

# PUMP USER'S GUIDE

CE



From  
**YOUR**  
perspective

**WILDEN**<sup>®</sup>

A **DOVER** COMPANY

PUG 10/01  
REPLACES PUG 4/00

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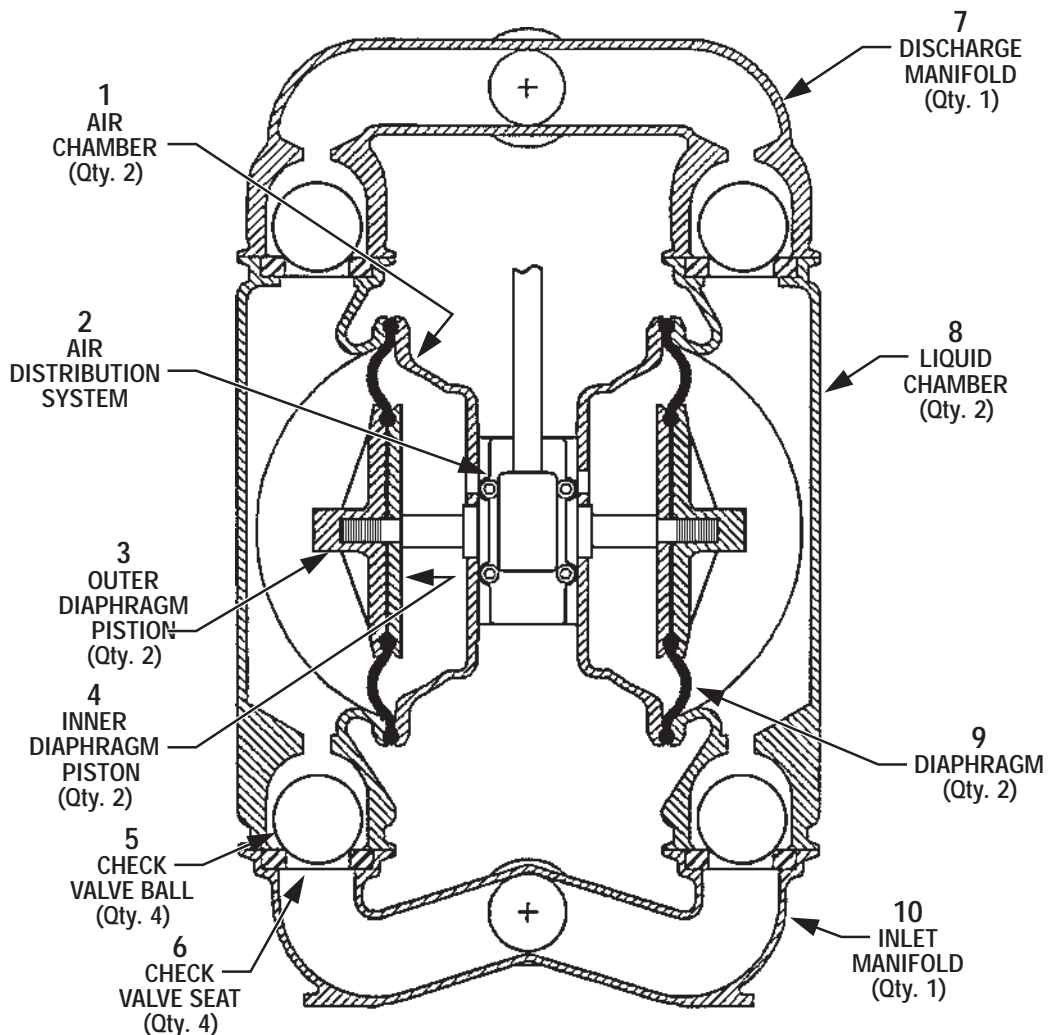
Wilden's "Pump User's Guide" was designed to familiarize you with the operation and mechanics of Wilden air-operated double-diaphragm pumps and accessories. This guide is to be used as a supplement with your pump's Engineering Operation and Maintenance manual (EOM). The Pump User's Guide is a resource for the following: Pump operation principles, application alternatives, air distribution systems, elastomers, pump selection, pump designation system,

pump performance, pump installation, pump operation, troubleshooting, and pump maintenance. In addition, a list of applicable pump accessories, pump warranty, and safety precautions are discussed.

For best results this guide should be used in conjunction with the EOM manual specific to your pump model.

## 1a. THE WILDEN PUMP - AODDP

1. **Air Chamber:** The air chamber is the chamber that houses the air which powers the diaphragms.
2. **Air Distribution System:** The air distribution system is the heart of the pump. The air distribution system is the mechanism that shifts the pump in order to create suction and discharge strokes. Wilden offers Wil-Flo™, Pro-Flo™, Turbo-Flo™, and Accu-Flo™ air distribution systems for your specific pumping needs. Turn to the Air Distribution Systems section on page 6 for more details.
3. **Outer Diaphragm Piston:** The outer diaphragm pistons provide a means to connect the diaphragms to the reciprocating common shaft and to seal the liquid side from the air side of the diaphragm.
4. **Inner Diaphragm Piston:** The inner piston is located on the air side of the pump and does not come into contact with the process fluid.
5. **Check Valve Ball:** Wilden air-operated pumps use suction and discharge check valves to produce directional flow of process fluid in the liquid chamber. The check valve balls seal and release on the check valve seats allowing for discharge and suction of process fluid to occur.
6. **Check Valve Seat:** The removable seats provide the ball valves a site to check.
7. **Discharge Manifold:** Process fluid exits the pump from the discharge port located on the discharge manifold at the top of the pump.
8. **Liquid Chamber:** The liquid chamber is filled with the process fluid during the suction stroke and is emptied during the discharge stroke. It is separated from the compressed air by the diaphragms.
9. **Diaphragm:** The diaphragm membrane provides for separation of the process fluid and the compressed air power source. To perform adequately, diaphragms should be of sufficient thickness and of appropriate material to prevent degradation or permeation in specific process fluid applications. Wilden offers a variety of diaphragm materials for your specific application requirements. Turn to the elastomers section on page 10 and 11 for more details.
10. **Inlet Manifold:** Process fluid enters the pump from the intake port located on the inlet manifold at the bottom of the pump.



## 1b. THE WILDEN PUMP - HOW IT WORKS

The Wilden air-operated pump is a reciprocating double-diaphragm, positive displacement type. The pump displaces fluid from one of its two liquid chambers upon each stroke completion. The following drawings and paragraphs detail the liquid flow pattern through the pump from its initial unprimed position.

There are a few wetted parts (parts that contact the fluid) which are dynamic: The two diaphragms which are connect-

ed by a common shaft, the two inlet valve balls, and the two discharge valve balls. The diaphragms act as a separation membrane between the compressed air supply and the liquid. Driving the diaphragms with compressed air instead of the shaft balances the load on the diaphragm which removes mechanical stress and therefore extends diaphragm life. The valve balls open and close on the valve seats to direct liquid flow.

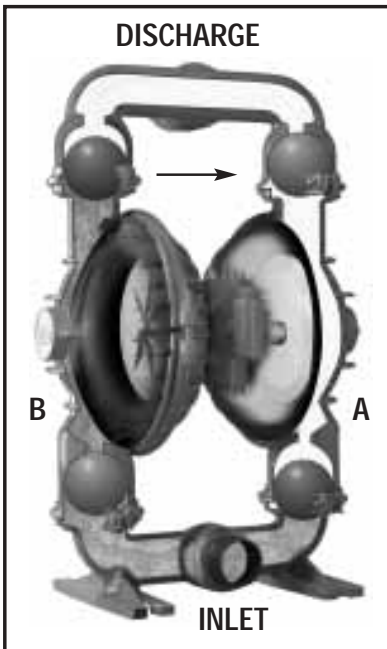


Figure 1 — Right Stroke

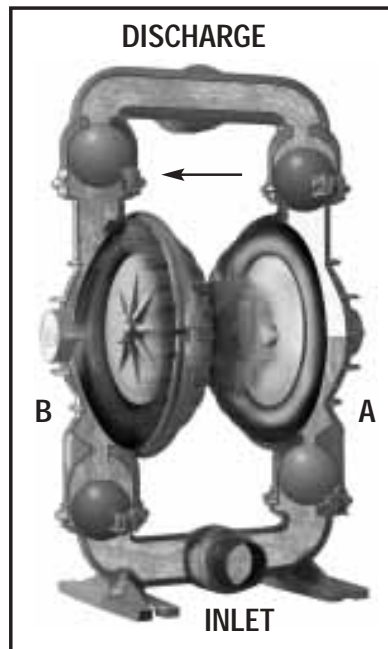


Figure 2 — Midstroke

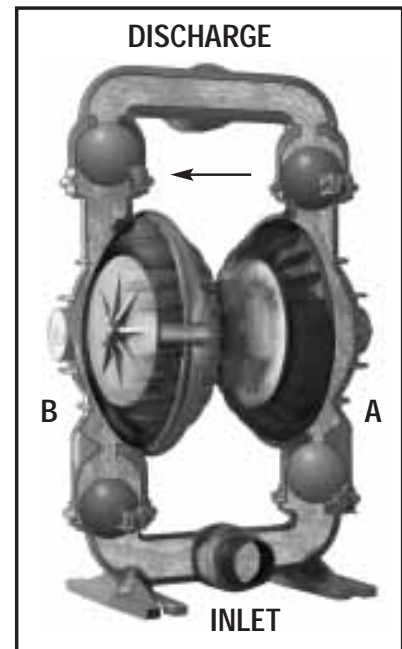


Figure 3 — Left Stroke

**FIGURE 1** The air distribution system directs the air supply to the right air chamber and therefore, the back side of diaphragm A. The compressed air moves diaphragm A away from the center block toward the liquid chamber. The opposite diaphragm (diaphragm B) is pulled inward by the shaft connected to the pressurized diaphragm (diaphragm A). Diaphragm B is now on its suction stroke; air behind the diaphragm has been forced out to atmosphere through the exhaust port of the pump. Diaphragm A is currently working against atmospheric pressure. The movement of diaphragm B toward the center block of the pump creates a vacuum within liquid chamber B. Atmospheric pressure forces fluid into the inlet manifold forcing the inlet valve ball off its seat. Liquid is now free to move past the inlet valve ball (lower left) and fill the liquid chamber.

**FIGURES 2 & 3** When the pressurized diaphragm (diaphragm A) reaches the limit of its discharge stroke, the air valve redirects the compressed air supply to the back side of diaphragm B. The pressurized air forces diaphragm B away from the center block while the shaft pulls diaphragm A toward the center block. The air chamber on side A exhausts its air to atmosphere through the exhaust port of the pump. Diaphragm B is now on its discharge stroke while diaphragm A is on its suction stroke. Diaphragm B forces the inlet valve ball (lower left) onto its seat due to the hydraulic forces developed in the liquid chamber and manifold of the pump. These same hydraulic forces lift the discharge valve ball off its seat, while the opposite discharge valve ball is forced onto its seat, forcing fluid to flow through the left side of the pump and out the discharge manifold. The movement of diaphragm A to the center block of the pump creates a vacuum within liquid chamber A. Atmospheric pressure forces fluid into the inlet manifold of the pump. The inlet valve ball (lower right) is forced off its seat allowing the fluid to enter the right liquid chamber.

As the pump reaches its original starting point, each diaphragm has gone through one suction and one discharge stroke. This movement constitutes one pumping cycle. The pump will take several cycles to completely prime depending on the application variables.

## 1c. PUMP AVAILABILITY CHARTS

### Plastic or Metal Wetted Construction

Pump Size	Pump Model	TURBO-FLO™		WIL-FLO™		ACCU-FLO™		PRO-FLO™		STALLION™	
		T-Series		W-Series		A-Series		P-Series		Solids Passage Pump	
		Wetted Construction		Wetted Construction		Wetted Construction		Wetted Construction		Wetted Construction	
		Plastic	Metal	Plastic	Metal	Plastic	Metal	Plastic	Metal	Plastic	Metal
6.35 mm (¼")	.025					•	•	•	•		
12.7 mm (½")	.050							•			
12.7 mm (½")	1	•	•			•	•	•	•		
25.4 mm (1")	2	•	•			•	•	•	•		
38.1 mm (1½")	4	•	•	•	•	•	•	•	•		•
50.8 mm (2")	8	•	•	•	•	•	•	•	•		•
76.2 mm (3")	15		•	•	•		•		•		•
101.6 mm (4")	20		•				•				

NOTE: Advanced Plastic pumps are offered in P-Series and W-Series only.

### Metal Wetted Construction Only

Pump Size	Pump Model	HIGH PRESSURE	SANIFLO™	SANIFLO™	SANIFLO™	UL-LISTED
		T8 HP250 (250 psi)	FDA	USDA	3A	50 psi Max. Air Supply
6.35 mm (¼")	.025					
12.7 mm (½")	.050					
12.7 mm (½")	1		•			
25.4 mm (1")	2		•		•	•
38.1 mm (1½")	4		•			•
50.8 mm (2")	8	•	•	•		•
76.2 mm (3")	15		•			•
101.6 mm (4")	20					

NOTE: A dot on the chart denotes availability. Example: The Wil-Flo™ series pump is available in the 38.1 mm (1½"), 50.8 mm (2"), and 76.2 mm (3") (W4, W8, and W15).

## 1d. WHY BUY A WILDEN AODDP

For the last 43 years, Wilden Pump & Engineering Co., the world's largest manufacturer of air-operated double-diaphragm pumps, has been providing the industry experts with the most reliable pumps on the market. Wilden pumps are self-priming, can handle viscous and abrasive products,

can run dry without damage, and are capable of passing up to 34.9 mm (1½") solids. Wilden pumps do not employ costly motors, variable speed drives, by-pass plumbing or mechanical trip rods. Please see the matrix below for a comparison of the Wilden AODDP versus Rotary and Centrifugal pumps:

	SOLIDS PASSAGE	SHEAR SENSITIVITY	ABRASIVES HANDLING	SOLVENTS HANDLING	DRY PRIMING	VISCOUS FLUIDS HANDLING	MAINTENANCE COSTS
Wilden Pumps	A	A	A	A	A	A	A
Vane Pumps	D	D	D	A	B	C	C
Internal Gear Pumps	D	D	B	B	C	A	D
External Gear Pumps	D	D	D	B	C	A	D
Lobe Pumps	A	C	B	C	C	A	D
Centrifugal Pumps	D	D	B	B	C	D	B
Progressive Cavity Pumps	D	C	A	B	A	A	D
Piston/Plunger Pumps	C	D	B	C	A	A	D

A = Excellent B = Good C = Fair D = Poor

## 2. SITE SELECTION

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### a. SELF-PRIMING

The Wilden pump is capable of pulling high vacuum. Design characteristics enable the pump to run dry without damage to create a pressure differential. This pressure differential creates suction lift up to 6.4 m (21') of water. Suction lift capability is dependent on pump size and operating conditions (see the Suction Lift Curves and Data Section of your EOM for suction lift curve).



### b. POSITIVE SUCTION HEAD

The pumping system can be designed so that a positive suction head condition is created. This condition is experienced when it is necessary to draw off the bottom of holding tanks, mixing tanks, clarifiers, etc. Pumps operate most efficiently and parts life is maximized when inlet pressure is limited to .68 Bar (10 psig).



### c. SUBMERGED

Many Wilden pumps can be completely submerged. The pump's materials of construction must be chemically compatible with the process fluid and the air exhaust must be plumbed to atmosphere.



### 3. IDENTIFICATION CHART

The following exploded view represents the bill of material of a generic T8 metal pump. Please note there are differences in pump builds due to size, wetted construction, and elas-

tomer choice. Please refer to Section 9 of your EOM (Engineering, Operation, and Maintenance manual) for your pump's exploded view and bill of materials.

Sample Exploded View

# T8 METAL Rubber/ TPE-Fitted

**WILDEN MODEL T8 METAL WITH RUBBER-FITTED ELASTOMERS**

Item	Part Description	Qty.
1	Air Valve Assembly <sup>1</sup>	1
2	Air Valve Screen	1
3	Air Valve End Cap w/ Guide (Top)	1
4	Air Valve End Cap w/o Guide (Bottom)	1
5	Air Valve Snap Ring	2
6	Air Valve Bushing (Optional)	1
7	Air Valve Cap O-Ring	2
8	Oil Bottle (Optional) w/Air Valve 08-2050-07	1
9	Plug (Optional)	1
10	Capillary Rod (Optional)	1
11	Air Valve Gasket — Buna-N <sup>®</sup>	1
12	Air Valve Screw 3/8" - 18 x 2 1/2"	4
13	Center Block	1
14	Center Block Glyd <sup>™</sup> Ring	7
15	Block Gasket — Buna-N <sup>®</sup>	2
16	Shaft	1
	Shaft, Ultra-Flex <sup>™</sup>	1
17	Piston, Outer	2
18	Piston, Outer, Ultra-Flex <sup>™</sup>	2
18	Piston, Inner	2
	Piston, Inner, Ultra-Flex <sup>™</sup>	2
19	Air Chamber, Counter Sunk	2
20	Air Chamber Screw 3/8" - 16 x 3 3/4"	3
21	Air Chamber Cone Nut 3/8" - 16	3
22	Liquid Chamber	2
23	Discharge Manifold	1
24	Inlet Housing for Screened Base	1
25	Screen Base for Item 24	1
26	Suction Hook Up Cover for Item 24	1
27	Cap Screw for Item 24 3/8" - 16 x 1/2"	1
28	Cap Screw Nut 3/8" - 16	2
29	Cap Screw 3/8" - 16 x 3"	2
30	Inlet Housing for Footed Base	1
31	Diaphragm <sup>*</sup>	2
32	Valve Ball <sup>*</sup>	4
33	Valve Seat <sup>*</sup>	4
34	Large Clamp Band	2
35	Large Carriage Bolt 3/8" - 16 x 3"	4
36	Large Hex Nut 3/8" - 16	4
37	Small Clamp Band	4
38	Small Hex Head Cap Screw 3/8" - 18 x 1 1/2"	8
39	Small Hex Nut 3/8" - 18	8
40	Muffler (Optional — not shown)	1
41	Spacer, Ultra-Flex <sup>™</sup>	2
42	Stud, Ultra-Flex <sup>™</sup>	1

All boldface items are primary wear parts.

## 4. AIR DISTRIBUTION SYSTEMS

### 4a. System Availability and Product Line Strategy

## SYSTEM AVAILABILITY



PUMP SIZE	PUMP MODEL	TURBO-FLO™ PROGRESSIVE PUMP TECHNOLOGY	PRO-FLO™ PROGRESSIVE PUMP TECHNOLOGY	WIL-FLO™ PROGRESSIVE PUMP TECHNOLOGY	ACCU-FLO™ SOLENOID PUMP TECHNOLOGY
		T-Series	P-Series	W-Series	A-Series
6.35 mm (1/4")	.025		✓		✓ <sup>1</sup>
12.7 mm (1/2")	.050		✓		
12.7 mm (1/2")	1	✓	✓		✓
25.4 mm (1")	2	✓	✓		✓
38.1 mm (1 1/2")	4	✓	✓	✓	✓
50.8 mm (2")	8	✓	✓	✓	✓
76.2 mm (3")	15	✓	✓	✓	✓
101.6 mm (4")	20	✓			✓

✓ = Product available immediately for sale.

<sup>1</sup> = The A.025 pump does not utilize Glyd™ rings.

## PRODUCT LINE STRATEGY

### **TURBO-FLO™** PROGRESSIVE PUMP TECHNOLOGY

#### **MARKET POSITION**

- Durability
- Low initial cost
- Ease of maintenance
- Low maintenance cost

#### **FEATURES**

- Design simplicity
- Breadth of size and material
- Largest installed base
- Fewest number of parts

#### **APPLICATION TRAITS**

- Utilitarian-type application
- Submersible
- Priority consideration=price

### **PRO-FLO™** PROGRESSIVE PUMP TECHNOLOGY

#### **MARKET POSITION**

- ON/OFF reliability
- Longest lasting wear parts
- Lube-free operation
- Anti-freezing

#### **FEATURES**

- Plastic C-block and A.V.
- Non-stalling unbalanced spool
- Few replaceable parts

#### **APPLICATION TRAITS**

- Maximum reliability
- Process applications
- Max. mean time between failures
- Plastic air system required

### **WIL-FLO™** PROGRESSIVE PUMP TECHNOLOGY

#### **MARKET POSITION**

- Superior anti-freezing
- ON/OFF reliability
- Most efficient  
(GPM/SCFM) or (L/Nm<sup>3</sup>/h)
- Superior flow rate
- Lube-free operation

#### **FEATURES**

- Metal C-block and A.V.
- Pressure relief valves
- Quick air exhaust
- Double muffler configuration

#### **APPLICATION TRAITS**

- Maximum reliability
- Very wet air supply
- Priority consideration=efficiency
- NFPA/UV stabilized (metal block)

### **ACCU-FLO™** SOLENOID PUMP TECHNOLOGY

#### **MARKET POSITION**

- Direct electrical interface
- Superior ON/OFF reliability
- Reduced system costs
- Lube-free operation

#### **FEATURES**

- Externally controlled
- Various voltage and currents
- Nema 4, Nema 7, or Cenelec
- Simple installation
- Wilden accessory interface

#### **APPLICATION TRAITS**

- System automation
- 4-20 mA (pH adjusting)
- Batching applications
- OEM accounts

## 4. AIR DISTRIBUTION SYSTEMS (Cont'd.)

The following section represents a quick overview of the heart of the pump: the air distribution system. The pump's air distribution system alternately routes air supply from one side of the pump to the next, shifting the pump. Wilden Pump & Engineering Co. offers four different air distribution systems to meet your specific pumping needs: Turbo-Flo™, Wil-Flo™, Pro-Flo™, and Accu-Flo™.

### 4b. Turbo-Flo™

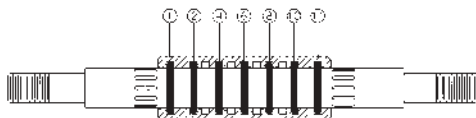


**TURBO-FLO™**  
PROGRESSIVE PUMP TECHNOLOGY

The patented Wilden Turbo-Flo™ air distribution system consists of a ported air valve body which houses a piston. This piston is the only moving component of the air distribution system. The system utilizes differential pressure only to shift the pump. There are no mechanical trip rods, bearings, or springs to repair due to wear. The air valve attaches to a center block which has matching ports. As air is supplied to the air valve, differential pressure causes the piston to move vertically. The vertical movement alternately supplies the power ports with pressurized air. The ports then direct the air to the back side of the diaphragms. Air valve tolerances allow for the passage of some moisture and air line particulates allowing free movement of the piston. The Turbo-Flo™ air distribution system utilizes Glyd™ rings. Glyd™ rings are Teflon® composite seals that offer long-lasting chemically resistant center block seals. The Turbo-Flo™ straight shaft used in conjunction with the Glyd™ rings enhances sealing characteristics and improves seal life. The anodized hollow aluminum piston provides a clean crisp shift. All air valve components can be inspected without disassembling the pump. The Turbo-Flo™ air distribution system is available in the T1, T2, T4, T8, T15, and T20 models.



Shaft and Glyd™ ring configuration for the T1 and T2 pumps. 1, 3, 6, and 8 are seal grooves while 4 and 5 are air bleed grooves.



Shaft and Glyd™ ring configuration for the T4, T8, T15, and T20 pumps. 1, 2, 4, 6, 8, 10, and 11 are seal grooves while 3, 5, 7, and 9 are air channeling grooves.

### 4c. Wil-Flo™



**WIL-FLO™**  
PROGRESSIVE PUMP TECHNOLOGY

The patent-pending Wil-Flo™ air distribution system greatly improves the performance characteristics of the air-operated, double-diaphragm pump. This innovative design incorporates instantaneous shift mechanisms and an enhanced exhaust configuration.

As air is supplied to the air valve, differential pressure causes the thermoplastic air valve piston to move vertically. The vertical movement alternately supplies air pressure to the power ports, through the spring-energized shuttle located directly behind each of the diaphragms. Piston shifting is initiated by inner piston contact with one of the pressure relief valves located on each side of the center block. This contact bleeds air pressure from one end of the air valve piston creating a pressure differential in the air valve body and forcing the piston to shift vertically.

Upon the shifting of the air valve piston, compressed air in the air chamber moves the sliding check assembly into its recess within the center block, thus exposing the exhaust channel. This channel vents exhaust air directly to atmosphere, bypassing the air valve and eliminating a major cause of freezing while maximizing flow rates and efficiency. The Wil-Flo™ air distribution system is available in the W4, W8 and W15 plastic and metal models. Wil-Flo™ retrofit kits are available for your T4, T8, and T15 pumps to easily convert your T-series pump to a Wil-Flo™ pump.

**NOTE:** Wil-Flo™ pumps employ unique W-series straight shafts.

**NOTE:** Wil-Flo™ pumps require a 5µ (micron) air filter.

## 4. AIR DISTRIBUTION SYSTEMS (Cont'd.)

### 4d. Pro-Flo™



**PRO-FLO™**  
PROGRESSIVE PUMP TECHNOLOGY

The Pro-Flo™ patented air distribution system incorporates three moving parts: the air valve spool, the pilot spool, and the main shaft/diaphragm assembly. The heart of the system is the air valve spool and air valve. This valve design incorporates an unbalanced spool. The smaller end of the spool is pressurized continuously, while the large end is alternately pressurized then exhausted to move the spool. The spool directs pressurized air to one air chamber while exhausting the other. The air causes the main shaft/diaphragm assembly to shift to one side — discharging liquid on that side and pulling liquid in on the other side. When the shaft reaches the end of its stroke, the inner piston actuates the pilot spool, which pressurizes and exhausts the large end of the air valve spool. The repositioning of the air valve spool routes the air to the other air chamber.

The Pro-Flo™ air distribution system provides superior on/off reliability in industrial processing applications where the pump is critical to process integrity. Seal technology and porting tolerance diminish blow-by in dead head conditions. Freezing is diminished due to the Pro-Flo™ porting and muffler design. Mating parts and seal configuration have a low coefficient of friction, allowing the pump to operate without in-line lubricants. Pro-Flo™ pumps are available in 6.35 mm (¼") (P.025), 12.7 mm (½") (P1), 25.4 mm (1") (P2), 38.1 mm (1½") (P4), and 50.8 mm (2") (P8). Pro-Flo™ retrofit kits are available for your T1, T2, T4 and T8 pumps to easily convert your T-series pump to a Pro-Flo™ pump.

**NOTE:** Pumps equipped with Pro-Flo™ air distribution system are non submersible.

**NOTE:** Pro-Flo™ pumps utilize a unique Pro-Flo™ straight shaft.

**NOTE:** Pro-Flo™ pumps require a 5µ (micron) air filter.

### 4e. Accu-Flo™



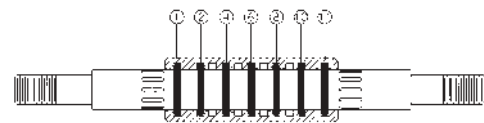
**ACCU-FLO™**  
SOLENOID PUMP TECHNOLOGY

Wilden Accu-Flo™ pumps use electrical impulses to stroke the pump instead of differential pressure. The solenoid air valve is a two position, four-way solenoid valve that has a single operator and spring return. The valve is internally air piloted for long coil and operator life. When the solenoid is unpowered, one air chamber within the pump is pressurized with air, while the opposite chamber is exhausted. When electric power is applied, the solenoid shifts, and the pressurized air chamber is exhausted while the opposite chamber is pressurized. By alternately applying and removing power, the Accu-Flo™ pump runs like a standard Wilden Pump. Wilden's Accu-Flo™ pumps interface directly with electronic devices, need no lubrication, and offer On/Off reliability. Three coil voltage options are available in both Nema 4 and Nema 7 ratings. One coil allows for 110 V AC operation. The second coil option allows for 24 V DC operation and the third option allows for either 24 V AC or 12 V DC operation at 60 Hz. The chart at the top of page 10 shows the options available by pump model.

**NOTE:** Accu-Flo™ pumps are not submersible.



Shaft and Glyd™ ring configuration for the A.025, A1, and A2 pumps. 1, 3, 6, and 8 are seal grooves.



Shaft and Glyd™ ring configuration for the A4, A8, A15, and A20 pumps. 1, 2, 4, 6, 8, 10, and 11 are seal grooves.

## 4. AIR DISTRIBUTION SYSTEMS (Cont'd.)

### 4f. Accu-Flo™ Solenoid Coil Options

Models Available:	Solenoid Coil Options								
	Nema 4 UL CSA Approved								
	Coil Part Number	Voltage ±10%		Power(W) ±10%	Current (A)		Resistivity (Ω)		
		DC	AC		DC	AC			
		60 Hz	50 Hz		Inrush	Holding			
A.025 6.35 mm (1/4")	00-2110-99-150	24	48	44	4.8	.20	.20	.20	121
A1 12.7 mm (1/2")	00-2110-99-151	12	24	22	4.8	.40	.40	.40	32
A2 25.4 mm (1")	00-2110-99-155	60	120	110	4.8	.08	.08	.06	840
A4 38.1 mm (1 1/2")	Nema 7 UL CSA Approved								
A8 50.8 mm (2")	00-2110-99-153	12	24	22	7	.60	.55	.32	19
A15 76.2 mm (3")	00-2110-99-154	24	48	44	7	.30	.30	.18	75
A20 101.6 mm (4")	00-2110-99-156	60	120	110	7	.12	.13	.06	475
	International Explosion Proof / Cenelec / PTB file# EX-91.C.2027								
	00-2110-99-157	24 VDC			3.3	.135	.135		177

## 5. ELASTOMERS

Diaphragms, valve balls, valve seats and O-rings are collectively known as pump elastomers. Wilden diaphragm pumps can be fitted with a wide range of elastomer compounds to meet virtually any application requirement.

Considerations for specifying elastomers include: temperature limitations, chemical compatibility, flex-life, abrasion resistance, initial investment, suction lift capabilities, and sanitary standards.

There are 3 types of elastomers: Rubber compounds, Thermoplastics, and Teflon® PTFE. Please see the Elastomer Options on page 12 for a comprehensive guide of material availability for each pump type and size.



**CAUTION:** Verify the chemical compatibility of the process and cleaning fluid to the pump's component materials in the Chemical Resistance Guide (E4.)

### 5a. Rubber Compounds:

These compounds consist of natural rubber and man-made additives to increase their resistance to specific types of fluids. Diaphragms made of these compounds utilize a nylon fabric mesh. The fabric mesh is centered within the diaphragm during the molding process. The fabric mesh lends dimensional stability and strength to the compound.

Elastomer	Usage	Temperature Limitations
Neoprene	An excellent general purpose elastomer for use in non-aggressive applications. Exhibits excellent flex life and low cost. Available for the T2, A2, P2, T4, A4, P4, W4, T8, A8, P8, W8, T15, A15, W15, T20 and A20 pumps.	- 17.7°C to +93.3°C 0°F to +200°F
Buna-N	Excellent for applications involving petroleum/oil-based fluids. Exhibits good flex life. Available for the A.025, P.025, T1, A1, P1, T2, A2, P2, T4, A4, P4, W4, T8, A8, P8, W8, T15, A15, W15, T20 and A20 pumps.	- 12.2°C to +82.2°C +10°F to +180°F
Nordel® (EPDM)	Excellent for use in applications requiring extremely cold temperatures. May also be used as a low cost alternative when pumping dilute acids or caustics. Not oil resistant. Available for the T2, A2, P2, T4, A4, P4, W4, T8, A8, P8, W8, T15, A15, W15, T20 and A20 pumps.	- 51.1°C to +137.8°C - 60°F to +280°F
Viton®	Excellent for use in applications requiring extremely hot temperatures. May also be used with aggressive fluids such as aromatic or chlorinated hydrocarbons and acids. The high cost and poor flex life of Viton® limit its use. Available for the T1, A1, P1, T2, A2, P2, T4, A4, P4, W4, T8, A8, P8, W8, T15, A15, W15, T20 and A20 pumps.	- 40°C to +175.7°C - 40°F to +350°F

## 5. ELASTOMERS (Cont'd.)



### Ultra-Flex™ Diaphragms

Wilden's latest breakthrough in diaphragm design is the Ultra-Flex™ diaphragm series. Neoprene, Buna-N, Nordel®, and Viton® Ultra-Flex™ diaphragms are available for the T4 Metal, Stallion, and Plastic, A4 Metal and Plastic, P4 Metal and W4 Metal, T8 Metal, Stallion, and Plastic, A8 Metal and Plastic, P8 Metal and Plastic, W8 Metal and Plastic, T15 Metal and Stallion, W15 Metal, T20 Metal and A20 Metal pumps. Wilden's Ultra-Flex™ patented technology diaphragms are **guaranteed to deliver longer life** than pie-shaped, dome-shaped, or any other competitive diaphragm technology. Ultra-Flex™ diaphragms are ideal for applica-

tions where the pump runs many hours per day and greater flex life is needed. Field results also show the Ultra-Flex™ to be an excellent diaphragm choice for powder transfer applications.

### 5b. Thermoplastic Compounds

These compounds are made up entirely of man-made elements. Diaphragms made of these compounds require no fabric reinforcement due to the dimensional stability and tensile strength inherent in TPE (Thermoplastic Elastomers) compounds.

Elastomer	Usage	Temperature Limitations
Wil-Flex™ (Santoprene®)	A low-cost alternative to Teflon® in many acidic and caustic applications. Exhibits excellent abrasion resistance and flex life. Available for the A.025, P.025, T1, A1, P1, T2, A2, P2, T4, A4, P4, W4, T8, A8, P8, W8, T15, A15, W15, T20 and A20 pumps.	- 40° C to +107.2° C - 40° F to +225° F
Polyurethane	A general purpose diaphragm for use in non-aggressive and/or highly abrasive applications. Available for the T1, A1, P1, T2, A2, P2, T4, A4, P4, W4, T8, A8, P8, W8, T15, A15, W15, T20 and A20 pumps.	- 12.2° C to +65.6° C +10° F to +150° F
Sani-Flex™ (Hytrel®)	Excellent abrasion resistance, flex life and durability. This material is FDA approved for food processing applications. An outstanding general purpose diaphragm. Good for oil and coolants. Available for the T1, A1, P1, T2, A2, P2, T4, A4, P4, W4, T8, A8, P8, W8, T15, A15, W15, T20 and A20 pumps.	- 28.9° C to +104.4° C - 20° F to +220° F

### 5c. Teflon® PTFE (Polytetrafluoroethylene)

Teflon® PTFE is one of the most chemically inert man-made compounds known. Wilden engineers were the first to discover that by reinforcing a molded Teflon® PTFE diaphragm with concentric ribs they could control the flex pattern of the diaphragm. Wilden's patented ribbed design extends flex life 5 to 10 times longer than that of any other Teflon® diaphragm. This innovation made the use of Teflon® elastomers in diaphragm pumps cost effective, greatly expanding the range of applications for diaphragm pumps. Teflon® is not an

elastic material, therefore when utilizing Teflon® diaphragms, a back-up diaphragm is required to provide flexibility and memory in every size except A.025 and P.025. Material options for back-up diaphragms are Neoprene, Sani-Flex®, and high temperature Buna-N. When using Teflon® diaphragms, see section 5 of EOM manual for Teflon® flow curve. Typically, Teflon® flow rates are different than TPE and rubber. This is due to the inability of Teflon® to flex as far as rubber diaphragms, thus decreasing the displacement of process fluid per stroke.

Elastomer	Usage	Temperature Limitations
Teflon® PTFE	Excellent choice when pumping highly aggressive fluids such as aromatic or chlorinated hydrocarbons, acids, caustics, ketones and acetates. Exhibits good flex life compared to a standard diaphragm. Available for the A.025, P.025, P.050, T1, A1, P1, T2, A2, P2, T4, A4, P4, W4, T8, A8, P8, W8, T15, A15, W15, T20 and A20 pumps.	+4.4° C to +104.4° C +40° F to +220° F  For T1, A1, P1 +4.4° C to +142° C +40° F to +300° F

### 5d. Specialty Diaphragms

Wilden offers a variety of specialty diaphragms such as the IPD (Integral Piston Diaphragm) for the A.025, P.025, P.050, T2, A2 and P2 pump series, as well as the non-pigmented Wil-Flex™ diaphragm for the HP250 high-pressure pump.

## 5e. ELASTOMER OPTIONS

### METAL PUMPS

#### DIAPHRAGM AND VALVE BALL

	PUMP MODEL															
	P.025	T1	P1	T2	T4	T8	T15	T20								
	A.025	A1	A2	A4	A8	A15	A20	P4	P8	P15	P20	W4	W8	W15	W20	
Neoprene				*	*	*	*	*	*	*	*	*	*	*	*	*
Polyurethane		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Buna-N	* <sup>1</sup>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Nordel <sup>®</sup>			*	*	*	*	*	*	*	*	*	*	*	*	*	*
Viton <sup>®</sup>		*	*	*	*	*	*	*	*	*	*	*	*	*	*	* <sup>2</sup>
Wil-Flex <sup>™</sup>	* <sup>1</sup>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	* <sup>2</sup>
Sani-Flex <sup>™</sup>		*	*	*	*	*	*	*	*	*	*	*	*	*	*	* <sup>2</sup>
Teflon <sup>®</sup> PTFE	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	* <sup>2</sup>

<sup>1</sup>Diaphragm only.  
<sup>2</sup>Valve balls only.

#### VALVE SEAT O-RINGS

	PUMP MODEL															
	P.025	T1	P1	T2	T4	T8	T15	T20								
	A.025	A1	A2	A4	A8	A15	A20	P4	P8	P15	P20	W4	W8	W15	W20	
Polyurethane		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Buna-N	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Nordel <sup>®</sup>			*	*	*	*	*	*	*	*	*	*	*	*	*	*
Sani-Flex <sup>™</sup>		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Teflon <sup>®</sup> PTFE	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Fluoro-Seal <sup>™</sup>					*	*	*	*	*	*	*	*	*	*	*	*
Wil-Flex <sup>™</sup>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

#### VALVE SEATS

	PUMP MODEL															
	P.025	T1	P1	T2	T4	T8	T15	T20								
	A.025	A1	A2	A4	A8	A15	A20	P4	P8	P15	P20	W4	W8	W15	W20	
Neoprene					*	*	*	*	*	*	*	*	*	*	*	*
Polyurethane					*	*	*	*	*	*	*	*	*	*	*	*
Buna-N					*	*	*	*	*	*	*	*	*	*	*	*
Nordel <sup>®</sup>					*	*	*	*	*	*	*	*	*	*	*	*
Viton <sup>®</sup>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Wil-Flex <sup>™</sup>					*	*	*	*	*	*	*	*	*	*	*	*
Sani-Flex <sup>™</sup>					*	*	*	*	*	*	*	*	*	*	*	*
Aluminum	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Stainless Steel	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Carbon Steel					*	*	*	*	*	*	*	*	*	*	*	*
Hastelloy C	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

#### MANIFOLD O-RINGS

The only metal pumps utilizing manifold O-rings are the T8 Sani-Flo<sup>™</sup>, models T20 and A20, which use Viton<sup>®</sup> or polyurethane, and the T1, P1 and A1 pumps, which utilize the same options as the T1, P1 and A1 Plastic. The Teflon<sup>®</sup> manifold O-rings utilized in the T1, P1 and A1 Metal pumps are Teflon<sup>®</sup> PTFE versus the Teflon<sup>®</sup> encapsulated Viton<sup>®</sup> O-rings utilized in the T1, P1 and A1 Plastic pumps.

### PLASTIC PUMPS

#### DIAPHRAGM AND VALVE BALL

	PUMP MODEL															
	P.025	P.050	T1	T2	T4	T8	T15	T20								
	A.025	A.050	A1	A2	A4	A8	A15	A20	P4	P8	P15	P20	W4	W8	W15	W20
Neoprene				*	*	*	*	*	*	*	*	*	*	*	*	*
Polyurethane			*	*	*	*	*	*	*	*	*	*	*	*	*	*
Buna-N	* <sup>1</sup>	* <sup>1</sup>	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Nordel <sup>®</sup>			*	*	*	*	*	*	*	*	*	*	*	*	*	*
Viton <sup>®</sup>			*	*	*	*	*	*	*	*	*	*	*	*	*	*
Wil-Flex <sup>™</sup>	* <sup>1</sup>	* <sup>1</sup>	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Sani-Flex <sup>™</sup>			*	*	*	*	*	*	*	*	*	*	*	*	*	*
Teflon <sup>®</sup> PTFE	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

<sup>1</sup>Diaphragm only.

#### VALVE SEAT O-RINGS

	PUMP MODEL															
	P.025	P.050	T1	T2	T4	T8	T15	T20								
	A.025	A.050	A1	A2	A4	A8	A15	A20	P4	P8	P15	P20	W4	W8	W15	W20
Polyurethane			*	*	*	*	*	*	*	*	*	*	*	*	*	*
Buna-N	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Teflon <sup>®</sup> (Encapsulated)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Wil-Flex <sup>™</sup>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Chemraz <sup>®</sup>			*	*	*	*	*	*	*	*	*	*	*	*	*	*
Sani-Flex <sup>™</sup>			*	*	*	*	*	*	*	*	*	*	*	*	*	*
Nordel <sup>®</sup>					*	*	*	*	*	*	*	*	*	*	*	*

#### VALVE SEATS

	PUMP MODEL															
	P.025	P.050	T1	T2	T4	T8	T15	T20								
	A.025	A.050	A1	A2	A4	A8	A15	A20	P4	P8	P15	P20	W4	W8	W15	W20
Polypropylene	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
PVDF	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Carbon-Filled			*	*	*	*	*	*	*	*	*	*	*	*	*	*
Acetal	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Teflon <sup>®</sup> PFA			*	*	*	*	*	*	*	*	*	*	*	*	*	*
Viton <sup>®</sup>			*	*	*	*	*	*	*	*	*	*	*	*	*	*

#### MANIFOLD O-RINGS

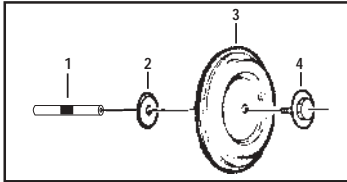
	PUMP MODEL															
	P.025	P.050	T1	T2	T4	T8	T15	T20								
	A.025	A.050	A1	A2	A4	A8	A15	A20	P4	P8	P15	P20	W4	W8	W15	W20
Polyurethane			*	*	*	*	*	*	*	*	*	*	*	*	*	*
Buna-N	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Teflon <sup>®</sup> (Encapsulated)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Wil-Flex <sup>™</sup>	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Chemraz <sup>®</sup>			*	*	*	*	*	*	*	*	*	*	*	*	*	*
Viton <sup>®</sup>			*	*	*	*	*	*	*	*	*	*	*	*	*	*
Sani-Flex <sup>™</sup>			*	*	*	*	*	*	*	*	*	*	*	*	*	*

Fluoro-Seal<sup>™</sup> is a trademark of Wilden Pump & Engineering Co.  
 Sani-Flex<sup>™</sup> and Wil-Flex<sup>™</sup> are registered trademarks of Wilden Pump & Engineering Co.  
 Buna-N<sup>®</sup>, Nordel<sup>®</sup> and Viton<sup>®</sup> are registered trademarks of DuPont Dow Elastomers.  
 Teflon<sup>®</sup> is a registered trademark of DuPont.

## 6. DIAPHRAGM ASSEMBLY

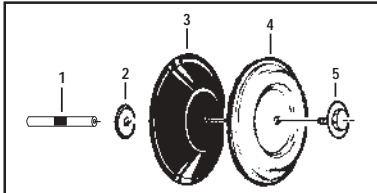
The following drawings represent generic diaphragm assemblies for a Wilden pump. Your specific diaphragm configuration might be different. Please consult Section 9A of your EOM for your pump's specific diaphragm assembly.

### 6a. Rubber/Thermoplastic Elastomer-fitted pumps:



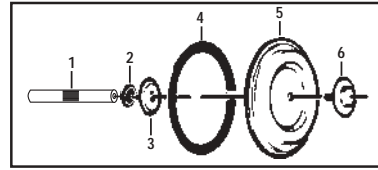
1. Main shaft
2. Inner piston
3. Primary diaphragm in contact with the process fluid
4. Outer piston holds the diaphragm to the shaft (in contact with process fluid)

### 6b. Teflon®-fitted pumps (except A.025 and P.025):



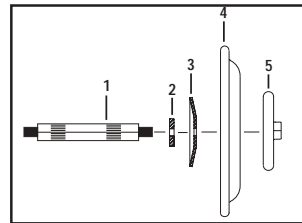
1. Main shaft
2. Inner piston
3. Back-up diaphragm not in contact with process fluid (employed with Teflon® primary diaphragms, except 1/4" pumps)
4. Primary Teflon® PTFE diaphragm in contact with process fluid on the outer piston side
5. Outer piston holds the diaphragm to the shaft (in contact with process fluid)

### Teflon®-fitted A.025 and P.025 pumps diaphragm assembly:



1. Main shaft
2. Bellville washer
3. Inner piston
4. Back-up O-ring not in contact with process fluid (employed with Teflon® primary diaphragms only)
5. Primary Teflon® PTFE diaphragm
6. Outer piston

### 6c. Ultra-Flex™-fitted pumps:



1. Main shaft
2. Spacer
3. Inner piston
4. Primary diaphragm — Ultra-Flex™
5. Outer piston

Note: Pro-Flo™ (P4 & P8) models fitted with Ultra-Flex™ diaphragms do not use a spacer.

Note: 6.35 mm (1/4"), 12.7 mm (1/2"), and 25.4 mm (1") pump shaft assemblies utilize Bellville washers, installed between the shaft and inner piston, and 242 Loctite.

## 7. PUMP SELECTION

### 7a. Pump Selection Chart

	Model	Pump Size	Maximum Solids Passage	Maximum Flow Rates
T-Series & A-Series*	A.025	1/4" inlet	0.4 mm (1/64")	10.6 LPM (2.8 gpm)
	T1, A1	1/2" inlet	1.6 mm (1/16")	54.9 LPM (14.5 gpm)
	T2, A2, T2R, A2R	1" inlet	3.2 mm (1/8")	132.5 LPM (35 gpm)
	T2 Saniflo <sup>3A</sup>	1 1/2" Tri-clamp	6.4 mm (1/4")	125 LPM (32.9 gpm)
	T4, A4	1 1/2" inlet	4.8 mm (3/16")	352.0 LPM (93 gpm)
	T4 Stallion	1 1/2" inlet	12.7 mm (1/2")	216.6 LPM (57 gpm)
	T8, A8	2" inlet	6.4 mm (1/4")	617 LPM (163 gpm)
	T8 Saniflo <sup>USDA</sup>	2" inlet	12.7 mm (1/2")	532 LPM (140 gpm)
	T8 Stallion	2" inlet	19.1 mm (3/4")	562.4 LPM (148 gpm)
	T8 HP250	2" inlet	6.4 mm (1/4")	359 LPM (96 gpm)
	T15, A15	3" inlet	9.5 mm (3/8")	878.1 LPM (232 gpm)
	T15 Stallion	3" inlet	25.4 mm (1")	695.4 LPM (183 gpm)
P-Series	P.025	1/4" inlet	0.4 mm (1/64")	18.9 LPM (5.0 gpm)
	P1	1/2" inlet	1.6 mm (1/16")	56.8 LPM (15 gpm)
	P2	1" inlet	3.2 mm (1/8")	170.3 LPM (45 gpm)
	P4	1 1/2" inlet	4.8 mm (3/16")	352.0 LPM (93 gpm)
	P8	2" inlet	6.4 mm (1/4")	590.5 LPM (156 gpm)
W-Series	W4	1 1/2" inlet	4.8 mm (3/16")	374.8 LPM (99 gpm)
	W8	2" inlet	6.4 mm (1/4")	779.8 LPM (206 gpm)
	W15	3" inlet	12.7 mm (1/2")	1086.4 LPM (287 gpm)

\*A-series pumps have a significant reduction in flow rate as compared to the T-series pumps. Refer to Section 5 of your EOM manual for specifics.

## 7. PUMP SELECTION (Cont'd.)

### 7b. Size

A pump's critical dimensions must be checked against existing piping to eliminate the need for costly re-plumbing. Please refer to Section 4 of your EOM manual for details.

### 7c. Solids Handling Capability

Maximum slurry particle size must not be greater than the pump's solids passage capability. A strainer may be placed on the inlet line to eliminate particles larger than the pump's capability. Please refer to Section 5 of your EOM manual for your pump's specific solids passage capabilities.

### 7d. Suction Lift

An application's suction lift requirements must not be greater than the pump's suction lift capabilities. Suction lift will vary depending on the number of inlet and discharge elbows, the viscosity of the process fluid, elevation (atmospheric pressure) and pipe friction loss. Wilden suction lift curves are calibrated for pumps operating at 305m (1,000') above sea level pumping water. When reading suction lift curves, locate the curve on the chart that represents your pump (Teflon®, TPE, Ultra-Flex™, or Rubber fitted). On the Inlet Air Pressure axis, locate the amount of air pressure you are running to the pump, follow that point straight up until you locate the curve. Once you locate the curve, trace that point to the left until you locate the Dry Vacuum vertical axis. The point you reach corresponds to the dry vacuum or suction lift your pump will achieve at that specific inlet air pressure. Please refer to Section 6 of your EOM for your pump's specific suction lift capabilities.

### 7e. Performance Curves

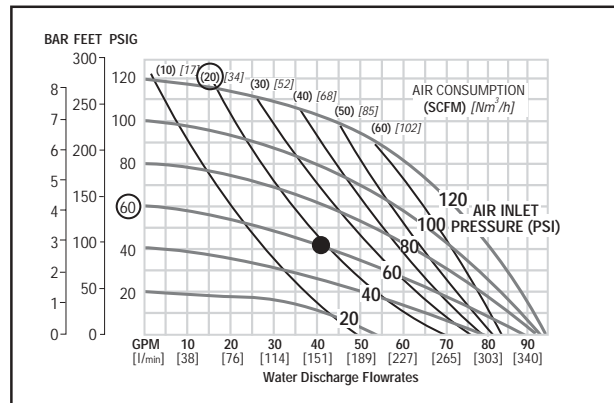
Pump performance capabilities must be matched with flow rate requirements. Please consult Section 5 of your EOM for your pump's performance curve.

- Discharge head (vertical axis).
- Required flow rate (horizontal axis).

A pump should be selected which will operate between the 25 and 75 percentile range of capacity.

For optimum life and performance, pumps should be specified so that daily operation parameters will fall in the middle of the pump performance curve. Wilden publishes 4 different performance curves for most metal and plastic pump models. These performance curves are unique due to the different stroke lengths of the diaphragm assemblies. The four classifications are: 1) Rubber-fitted pumps; 2) Ultra-Flex™-fitted pumps; 3) Thermoplastic (TPE)-fitted pumps; and 4) Teflon®-fitted pumps. When applicable, all four of these curves are included in the Engineering, Operation, and Maintenance manuals (EOM's).

**How to read a Wilden performance curve:** Determine the flow rate your application requires and calculate the Total Discharge Head (page 15). Plot the intersection of the discharge head on the vertical axis to the flow rate on the horizontal axis. Now the air supply pressure and air supply volume can be extracted from the curve. Simply locate the solid black line closest to this intersection and follow it to the vertical axis to the left. This is the air supply pressure needed to provide the flow rate you require at the given discharge head. Next locate the closest gray line to the intersection and follow it up to where the numbers are provided. These numbers indicate the air supply volume needed to provide the flow rate you require at the given discharge head.



To pump 151 lpm (40 gpm) against a discharge pressure head of 2.7 Bar (40 psig) requires 4.1 Bar (60 psig) and 30.6 Nm<sup>3</sup>/h (18 scfm) air consumption. Dot on chart represents the plotted intersection and the circled numbers are the air pressure and volume figures.

### 7f. Total Dynamic Head Calculation:

Please refer to the example at the top of page 15 for calculating your TDH (Total Dynamic Head). Wilden publishes a Pump Viscosity and Cavitation Chart (E6) that needs to be used in accordance with the boxed worksheet to obtain the Total Dynamic Head. Process fluid viscosity plays an integral part in calculating TDH. The more viscous a product, the more head a pump has to overcome to move that product. Please contact your authorized Wilden distributor for more information.

### 7g. Chemical Compatibility

Wilden's chemical resistance guide (E4) should be used in conjunction with personal experience to select wetted pump construction and elastomers for chemical compatibility with the process fluid.

### 7h. Temperature Limitations

Temperature limitations are based on mechanical stress only. Certain chemicals will significantly reduce the maximum safe operating temperatures. Consult Wilden's Chemical Resistance Guide (E4) for chemical compatibility and temperature limits for specific fluids. Process fluid and environmental temperatures must be considered. Temperature limits for materials of construction and elastomers are listed below: Additionally, temperature limitations are listed in Section 3 of your EOM.

#### TEMPERATURE LIMITS:

Polypropylene	0°C to +79°C	+32°F to +175°F
PVDF Kynar®	-12°C to +107°C	+10°F to +225°F
Teflon® PFA	+7°C to +143°C	+20°F to +300°F
(T1 and P1 UP III)		
Teflon® PFA	+7°C to +107°C	+20°F to +225°F
(T1 and P1 UP I and T4, A4, W4, P4 only)		
Neoprene	-17.7°C to +93.3°C	0°F to +200°F
Buna-N	-12.2°C to +82.2°C	+10°F to +180°F
Nordel®	-51.1°C to +137.8°C	-60°F to +280°F
Viton®	-40°C to +176.7°C	-40°F to +350°F
Wil-Flex™	-40°C to +107.2°C	-40°F to +225°F
Saniflex™	-28.9°C to +104.4°C	-20°F to +220°F
Polyurethane	-12.2°C to +65.6°C	+10°F to +150°F
Teflon® PTFE	+4.4°C to +104.4°C	+40°F to +220°F
Carbon-filled Acetal	-28.9°C to +65.6°C	-20°F to +150°F
Teflon® PTFE (P.050 only)	0°C to +120°C	+32°F to +248.9°F

## 7. PUMP SELECTION (Cont'd.)

### TOTAL DYNAMIC HEAD WORKSHEET

Need to Know: G.P.M. Specific Gravity (s.g.,  $\gamma$ ) Pipe Size ( $\phi$ ) Viscosity( $\mu$ )  
Need to Have: Wilden Cavitation/Pipe Friction Chart and Viscosity Chart (RBG-E6)

TOTAL DYNAMIC HEAD = +/- TOTAL SUCTION LIFT + TOTAL DISCHARGE HEAD

#### I. Static Suction Head/Lift

Static Lift (head) = vertical distance from liquid surface to center line of pump

\_\_\_\_\_ (Vertical feet) x \_\_\_\_\_ s.g. = \_\_\_\_\_ feet  
 \_\_\_\_\_ feet x .433 (or Divide by 2.31) = \_\_\_\_\_ PSI

#### II. Dynamic Suction

(A) Pipe Diameter \_\_\_\_\_ (inches)  
 (B) Viscosity \_\_\_\_\_ (ssu)  
 (C) Pipe \_\_\_\_\_  
 + elbows\* \_\_\_\_\_  
 = total pipe \_\_\_\_\_ (feet)

Viscosity Chart Figure \_\_\_\_\_ (PSI loss/100 ft)

\_\_\_\_\_ x \_\_\_\_\_ s.g. x \_\_\_\_\_ total pipe = \_\_\_\_\_ PSI  
 (PSI loss 100)

#### II. Total Suction Lift/Head

\_\_\_\_\_ (PSI figure from calculation I)  
 + \_\_\_\_\_ (PSI figure from calculation II)  
 = \_\_\_\_\_ PSI

+/- \_\_\_\_\_ **Total Suction Lift**

\_\_\_\_\_ **Total Discharge Head**

= \_\_\_\_\_ **PSI Total Dynamic Head**

\* Assume 10 ft loss for every 90° elbow.

#### Static Discharge Head

Discharge Head = vertical distance from center line of pump to point of free discharge

\_\_\_\_\_ (Vertical feet) x \_\_\_\_\_ s.g. = \_\_\_\_\_ feet  
 \_\_\_\_\_ feet x .433 (or Divide by 2.31) = \_\_\_\_\_ PSI

#### Dynamic Discharge

(A) Pipe Diameter \_\_\_\_\_ (inches)  
 (B) Viscosity \_\_\_\_\_ (ssu)  
 (C) Pipe \_\_\_\_\_  
 + elbows\* \_\_\_\_\_  
 = total pipe \_\_\_\_\_ (feet)

Viscosity Chart Figure \_\_\_\_\_ (PSI loss/100 ft)

\_\_\_\_\_ x \_\_\_\_\_ s.g. x \_\_\_\_\_ total pipe = \_\_\_\_\_ PSI  
 (PSI loss 100)

#### Total Discharge Head

\_\_\_\_\_ (PSI figure from calculation I)  
 + \_\_\_\_\_ (PSI figure from calculation II)  
 = \_\_\_\_\_ PSI

Please refer to page 25 for conversion tables.

#### 7i. Abrasion Resistance

When a highly abrasive fluid is pumped, damage can occur to the pump's internals if the given internals do not exhibit the abrasion resistance needed. Certain powders, as well as, slurries containing rocks, metal fines, or sand tend to be highly abrasive "scratching" the pump's internals as they go through the pump. Pump internals most likely to get damaged are a pump's ball cages and elastomers: diaphragms, balls, and seats. If the given elastomers do not exhibit the abrasion resistance required, they will wear prematurely. This premature wear will affect the pump's performance.

Note: When pumping highly abrasive substances, it is suggested to install an oversize pump in order to reduce the velocity of the process fluid and hence reduce elastomer abrasion. Ultra-Flex™ diaphragms exhibit exceptional abrasion resistance given special fabric placement that allows for more sacrificial rubber. In addition, Wilden Pump & Engineering Co. offers a complete line of abrasion resistant materials to revolutionize the way you solve your toughest pumping problems.

#### 7j. Cavitation

Cavitation is a hydraulic condition which can exist in any type of pump. It is primarily a situation in which the pump is discharging less liquid than its rated capacity due to reduction or lack of fluid supply to the pump. Common causes of cavitation are excessive suction lift, insufficient Net Positive Suction Head (NPSH), or operation at too high a speed. Pitting, vibration, and noise are common troubles stemming from cavitation. While severe cavitation is usually accompanied by excessive noise, mild cavitation may produce nothing more than a small reduction in pump efficiency and moderate wear of pump parts. You should:

- Slow pump down
- Reduce suction lift
- Increase positive head pressure
- Use a larger pump if you are not getting the required flow rates
- Consult Wilden's Cavitation and Pump Friction Guide (E6) for more details

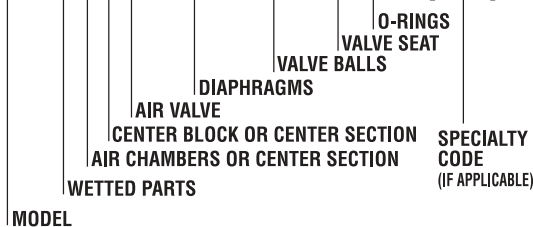
## 8. WILDEN PUMP DESIGNATION SYSTEM

The following is a generic pump designation system to familiarize you with Wilden's nomenclature. Please refer to Section 1 of your EOM for the Material Code designation system for your pump size. Your specific pump model is located on your pump's serial tag.

Please note some model descriptions include a three digit specialty code at the end. This specialty code signifies an additional feature for the specific pump. See your authorized Wilden distributor for additional information.

### WILDEN PUMP DESIGNATION SYSTEM

**A, P, T, or W / XXXX / XX / XX / XXX / (xxx)**



#### PUMP MODEL — INLET

A or P.025	=	1/4"
P.050	=	1/2"
A, T, or P1	=	1/2"
A, T, or P2	=	1"
A, T, P, or W 4	=	1 1/2"
A, T, P, or W 8	=	2"
A, T, or W 15	=	3"
A or T 20	=	4"

#### WETTED PARTS

A	=	Aluminum
G	=	Acetal, Carbon-Filled
H	=	Hastelloy
K	=	Kynar®/PVDF
P	=	Polypropylene
S	=	Stainless Steel
T	=	Teflon® (PFA)
W	=	Cast Iron

#### AIR CHAMBERS

A	=	Aluminum
C	=	Teflon®-Coated
G	=	Acetal, Carbon-Filled (A.025, P.025, A1, T1)
K	=	Kynar (P.050 only)
L	=	Virgin Acetal
M	=	Mild Steel (A4, T4)
N	=	Nickel-Plated
P	=	Polypropylene
R	=	Carilon®
S	=	Stainless Steel
V	=	Halar-Coated
W	=	Cast Iron
Y	=	Nylon

#### CENTER BLOCK

A	=	Aluminum
C	=	Teflon®-Coated
G	=	Acetal, Carbon-Filled
K	=	Kynar®
L	=	Virgin Acetal
N	=	Nickel-Plated
P	=	Polypropylene
R	=	Carilon®
S	=	Stainless Steel
Y	=	Nylon

#### AIR VALVE

A	=	Aluminum
B	=	Brass
C	=	Teflon®-Coated
D	=	Brass w/Oil Btl.
L	=	Virgin Acetal
N	=	Nickel-Plated
P	=	Polypropylene
Q	=	Conductive Isoplast
S	=	Stainless Steel
Z	=	Lube-Free

#### DIAPHRAGMS

BN	=	Buna-N
ET	=	Teflon® w/Integral Piston & Rubber Laminate 3A Model
FG	=	Sani-Flex™
ND	=	Nordel®
NE	=	Neoprene
PU	=	Polyurethane
TF	=	Teflon® (Primary)
TX	=	Teflon® w/Integral Piston A.025, P.025, P.050
VT	=	Viton®
WF	=	Wil-Flex™

#### DIAPHRAGMS, ULTRA-FLEX™

UB	=	Buna-N
UE	=	Nordel®
UN	=	Neoprene
UV	=	Viton®

#### VALVE BALL

BN	=	Buna-N
FG	=	Sani-Flex™
FV	=	Food Grade Viton®
ND	=	Nordel®
NE	=	Neoprene
PU	=	Polyurethane
SS	=	Stainless Steel
TF	=	Teflon® PTFE
VT	=	Viton®
WF	=	Wil-Flex™

#### VALVE SEAT

A	=	Aluminum
BN	=	Buna-N
FG	=	Sani-Flex™
H	=	Hastelloy
K	=	Kynar®/PVDF
M	=	Mild Steel
ND	=	Nordel®
NE	=	Neoprene
P	=	Polypropylene
PU	=	Polyurethane
S	=	Stainless Steel
T	=	Teflon® PFA
VT	=	Viton®
WF	=	Wil-Flex™

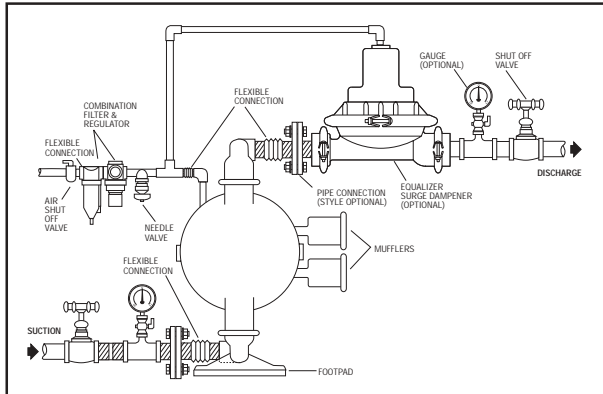
#### VALVE SEAT O-RING

BN	=	Buna-N
CR	=	Chemraz (UP)
FG	=	Sani-Flex™
FS	=	Fluoro-Seal (Metal)
ND	=	Nordel®
PU	=	Polyurethane
TF	=	Teflon® PTFE (Metal)
TV	=	Teflon® Encap. Viton®
WF	=	Wil-Flex™

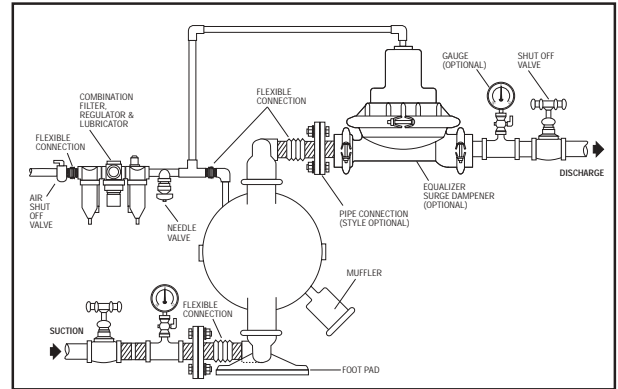
**NOTE: Not all combinations are available on all pump models. Please contact your local authorized distributor for more information.**

## 9. SUGGESTED INSTALLATION

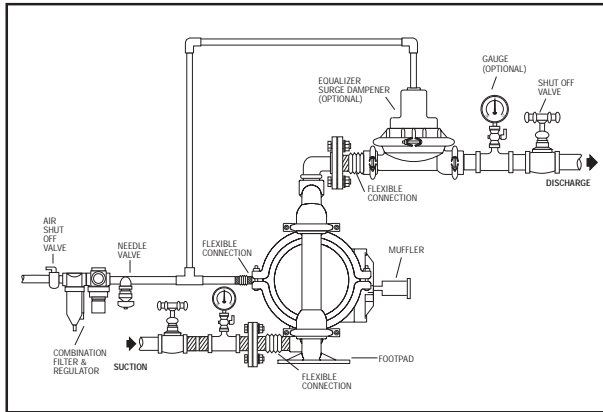
### Wil-Flo™ Suggested Installation



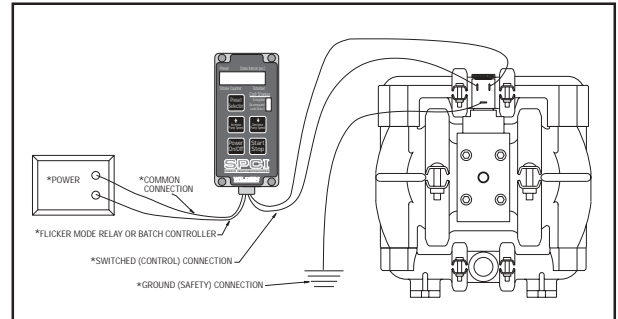
### Turbo-Flo™ Suggested Installation



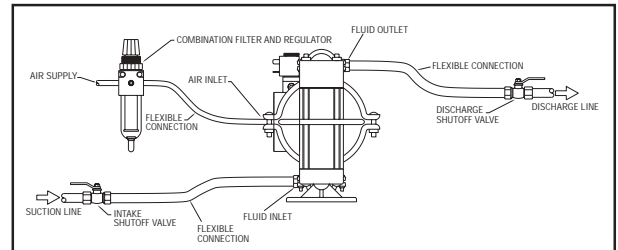
### Pro-Flo™ Suggested Installation



### Accu-Flo™ Electrical Connections



### Accu-Flo™ Plumbing Connections



#### 9a. Pre-Installation Checklist:



##### Cautions

- Verify pump model received against purchase order or spec sheet.
- Re-torque all bolts to specifications on torque table.
- Remove shipping plugs.
- Pumps that need to be submersed must have both wetted and non-wetted parts compatible with material being pumped.
- Submersed pumps must have a hose attached to pump's air exhaust and the exhaust air piped above liquid level.
- Pumps should be thoroughly flushed with water before installation.
- FDA, USDA, and 3A pumps should be sanitized prior to usage.
- Do not exceed 8.6 bar (125 psi) air supply pressure (50 psi on UL models).
- Blow out air line for 10 to 20 seconds before attaching to pump to make sure all pipe line debris is clear.

#### 9b. Suggested Installation:

The suction pipe should be at least the diameter of the pump's inlet manifold connection or larger if highly viscous material is being pumped. The suction hose must be non-collapsible, reinforced type as Wilden pumps are capable of pulling a high vacuum. Discharge piping should be at least

the diameter of the pump's discharge manifold connection; larger piping can be used to reduce friction losses. It is critical that all fittings and connections are airtight or a reduction or loss of pump suction capability will result. The pump should not be used as a support mechanism for the piping system. Wilden suggests the use of flexible connections for inlet/outlet ports and air line (see diagrams).

Due to the reciprocating action of the pump, lateral instabilities can occur during normal operation, thus footed pumps should be bolted to the ground and pads should be used. Ensure the operating surface is level and flat.

Most Wilden pumps can be used in submersible applications only when both wetted and non-wetted portions are compatible with the material being pumped. If the pump is to be used in a submersible application, a hose should be attached to the pump's air exhaust and the exhaust air piped above the liquid level.

NOTE: Pro-Flo™ and Accu-Flo™ pumps cannot be submersed.

## 9. SUGGESTED INSTALLATION (Cont'd.)

If the pump is to be used in a self-priming application, be sure that all connections are airtight and that the suction lift is within the pump's ability. Note: Materials of construction and elastomer material have an effect on suction lift parameters. Refer to Section 6 of your EOM for your pump's specific suction lift capability.

Pumps in service with a positive suction head are most efficient when inlet pressure is limited to 0.5–0.7 bar (7–10 psig). Premature diaphragm failure may occur if positive suction head is 0.8 bar (11 psig) and higher, particularly when using Teflon® and Thermoplastic diaphragms. All positive suction head applications should include a "check valve" at the pump liquid inlet to allow for the pump to be disconnected.

Each Wilden pump has a specific maximum solids capability. Whenever the possibility exists that larger solid objects may be sucked into the pump, a strainer should be used on the suction line. (See page 13 for maximum solids passage.)



**CAUTION:** Do NOT exceed 8.6 bar (125 psig) air supply pressure. 50 psi (3.45 bar) for UL-listed and 5.86 bar (85 psi) for H800.



**CAUTION:** Blow out air line for 10 to 20 seconds before attaching to pump to make sure all pipe line debris is clear. Use a 5 $\mu$  (micron) air filter on all Pro-Flo™ and Wil-Flo™ models.

**NOTICE:** All fasteners should be checked to match the pump's given torque specifications listed in Section 8 of the Engineering, Operation and Maintenance manual.



**CAUTION:** Ensure proper ventilation of tanks/vessels that house liquid supply. Due to the pump's high vacuum ability, improper ventilation of these supply tanks can lead to implosion of tanks when fluid is completely evacuated.



**CAUTION:** Thermal expansion: Some liquids present in piping may expand at elevated temperatures, resulting in pipe and/or pump damage and subsequent risk to operator.

### ELECTRICAL HAZARDS

Static Spark can cause explosion resulting in severe injury or death. Electrostatic hazard is eliminated by properly grounding the pump and the pumping system. For some applications the A.025, P.025, T1 and A1 Carbon Filled Acetal (CFA) pumps will provide a more adequate dispersal of static electricity. Consult local building codes and electrical codes for specific grounding requirements.

**Conductivity:** Certain Wilden pumps provide for safe transfer of flammable materials. UL 79, Carbon-Filled Acetal pumps (CFA), and Nema 7 coils are available to meet your specific conductivity needs. Please contact Wilden at (909) 422-1730 for more information.

### TEMPERATURE HAZARDS

Fluid being pumped should be compatible with the pump's material of construction and temperature limits as stated in the Wilden Chemical Resistance Guide (E4).

### HAZARDS GENERATED BY NOISE

Pump noise can be excessive under certain operating conditions, e.g. high air pressure supply and little or no discharge head. Extended periods of operation under such conditions can create a hazard to operators working in proximity to the pumps. Ways to avoid this hazard are listed as follows:

- Use proper hearing protection devices.
- Use mufflers on the pump's air exhaust.
- Plumb the pump's exhaust air to an area not in proximity of plant workers.
- Use elastomeric valve balls in lieu of Teflon® valve balls since soft balls reduce noise. (Ensure proper chemical resistance of ball elastomer used)

### HAZARDOUS MATERIALS

Handler should obtain Material Safety Data Sheet (MSDS) from the chemical supplier for all materials being pumped for appropriate handling instructions.

When pumping hazardous fluids, Wilden pumps should be fitted with the Wil-Gard™ II diaphragm monitoring system, which will detect a diaphragm failure before hazardous material exits the pump. Wil-Gard™ II diaphragm monitoring system is only available with Teflon® fitted pumps.

In case of diaphragm failure, material being pumped may exit pump via air exhaust, in which case contact with the hazardous material is possible.

### CHEMICAL COMPATIBILITY

When selecting a pump for a particular application, pump wetted materials of construction and elastomer materials must be compatible with the material being pumped. Please consult Wilden Chemical Resistance Guide (E4) or your local authorized distributor for more information.



**CAUTION:** Some materials such as halogenated solvents should not be pumped with an aluminum construction pump due to a possible explosive reaction. Consult your chemical supplier.

### 9c. Accu-Flo™ Installation

All wiring used to operate the pumps should be placed and connected according to the proper electrical codes. It is important that the wiring is of adequate gauge to carry the current required to operate the pump. In addition, it is necessary that the electrical power supply is large enough to supply the current required to operate the pump. Wiring should be above ground level if possible (in case of fluid spill or leakage), and all wiring and connections which could become wet or damp should be made watertight.

The solenoid valve is rated for continuous duty; however, stopping an even number stroke count insures that the electrical power is off when the pump is stopped. This practice is safer and also eliminates unwanted strokes when the system is shut down and electrical power is off.

Solenoid valve fitted pumps should not be used in an area where explosion proof equipment is required unless an explosion proof coil is utilized. Nema 7 explosion proof coils are available for all Accu-Flo™ pumps.

## 10. MAINTENANCE

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### 10a. Directions for disassembly/re-assembly

The following are generic directions for disassembly/reassembly of the Wilden pump. Please refer to Section 8 of your EOM for detailed disassembly/reassembly instructions and photographs pertaining to your specific pump.

**CAUTION:** Before any maintenance or repair is attempted, the compressed air line to the pump should be disconnected and all air pressure allowed to bleed from the pump. Disconnect all intake, discharge, and air lines. Drain the pump by turning it upside down and allowing any fluid to flow into a suitable container. Wear safety glasses. When diaphragm failure occurs, material being pumped may be forced out the air exhaust.

**NOTE:** Before starting disassembly, mark a line from each liquid chamber to its corresponding air chamber. This line will assist in proper alignment during reassembly.

#### **Before you disassemble the pump:**

- Wear safety glasses
- Shut off main air supply
- Disconnect air hose from air valve to drain air pressure in hose
- Isolate pump using isolation valves to avoid product spillage from pipe
- Turn pump upside down to drain all liquid trapped by valve balls
- Mark a line from each liquid chamber to its corresponding air chamber to assist in proper alignment during reassembly

### 10b. Inspection

#### **Air Valve Piston/Spool and Casing**

- Ensure piston/spool can move freely
- Clean out debris

#### **Diaphragms**

- Make sure no swelling, cracking, or other damage is apparent

#### **Balls/Seats/O-rings**

- Make sure no swelling, cracking, or other damage is apparent
- Lubricate shaft if needed

### 10c. Mean Time to Failure

**A Preventative Maintenance Schedule (PMS) should be set up for the following parts to ensure pump is serviced prior to part wear**

- Diaphragms
- Valve Seats
- Valve Balls
- O-rings

### 10d. Seal Replacement

Proper seal installation is critical to pump performance when employing AODDPs in your application. Great care must be taken to ensure that seals are placed in the proper grooves and not damaged during installation. Incorrect seal location will render the pump inoperable. Damaged seals may cause decreased performance and shorter seal life. The Ringer™ seal installation kit, containing an installation tool and locator bushings simplifies seal installation on the T4, T8, T15, and T20 Turbo-Flo™ pumps.

### 10e. Disassembly Overview

The following instructions are to be used as a reference for disassembly/reassembly of your Wilden pump. These instructions are meant solely to give you an idea on how to disassemble/reassemble a Wilden pump. Your pump size and build may vary substantially. Please refer to Section 8 of your EOM for specific detailed instructions on disassembly/reassembly of your Wilden pump.

Before starting disassembly, mark a line from each liquid chamber to its corresponding air chamber. This line will assist in proper alignment during reassembly.

Utilizing a box wrench, remove the two small clamp bands that fasten the discharge manifold to the liquid chambers. Remove the discharge manifold to expose the valve balls and seats. Inspect the ball cage area of the manifold for excessive wear or damage. Remove the discharge valve balls, seats, and O-rings from the discharge manifold and inspect for nicks, gouges, chemical attack and/or abrasive wear. Replace worn parts with genuine Wilden parts for reliable performance.

Remove the small clamp bands that fasten the intake manifold to the liquid chamber. Lift the intake manifold away to expose the valve balls and seats. Inspect intake valve ball cage for excessive wear or damage. Remove the intake valve balls, seats and O-rings from the discharge manifold and inspect for nicks, gouges, chemical attack and/or abrasive wear. Replace worn parts with genuine Wilden parts for reliable performance.

Remove one set of large clamp bands that attach the liquid chamber to the center section assembly. Lift liquid chamber away from the center section to expose the diaphragm and outer piston. Using an adjustable wrench remove the diaphragm assembly. Inspect diaphragm assembly and shaft for signs of wear or chemical attack. Repeat disassembly instructions for opposite liquid chamber.

Please see Section 8 of your EOM for detailed disassembly/reassembly instruction of your pump's air distribution system.

## 11. WILDEN ACCESSORIES

### 11a. SD Equalizer® Surge Dampener



An inherent characteristic of reciprocating pumps is the pressure change between each pump stroke. The Equalizer® can be used to provide a supplementary pumping action between pump strokes, thus minimizing pressure fluctuation while offering protection to your pumping system. The Equalizer® reduces water hammer, absorbs acceleration head, lowers system maintenance costs, and minimizes pipe strain protecting in-line equipment. Sizes available are SD½ 12.7 mm (½") inlet/discharge, SD1 25.4 mm (1") inlet/discharge, and SD2 50.8 mm (2") inlet/discharge.

#### Materials of Construction Available:

	SD½	SD1	SD2
Aluminum	✓	✓	✓
316 Stainless Steel	✓	✓	✓
Cast Iron	—	✓	✓
Polypropylene	✓	✓	✓
PVDF	✓	✓	✓
Carbon-Filled Acetal	✓	—	—
Teflon® PTFE	✓	✓	—

### 11b. BF Equalizer® Series



BF Equalizers® utilize an elastomeric bladder which prevents contact between the process fluid and the compressed air or gas. When a pulse is created, fluid enters the wetted chamber of the BF Equalizers®, displacing the bladder, compressing the air/gas, and absorbing the shock. When the liquid pressure decreases, the gas expands, pushing the fluid back into the process line. Wilden offers the BF Equalizers® in sizes ranging from 9.52 mm (¾") to 76.2 mm (3"), bolted, as well as flanged connections (ANSI and DIN). Wilden also offers high pressure dampeners, food grade with tri-clamp, sanitary with tri-clamp, as well as an extended Teflon® family. The following two options are available:

#### Adjustable

- Self-relieving regulator
- Permanent air supply
- Easy adjustment of internal air pressure
- Inlet & discharge for constant pressure systems

#### Automatic

- Automatic valve
- Permanent air supply
- Self-adjusting
- Discharge siding on varying pressure systems

### 11c. FCSI



The Flow Control System™ I (FCSI) counts the strokes of the Wilden pump and controls the pump so that specific repeatable quantities can be batched. The system has manual entry screens which allow the user to customize the data based on specific application calculations. Once the unit is programmed, the data is held in memory even when the unit is off or disconnected. To aid the user, the FCSI provides help screens where additional information concerning every system setup is displayed at the touch of a button. The FCSI can be used with either standard Wilden air-shifted pumps or Wilden Accu-Flo™ pumps. Three separate batch quantities can be programmed.

### 11d. SPCI



The Solenoid Pump Controller I (SPCI) is designed to provide an intuitive interface between you and your Accu-Flo™ pump. The SPCI energizes and de-energizes the solenoid coil at a programmed rate to control Wilden Accu-Flo™ pumps. The pump speed can be easily adjusted by simply pushing the appropriate (increase or decrease) buttons on the keypad. To expedite your pump speed selection, three programmable presets are available. The LCD screen and LED's (light emitting diodes) display operational status which allows you to operate the pump from a remote location. The preset number, the stroke interval in seconds (pump speed), the stroke counter, and stroke totalizer are indicated on the LCD screen. The leak detection LED informs you of the optional Wil-Gard™ II leak detection device status. The SPCI will stop pump operation if a leak is detected by the Wil-Gard™ diaphragm monitoring system. An external input can be utilized to remotely start and stop the pump to customize the application. Liquid level controllers, proximity switches, temperature switches, etc. can easily interface with the SPCI by simply wiring the external component to the terminal strip and selecting the external input mode. The SPCI can be powered by three different voltages: 110 V AC, 220 V AC, and 12 V DC. The output voltage of the SPCI is 12 V DC which must be used with Wilden's Nema 4 or Nema 7 12 V DC Accu-Flo™ pumps.

## 11. WILDEN ACCESSORIES (Cont'd.)

### 11e. Wil-Gard™ II



The Wil-Gard™ II diaphragm monitoring system will sense the presence of fluid between the primary Teflon® PTFE diaphragm and back-up diaphragm once installed on a Teflon® fitted pump. Upon sensing the fluid, a high brightness LED, and an internal relay are activated while the back-up diaphragm offers product containment. The sensor cables are engineered to withstand millions of pump cycles while detecting conductive fluids. The Wil-Gard™ II can be factory installed on Wilden Teflon® fitted pumps and can be purchased as an accessory to an existing pump. The Wil-Gard™ II reduces chemical attack on non-wetted parts, reduces hazardous emissions passing through the air exhaust and detects a leak while the back-up diaphragm offers containment protecting from product contamination. The Wil-Gard™ II can easily be connected to the FCSI or SPCI in order to detect diaphragm failure while offering product containment.

### 11f. Drum Pump Kit



The Wilden Universal Drum Pump Kit is designed as a lightweight, portable means of adapting your Wilden pump to drum pumping applications. The Wilden Drum Pump Kit is used in conjunction with the Wilden P.025, A.025, P1, T1 and A1 models. The drum base adapter is available in Nylon and Polypropylene, and the pick-up tube is available in Nylon, Polypropylene, and Teflon® PTFE. The drum adapter is available with a 50.8 mm (2") NPT male connection suitable for installation on most drums. The pick-up tube can be cut to length to accommodate various drum sizes.

### 11g. Automatic Powder Valve



The Wilden pump can be used to successfully transfer many low density powders. The Automatic Powder Valve (APV) is a spring loaded valve that is installed on the inlet line to the Wilden pump. The APV introduces atmospheric air to the inlet line of the pump and lightens or fluidizes the material being transferred before it reaches the pump. While best results have been achieved transferring powders with a density up to 400 Kg/m<sup>3</sup> (25 lbs. per cubic foot), a test should be performed to determine if desired capacities can be obtained in your specific application.

### 11h. 2 for 1 System



Wilden's split manifold kit allows users of the Wilden plastic pump line to turn one pump into two. This simple kit contains four adapters to allow one Wilden pump to transfer two different products, pump a product from one side and return it with the other, blend two separate products using one pump, or fill two separate containers with two different products. Wilden pumps can be purchased equipped with a 2 for 1 split manifold kit. Existing pumps can also be retrofitted with the 2 for 1 kit. A1, T1, P1, A2 cross bolted, T2 cross bolted, A4, T4, P4, W4, A8, T8, P8, and W8 plastic Pump line available in Polypropylene or Kynar can be equipped with the 2 for 1 system. A4, T4, P4, and W4 Aluminum bolted pumps are also available in the 2 for 1 configuration.

### 11i. Air-Tech™ Pneumatic Pump Controllers



Wilden's Air-Tech™ air-operated devices pneumatically control the air supply of the pump to automate your fluid handling process safely and cost effectively. Wilden offers the LC series level controllers, TGC tank controllers, OSC series. The LC series level controller is designed for unsupervised on/off operation of your pump. The TGC series (tank controllers) acting as a high level shut off for waste oil tanks employing a Wilden Pump as the feed pump. The OSC series (over-speed controllers) prevent Wilden pumps from running dry.

## 12. TROUBLESHOOTING

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The following is a concise set of troubleshooting suggestions. Contact your local Wilden distributor for a comprehensive Troubleshooting Guide (E9), or turn to Section 7 of your EOM for your pump's specific troubleshooting techniques.

### ***Pump Will Not Run or Runs Slowly:***

1. Check air inlet screen and air filter for debris.
2. Check for sticking air valve, flush air valve with cleaning fluid.
3. Check for worn out air valve. Replace if necessary.
4. Check center block seals. If worn excessively, they will not seal and air will simply flow through the pump and out the air exhaust. Use only Wilden seals as they are of special construction.
5. Check for rotating piston in air valve.
6. Check type of lubricant being used if you are using a pump that needs lubrication. A higher viscosity oil than suggested may cause the piston to stick or run erratically. Wilden suggests the use of a hydraulic oil with arctic characteristics (ISO grade 15/5wt. arctic oil).

### ***Pump Runs But Little or No Product Flows:***

1. Check for pump cavitation; slow pump speed down to allow material to enter pumping chambers. Increase speed accordingly.

2. Check for sticking ball checks. If material being pumped is not compatible with pump elastomers, swelling may occur. Replace balls with the proper elastomers.
3. Check to make sure all suction connections are air tight, especially clamp bands around intake balls.

### ***Pump Air Valve Freezes:***

Check for excessive moisture in compressed air. Install either a dryer or a hot air generator for compressed air.

### ***Air Bubbles In Pump Discharge:***

1. Check for rupture diaphragm.
2. Check tightness of clamp bands, especially at the intake manifold.

### ***Product Comes Out Air Exhaust:***

1. Check for diaphragm rupture.
2. Check tightness of large clamp bands.
3. Check tightness of piston plates to shaft if applicable.

### ***Pump Rattles:***

1. Use softer balls.
2. Create false discharge head or suction lift.
3. See E9 Troubleshooting Guide.

## 13. WARRANTY

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Each and every pump manufactured by Wilden Pump and Engineering Co. is built to meet the highest standards of quality. Every pump is functionally tested to ensure the integrity of operation. Wilden Pump and Engineering Co. warrants that pumps, accessories and parts manufactured or supplied by it are free from defects in material and workmanship for a period of one year from date of startup or two years from date of shipment, whichever comes first. Failure due to normal wear, misapplication, or abuse is excluded from this warranty. Since the use of Wilden pumps and parts is beyond our control, we cannot guarantee the suitability of any pump or part for a particular application and Wilden Pump and Engineering Co. shall not be liable for any consequential damage or expense arising from the use or misuse of its products on any application. Responsibility

is limited solely to replacement or repair of defective Wilden pumps and parts. All decisions as to the cause of failure are the sole determination of Wilden Pump and Engineering Co. Prior approval must be obtained from Wilden for return of any items for warranty consideration. A Return Goods Tag, obtained from an authorized Wilden distributor, must be included with the items which must be shipped freight prepaid. The foregoing warranty is exclusive and in lieu of all other warranties expressed or implied (whether written or oral), including all implied warranties of merchantability and fitness for any particular purpose. No distributor or other person is authorized to assume any liability or obligation for Wilden Pump and Engineering Co. other than expressly provided herein.

## 14. SAFETY SUPPLEMENT

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### WILDEN PUMP & ENGINEERING CO. SAFETY MANUAL

Supplement to Engineering, Operation and Maintenance Manual

**ALWAYS FIRST READ THIS MANUAL BEFORE INSTALLATION, START-UP OR MAINTENANCE.**


Supplement to Engineering, Operation and Maintenance Manual

**ALWAYS FIRST READ THIS MANUAL BEFORE INSTALLATION, START-UP OR MAINTENANCE.**

This safety manual applies to all Wilden pumps and comprises instructions for safe installation, use and maintenance of your pump.

In addition to this manual, more detailed instructions on installation, suggested operation and maintenance instructions and troubleshooting are given in the Engineering, Operation and Maintenance manual of the pump type in question.

In this manual you may be warned for remaining hazards. This kind of information is preceded by the following label.


 **CAUTION** = Hazards or unsafe practices which could result in severe personal injury, death or in substantial product or property damage.

 **CAUTION**

- Verify pump model received against purchase order or spec sheet.
- Retorque all bolts to specifications on torque table. Remove shipping plugs.
- Pumps that need to be submersed must have both wetted and non-wetted parts compatible with material being pumped.
- Submersed pumps must have a hose attached to pump's air exhaust and the exhaust air piped above liquid level. Pumps should be thoroughly flushed with water before installation.
- FDA, USDA, and 3A pumps should be sanitized prior to usage.

 **CAUTION**

- Blow out air line for 10 to 20 seconds before attaching to pump to make sure all pipe line debris is clear.
- Always wear safety glasses when operating pump. If diaphragm rupture occurs, material being pumped may be forced out air exhaust.

 **CAUTION:** All suction and discharge piping/hoses should be designed to withstand the pressure and temperature of the specific application.

 **CAUTION:** Do not exceed 0.7 bar (10 psig) liquid inlet pressure to pump port; this creates potential for premature wear and parts failure.

 **CAUTION:** Do not exceed 8.5 bar (125 psig) air supply pressure. UL-listed models should not exceed 50 psi air supply.


**1.0** Due to the reciprocating action of the pump, lateral instabilities can occur during normal operation, thus footed pumps should be bolted to structural steelwork/concrete. Ensure the operating surface is level and flat.

**1.1** Most Wilden pumps can be used in submersible applications only when both wetted and non-wetted portions are compatible with the material being pumped. If the pump is to be used in a submersible application, a hose should be attached to the pump's air exhaust and the exhaust air piped above the liquid level.

**1.2** Each Wilden pump has a particular maximum solids capability. Whenever the possibility exists that larger solid objects may be sucked into the pump, a strainer should be used on the suction line to prevent damage to the pump and subsequent risk to the operator.

#### **1.3 Installation Instructions**

Detailed installation instructions are supplied in Section 7 of your Pump's Engineering, Operation, and Maintenance manual.

 **CAUTION:** **1.4** Ensure proper ventilation of tanks/vessels that house liquid supply. Due to a pump's high vacuum ability, improper ventilation of these supply tanks can lead to implosion of tanks when fluid is completely evacuated.

## 14. SAFETY SUPPLEMENT (Cont'd.)

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### CAUTION: 1.5 ELECTRICAL HAZARDS

Take action to prevent static sparking. Fire or explosion can result, especially when handling flammable liquids. The pump, piping valves, containers or other miscellaneous equipment must be grounded.

### CAUTION: 1.6 TEMPERATURE HAZARDS

Material being pumped should be compatible with pump's materials of construction and stated temperature limits as stated in Wilden Chemical Resistance Guide (E4).


### CAUTION: 1.7 HAZARDS GENERATED BY NOISE


Pump noise can exceed 75 dba under certain operating conditions, e.g. high air pressure supply and little or no discharge head. Extended periods of operation under such conditions can create a hazard to operators working in proximity of the pumps. Use proper hearing protection devices.


### CAUTION: 1.8 HAZARDOUS MATERIALS

- a. Maintenance instructions in section eight of your pump's Engineering, Operation and Maintenance Manual must be followed to avoid diaphragm failure.
- b. Where possible, Teflon® fitted Wilden pumps should be fitted with the Wil-Gard™ II Diaphragm Monitoring System, which will detect a diaphragm failure before hazardous material exits pump.
- c. **NOTICE:** All fasteners should be checked to match the pump's given torque specifications, listed in Section 8 of the Engineering, Operation and Maintenance Manual.
- d. Handler should obtain Material Safety Data Sheet from the supplier for all materials being pumped for appropriate handling instructions.


#### 1.9 CHEMICAL COMPATIBILITY

 CAUTION: a. When specifying a pump for a particular application, pump wetted materials of construction and elastomer materials must be compatible with the process fluid. Please consult Wilden Chemical Resistance Guide (E4) or your local authorized Wilden distributor for more information.

 CAUTION: b. Explosive reaction: Some materials such as halogenated hydrocarbon solvents should not be pumped with an aluminum construction pump due to a possible explosive reaction.

 CAUTION: c. Certain materials' chemical compatibility with a particular pump construction, in particular plastic wetted parts, can change as material concentration and temperature vary. Please consult your local authorized Wilden distributor for more information.

#### 2.0 OPERATION

 CAUTION: 2.1 Ensure all operators are properly trained and employ safe operating and maintenance practices as outlined in this Safety Manual, the Pump User's Guide, and the pump's Engineering, Operation and Maintenance Manual. In addition, all proper safety eyewear and ear protection should be used when necessary.

#### Temperature Limits

Polypropylene	0°C to 79°C	32°F to 175°F
PVDF	-12°C to 107°C	10°F to 225°F
Carbon-Filled		
Acetal	-28.9°C to 65.6°C	-20°F to 150°F
Teflon® PFA	-28.9°C to 148.9°C	20°F to 300°F
Neoprene	-17.8°C to 93.3°C	0°F to 200°F
Buna-N	-12.2°C to 82.2°C	10°F to 180°F
Nordel®	-51.1°C to 137.8°C	-60°F to 280°F
Viton®	-40°C to 176.7°C	-40°F to 350°F
Wil-Flex™	-40°C to 107.2°C	-40°F to 225°F
Polyurethane	12.2°C to 65.6°C	10°F to 150°F
Saniflex™	-28.9°C to 104.4°C	-20°F to 220°F
Teflon® PTFE	4.4°C to 104.4°C	40°F to 220°F

# CAVITATION AND PIPE FRICTION

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Cavitation is a hydraulic condition which can exist in any type of pump. It is primarily a situation in which the pump is discharging less liquid than its rated capacity due to a reduction or lack of liquid supply to the pump intake. "Excessive suction lift, insufficient NPSH, or operation at too high a speed are common troubles stemming from cavitation. Pitting, vibration, and noise are common troubles stemming from cavitation. While severe cavitation is usually accompanied by excessive noise and damage to the pump, mild cavitation may produce nothing more than a small reduction in pump efficiency and moderate wear of pump parts." <sup>1</sup>

Diaphragm pumps, like other pumps, "do not suck in liquids; they reduce pressure in the suction chamber, and external pressure, usually atmospheric, pushes the liquid into the pump. For any pump with a given size suction line, capacity or maximum speed is fixed by the the existing net positive suction head (NPSH)." <sup>2</sup> A diaphragm pump can be particularly vulnerable to a "starved suction" condition because it is generally pumping a viscous, solid-laden slurry. In fact most cases of low flow rates can be traced to starved suction conditions due to either too high a static lift, too long a suction line, or a combination of both.

It is likewise possible to experience cavitation even though the pump may have a "flooded suction." In this case it is due to trying to discharge more than can be pulled in through a suction line that is too long and/or too small in diameter. If a slurry is quite "thick" it will only be possible to pump a much smaller amount than the pump's full capacity.

Cavitation is harmful to diaphragm life because on the suction stroke the diaphragm is being pulled mechanically by the shaft connected to the pressurized diaphragm. There is an "unbalanced" pressure on the diaphragm equal to the amount of suction produced. Cavitation makes the "unbalanced" pressure on the suction stroke higher. The lower the suction lift condition imposed on the diaphragm, the less the unbalanced mechanical load, and the longer the diaphragm life. Every diaphragm has a given number of flexes before failure. If the pump is cavitating, less liquid is being pumped per flex; therefore, diaphragm cost per gallon is increased.

Cavitation can be eliminated in the Wilden air-operated double-diaphragm pump easier than with any other type of pump. Start the pump slowly by controlling the volume of compressed air to the pump by the use of a gate or globe valve. After the unit starts pumping, the throttling valve can be opened to increase capacity. The point at which further opening of the valve increases cycling rate without an increase in discharge rate will be the cavitation point, and the valve should be closed slightly. Further attempts to increase capacity should be oriented around a larger suction intake line, larger pump, reduced lift condition and/or a combination of these conditions.

Under conditions of limited flow due to cavitation, damage to the Wilden double-diaphragm pump most likely will be limited only to the diaphragms, in comparison to numerous expensive parts in other types of pumps.

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<sup>1</sup>Tyler G. Hicks and Theodore W. Edwards, *Pump Application Engineering*, page 87.

<sup>2</sup>Tyler G. Hicks and Theodore W. Edwards, *Pump Application Engineering*, page 51.

# WILDEN

A **DOVER** COMPANY

# HIGH VISCOSITY PIPE FRICTION

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Viscosity is that property of a liquid which resists free flow. The most common method of expressing viscosity is in SSU (Saybolt Seconds Universal). Water has a SSU viscosity of 31.5.

Centrifugal pumps can handle viscosities up to 500 SSU. Beyond 500 SSU, a positive displacement pump must be used to move a liquid. Most pipe friction tables are based on water or at most go to liquids of up to 500 SSU. The Wilden air-operated double-diaphragm pump is capable of pumping viscous slurries. On page 3 and 4 is a Pipe Friction Chart showing line losses at viscosities up to 500,000 SSU.

NOTE: These friction tables give the loss in Pounds per Square Inch. The losses at the very high viscosities (100,000 SSU and up) are great.

Note also that all friction losses in these tables must be multiplied by the specific gravity of the slurry being pumped.

With the friction losses observed at these high viscosities, suction conditions become ultra critical. At best there will only be a maximum of 14# available at sea level to push liquid into pump.

For example, the friction loss in 100' of 2" pipe of a 100,000 SSU liquid at a flow rate of 7 gpm is 23#. (See chart.) Through 10' of 2" pipe the loss would be 23#, well above the 14# available. It would only be possible to pull approximately 3 gpm through 10' of 2" pipe due to friction alone. No static lift would be possible.

The fact is that no pump can exert force on a liquid until it is in the pump. The only force able to act on the suction side is the earth atmospheric pressure of 14.7 psi at sea level. Once the liquid is in the pump, the Wilden pump can push with as much pressure as the air supply pressure available.

Typical "in plant" air supply pressures are seldom over 100 psi. Therefore, any calculated friction loss approaching this figure calls for either a shorter pipe, a larger pipe size, or a reduction in the amount of elbows. This will reduce the amount of friction loss.

## CONSIDERATIONS FOR SPECIFYING A WILDEN AIR-OPERATED DOUBLE-DIAPHRAGM PUMP

- **Gallons per minute (GPM):** Required flow rate or output.
- **Specific Gravity:** The ratio of a fluid's density to that of water. Water equals 1.0.
- **Viscosity:** A measure of a fluid's tendency to resist a shearing force. Viscosity is not a constant, fixed property of a fluid, it varies with the conditions of the fluid and the system.
- **Temperature:** The temperatures of a fluid at the pump inlet is usually of greatest concern.
- **Vapor Pressure:** The absolute pressure (at a given temperature) at which liquid will change to vapor.
- **Static Suction Lift:** The vertical distance from the center line of the pump up to the free level of the liquid source.
- **Static Suction Head:** The vertical distance from the center line of the pump up to the free level of the liquid source.
- **Static Discharge Head:** The vertical elevation from the center line of the pump to the point of free discharge.
- **Dynamic Discharge Head:** Static discharge head plus friction head.
- **Pipe Diameter, Pipe Length and the number of Elbows** are needed to calculate friction head.

**ENGINEERING DATA: PIPE FRICTION-VISCOUS LIQUIDS**  
**LOSS IN POUNDS PER SQUARE INCH PER 100 FEET OF NEW STEEL PIPE**  
**BASED ON SPECIFIC GRAVITY 1.0**

GPM	SIZE PIPE	VISCOSITY - SAYBOLT SECONDS UNIVERSAL														
		20,000	25,000	30,000	40,000	50,000	60,000	70,000	80,000	90,000	100,000	125,000	150,000	175,000	200,000	500,000
3	$\frac{1}{2}$	11.0	23	35	48	60	120	182	240	300	365	475	600	720	840	960
	$\frac{3}{8}$	3.7	7.7	11.8	15.8	19.5	39	59	78	96	117	160	195	237	273	312
	1	1.4	3.0	4.5	6.0	7.4	15	23	30	37.5	45	60	75	90	105	120
5	$\frac{3}{8}$	6.2	13	20	26.5	33	66	99	132	165	198	264	330	396	462	528
	1	2.3	5	7.4	10.0	12.5	25	38	50	62.5	74	100	125	150	175	200
	$1\frac{1}{4}$	0.78	1.7	2.5	3.3	4.2	8.3	12.5	16.6	21	25	34	42	50	58	66
7	$\frac{3}{4}$	8.7	18	27.5	37	46	92	137	184	225	280	370	460	552	644	736
	1	3.3	6.9	10.5	14	17.5	35.5	53	71	89	106	142	178	213	249	284
	$1\frac{1}{4}$	1.1	2.3	3.5	4.7	5.8	11.5	17.5	23	29	35	47	59	70	81	93
10	1	5.0	10	15	20	25	51	76	102	128	153	204	255	306	357	408
	$1\frac{1}{4}$	1.6	3.3	5.0	6.7	8.3	16.7	25	33.5	42	50	68	84	100	117	134
	$1\frac{1}{2}$	0.84	1.8	2.7	3.6	4.5	9.0	13.5	18	23	27	36	45	54	63	71
15	1	11.0	15	22	30	37.5	76	114	152	190	228	304	380	456	532	608
	$1\frac{1}{4}$	2.7	4.9	7.6	10.0	12.5	25	37.5	50	63	75	100	125	150	175	200
	$1\frac{1}{2}$	1.2	2.7	4.0	5.4	6.8	13.5	20	27	34	41	54	68	81	95	108
20	1	20	20	30	40	50	100	150	200	250	300	400	500	600	700	800
	$1\frac{1}{2}$	2.3	3.6	5.4	7.2	9.0	18	27.5	36	46	54	72	90	108	126	144
	2	0.64	1.3	2.0	2.7	3.3	6.7	10	13.5	17	20	27	34	41	47	55
25	$1\frac{1}{2}$	3.5	4.5	6.7	9.0	11.5	23	34	46	57	68	90	115	138	161	184
	2	1.0	1.7	2.5	3.3	4.2	8.4	12.5	16.5	21.5	25	33	42	51	59	68
	$2\frac{1}{2}$	0.42	.8	1.2	1.6	2.0	4.0	6.0	8.0	10	12	16	20	24	28	32
30	$1\frac{1}{2}$	5.0	5.4	8.0	11.0	13.5	27	41	54	69	81	108	135	162	189	216
	2	1.4	2.0	3.0	4.0	5.0	10	15	20	25	30	40	50	60	70	80
	$2\frac{1}{2}$	0.60	0.95	1.5	1.9	2.4	4.8	7.2	9.8	12	14.5	19	24	29	34	38
40	$1\frac{1}{2}$	9.0	9.0	11.0	14.5	18	37	55	73	92	111	148	185	222	259	296
	2	2.6	2.7	3.9	5.3	6.7	13.5	20	27	34	40	54	68	82	95	108
	$2\frac{1}{2}$	1.1	1.3	2.0	2.6	3.3	6.5	9.7	13	16.5	19	25.5	32	38	45	52
50	$1\frac{1}{2}$	14.0	14.0	14.0	18.0	23	46	68	90	115	138	184	230	276	322	368
	2	3.8	4.0	5.0	6.7	8.4	17	25.5	34	43	51	68	85	102	119	136
	$2\frac{1}{2}$	1.6	1.7	2.4	3.2	4.0	8.0	12	16	20	24	32	40	48	56	64
60	2	5.3	5.8	5.9	8.0	10.0	20	30	41	52	61	80	100	120	140	160
	$2\frac{1}{2}$	2.3	2.4	2.9	3.8	4.8	9.6	14.5	19.5	24	29	38	49	58	67	77
	3	0.8	0.8	1.2	1.7	2.1	4.1	6.1	8.3	10	12.5	16.5	20.5	24.5	28	33
70	$2\frac{1}{2}$	2.9	3.2	3.4	4.5	5.7	11	17	23	28	34	44	55	66	77	88
	3	1.0	1.1	1.4	1.9	2.4	4.8	7.1	9.7	12	14.5	19	24	29	34	38
	4	0.27	0.32	0.48	0.65	0.80	1.6	2.4	3.2	4.1	4.9	6.6	8.1	10	11.2	13
80	$2\frac{1}{2}$	3.7	4.3	4.3	5.2	6.5	13	19.5	26	33	39	52	62	78	91	104
	3	1.3	1.4	1.7	2.2	2.8	5.5	8.2	11	13.5	17	22	27.5	33	38.5	44
	4	0.36	0.36	0.54	0.74	0.92	1.8	2.7	3.7	4.7	5.6	7.5	9.3	11.5	12.6	14.4
90	$2\frac{1}{2}$	5.5	6.7	6.7	6.7	8.0	16.5	24.5	32.5	41	48	64	80	96	112	128
	3	1.9	2.2	2.2	2.8	3.5	6.8	10	14	17	21	27.5	34	41	48	54
	4	0.53	0.57	0.68	0.92	1.2	2.3	3.4	4.5	5.9	7.0	9.3	11.5	14	16.1	18.5
100	$2\frac{1}{2}$	5.5	6.7	6.7	6.7	8.0	16.5	24.5	32.5	41	48	64	80	96	112	128
	3	1.9	2.2	2.2	2.8	3.5	6.8	10	14	17	21	27.5	34	41	48	54
	4	0.53	0.57	0.68	0.92	1.2	2.3	3.4	4.5	5.9	7.0	9.3	11.5	14	16.1	18.5

MULTIPLY VALUES IN THIS TABLE BY SPECIFIC GRAVITY OF LIQUID

**Example** – 30 gpm Viscosity 1000 SSU. Specific Gravity 0.90 200 feet of 2" pipe Loss= 10 x 0.90 x 2=18 lb./sq. in.

**Caution** – Since viscosity increases greatly with a little reduction in temperature, it is wise to be liberal in estimating pipe friction.

IF VISCOSITY IS GIVEN IN CENTIPOISES: CONVERT TO SSU BY MULTIPLYING BY 4.6.



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**ENGINEERING DATA: PIPE FRICTION-VISCOUS LIQUIDS**  
**LOSS IN POUNDS PER SQUARE INCH PER 100 FEET OF NEW STEEL PIPE**  
**BASED ON SPECIFIC GRAVITY 1.0**

GPM	SIZE PIPE	VISCOSITY - SAYBOLT SECONDS UNIVERSAL														
		20,000	25,000	30,000	40,000	50,000	60,000	70,000	80,000	90,000	100,000	125,000	150,000	175,000	200,000	500,000
3	$\frac{1}{2}$	11.0	23	35	48	60	120	182	240	300	365	475	600	720	840	960
	$\frac{3}{4}$	3.7	7.7	11.8	15.8	19.5	39	59	78	96	117	160	195	237	273	312
	1	1.4	3.0	4.5	6.0	7.4	15	23	30	37.5	45	60	75	90	105	120
5	$\frac{3}{4}$	6.2	13	20	26.5	33	66	99	132	165	198	264	330	396	462	528
	1	2.3	5	7.4	10.0	12.5	25	38	50	62.5	74	100	125	150	175	200
	$1\frac{1}{4}$	0.78	1.7	2.5	3.3	4.2	8.3	12.5	16.6	21	25	34	42	50	58	66
7	$\frac{3}{4}$	8.7	18	27.5	37	46	92	137	184	225	280	370	460	552	644	736
	1	3.3	6.9	10.5	14	17.5	35.5	53	71	89	106	142	178	213	249	284
	$1\frac{1}{4}$	1.1	2.3	3.5	4.7	5.8	11.5	17.5	23	29	35	47	59	70	81	93
10	1	5.0	10	15	20	25	51	76	102	128	153	204	255	306	357	408
	$1\frac{1}{4}$	1.6	3.3	5.0	6.7	8.3	16.7	25	33.5	42	50	68	84	100	117	134
	$1\frac{1}{2}$	0.84	1.8	2.7	3.6	4.5	9.0	13.5	18	23	27	36	45	54	63	71
15	1	11.0	15	22	30	37.5	76	114	152	190	228	304	380	456	532	608
	$1\frac{1}{4}$	2.7	4.9	7.6	10.0	12.5	25	37.5	50	63	75	100	125	150	175	200
	$1\frac{1}{2}$	1.2	2.7	4.0	5.4	6.8	13.5	20	27	34	41	54	68	81	95	108
20	1	20	20	30	40	50	100	150	200	250	300	400	500	600	700	800
	$1\frac{1}{2}$	2.3	3.6	5.4	7.2	9.0	18	27.5	36	46	54	72	90	108	126	144
	2	0.64	1.3	2.0	2.7	3.3	6.7	10	13.5	17	20	27	34	41	47	55
25	$1\frac{1}{2}$	3.5	4.5	6.7	9.0	11.5	23	34	46	57	68	90	115	138	161	184
	2	1.0	1.7	2.5	3.3	4.2	8.4	12.5	16.5	21.5	25	33	42	51	59	68
	$2\frac{1}{2}$	0.42	.8	1.2	1.6	2.0	4.0	6.0	8.0	10	12	16	20	24	28	32
30	$1\frac{1}{2}$	5.0	5.4	8.0	11.0	13.5	27	41	54	69	81	108	135	162	189	216
	2	1.4	2.0	3.0	4.0	5.0	10	15	20	25	30	40	50	60	70	80
	$2\frac{1}{2}$	0.60	0.95	1.5	1.9	2.4	4.8	7.2	9.8	12	14.5	19	24	29	34	38
40	$1\frac{1}{2}$	9.0	9.0	11.0	14.5	18	37	55	73	92	111	148	185	222	259	296
	2	2.6	2.7	3.9	5.3	6.7	13.5	20	27	34	40	54	68	82	95	108
	$2\frac{1}{2}$	1.1	1.3	2.0	2.6	3.3	6.5	9.7	13	16.5	19	25.5	32	38	45	52
50	$1\frac{1}{2}$	14.0	14.0	14.0	18.0	23	46	68	90	115	138	184	230	276	322	368
	2	3.8	4.0	5.0	6.7	8.4	17	25.5	34	43	51	68	85	102	119	136
	$2\frac{1}{2}$	1.6	1.7	2.4	3.2	4.0	8.0	12	16	20	24	32	40	48	56	64
60	2	5.3	5.8	5.9	8.0	10.0	20	30	41	52	61	80	100	120	140	160
	$2\frac{1}{2}$	2.3	2.4	2.9	3.8	4.8	9.6	14.5	19.5	24	29	38	49	58	67	77
	3	0.8	0.8	1.2	1.7	2.1	4.1	6.1	8.3	10	12.5	16.5	20.5	24.5	28	33
70	$2\frac{1}{2}$	2.9	3.2	3.4	4.5	5.7	11	17	23	28	34	44	55	66	77	88
	3	1.0	1.1	1.4	1.9	2.4	4.8	7.1	9.7	12	14.5	19	24	29	34	38
	4	0.27	0.32	0.48	0.65	0.80	1.6	2.4	3.2	4.1	4.9	6.6	8.1	10	11.2	13
80	$2\frac{1}{2}$	3.7	4.3	4.3	5.2	6.5	13	19.5	26	33	39	52	62	78	91	104
	3	1.3	1.4	1.7	2.2	2.8	5.5	8.2	11	13.5	17	22	27.5	33	38.5	44
	4	0.36	0.36	0.54	0.74	0.92	1.8	2.7	3.7	4.7	5.6	7.5	9.3	11.5	12.6	14.4
90	$2\frac{1}{2}$	5.5	6.7	6.7	6.7	8.0	16.5	24.5	32.5	41	48	64	80	96	112	128
	3	1.9	2.2	2.2	2.8	3.5	6.8	10	14	17	21	27.5	34	41	48	54
	4	0.53	0.57	0.68	0.92	1.2	2.3	3.4	4.5	5.9	7.0	9.3	11.5	14	16.1	18.5
100	$2\frac{1}{2}$	5.5	6.7	6.7	6.7	8.0	16.5	24.5	32.5	41	48	64	80	96	112	128
	3	1.9	2.2	2.2	2.8	3.5	6.8	10	14	17	21	27.5	34	41	48	54
	4	0.53	0.57	0.68	0.92	1.2	2.3	3.4	4.5	5.9	7.0	9.3	11.5	14	16.1	18.5

MULTIPLY VALUES IN THIS TABLE BY SPECIFIC GRAVITY OF LIQUID

**Example** – 30 gpm Viscosity 1000 SSU. Specific Gravity 0.90 200 feet of 2" pipe Loss= 10 x 0.90 x 2=18 lb./sq. in.

**Caution** – Since viscosity increases greatly with a little reduction in temperature, it is wise to be liberal in estimating pipe friction.

IF VISCOSITY IS GIVEN IN CENTIPOISES: CONVERT TO SSU BY MULTIPLYING BY 4.6.

# WILDEN

A  **DOVER** COMPANY

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# 15. CONVERSION TABLES

CELSIUS/FAHRENHEIT				VISCOSITY CONVERSION			PARTICLE SIZE			
DEGREES		DEGREES		POISE	CENTIPOISE	SSU	U.S. MESH	MICRONS	INCHES	MILLIMETERS
'C'	'F'	'C'	'F'							
0	32	56	132.8	00.00	1	32	3	6730	.265	6.73
2	35.6	58	136.4	.1	10	60	3.5	5660	.223	5.66
4	39.2	60	140.0	.2	20	100	4	4760	.187	4.76
6	42.8	62	143.6	.4	40	210	5	4000	.157	4.00
8	46.8	64	147.2	.6	60	320	6	3360	.132	3.36
10	50.0	66	150.8	.8	80	430	7	2830	.111	2.83
12	53.6	68	154.4	1.0	100	530	8	2380	.0937	2.38
14	57.2	70	158.0	1.4	140	690	10	2000	.0787	2.00
16	60.8	72	161.6	2.0	200	1000	12	1680	.0661	1.68
18	64.4	74	165.2	2.6	260	1280	14	1410	.0555	1.41
20	68.0	76	168.8	3.0	300	1475	16	1190	.0469	1.19
22	71.6	78	172.4	3.6	360	1730	18	1000	.0394	1.00
24	75.2	80	176.0	4.0	400	1950	20	841	.0331	.84
26	78.8	82	179.6	4.6	460	2270	25	707	.0280	.71
28	82.4	84	183.2	5.0	500	2480	30	595	.0232	.59
30	86.0	86	186.8	6.0	600	2900	35	500	.0197	.50
32	89.6	88	190.4	8.0	800	3880	40	420	.0165	.42
34	93.2	90	194.0	10.0	1000	4600	45	354	.0138	.35
36	96.8	92	197.6	12.0	1200	5620	50	297	.0117	.297
38	100.4	94	201.2	14.0	1400	6480	60	250	.0098	.250
40	104.0	96	204.8	16.0	1600	7500	70	210	.0083	.210
42	107.6	98	208.4	18.0	1800	8500	80	177	.0070	.177
44	111.2	100	212.0	22.0	2200	10300	100	149	.0059	.149
46	114.8	102.2	216.0	26.0	2600	12100	120	125	.0049	.125
48	118.4	104.4	220.0	30.0	3000	14500	140	105	.0041	.105
50	122.0	107.8	226.0	35.0	3500	16500	170	88	.0035	.088
52	125.6	110.0	230.0	40.0	4000	18500	200	74	.0029	.074
54	129.2	115.6	240.0	45.0	4500	21000	230	63	.0024	.063
				50.0	5000	23500	270	53	.0021	.053
				55.0	5500	26000	325	44	.0017	.044
				60.0	6000	28000	400	37	.0015	.037

FLOW	VOLUME	PRESSURE
Lbs of Water/Hr x .002 = Gal Min	Ft <sup>3</sup> x .0283 = M <sup>3</sup>	Ft of Water x .433 = PSI
Gal/Min x 500 = Lbs of Water/Hr	Lbs Water x .119 = Gal	PSI x 2.31 = Ft of Water
	Gal (Brit) x 1.2 = Gal (US)	Inches Hg x .491 = PSI
Lbs of Fluid/Hr	Gal x 128 = Fluid Ounces	Inches Hg x 1.133 = Ft of Water
x .002 = Gal Min	Cubic Ft x 7.48 = Gal	ATM x 14.7 = PSI
Specific Gravity	Cubic In x .00433 = Gal	ATM x 33.9 = Ft of Water
	Gal x 3.785 = Liters	Kg/Sq cm x 14.22 = PSI
Liter Min x .264 = Gal/Min (US)	Liter x .264 = Gal	Meters of Water x 1.42 = PSI
GPM x 3.785 = Liters/Min	Cubic Meters x 264.2 = Gallons	ATM x 760 = mm Hg
Cu Meters/Hr x 4.4 = Gal/Min (US)	Cubic Meter x 1000 = Liter	mm Hg x .039 = Inches Hg
Gal/Min x 227 = C Meters/Hr	Liters x 100 = Cubic Centimeters	Bar x 14.5 = PSI
Kg of Water/Min x .264 = Gal/Min (US)	Cubic Centimeters x 0.338 = Fluid Ounces	Newton/Meter <sup>2</sup> x 1 = Pascal
Gal Min x 3.8 = Kg of Water/Min	Fluid Ounces x 29.57 = Cubic Centimeters	PSI x 6.9 = kPa (Kilopascal)
		kPa x .145 = PSI

LENGTH	
Mils x .001 = Inches	
Meters x 3.281 = Feet	
Centimeters x .394 = Inches	
Millimeters x .0394 = Inches	
Microns x .0000394 = Inches	

MASS	
Gal of Water x 8.336 = Lbs	
Cubic Ft of Water x 62.4 = Lbs	
Ounces x .0625 = Lbs	
Kilograms x 2.2 = Lbs	
Lbs x .454 = Kilograms	
Metric Ton x 2205 = Lbs	

## FRACTIONAL EQUIVALENTS

FRAC.	DEC.	METRIC	FRAC.	DEC.	METRIC
1/64	.0156	.39688	33/64	.5156	13.0968
1/32	.0312	.79375	17/32	.5312	13.4937
3/64	.0468	1.19063	35/64	.5468	13.8906
1/16	.0625	1.58750	9/16	.5625	14.2875
5/64	.0781	1.98438	37/64	.5781	14.6843
3/32	.0937	2.38125	19/32	.5937	15.0812
7/64	.1093	2.77813	39/64	.6093	15.4781
1/8	.125	3.17500	5/8	.625	15.8750
9/64	.1406	3.57188	41/64	.6406	16.2718
5/32	.1562	3.96875	21/32	.6562	16.6687
11/64	.1718	4.36563	43/64	.6718	17.0656
3/16	.1875	4.76250	11/16	.6875	17.4625
13/64	.2031	5.15938	45/64	.7031	17.8593
7/32	.2187	5.55625	23/32	.7187	18.2562
15/64	.2343	5.95313	47/64	.7343	18.6531

1/4	.25	6.35000	3/4	.75	19.0500
17/64	.2656	6.74688	49/64	.7656	19.4468
9/32	.2812	7.14375	25/32	.7812	19.8437
19/64	.2968	7.54063	51/64	.7968	20.2406
5/16	.3125	7.93750	13/16	.8125	20.6375
21/64	.3281	8.33438	53/64	.8281	21.0343
11/32	.3437	8.73125	27/32	.8437	21.4312
23/64	.3593	9.12813	55/64	.8593	21.8381
3/8	.375	9.52500	7/8	.875	22.2250
25/64	.3906	9.92188	57/64	.8906	22.6218
13/32	.4062	10.31875	29/32	.9062	23.0187
27/64	.4218	10.71563	59/64	.9218	23.4156
7/16	.4375	11.11250	15/16	.9375	23.8125
29/64	.4531	11.50938	61/64	.9531	24.2093
15/32	.4687	11.90625	31/32	.9687	24.6062
31/64	.4843	12.30313	63/64	.9843	25.0031
1/2	.5	12.70000	1	1.0000	24.4000

Metric equivalents are in millimeters.