ALIS Engineering

A product of Advanced Lawn Irrigation Systems (ALIS)

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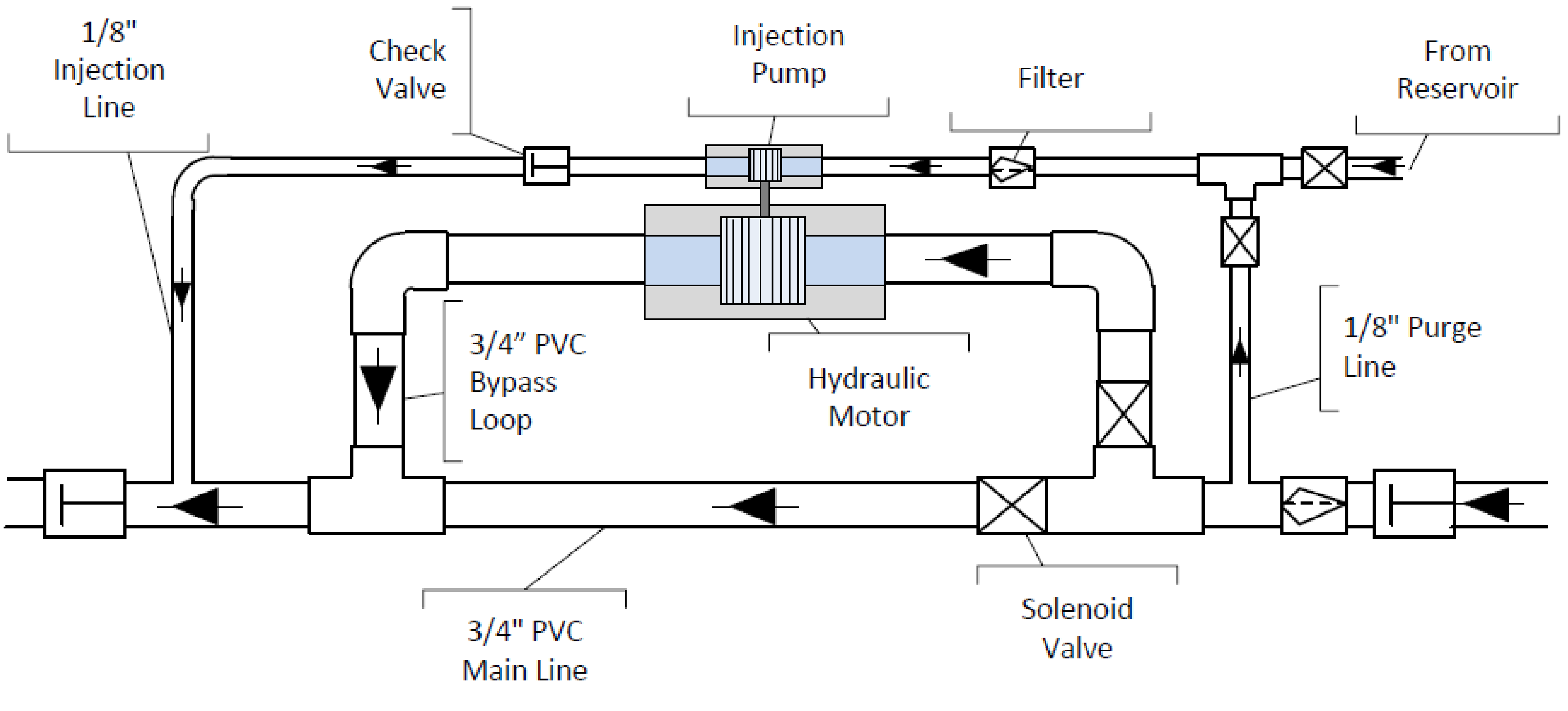
Project Introduction

- Conventional Application
  - Time Consuming
  - Requires Labor
  - Chemical Exposure
  - Precision of Application
- Professional Application
  - Additional Costs
  - Scheduling

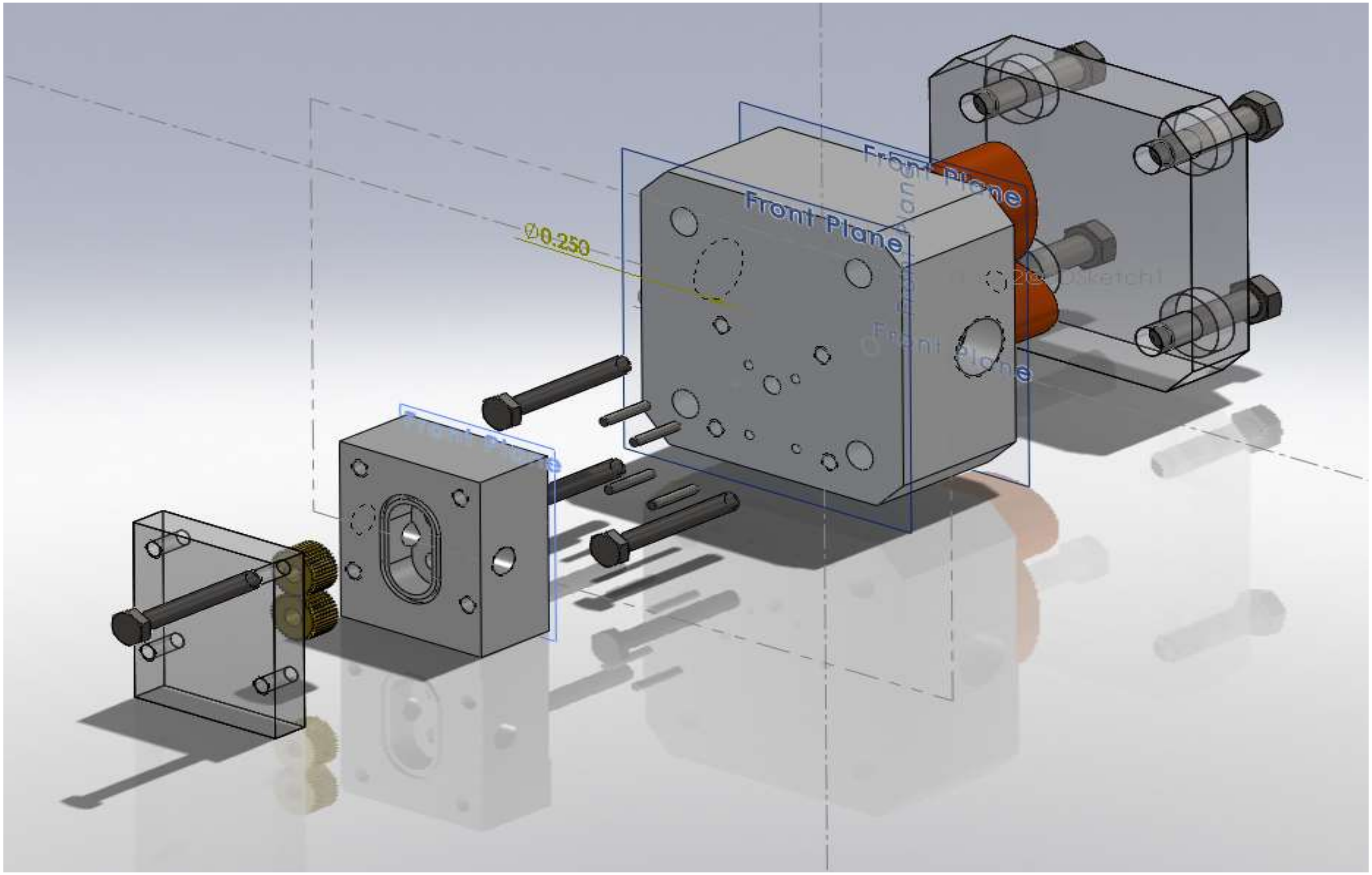
Goals

- Precise Application
- Minimal Labor
- Long Term Cost Reduction
- Utilize Existing Sprinkler System

Injection System



Injection Unit



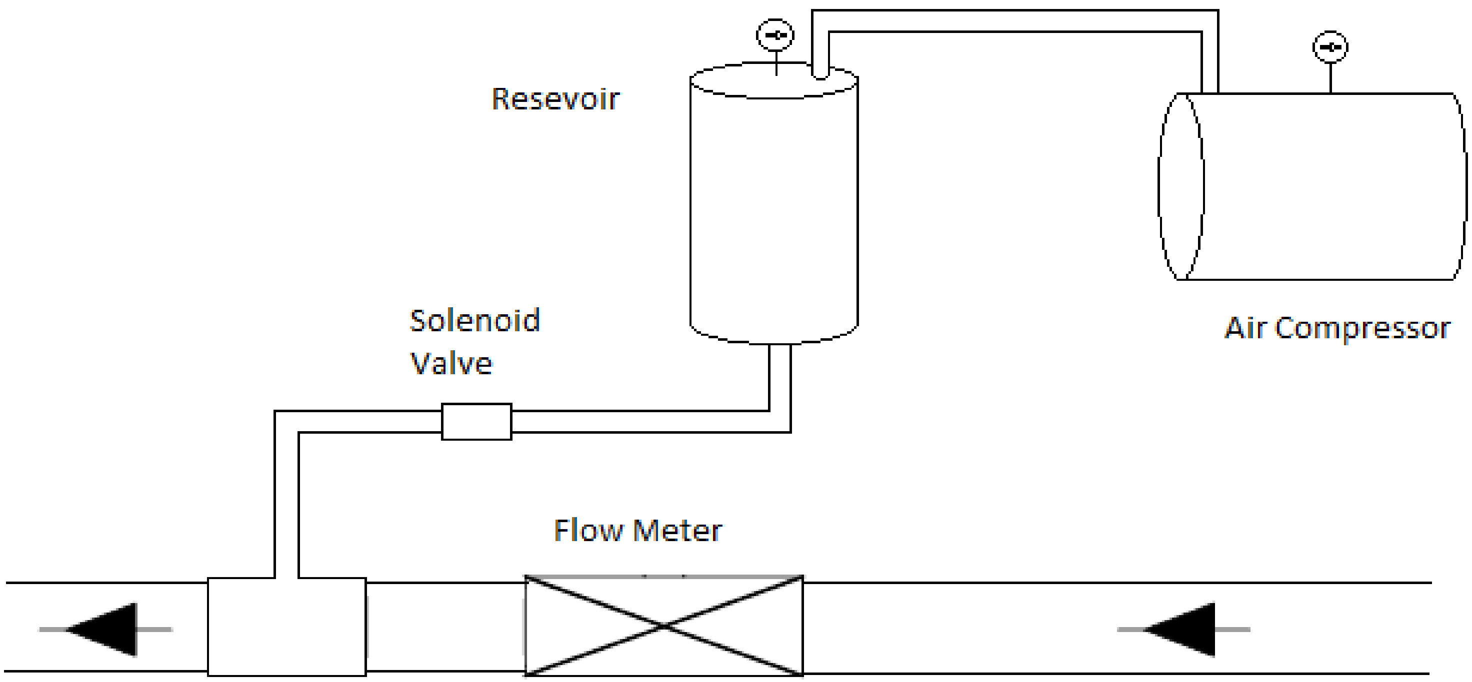
Specifications

- 40 to 80 psi operating pressure
- 3 to 8 gpm water flow rate
- 1:100 chemical to water mixing ratio
- Minimum factor of safety of 1.5 for pressurized components

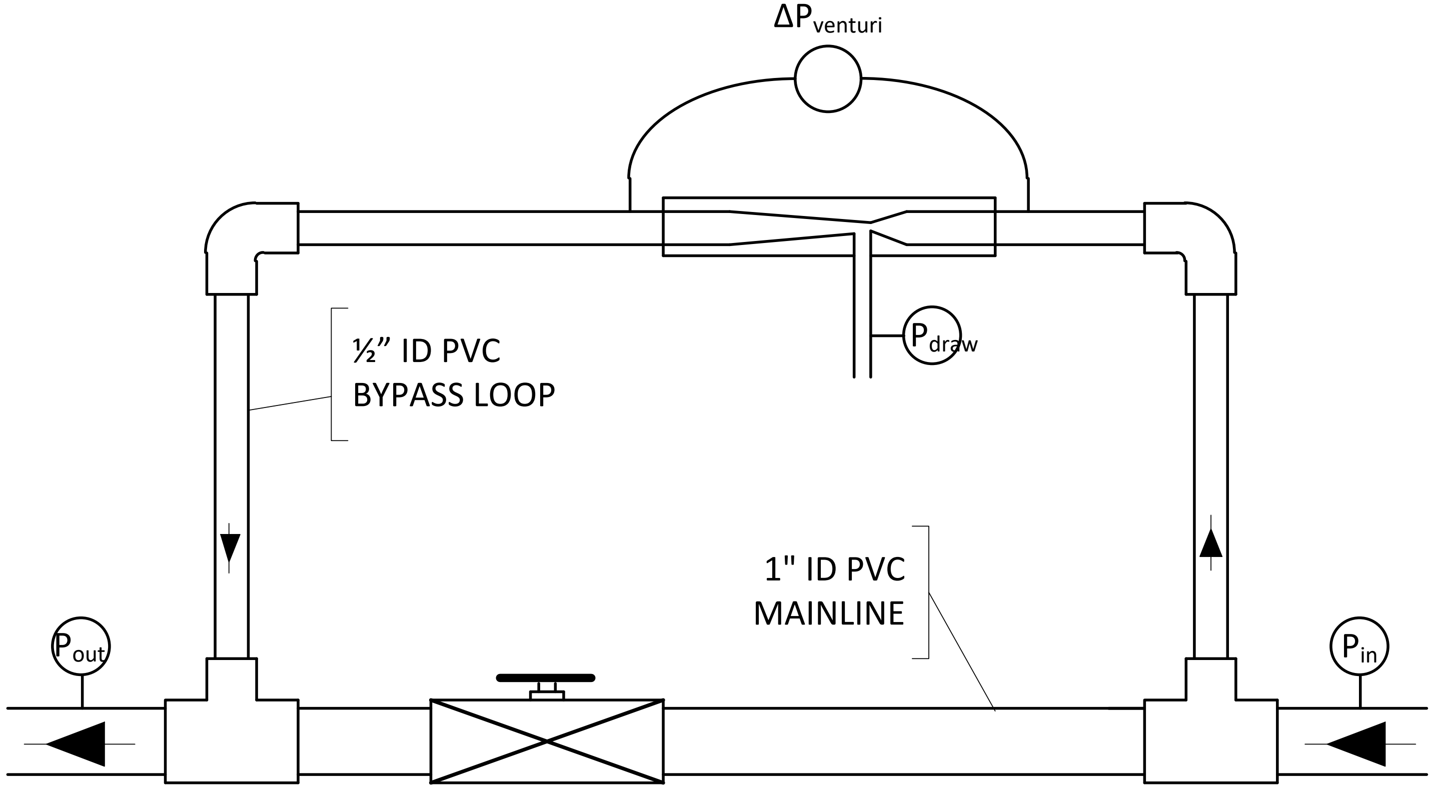
Designs Considered

- Pressurized Reservoir
- Venturi Injector
- Electric Powered Injector

Pressurized Reservoir

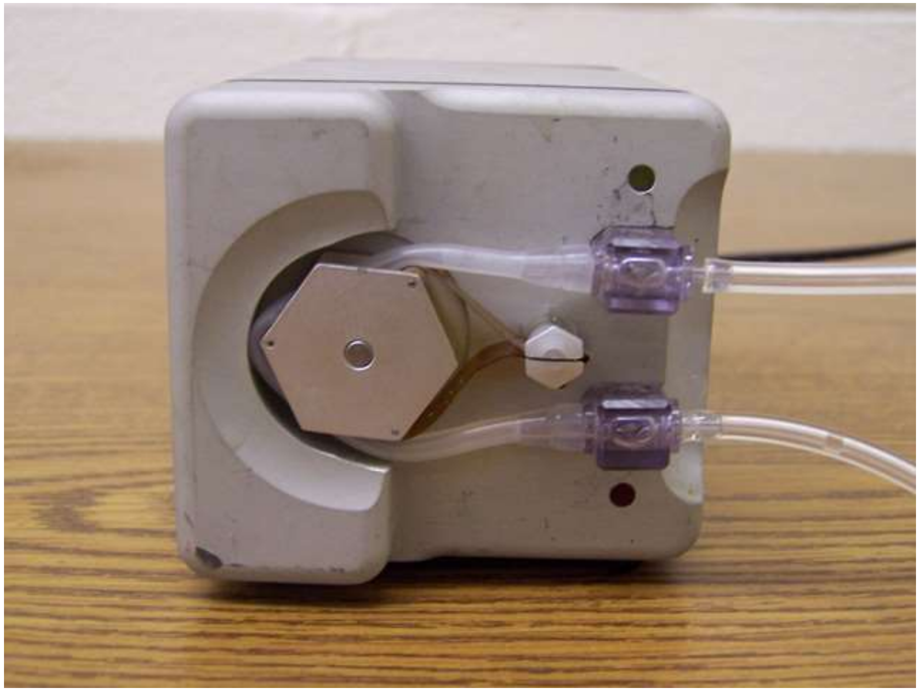


Venturi Injector



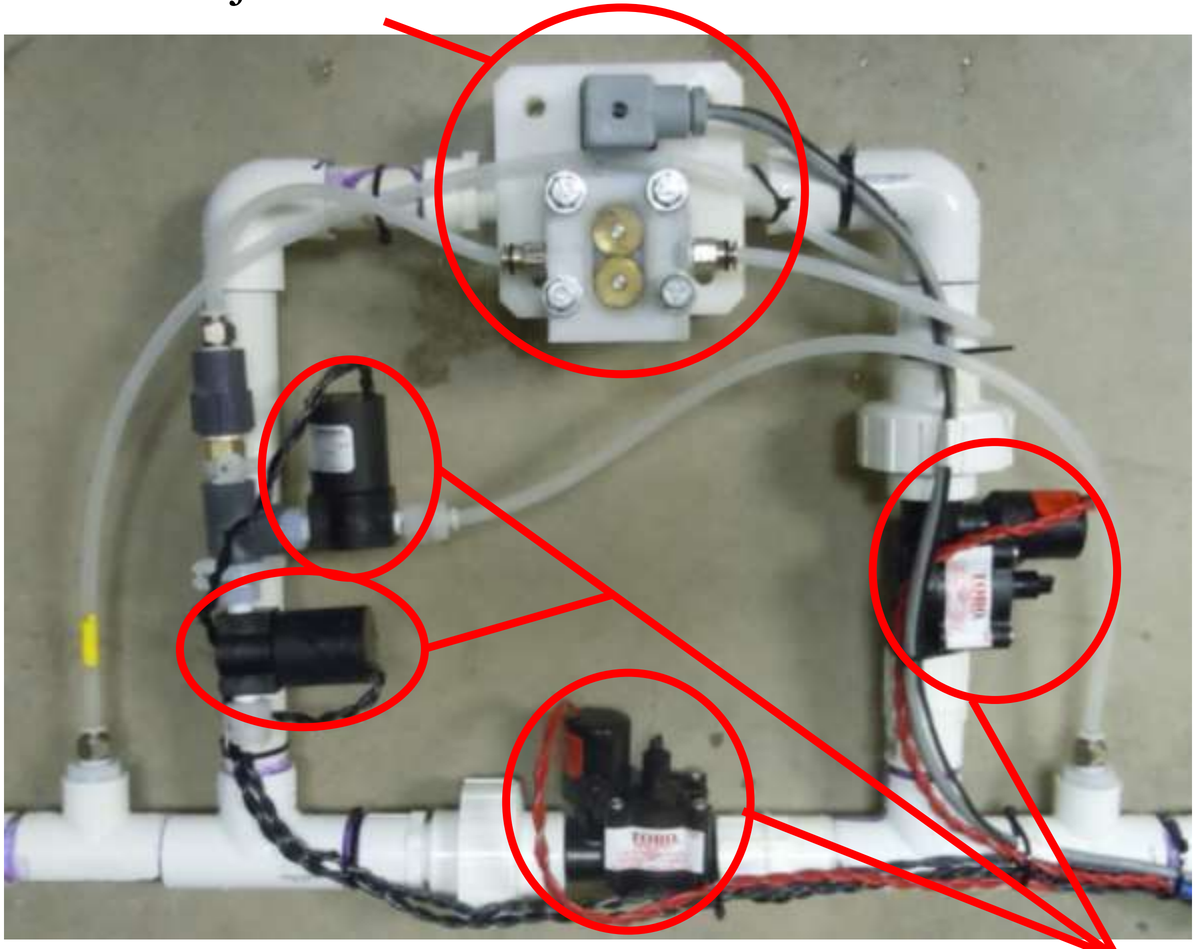
Electric Powered Injector

- Not cost effective
- Intensive controls
- High maintenance



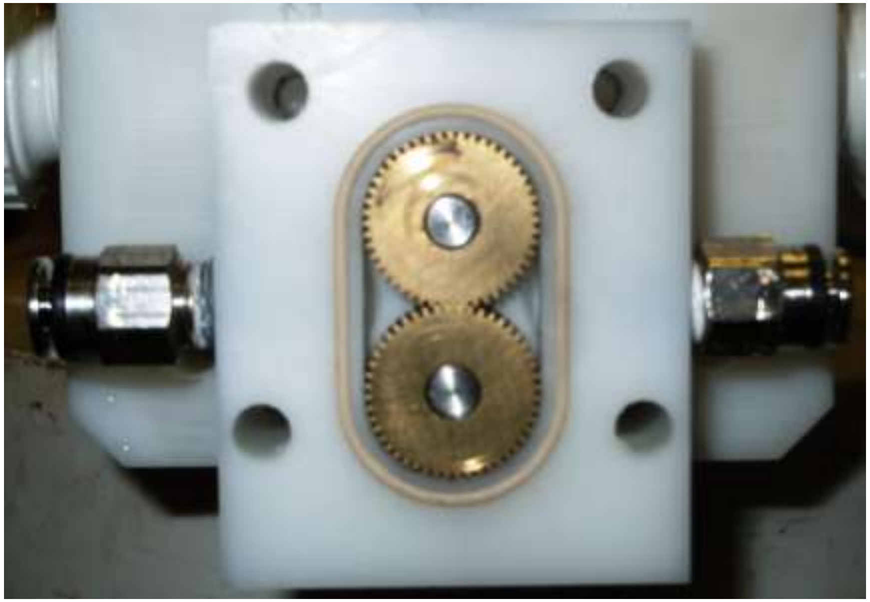
Final Assembly

Injection Unit



Solenoid Valves

Design

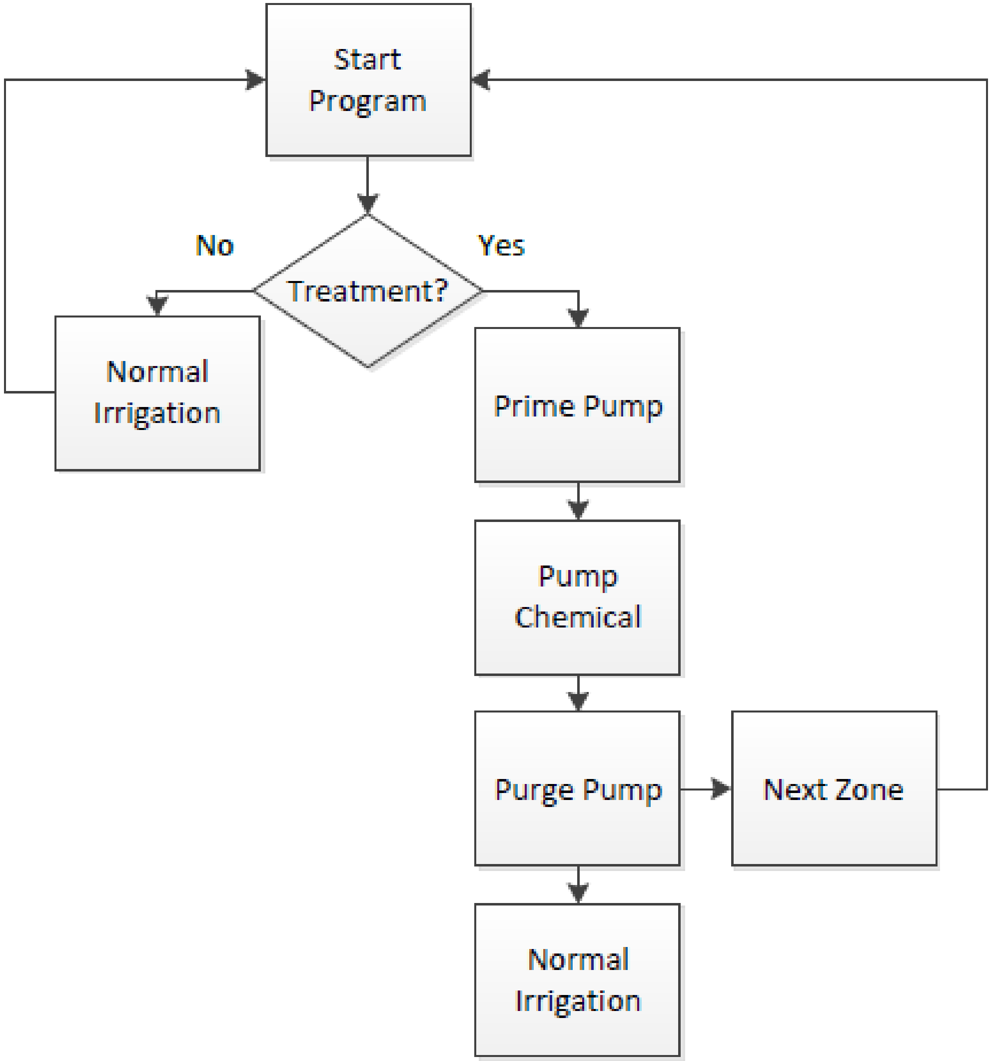


- Pump
  - $Vg=2\pi bm^2(z_t-\sin^2\gamma)$
    - b=width
    - m=module
    - z_t=number of teeth
    - γ=Pressure Angle
- Motor
  - 198 pulses/gallon and 2 pulses/revolution
  - 0.0101 gallons/revolution of motor
  - 1:100 ratio for volume per rotation of pump

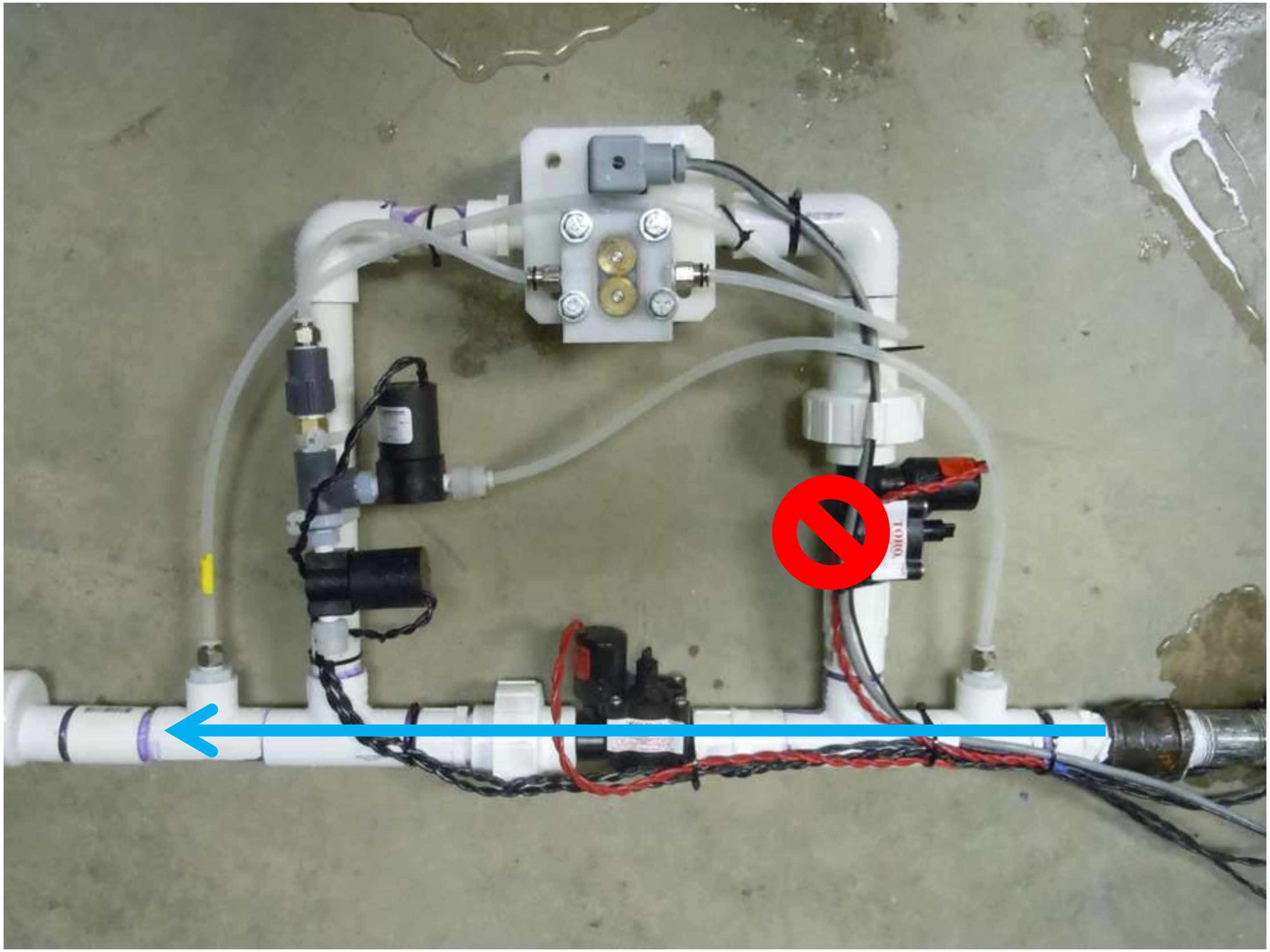
Control System

- 110 V AC Power Supply
- 12-24V DC Inputs
- Relay Outputs
- Controls Solenoid Valves
- Monitor Hall-Effect Sensor, Zone Valves
- Chemical low-level indicator

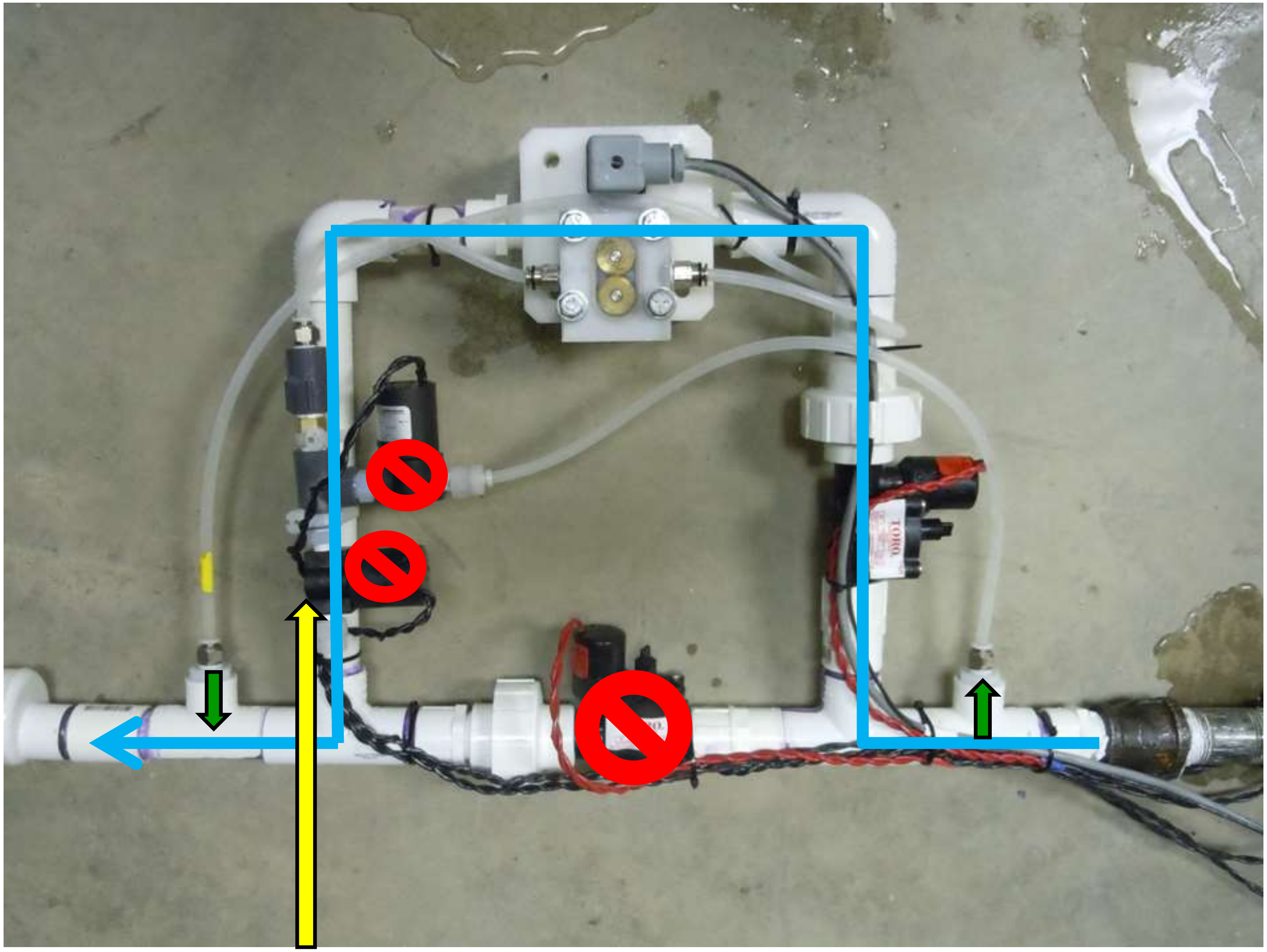
Flow Diagram



Normal Operation



Injection Cycle Operation



Testing

- Static Pressure
- Dynamic Pressure
- Injection Pressure
- Injection Volume
- Starting Pressure
- Operating Pressure Differential

Testing Results

- Passed static and dynamic pressure tests.
- 34 psi max injection pressure was achieved.
- Injection volume was 55% of desired amount.
- Average 12 psi differential pressure to start.
- Average 6.55 gpm to start.

Issues

- Slip
  - Gear Stock
    - Circumference 0.005”
    - Face 0.002”
  - Hydraulic Motor
    - Gear-Housing Clearance 0.009”
    - Face 0.006”
- O-ring Failure
  - O-ring melted, caused seizure.
  - Caused by friction

Recommendations – Reducing Slip

- Slip was greatest source of inefficiency
  - Suggested clearance: 0.0005”
    - Lowest clearance in design: 0.002”
- Reduce Slip
  - Injection Molding
  - High Tolerance Molds

Recommendations – O-ring Failure

- O-ring failed due to friction
- Magnetic Drive
  - Eliminates Shaft
  - Reduces Friction

Prototyping Costs

Piping	$109.78
Tubing	$32.39
Valves	$87.98
Gear Pump	$181.73
Electronics	$365.67
Shipping	$48.47
Total	**$826.02**

Material Costs

Materials		Cost per	#	Total
Hydraulic Motor Block	Injection Mold	4.49	1	$4.49
Hydraulic Pump Block	Injection Mold	2.46	1	$2.46
Motor Gears	Injection Mold	0.88	2	$1.76
Pump Gears	Injection Mold	0.61	2	$1.22
Magnetic Drive Components	Buy	2	4	$8.00
Hall Effect	Buy	1.5	2	$3.00
Control Board	Manufacture	20	1	$20.00
Solenoid Valves	Buy	5	4	$20.00
Resevoir	Injection Mold	5	1	$5.00
Misc. Plastic Parts	Injection Mold	0.88	5	$4.40
Tubing	Buy	0.3	3	$0.90
Specialty PVC fittings	Buy	13.92	1	$13.92
	TOTAL			**$85.15**

Manufacturing Costs

Capital Costs ($)			Operating($ per hour)	
Building	$900,000		Labor	$160
Machines	$60,000		Administration	$40
R&D & Prototyping	$9,360		Building	$6.25
Total	$969,360		Total	$206.25
Per part	**$9.69**		**Price per part**	**$20.63**

Cost ($ per part)	
Material	$85.15
Capital Costs	$9.69
Operating	$20.62
TOTAL	**$115.46**

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Questions