

Valve Efficiency Testing Device

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Background and Problem

- Phillips 66 Rodeo Refinery located near Oakland, CA
- Reciprocating compressors are used to increase the pressure of gases in the refining process
- The Rodeo facility does not have a device to accurately measure valve leakage prior to installation in a compressor



Reciprocating Compressor

Valve

Objective

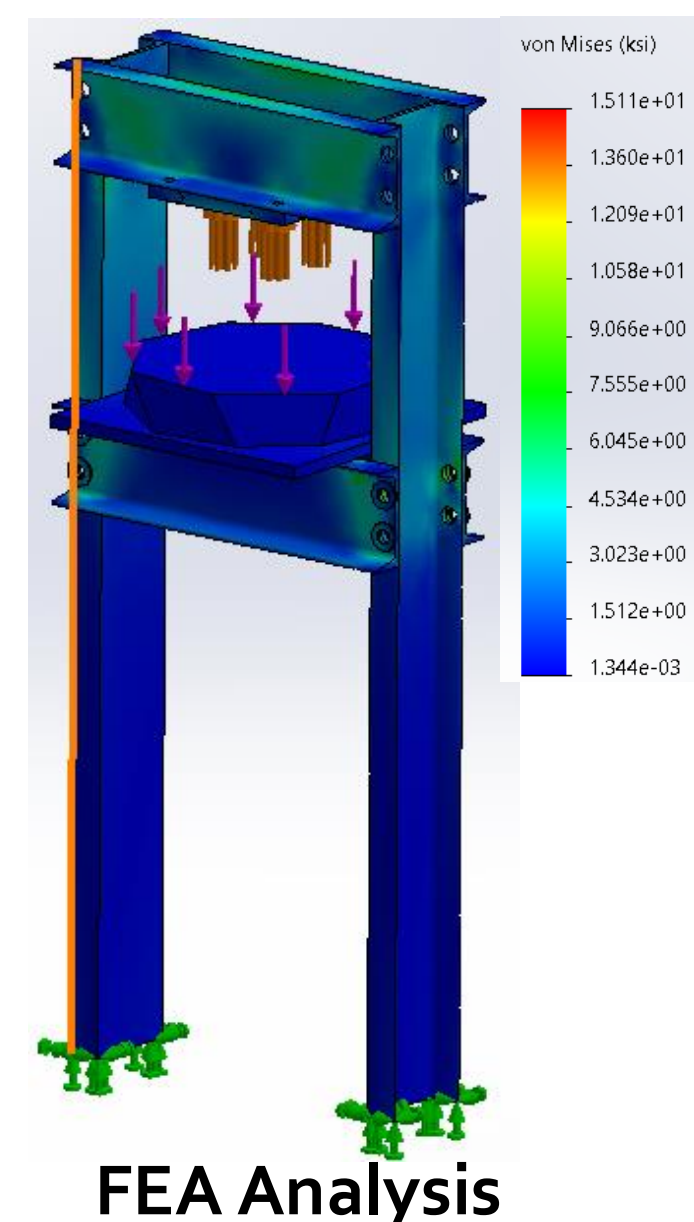
Design and build a testing device that can quickly, repeatedly, accurately, and safely measure the leakage rates of 4-16" diameter compressor valves

Engineering Specifications

- Time to Test 1 Valve:** < 5 min.
- 2 Testable Valves:** 8" poppet suction and discharge
- Leakage:** >5% under valve max allowable valve leakage, <5% difference between system leakage trials, <5% uncertainty in valve leakage

Engineering Analysis

Value	4" Valve	16" Valve
Total Force Required = O-Ring Compression Force + Pressure*Area Force	1,413.7 lbf	16,588 lbf
Pressure Vessel Yield F.O.S.	16.1	3.86
Top C-Channel F.O.S. for Fmax	X	2.45
Bolt Holes F.O.S. for Fmax	X	5.28

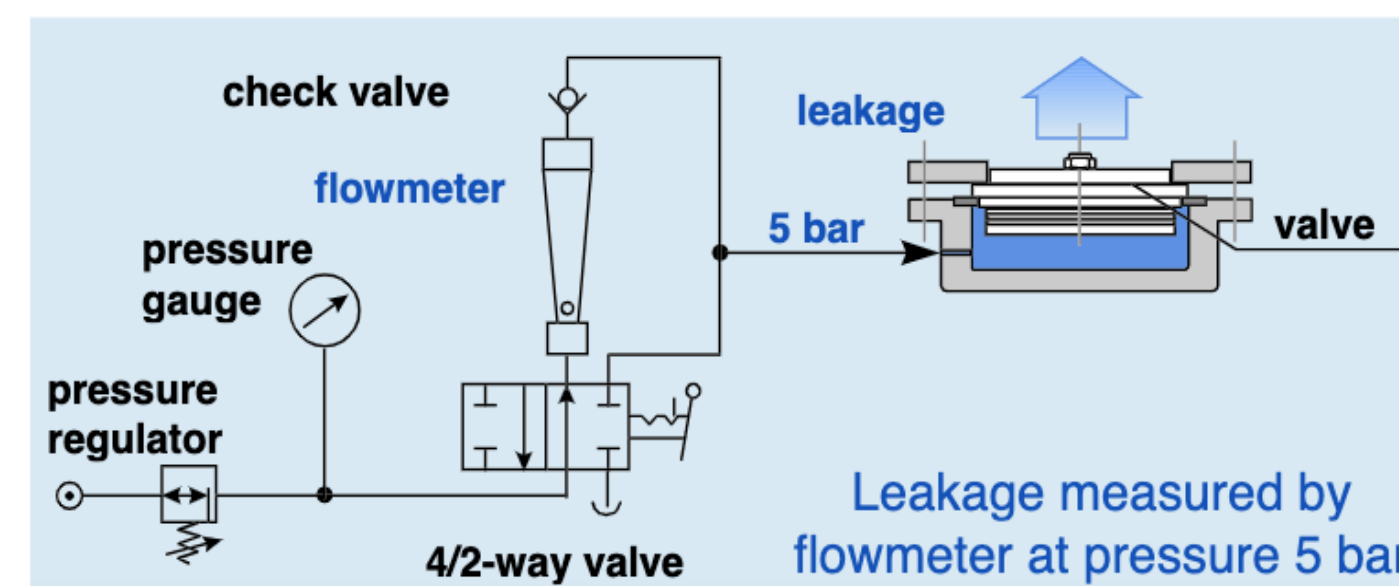


Final Design

- Flowmeter test (recommended by Hoerbiger, valve manufacturer) to determine valve leakage
- Sheet metal control panel
- Pressure Vessel – Serves as valve fixture, seals to valve and table with O-Rings, pressurized to 70 psi during testing
- Manual clamp with removable clamping cup chosen over hydraulic cylinder
- C-Channel frame, L-Channel base, and removable ground plate table

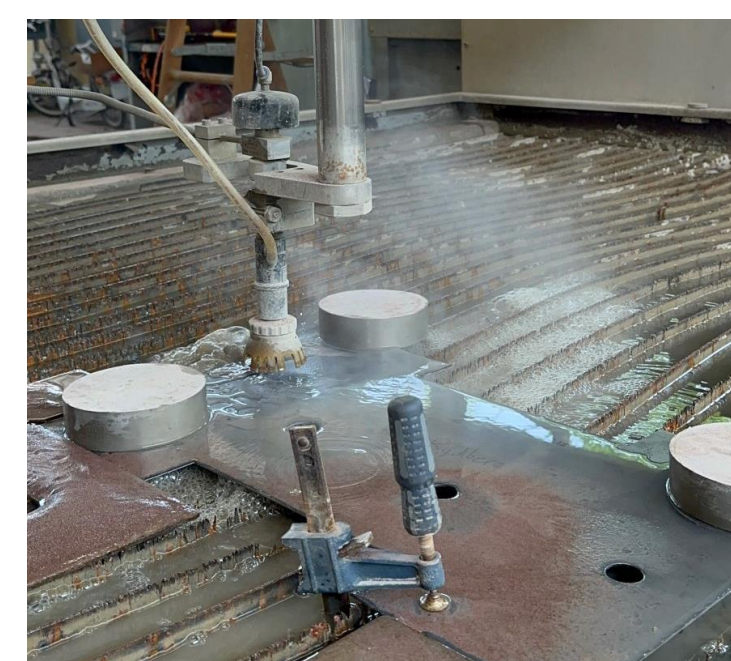


Final Prototype



Flow Meter Test

Manufacturing



Water Jet - Sheet Metal Control Panel



Mill - Grooves for O-Rings



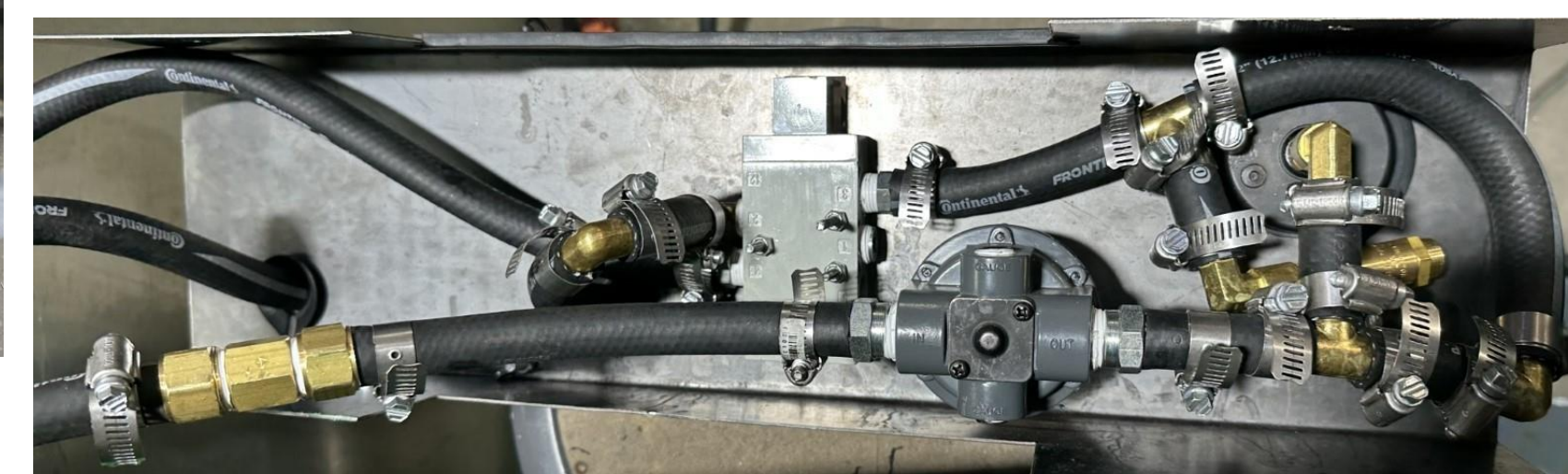
Weld - Nuts for Threaded Rod



Assembly – Clamping Cup



Lathe - Aluminum Clamping Cup



Assembly - Flowmeter System (Back View)

Testing and Analysis

Leakage Test

- System Leakage (Calibration) Test: 0.68 SCFH

Value	8" Suction Valve	8" Discharge Valve
Average Leakage (10 Trials)	140.5 +/- 1.12 SCFH	92.9 +/- 0.74 SCFH
% Uncertainty	0.80 %	0.80 %
% Difference Between Min and Max Leakage from 10 Trials	24.1 %	9.40 %
% Under Max Allowed (228 SCFH)	47.5 %	84.2 %

Time to Use

- Read and Record Results: 6.47 seconds
- Test 1 Valve: 1 minute 50 seconds
- Training: 16 minutes

Bump/Push Test

- No displacement in any members
- Will be bolted to ground at Phillips 66

Dimensions

- Table: 18.125" x 18.25"
- Footprint Area: 36" x 28.75"



Testing 8" Valve

Results: Test stand meets all specifications and objectives

Conclusions

Recommendations

- Bolt test stand to ground
- Design additional fixtures for other valve sizes
- Collect and document leakage data to determine valve leakage criteria
- Create plywood/carpet covering for test stand table
- Keep table covered when not in use

Lessons Learned

- Manufacturing time is always longer than anticipated
- Always design with manufacturability in mind
- Safety is the most important consideration in engineering projects