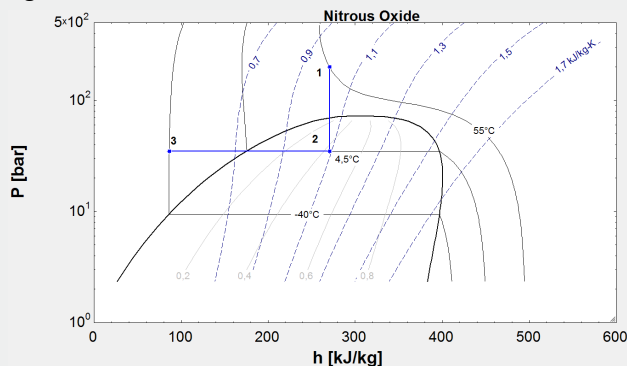
DanSTAR is a year-old rocketry association that strives to make rocketry accessible to students. In order to fuel both this need

System Specifications at 55C

Operating Range: Up to 55C
Cooling Capacity: 12,3 kW
Cycle Type: Open Intercooler
Nitrous Oxide Flow: 0,067 kg/s
LT Coolant Flow: 0,03569 kg/s
HT Coolant Flow: 0,08009 kg/s
COP@10C Ambient: 2,5
COP@55C Ambient: 0,84

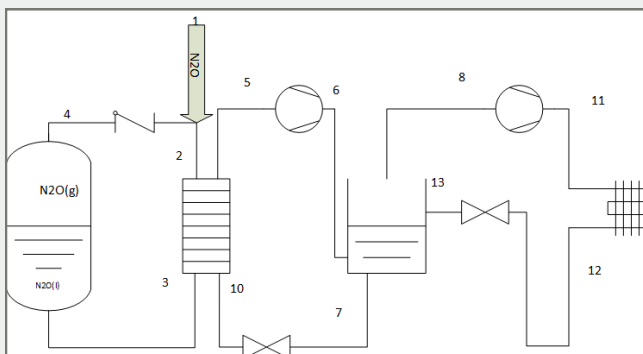
and our rocket engines, a system that takes nitrous oxide from a gas bottle and condenses it to a supercooled, pressurized liquid needs to be made.

Nitrous oxide is usually stored in steel containers that are pressurized to 200 bar. To ensure proper understanding of the thermodynamic path nitrous oxide needs to take to end up at our specified end conditions, its path is drawn in a log(P),h-diagram.



Selection of System Specifications

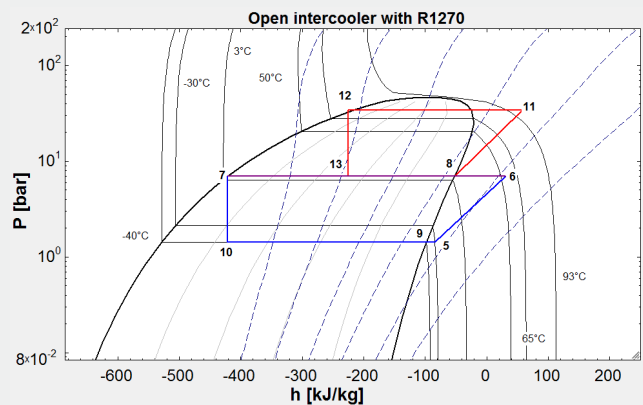
As we wanted to ensure safety, ease of use, and stay within environmental legislation, we were left with few options in regards to coolant. We ended up choosing R1270 otherwise known as propylene. As for the cycle itself, many were considered, but the open intercooler was the best choice.



Open Intercooler

A refrigeration cycle with open intercooler is suitable for this task given that we have few load changes and a continuous operation. By using this configuration we can go from our low temperature side to the high temperature side in two stages.

This means that we will have two smaller compressors instead of one. The open intercooler makes sure that no two-phase flow gets into our second compressor and likewise we will have a liquid flowing from the intercooler back to our expansion valve before the heat exchanger with the nitrous oxide.



Components

Part of designing a refrigeration system is choosing suitable components for the task at hand. For this specific system, a SWEP V25Tx10 plate heat exchanger was chosen as the interface on the nitrous oxide side, and an Ahlsell 3C-A 3545-R fin tube exchanger was chosen on the high temperature side. The compressors are from Bitzer's Ecoline P series.

Future Work

This system is a crucial piece in the DanSTAR repository. It will be used for years to come and as such needs to be close to perfect upon completion. To ensure this project, we will take contact to both our sponsors and relevant experts in order to find the most optimal solution.

