DALHOUSIE UNIVERSITY
FACULTY OF ENGINEERING

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DSM
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DSM Mulgrave

Department of Process Engineering and Applied Science

Central Vacuum System

Introduction

This project aims to improve the reliability of the vacuum systems at DSM Mulgrave.

Mulgrave, Nova Scotia

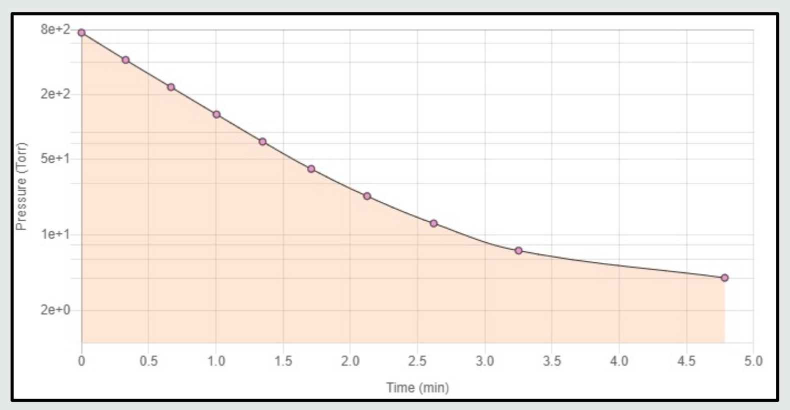
The current systems allow too many vapours to pass through the pumps, decreasing performance and causing failure. When a pump fails in an isolated system the whole process loses vacuum, so redundancy has been a major focus to reduce the frequency of pump failure. A central system will handle all process vapours from the vacuum streams with a condenser and phase separator for additional liquid removal.

Skid Location

Redundant pumps will provide vacuum to the system and redundant vacuum blowers will be in place to provide additional negative pressure to the necessary processes.

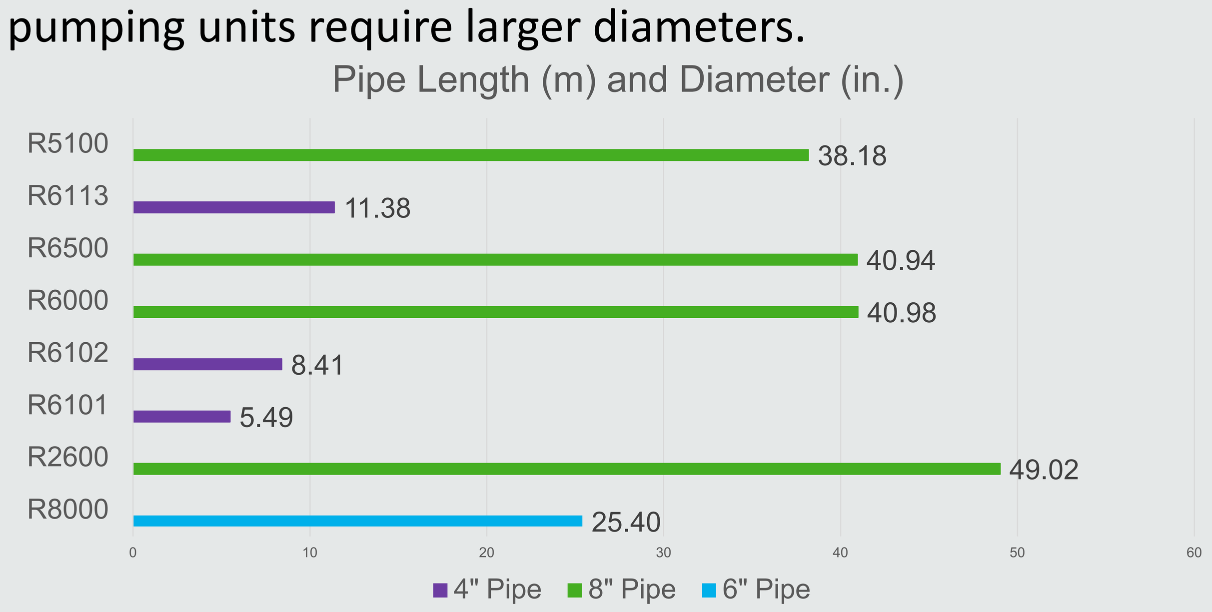
Design Process

- Evacuation time for the system is shown below. Based on the gas pocket and piping volume of 60 m3, the selected pumps can evacuate the system to 4 torr from atmospheric in under 5 min.
- Pipe lengths required to serve each process are shown below.



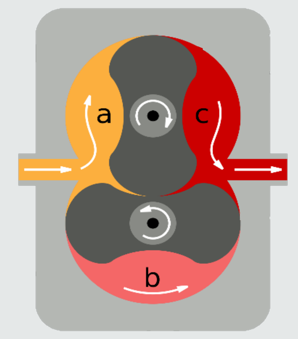
Evacuation curve of abs. Pressure (torr) vs time (min)

- The diameter of pipe selected to maintain adequate conductance is also represented. Pipes further from pumping units require larger diameters.

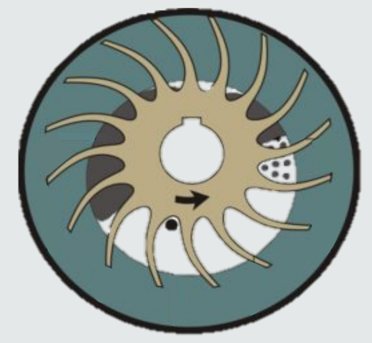


Details of Design

- Based on the current operations and assuming 100% production, the requirements for the pumps are:
  - Throughput of 2000 cfm
  - Ultimate Pressure of 4 torr
- The pump technologies selected are roots blowers for the first compression stage and boosters, and liquid-ring vacuum pumps (LRVP) for the final stage.

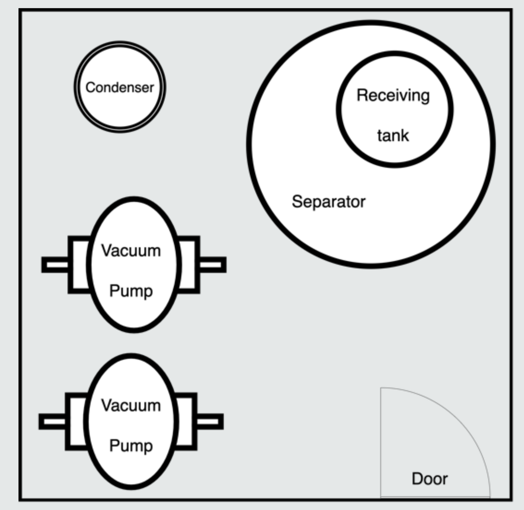


Roots Blower

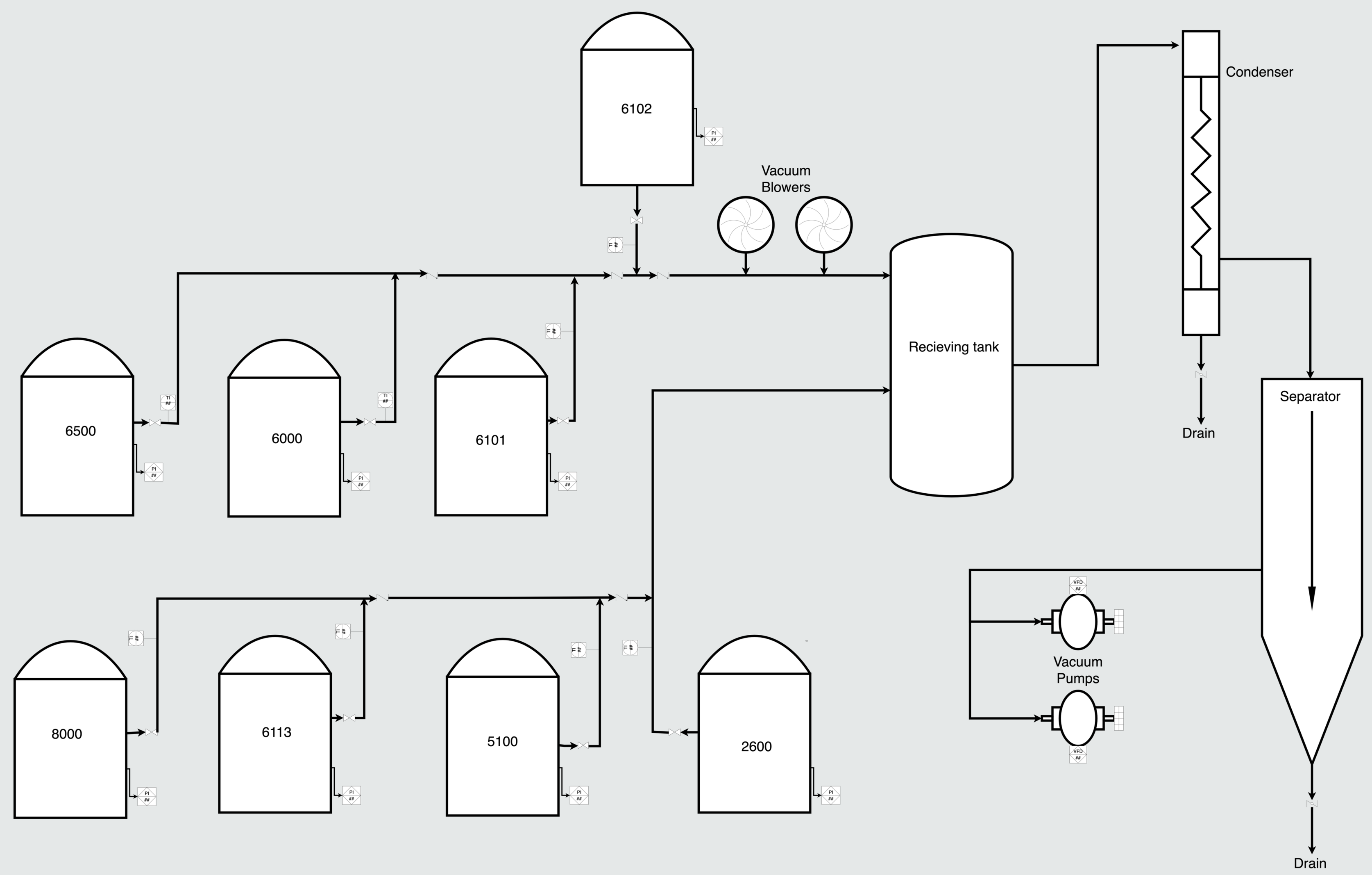


LRVP

- Temperatures and pressures, pump-down times and energy consumption provide a system that will perform quickly and safely without excessive cost.
- The pumps are protected from shock and debris by a condenser, knock-out drum and receiving vessel. Components are arranged on a skid as shown in the diagrams.
- The PFD below demonstrates the piping and controls from each process to exhaust.

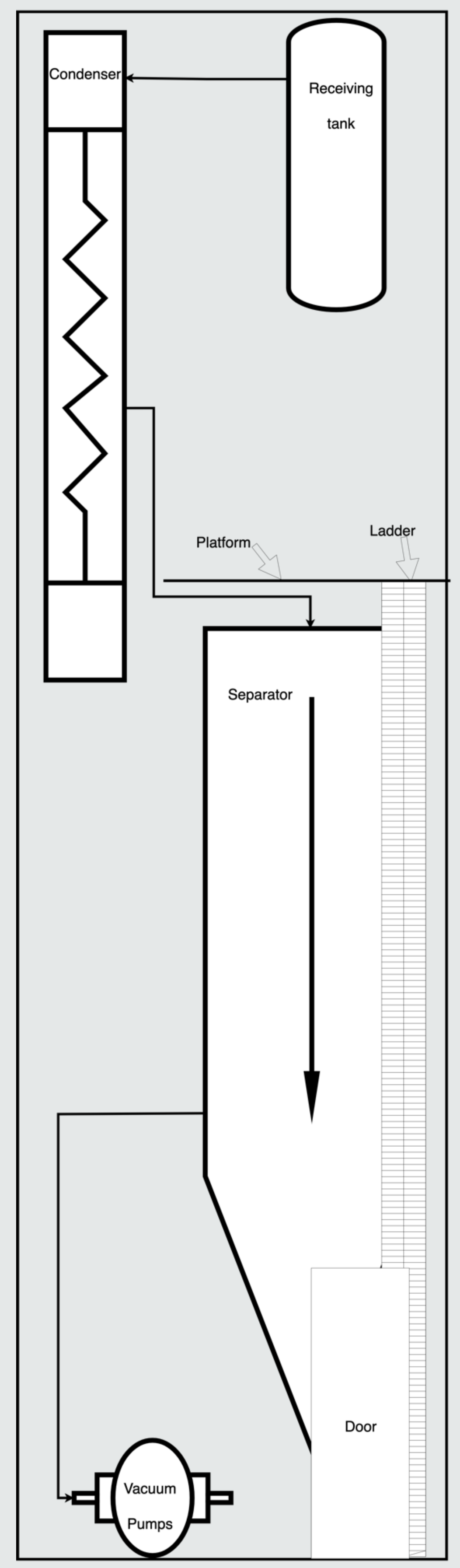


Pictured: skid overhead view (above), skid front view (below)



- The condenser is required to remove water and ethanol vapours from the stream.
- Specifications are shown on the right.

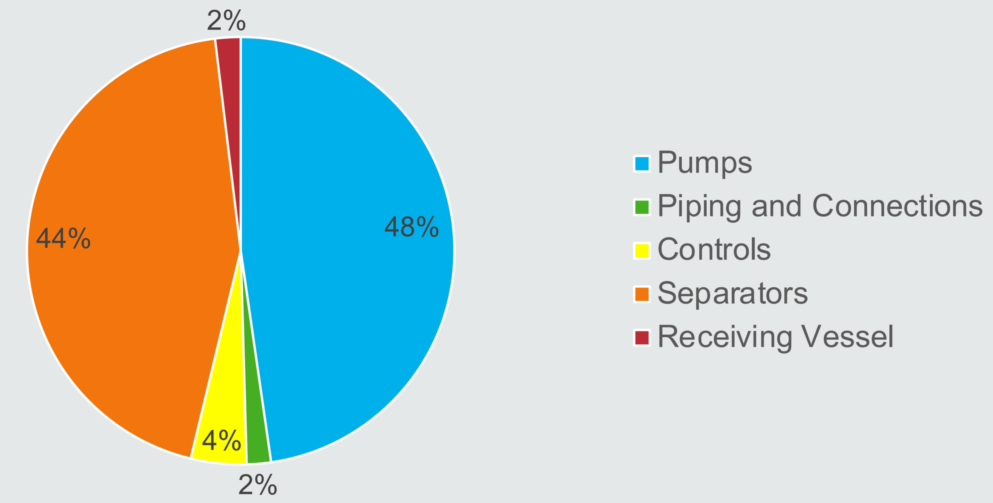
Required heat exchange area	56.78	m^2
Tube diameter	0.022	m
Tube count	160	
Tube length	6.69	m
Overall heat transfer coefficient	183.58	kW/m^2K



- The system is controlled based on pressure specifications in each zone. Pumping units on VFDs and throttling valves will be employed to achieve the requirements. System performance can be monitored based on motor work and thermocouples in each major zone. Reactors not in use will be isolated.
- Four processes operating at lower pressure than the others are separated by a booster pump to maintain the pressure differential without overworking the main pump and wasting energy.
- In order to meet the requirement for complete redundancy, both pumping units were duplicated and placed in parallel to ensure availability of backup.

Conclusion and Recommendations

- The total cost of the design in CAD is $1.1 million, reaching an installed cost of $1.3 million.



- By retrofitting the existing pumps at the plant, savings of almost $500k may be realized at a 25% increase in controls expenditure and operational costs.
- Operational costs associated with the pumping equipment is estimated at $105k annually.

Safety and sustainability

- PRVs will be in place on each vessel for cavitation prevention, all auxiliary equipment will be properly pressure rated such as valves, pipes and instruments.
- Blowers will be controlled by pressure measurements to maintain vacuum in processes.
- Silencers or sound proofing will be implemented at the skid for vacuum pumps according to their decibel level to prevent noise pollution to the surrounding environment.
- Skid support will require structural design and maintenance access will be based on the provided layout.
- Air leakage has been minimized in system to avoid additional emissions from unnecessary vacuum pump energy usage.
- Discharge of air from the pumps will be filtered for particulate and a spark arrestor will account for any ethanol released from the stream.

References

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