OPERATION MANUAL

Senior Design Team 509

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Overview

The Operation Manual provides operation instructions on the assembly and operation, as well as thermostatic and humidity controls for the Environment-Controlled Test Chamber used for the testing of Danfoss Turbocor compressors.

GENERAL

* Due to the COVID-19 outbreak, the physical completion of this project cannot be accomplished as well as some documentation. A list of parts, as well as the fabrication process, will be described to complete this project in the foreseeable future.

Introduction and Purpose

This document will serve to describe, in detail, the assembly and operation of the environment-controlled testing chamber HVAC and control system. Detailed information will be provided on the physical assembly of the chamber's HVAC and duct systems and the proposed control units.

Parts List

- 1" x 1" aluminum T-slot
- Polycarbonate sheeting
- Concealed corner framing brackets
- 1" lift-off hinges
- 1" lever lock position hinges
- Plastic door handles
- 6" diameter plastic duct hose
- 6" flexible duct hose
- 6" diameter 45° duct elbow fittings*
- 6" diameter swept tee duct fittings*
- Duct flanges and clamps
- Honeywell portable air conditioner
- On-off controllers*
- Honeywell advanced electrode humidifier
- Honeywell 70-pint dehumidifier*
- 650W PTC fan heater
- Magnetic door latches*
- 1" plastic wear strip
- Angled flat frame support plate
- Custom AC unit inlet duct transition
- Custom AC unit outlet duct transition
- Custom dehumidifier inlet duct transition*
- Custom dehumidifier outlet duct transition*
- Custom heater inlet duct transition*
- Custom heater outlet duct transition*

* Parts not yet purchased due to the COVID-19 outbreak

SYSTEM OVERVIEW

System Application

The environment-controlled test stand chamber is designed to meet and maintain certain ranges of temperature and humidity to mimic real-life applications for the TT and TG models of Danfoss-Turbocor compressors. The chamber will be used inside Danfoss Turbocor's Research and Development facility and will be operated by Danfoss employees at various testing conditions. The temperature settings for this system range from 16° to 50° Celsius, while the relative humidity settings range from 20% to 90%.

System Integration

i) The assembly of the chamber is constructed as follows:

(1) The machined pieces of the T-slot aluminum are organized for each part of the chamber (i.e. big doors, small doors, roof, and sides)

(2) Each door is assembled using the corner brackets. Do not secure the top piece of T-slot

(3) The polycarbonate sheet associated with that door of the chamber is then carefully placed inside the T-slot

(4) Before securing the top piece, you will need to insert the hinge and door handle sliders in the slots where necessary. Each door will have two hinges on one side and a handle on the other.

(5) The top piece of T-slot is then secured on top of the polycarbonate using the corner brackets. Secure the hinges at the appropriate locations

(6) Repeat steps (2) – (5) for each door

(7) Insert two sets of frame support sliders on the bottom bar

(8) Construct each side of the chamber using the same process as steps (2)

(9) Follow the same process as step (3) with each side piece of polycarbonate

(10) Insert two sets of the frame support sliders on each side of the wall

(11) Repeat step (5) and secure the frame support bracket at each corner

(12) Repeat steps (2) – (3) for the roof portions of the chamber. Insert the hinge sliders on one side of the large piece and secure the top piece of T-slot.

(13) Repeat this process for the smaller side. On the opposite side, install the lever lock hinge sliders

(14) Assemble the front and back pieces of the chamber

(15) Install the polycarbonate on each side of the back wall

(16) Install the other half of the lever lock sliders on the top of the back panel. Ensure these align with the smaller part of the roof

(17) Insert two sets of hinge sliders on each side of the front and back panel. Ensure these align with the door hinges

(18) Install the handle on each door and two on the front part of the roof

(19) Place each door onto the frame of the chamber

(20) Place the roof on the chamber

ii) The assembly of the HVAC system is constructed as follows:

(1) One 45° duct elbow fitting on each of the chamber walls that do not have doors

(2) On the outlet side of the chamber (left side of the chamber in figures __ and __, attach flexible duct hose to elbow fitting using a duct clamp. Lead duct hose from elbow fitting to one parallel end of T duct fitting.

(3) On the other parallel end of the T duct fitting, attach heater inlet transition, then heater, then heater outlet transition. Fasten flexible duct hose with a clamp to heater outlet transition.

(4) On the perpendicular end of the duct mentioned in step (3), attach AC inlet transition. AC inlet transition is then attached to the back of the AC unit and sealed with silicone sealant. AC outlet transition is then fixed to the top of the AC unit and sealed with silicone sealant.

(5) Attach 45° duct elbow fitting to AC outlet transition. Fasten flexible duct hose to the other end of elbow fitting with a clamp.

(6) Flexible duct hose from AC outlet transition attaches to one parallel end of the second the T fitting with a clamp. Flexible duct hose from heater outlet transition

attaches to the perpendicular end of T fitting with a clamp. The remaining free parallel end of tee fitting attaches to the dehumidifier inlet transition.

(7) Attach the back of the dehumidifier to the dehumidifier inlet transition, seal with silicon.

(8) Attach the dehumidifier outlet transition to the top of the dehumidifier.

(9) Fix 45° duct elbow fitting to dehumidifier outlet transition. Flexible duct hose from the other end of the elbow to the final elbow fitting on the right side of the chamber.

(10) Humidifier hose is to be attached to the inside of the duct elbow on the right side of the chamber through a hole drilled into the elbow. The hose is to be facing directly into the chamber so that humidity isn't lost throughout the ductwork.

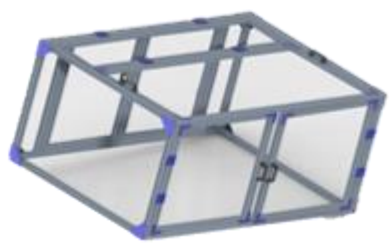

Figure 1: Chamber Assembly

Figure 2: Chamber Assembly with Open Roof

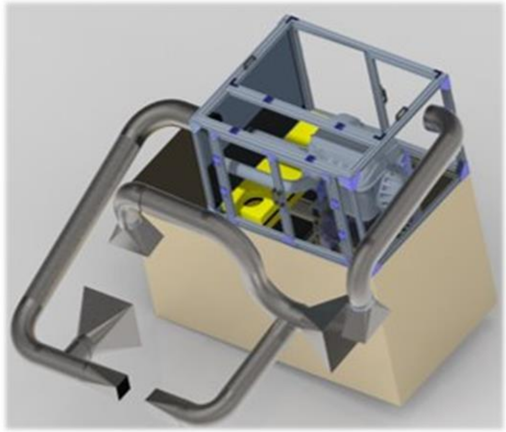

Figure 3: Chamber and Duct Assembly on Testing Rig

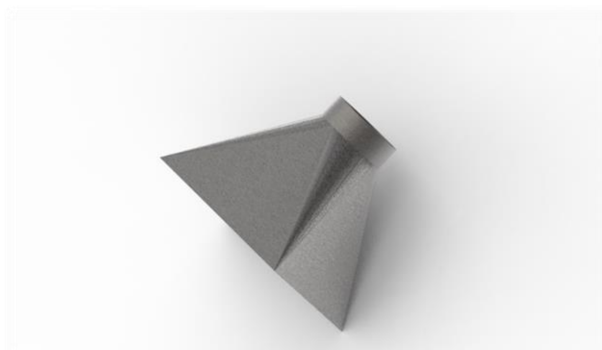

Figure 4: AC Inlet Custom Duct Transition

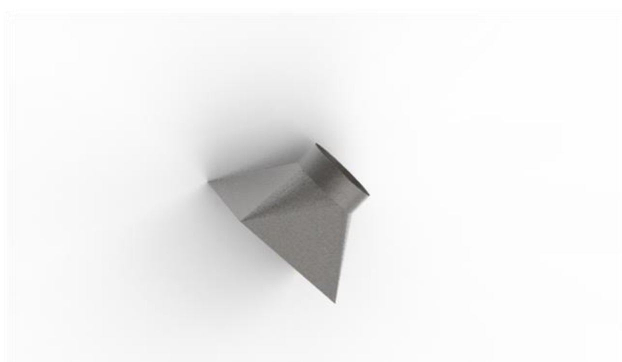

Figure 5: AC Outlet Custom Duct Transition

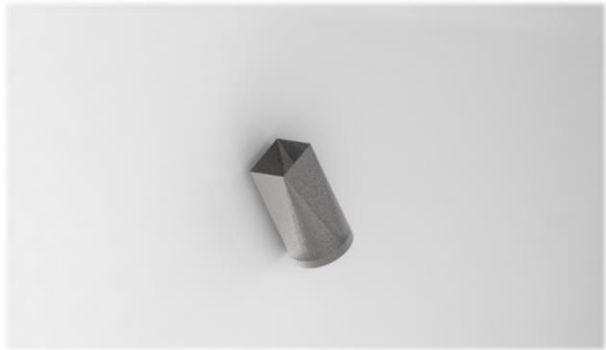

Figure 6: Heater Inlet and Outlet Custom Duct Transition

System Control

Out of the four purchased systems, three are manufactured by Honeywell. This was done intentionally to ease the fabrication of the control system. Team 509 drafted several solutions for the control system.

The first solution, which we initially planned to implement, was to separate the control of humidity and temperature. This can be done by grouping the A/C unit and the additional heater into one control unit to control the temperature. We tested the A/C unit and confirmed that it will keep its setting when the A/C is suddenly turned off. This allows us to use an on/off controller to regulate the room temperature. The humidifier and dehumidifier will be wired to one controller to solely control the humidity of the chamber. The user inputs the temperature first on the temperature side, then set the humidity on the other controller.

Another more advanced solution is to build a control system that will integrate both humidity and temperature control. This solution would utilize software like LabVIEW with a thermostat and wet-bulb thermostat to track the humidity and temperature. Users can also input the desired temperature and humidity testing conditions into one program to control all four systems. This solution is the most desired.

TROUBLESHOOTING

The Chamber

The initial construction of the chamber was completed at the FAMU-FSU College of Engineering. The design of the chamber allows for easy assembly and disassembly. This allowed the chamber to be disassembled, and Team 509 is, therefore, able to identify potential areas of improvement.

The weight of polycarbonate sheets that were used for doors tends to pull the frame apart when doors are in open positions. Users might see the frame deforms overtime, door gaps might get bigger, the rooftop will not close well, etc. Because of this, Team 509 proposes purchasing extra 90° brackets to reinforce critical 90°corners. An additional hinge for each door is also recommended.

While the entire chamber was fabricated at the College of Engineering, the inlet and outlet on the walls of the chamber would still need to be cut. We are intent on keeping these cut-outs as well in the case when one of these holes is not in use and can be plugged to not allow for further leaks in the chamber.

The HVAC System

Due to Covid-19 complications, the HVAC system was not fully completed. The team moved into a virtual validation phase, using software to create simulations. However, various parts of the HVAC system were purchased and machined. Installation steps for the HVAC system were provided in the System Integration section, and simulations will be completed to test and validate the proposed system. Team 509 will provide a completed bill of materials to aid in future work and will also return all purchased items to Danfoss.