Virginia Commonwealth University
VCU Scholars Compass

Capstone Design Expo Posters | College of Engineering

2016

Flow-Differential Pressure Test Rig

Stuart Jennings
Virginia Commonwealth University

David Keegan
Virginia Commonwealth University

Juan Ramonet
Virginia Commonwealth University

Nicholas Upton
Virginia Commonwealth University

Follow this and additional works at: https://scholarscompass.vcu.edu/capstone


Part of the Mechanical Engineering Commons, and the Nuclear Engineering Commons

© The Author(s)

Downloaded from
https://scholarscompass.vcu.edu/capstone/95

This Poster is brought to you for free and open access by the College of Engineering at VCU Scholars Compass. It has been accepted for inclusion in Capstone Design Expo Posters by an authorized administrator of VCU Scholars Compass. For more information, please contact libcompass@vcu.edu.

Team Members: Stuart Jennings, David Keegan, Juan Ramonet, and Nicholas Upton
Faculty Advisors: Prof. James Miller and Dr. Hong Zhao
Sponsor: Porvair Filtration Group
Sponsor Advisors: Eric Duvekot and Will Sanderson

MECHANICAL AND NUCLEAR

Flow-Differential Pressure Test Rig

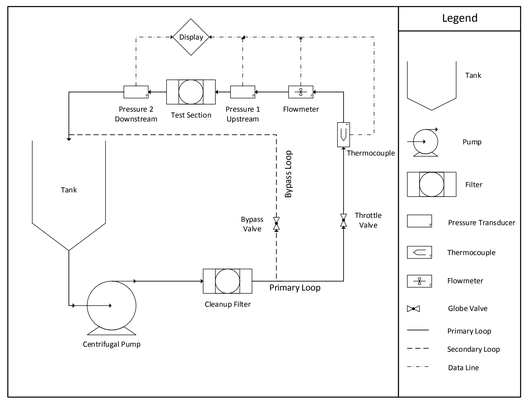
CAPSTONE DESIGN EXPO 2016

Motivation

The correct filter in the proper application has the ability to prevent unwanted system failure, to protect your investment, and to potentially save lives. Proper quality assurance prior to delivery is necessary for product integrity and performance reliability. Currently, proper quality assurance can only be performed offsite, which presents the need for an on-site testing apparatus. By utilizing the Flow-Differential Pressure Test Rig, Porvair can now provide the quality assurance necessary to guarantee product integrity and performance reliability in a shorter timeframe.

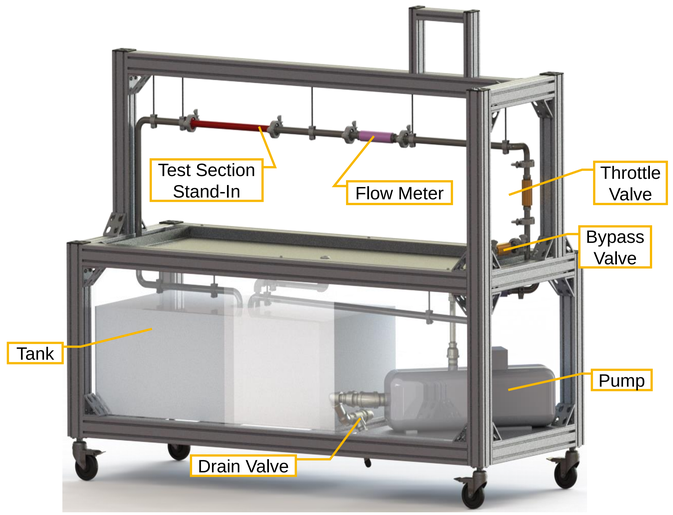
Background

- As a fluid flows across an obstruction – in this case, a filter – it experiences a drop in pressure which is important for system design and performance.
- The pressure drop depends on fluid properties (viscosity, density, and flow rate) and filter properties (construction, housing, porosity, etc.).
  - A standardized fluid, e.g. deionized water, is used for the test.
  - Flow rate is controlled, and the test is performed at intervals from zero flow to the maximum rated flow of the filter.
  - Pressure is measured upstream and downstream of the filter to find the pressure drop, or differential pressure.
- Pressure drop in other fluids, like fuel, oil, air, combustion exhaust, etc. can be determined using Dimensional Analysis of the fluids and known properties of the test rig.

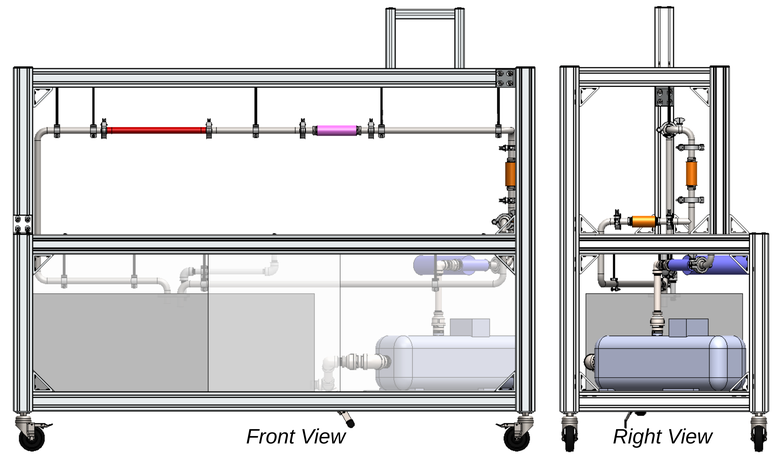


Schematic Diagram of System

Test Rig Design



porvair filtration group

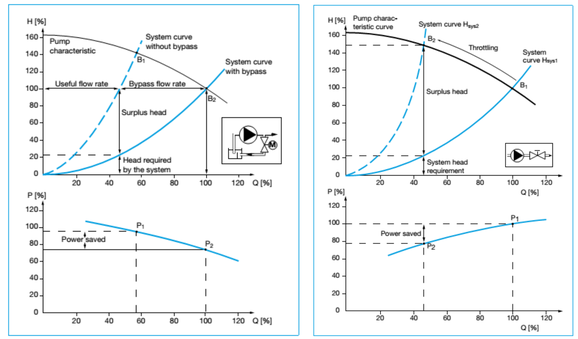


Design Considerations

Specifications: The required performance of the rig is a system pressure range of 0-100 psi_g and a flow rate of 0-63.4 gpm. The rig is to use deionized water as the test fluid, and must have a section where adapters can be placed to cover a wide range of filtration products using standard sanitary tube fittings.

Challenges:

- The required range is outside the normal performance of any pump.
  Solution: A triple-control system was designed using a variable frequency drive to control the pump's rotational speed, a throttling valve to fine-tune the system pressure, and a bypass valve to fine-tune the flow rate.
- Due to the sensitivity of the instrumentation requiring fully-developed flow, and the size of equipment such as a large pump, tank, and variable-frequency drive, the footprint of the rig was very large.
  Solution: A series of iterative designs were produced, shrinking the size from 4'x8'x6'(depth x width x height) to 2.6'x6.5'x5.5'.
- Because of the need for fluid with well-known properties, high purity of the deionized water must be maintained.
  Solution: A filter provided by Porvair was used to remove contaminants, and sanitary tubing was used for cleanliness and reduced biofilm growth.



Bypass valve (left) and throttling valve (right) and how they affect the pump curve. From KSB AG, "Selecting Centrifugal Pumps," 2005.

The student members would like to acknowledge our families and friends for their support, and the Porvair Filtration Group and our faculty advisors for their advice and consideration.

VCU School of Engineering

Make it real.

VIRGINIA COMMONWEALTH UNIVERSITY