

UDR Engineering

U're Dreams Realized

Fuel Tank Tumbler

Presented by:

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Acquisitions Officer

Background

- Old Fuel Tanks
 - Rust
 - Pinholes
 - Out of Production
- Reconditioning Old Tanks
 1. Cleaning – Acetone
 2. Etching – Muriatic Acid
 3. Coating - Tank Sealant

Inner View of Fuel Tank



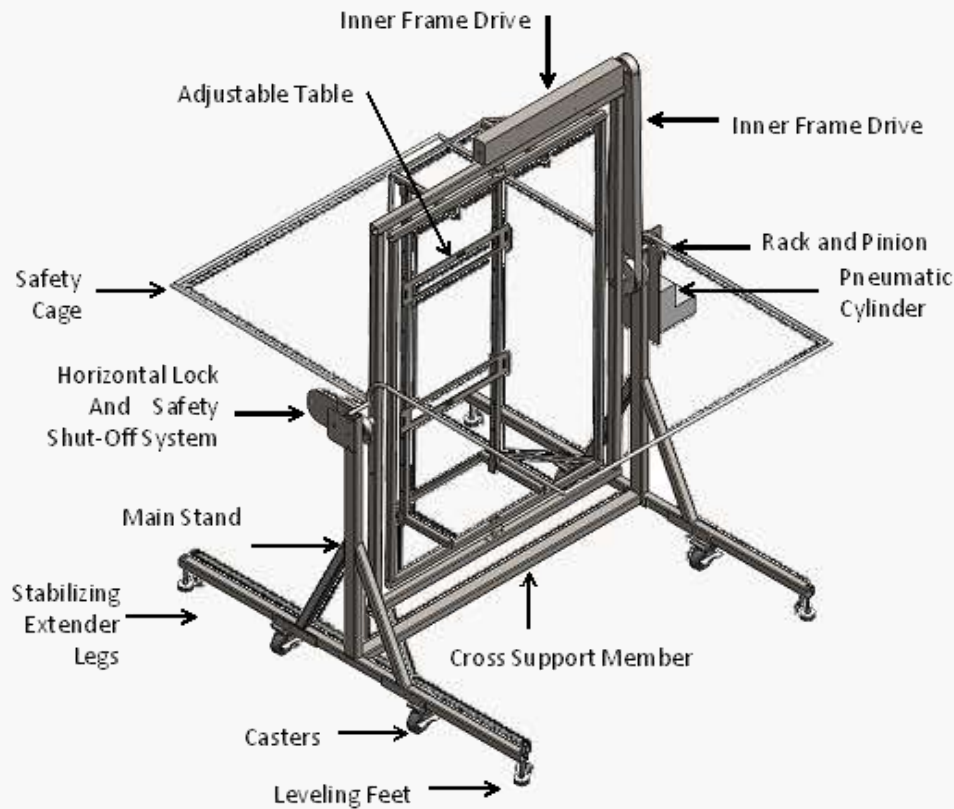
Before

After

Objectives

- Laramie Radiator Works, Laramie Wyoming
 - Owner: Mr. Arvin Martinez
 - Tank Sealing: Manual Operation
- Goals
 - Improve Sealant Coverage
 - Improve Coverage Consistency
 - Decrease Operation Time

Solution



- Fuel Tank Tumbler
 - Perpendicular Biaxial Rotation
 - Pneumatic Driven
 - Adjustable Mounting
 - Air Introduction
 - Compact Storage
 - Safety Features

Design Challenges

- Fuel Tank Sealant Properties
 - Flammable
 - Mild Toxicity
 - Viscosity



Design Specifications

- Resources

- 120 Volt (V) single phase power supply is available
- 500 Watt (W) power constraint
- 120 pounds per square inch (psi) air line
- 15 cubic feet per minute (cfm) constraint

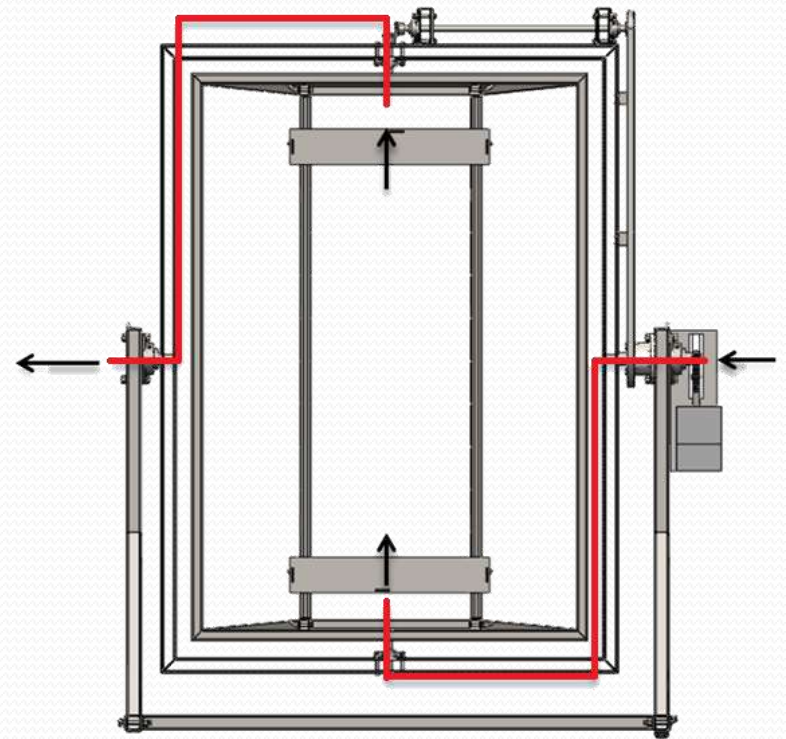
- Size

- Storage envelope: 10x8x8 feet
- Tank table size: 6x4x2 feet



Design Specifications

- Drying Airflow
 - Processing time < 2 days
 - Closed air system
 - Discharge of sealant fumes into a paint booth
 - Accommodate different input and output positions
 - Maximum pressure of 2 psi inside the fuel tanks



Design Specifications

- Operation
 - Require minimal to no prior training
 - Tank loading height of approximately 3-4 feet
 - Unsupervised operation cycle
 - Safe operation: OSHA code 1910.212
- Budget: \$1,000

Proposed Solutions

- Mounting Method
 - End Clamps
 - Adjustable Table
 - Set Table

Mounting Method Morphology							
	Cost	Ease of Use	Biaxial Flexibility	Coating Consistency	Torque Requirement	Total Score	Rank
Factor Weight	10	7	5	7	8		
End Clamps	8	3	2	8	10	247	2 nd
2D Adjustable Table	6	7	9	8	8	274	1 st

Proposed Solutions

- Rotation Method
 - Electric Motor
 - Pneumatic Motor
 - Pneumatic Cylinder
 - Hydraulic Motor



<http://www.electricmotorwarehouse.com/IMAGES/GF2034.jpg>



<http://www.pneumatic-hydraulic.com/PNEUMATIC%20CYLINDER/Pneumatic%20cylinder.htm>

Proposed Solutions

- Air Introduction
 - Regulated Air Line
 - Electric/Mechanical Fan
 - Exhaust Gases
 - Free Vent



<http://www.hobbylinc.com/htm/bad/bad50-054.htm>



<http://www.mcbargainelectronics.com/Case-Fan-200MM-Big-Boy-TriColor-Antec.php>

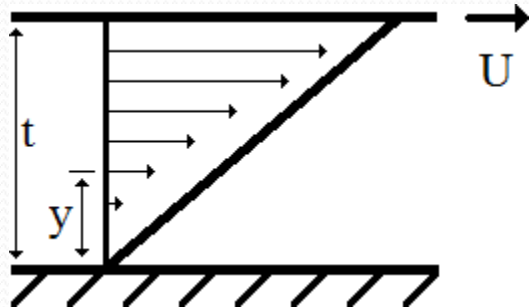
Proposed Solutions

- Coverage Methods
 - Passive Method
 - Center/End Tilting
 - Biaxial Rotation



Engineering Principles

Shear Flow of a Liquid

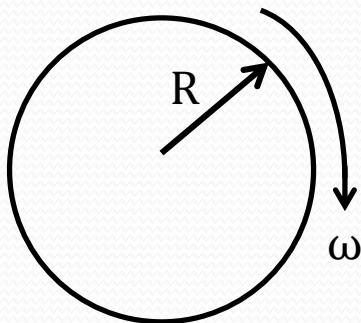


Sealant to Air Interface

- Frame Rotation Rates

- 2:1 Inner to Outer Frame
- Maximum Rotation Rate
 - Shear Driven Couette Flow
 - Viscosity Dependent

Tank Cross Section



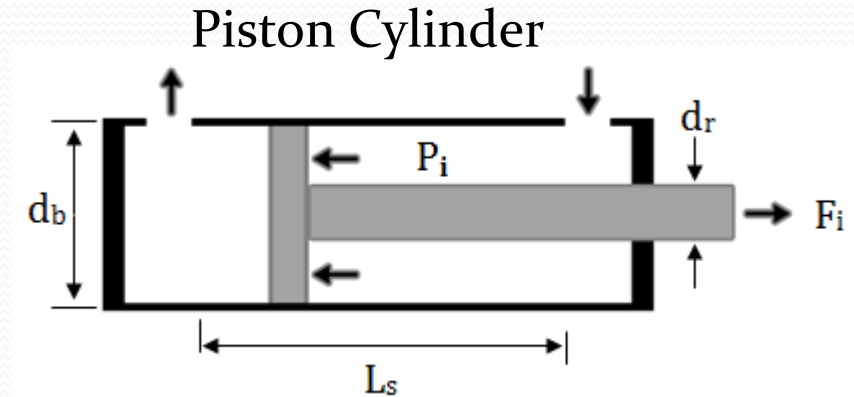
$$u = U \frac{y}{t} \longrightarrow u = U \frac{t-y}{t}$$

$$\longrightarrow U = \omega 2\pi R \quad \downarrow \quad \tau = -\mu \frac{du}{dy}$$

$$\omega = g \frac{t}{\nu 2\pi}$$

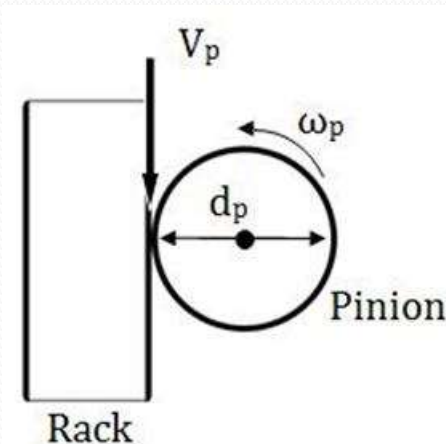
Engineering Principles

- Torque Requirements
- Air Consumption
 - Pressure Requirement
 - Piston Velocity



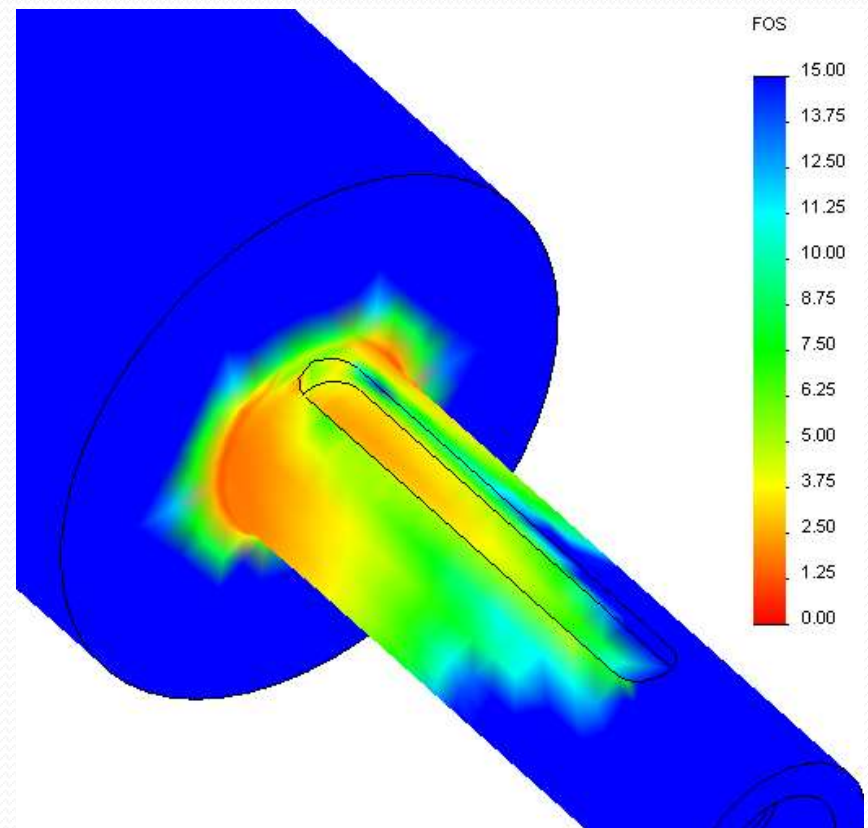
$$P_i = \frac{F_i}{A_c} \longrightarrow P_i = \frac{F_i}{\left[\frac{\pi}{4} (d_b - d_r)^2\right]}$$

$$Q_p = \left[\frac{\pi}{4} d_b^2\right] V_p \longrightarrow Q_p = \left[\frac{\pi}{4} d_b^2\right] \frac{\pi d_p \omega_p}{12}$$



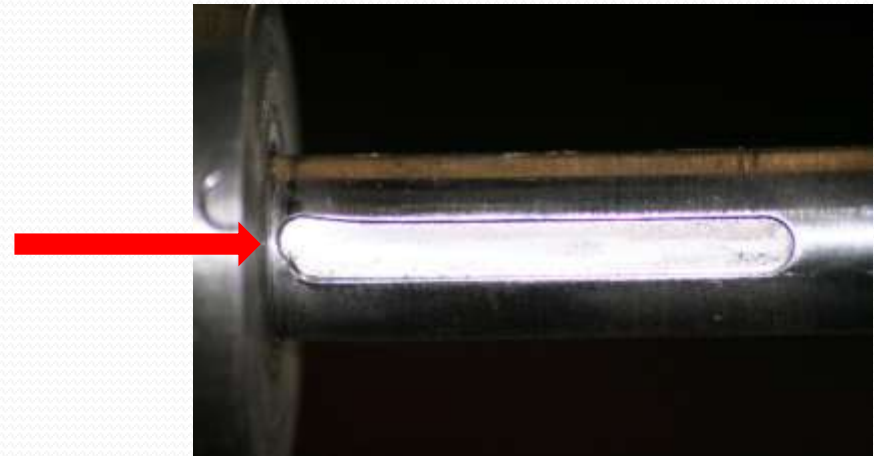
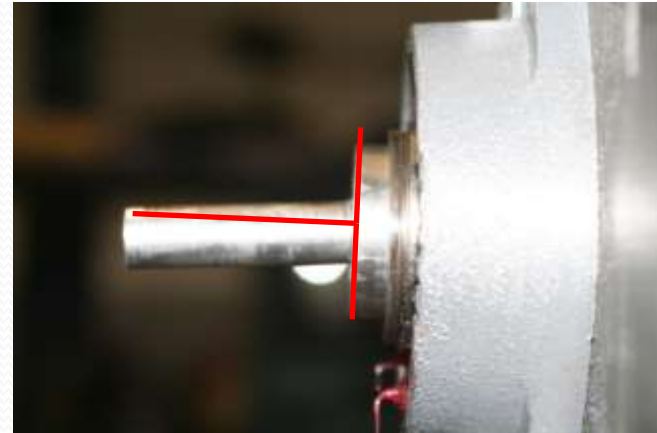
Engineering Principles

- Forces on Components
 - Stress Analysis
 - Failure Analysis



Problems Encountered

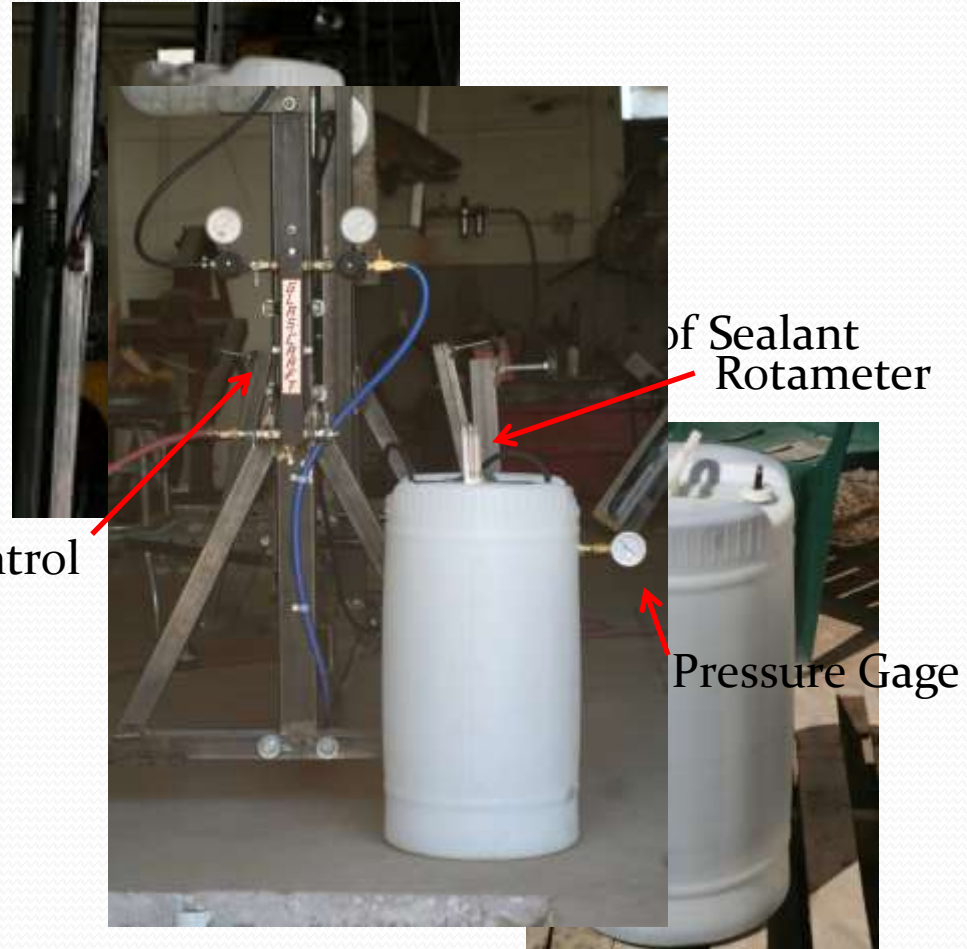
- Excessive Torque
- Shaft Failure
 - Impact Loading
 - Shaft Yielding
- Solution for testing
 - Manual Rotation
 - System Balancing



Compliance Testing

- Air Flow Through Piston Cylinder
- Air Flow Through Fuel Tank
- Coverage

Air Control System



Performance Review

Specification

- < 15 cfm during operation
- 0.25 cfm and < 2 psi for drying air
- 95% Sealant Coverage
- 10x8x8 feet storage envelope
- 6x4x2 feet tank table size

Results

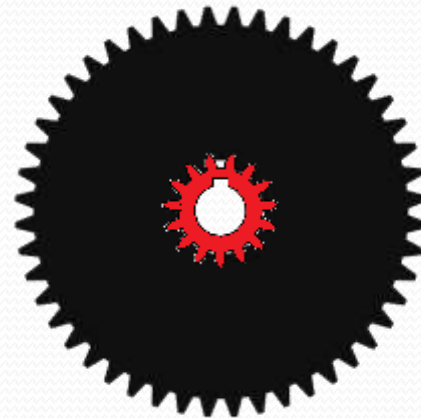
- Test Pending Design Change
- 0.25 cfm and < 0.5 psi
- 99% Sealant Coverage
- 9x7x4 feet storage envelope
- 6x4x2 feet tank table size

Project Costs

Cost	Estimated	Actual
Materials	\$1,150	\$900
Engineering	\$25,000	\$24,000
Labor	\$3,500	\$2,500
Total	\$29,650	\$27,400
Unit Production	\$6,800	-

Recommendations

- Electric Motor with Gear Reduction
- Extend Piston Stroke Length
 - Increase from 4 to 12 inches
 - Increase pinion diameter to 4 inches
 - Additional Cost: \$326



UDR Engineering would like to thank the following:

- Laramie Radiator Works
- Mr. Arvin Martinez
- Professor Scott Morton
- Dr. Chung-Souk Han
- University of Wyoming Machine Shop



Questions?