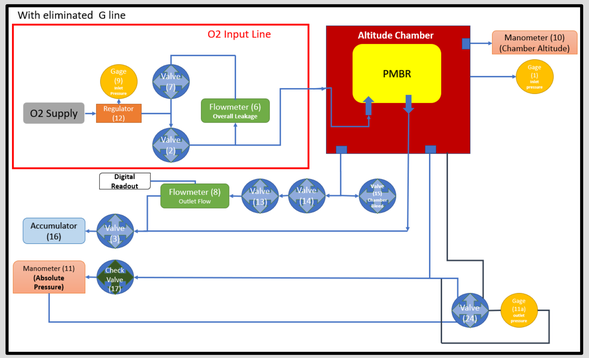
Modification of Oxygen Regulator Functionality Tester for X-59 Regulator Testing

Functionality Tester

NASA Armstrong Flight Research Center currently has possession of an oxygen regulator functionality tester. This device was used for ensuring that the oxygen regulators for aircraft life support systems are functional and safe for flight and/or other testing. This tester has been in storage for about 25 years, with occasional adjustment to sensors and instruments. Due to the aging structure, there are components and instruments that may be broken, unstable, worn out, and thus inhibits safe and accurate future testing on other oxygen regulators. This tester is also limited in the types of regulators it may test, limited to ones that only have one line to deliver oxygen in and out of the regulator, to the pilots mask. It has been requested for this tester to be modified to test the X-59 oxygen regulator.



Tasks:

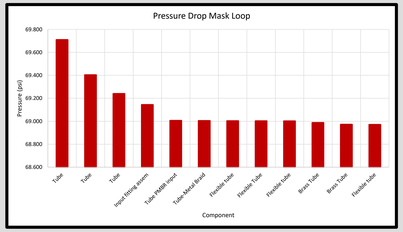
- Identify instruments, tubing, and other components that make up the tester.
- Create CAD model of tester in its current configuration.
- Outline modifications to be made to tester.
- Write procedures for ensuring the tester is operational.
- Write requirements document.
- Perform flow analysis with known information on the tester.
- Create Simulink model of the tester.

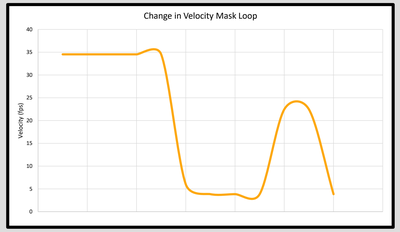
Fluid Mechanics Analysis

An important component in understanding how this functional tester operates is understanding the change of flow and pressure throughout the system. The inlet of the oxygen regulator must meet a certain pressure and flow rate in order to fully test its operational functionality. In other words, in order to meet certain outlet flow and pressure requirements, we must meet the inlet flow and pressure requirements.

Excel Flow and Pressure Calculations

To analyze the changes of pressure and flow through the system, we mapped out the different oxygen delivery loops, organized them by parts in their respective place in the loop series and estimated their diameters and lengths. From there, we used relevant fluid mechanics equations to perform flow and pressure analysis, and calculate the pressure drop in that component. This was done for each observable component, cumulatively adding the pressure drops for each loop. This yielded results that show the overall pressure drop through each individual loop, allowing us to discern if we can provide appropriate inlet conditions to the oxygen regulator.





Simulink/Simscape Modeling

To better understand the workings of the tester, and how modifications should be made in order for this to interface with a the X-59 oxygen regulator, a Simscape model was created to simulate the flow of gas through the tester and regulator with relevant instrumentation included. This allowed us to point out any critical areas of pressure loss, change of flow, and where we could change instrumentation and other components. This model includes both a line for an input and output of oxygen, and a vacuum chamber to emulate a range of different altitudes. Having this model was also useful in that we could compare our results with the results in the former excel fluid mechanics flow and pressure calculations to ensure mathematical consistency.

Documentation

At the start of this project, there was a scatter of information available on this functionality tester. There are few relevant schematics that matched up to the current state of exterior/interior schematics, plumbing schematics that have since been changed, and procedures that were relevant only to the regulator tested at the time. Due to the aged quality of these documents, updates were to be made in aforementioned areas.

Requirements Document

In order to figure out what physical modifications are needed to interface with the X-59 oxygen regulator, we need to know what the requirements are to test that regulator and operate the test stand in that process. To determine this, we analyzed several documents that alluded to the operation of the test stand from previous regulator testing trials, and a qualification testing document for the X-59 oxygen regulator. This helped us set up a requirements document that meets the needs of both the tester and the oxygen regulator.

Schematics/Procedures

While analyzing the working of the tester, it was imperative to create an updated plumbing schematic in order to understand what we were working with and how we could change its characteristics to fit our testing needs. Through a PowerPoint medium, an updated plumbing schematic with added modifications was created. For the future of ensuring this tester is functional for regulator testing, a procedure was created. This was formed by analyzing previous documents that include their individual functional testing, and preliminary tests to the tester itself.

Modifications

Over the course of analyzing several documents, performing flow analysis, and preliminary inspection of the tester, these are the current determined modifications needed for the tester to perform future tests on the X-59 oxygen regulator:

- New flowmeters with larger range.
- Secondary input pressure gage.
- New gages with larger ranges.
- Installment of air delivery line.
- Input/output fittings for new regulator
- New mask pressure manometer.
- Removal and replacement of deteriorated hoses.

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