

# SENTRY

## PULSATION DAMPENERS



### Engineered Products for Industrial Fluid Control

- Pulsation Dampening
- Surge Suppression
- Suction Stabilization
- Shock Absorption

**Blacoh**  
FLUID  
CONTROL

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## Not Just An Accessory... A Necessity

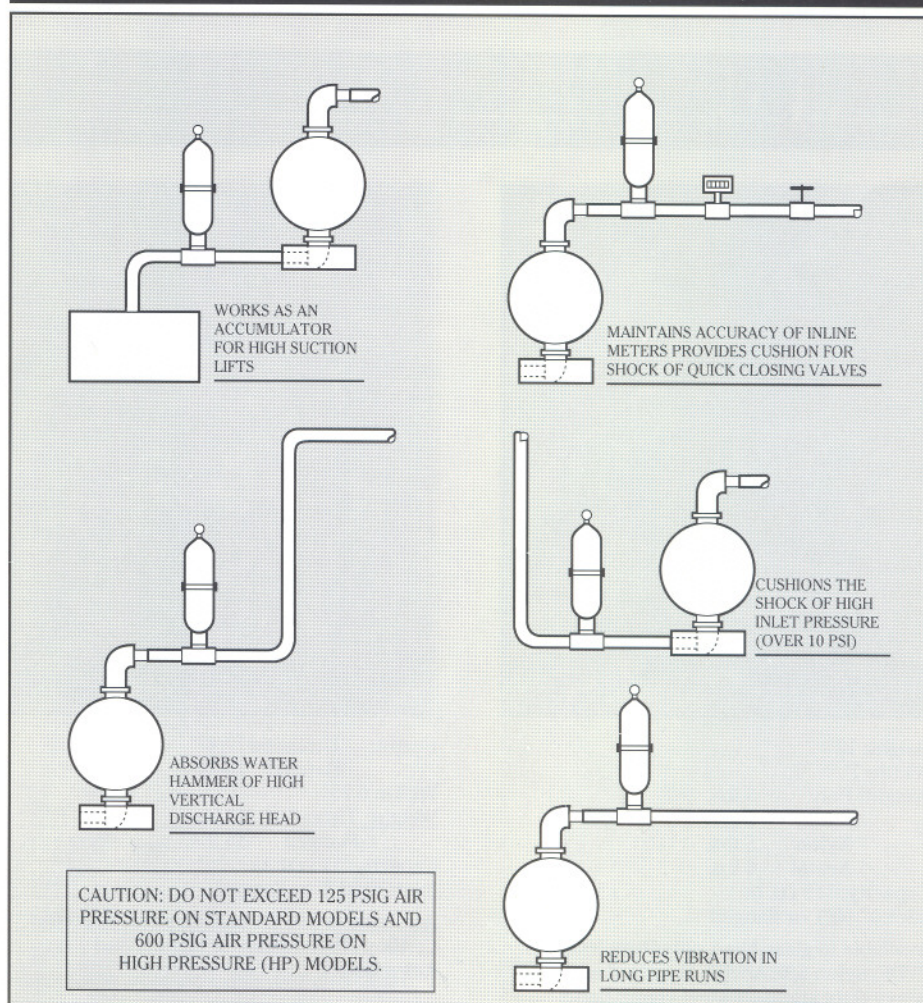
The solution to pump pulsation is Blacoh's line of SENTRY pulsation dampeners, suction stabilizers, and surge suppressors. SENTRY minimizes the destructive effect of these uncontrolled pressure surges much as a shock absorber dampens and smoothes the ride of an automobile over an uneven road surface.

SENTRY dampeners and suppressors, properly sized and installed, can economically eliminate up to 98% of the low frequency, high amplitude pulsations produced by reciprocating pumps. SENTRY is available in the right size and material of construction for every application.

## Let Sentry Stand Guard Over Your Pumping System

- Smooth and continuous, almost linear, flow — prevent splashing of liquids or chemicals.
- Prevent pipe and joint fatigue — protect your environment from contamination by chemical leaks.
- Absorb shock from quick-closing valves — protect against catastrophic pipe failure.
- Insure accuracy and protection of in-line meters and instruments.
- Provide suction stabilization at pump inlet — easing the pump's work load and minimizing cavitation.
- Extend the life of critical pump components — providing more production time than down-time.

### WHERE SENTRY BENEFITS YOUR PUMP





# The Necessity of Pulsation Control

Positive displacement pumps, whether piston, gear, diaphragm, peristaltic, lobe or progressive cavity, all derive their pumping action by capturing a given amount of liquid in a chamber and pushing it out the discharge. With this type of pumping action, the discharge flow is in low frequency, high amplitude pulsations rather than a steady flow similar to the centrifugal pump. The pulsations are units of uncontrolled fluid energy, which express themselves as vibration, pressure surges and water hammer. The reciprocating type of the positive displacement pump produces the worst of these uncontrolled energy pulsations due to the start and stop action of the captured fluid with each pump stroke or cycle. The vibrations and surges from these pulsations not only damage pipes, fittings, joints and meters, but also shorten the life of pump components, such as diaphragms, check balls and valve seats.

# Simplicity of Design/ Efficient in Operation

## FEATURES

- Lightweight, compact design.
- No bracing required.
- Leak-free, single-tee connection
- Simple design for quick and easy in-line maintenance
- Single wear part
- Non-bleed air design ensures faster response time for effective dampening.
- Available with threaded or flanged mounting
- Self-adjusting bladder for optimum dampening
- Self-relieving regulator or automatic self-adjusting valve
- Low cost broad chemical resistance
- One-way air inlet valve prevents product backflow if bladder failure occurs
- Bolt design for higher pressures up to 600 psi
- Thick wall construction for extra margin of safety
- Clamp band bolt provides a convenient grounding lug
- Molded-in inlet gate prevents bladder extrusion
- Pressure gauge standard for quick reference and adjustment
- High volumetric efficiency
- Bladder automatically seeks proper level based on pump discharge volume

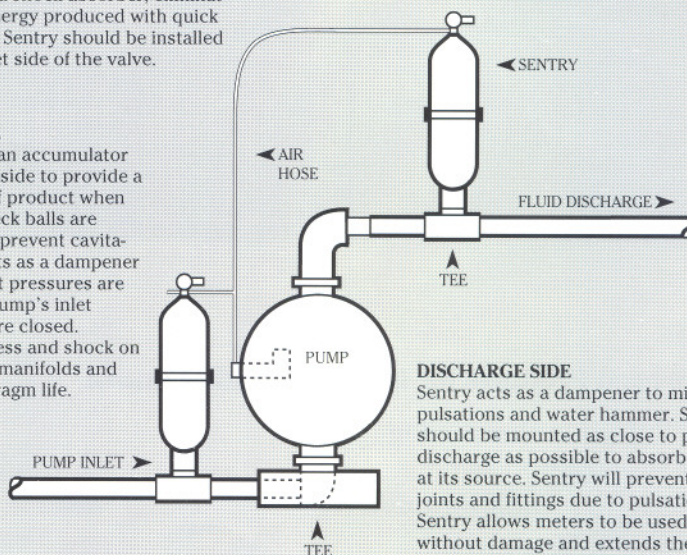
## TYPICAL INSTALLATION

### WATER HAMMER (Not pictured)

Sentry acts as a shock absorber, eliminating the fluid energy produced with quick closing valves. Sentry should be installed next to the inlet side of the valve.

### SUCTION SIDE

Sentry acts as an accumulator on the suction side to provide a close source of product when pump inlet check balls are opened. Helps prevent cavitation. Sentry acts as a dampener when high inlet pressures are generated as pump's inlet check valves are closed. Minimizing stress and shock on pipes, fittings, manifolds and extends diaphragm life.



### DISCHARGE SIDE

Sentry acts as a dampener to minimize pulsations and water hammer. Sentry should be mounted as close to pump discharge as possible to absorb shock at its source. Sentry will prevent leaking joints and fittings due to pulsation. Sentry allows meters to be used without damage and extends the life and reliability of pump components.





## SENTRY I



Height: 21 $\frac{1}{8}$ "  
Width: 8 $\frac{3}{4}$ "

Weight: Poly 13 lbs.  
Kynar 16 lbs.  
Nylon 13 lbs.  
Acetal 16 lbs.

Capacity: 370 cu. in.

Inlet: 2" NPT or female flanged

Available in glass-filled polypropylene, PVDF, nylon 6/6, Acetal. Standard with heavy duty stainless steel clamp band. Available in Manual or Automatic.



Height: 25 $\frac{1}{2}$ "  
Width: 9 $\frac{1}{4}$ "

Weight: All Metal 36 lbs.  
Poly Non-Wetted 16 lbs.

Capacity: 370 cu. in.

Inlet: Flow-through or 2" flanged

Available in 316 SS, carbon steel, Hastelloy C, all metal, or poly non-wetted. Available in Manual and Automatic.



Height: 15 $\frac{1}{2}$ "  
Width: 8.3"

Weight: 18 lbs.

Capacity: 120 cu. in.

Inlet: 2" flanged

Available in virgin TFE with heavy duty stainless steel Teflon®-coated clamp band. Available in Manual and Automatic.



## SENTRY II



Height: 13"

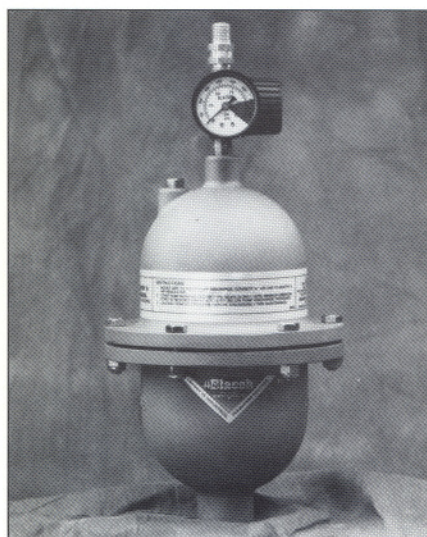
Width: 7"

Weight: Poly 5 lbs.  
Kynar 6 lbs.  
Nylon 5 lbs.  
Acetal 6 lbs.

Capacity: 115 cu. in.

Inlet:  $\frac{3}{4}$ " NPT or flanged

Available in glass-filled polypropylene, PVDF, nylon 6/6, Acetal. Standard with heavy duty stainless steel clamp band. Available in Manual or Automatic.



Height: Threaded 12.47"

Flanged 13.27"

Width: 6.25"

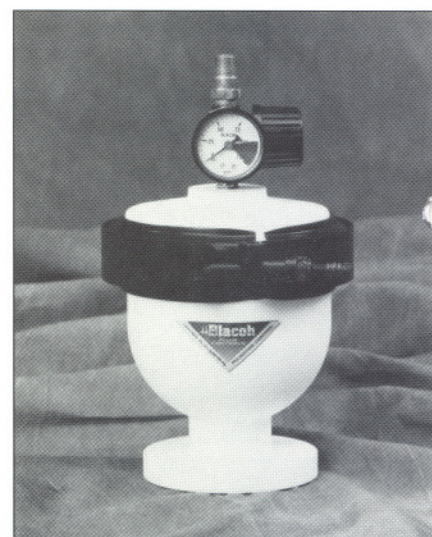
Weight: Threaded 12 lbs.

Flanged 15 lbs.

Capacity: 115 cu. in.

Inlet:  $\frac{3}{4}$ " NPT or flanged

Available in 316 SS, carbon steel, Hastelloy C, Alloy 20. Available in Manual and Automatic.



Height: 10"

Width: 6"

Weight: 8 lbs.

Capacity: 18 cu. in.

Inlet:  $\frac{3}{4}$ " NPT or flanged

Available in virgin TFE with heavy duty stainless steel Teflon®-coated clamp band. Available in Manual and Automatic.

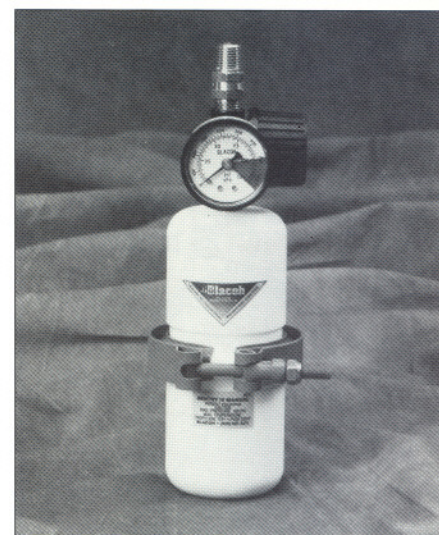




Height: 8"  
Width: 2.85"  
Weight: Poly 2 lbs.  
PVDF 2 lbs.  
Acetal 2 lbs.  
Capacity: 10 cu. in.  
Inlet: 1/2" NPT flow through  
Available in glass-filled polypropylene, PVDF, Acetal.



Height: 5 1/4"  
Width: 4 1/2"  
Weight: 5 lbs.  
Capacity: 10 cu. in.  
Inlet: 3/8" NPT  
Available in 316 SS, carbon steel, Hastelloy C, Alloy 20.



Height: Domed 8 3/4"  
Flat Top 6 3/4"  
Width: 3"  
Weight: Domed 1 lb. 13 oz.  
Flat Top 1 lb. 13 oz.  
Capacity: Domed 8 cu. in.  
Flat Top 3 cu. in.  
Inlet: 3/8" NPT  
Virgin TFE with heavy duty stainless steel Teflon®-coated clamp band.



## RUBBER BLADDER OPTIONS

COMPOUND	CODE STAMP/COLOR	TEMPERATURE LIMITS	SUITABLE APPLICATIONS
Neoprene	NE	0° to +170° F	Good abrasion resistance and flex; use with non-aggressive fluids
Buna-N	BN	+10° to +180° F	Good flex life; use with petroleum/oil-based fluids
Nordel	ND	-60° to +280° F	Use in extreme cold and/or mildly aggressive applications
Viton	VT	+30° to +350° F	Use in extreme hot applications and/or aggressive fluids
Hypalon	HY	+10° to +275° F	Excellent abrasion resistance; use in non-aggressive applications
Food Grade Silicon	Orange	-20° to +220° F	FDA-approved material; use in food processing applications
Aflas	AF	0° to +600° F	High temperature, petroleum-based chemicals, strong acids, bases
Teflon® TFE	White	+40° to +220° F	Excellent flex life; highly aggressive fluids

### TEMPERATURE LIMITS FOR PLASTICS

Polypropylene	+32° F to +175° F	0° C to +79.4° C
PVDF (Kynar)	+10° F to +250° F	-12.2° C to +121.1° C
Teflon®	-20° F to +225° F	-28.9° C to +107.2° C
Nylon	0° F to +200° F	-17.8° C to +93.3° C
Acetal	-20° F to +180° F	-28.9° C to +82.2° C

Note: Consult chemical resistance charts — temperature limits vary with different chemicals.

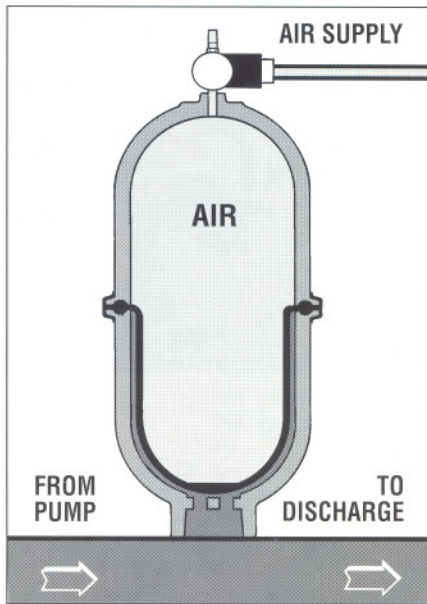


Teflon® bellows come with a 3-year manufacturer's warranty of performance.

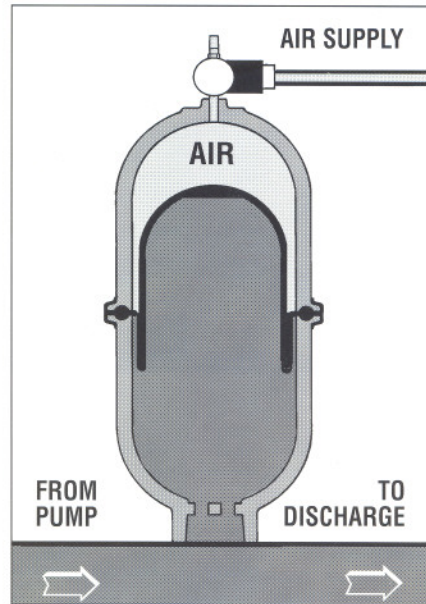




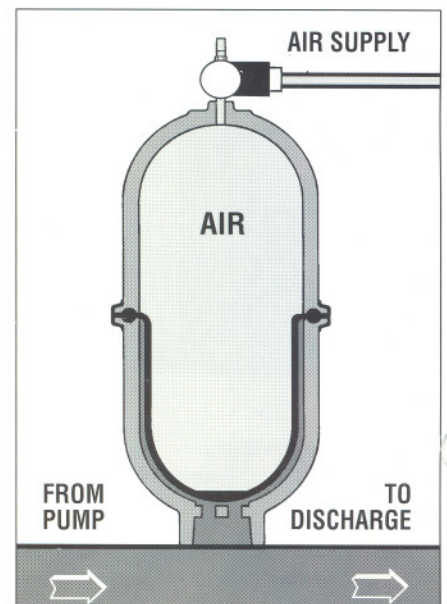
## Manual Model



**Figure 1.** Compressed air is supplied to the regulator on top of the SENTRY dampener. The SENTRY dampener pressure is set 4 to 6 PSI less than the fluid line pressure. As pump fluid flows, it takes the line of least resistance and enters the SENTRY dampener.

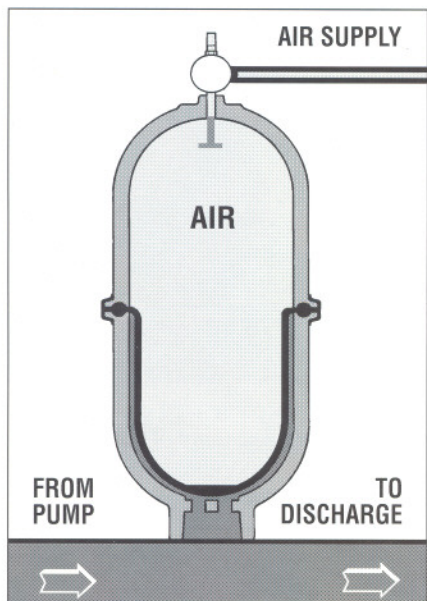


**Figure 2.** As fluid fills the SENTRY dampener, the bladder is inverted but the regulator maintains dampener pressure. At the point of pump shift, the system pressure drops below the regulated pressure in the SENTRY dampener.

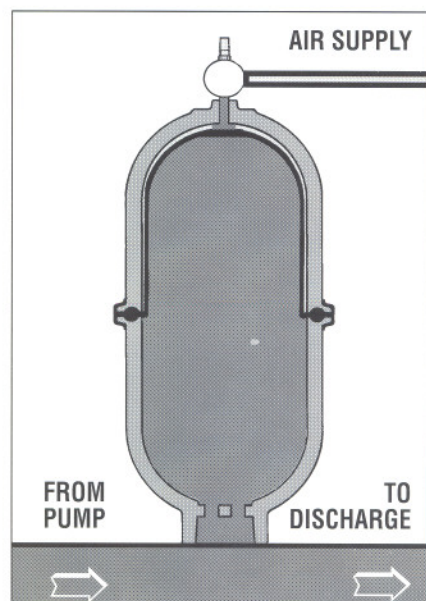


**Figure 3.** With the system pressure now less than the SENTRY dampener pressure, the bladder is forced down discharging the accumulated fluid back into the discharge line filling the void created during the pump shift. The result is a continuous, vibration-free flow.

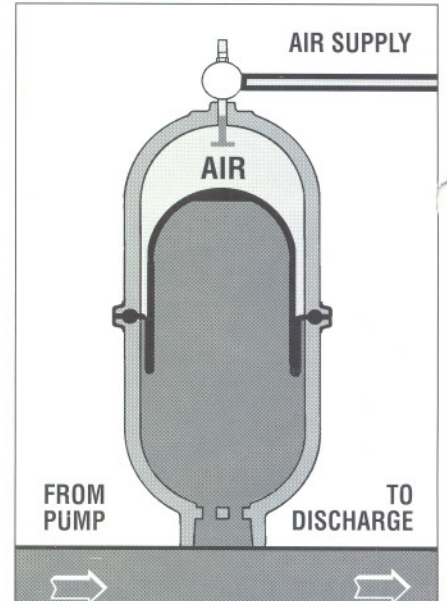
## Automatic Model



**Figure 1A.** There is no regulator, an air line is installed directly to the top of the SENTRY dampener. The SENTRY dampener must have air pressure available that is higher than anticipated fluid pressure from the pump. As fluid enters the SENTRY dampener, the bladder is inverted, compressing the trapped air in the dampener creating a shock absorbing cushion.



**Figure 2A.** As the fluid pressure increases from the pump discharge, the bladder will contact the automatic, one way poppet valve. The valve will open, allowing pressurized air into the SENTRY dampener to equalize the fluid pressure and force the bladder away from the poppet valve.



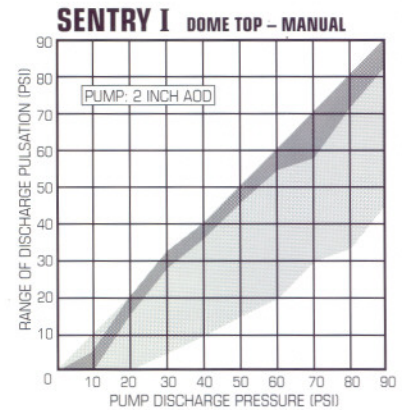
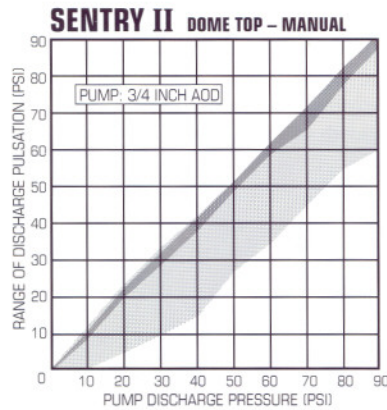
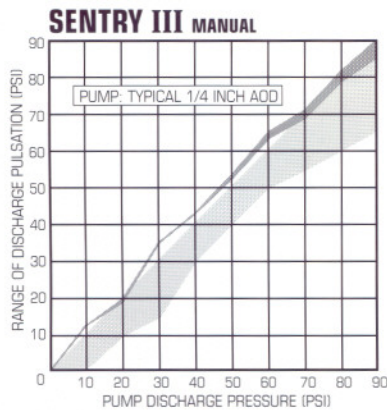
**Figure 3A.** The SENTRY dampener is now charged with air and operates the same way as the manual model. If the system pressure increases, the process in Figure 2A is repeated. If the system pressure is reduced, the bladder is forced to a lower level. Since the pressurized air is now in a larger area, it expands and, inversely, pressure is reduced automatically to a new point of system equilibrium. When the pump is shut off, the bladder is forced to its original position in Figure 1A and the pressure is reduced to near atmospheric.



The charts below show typical pulsation control with SENTRY dampeners. The wide, light gray bands show the undampened range of pulsation at the discharge of the specified pump. The narrow, dark gray bands show the reduced range of pulsation when a SENTRY dampener is applied to the system. Reduction in pulsation will vary depending upon viscosity, flow rate and type of fluid and the pipe size of the system. Consult factory for performance expected for specific applications.

Undampened Range      Dampened Range

**Example:** Graph 3, below, at 50 PSI pump discharge pressure, shows the undampened discharge pressure pulsations ranging from 16 PSI to 50 PSI. That is a 34 PSI fluctuation in discharge pressure. With the SENTRY dampener, the discharge pressure is steady in the range of 46 PSI to 50 PSI.



## Sentry Dampener Capacity Requirement Formula

Pulsation dampeners are normally used in process applications in three areas:

1. Located immediately at the discharge of positive displacement pumps to dampen flow fluctuations.
2. Located immediately in front of the inlet of positive displacement pumps to absorb pressure surges into the pump.
3. Located directly upstream of quick closing valves to protect pipes and joints from pressure surges or spikes caused by rapid deceleration of fluid.

Experience has shown that a properly sized SENTRY Suppressor can reduce pulsation 90% to 98%. To completely eliminate pulsation would theoretically require an infinite dampener volume.

### Information Necessary To Determine Sentry Model Required:

1. Volume per stroke of pump (in cubic inches)  
One gallon equals 231 cubic inches  
Volume is determined by the following:  
 $.7854 \times (\text{bore diameter})^2 \times (\text{stroke length})$
2. Type of pump, i.e., simplex (single piston), duplex, triplex
3. Maximum operating pressure
4. Minimum operating pressure
5. Average operating pressure (minimum and maximum divided by 2)

Capacity (c) equals: 
$$\frac{(V) \times (K) \times (P_{avg}/P_{min})^Y}{1 - (P_{avg}/P_{max})^Y}$$

Where: V = volume per stroke in cubic  
Pmax = maximum discharge pressure  
Pmin = minimum discharge pressure (usually 50% of the maximum pressure in a double diaphragm pump)  
Pav = maximum pressure added to minimum pressure divided by 2  
K = number from pump type table  
Y { = 1 if charge in suppressor is compressed air  
= number from pump type table

### K Factor Table:

Pump Type	K Factor
Simplex single acting	.60
Simplex double acting	.25
Duplex single acting*	.25
Duplex double acting	.15
Triplex single acting	.13
Triplex double acting	.06

\*Air operated double diaphragm pumps are this type.

### Example:

V = .33 gallons or  $.33 \times 231 = 76.23$  cubic inches  
K = .25 from K Factor Table (typical AOD pump)  
Pmax = 60 psi  
Pmin = 30 psi  
Pav =  $60 + 30$  divided by 2 = 45  
Y = 1 for compressed air charge  
C = 
$$\frac{76.23 \times .25 \times (45/30)^1}{1 - (45/60)^1}$$
  
$$= \frac{19.06 \times (45/30)^1}{1 - (45/60)^1}$$
  
$$= \frac{19.06 \times 1.5}{1 - .75}$$
  
$$= \frac{28.59}{.25}$$
  
114.36 cubic inches suppressor capacity

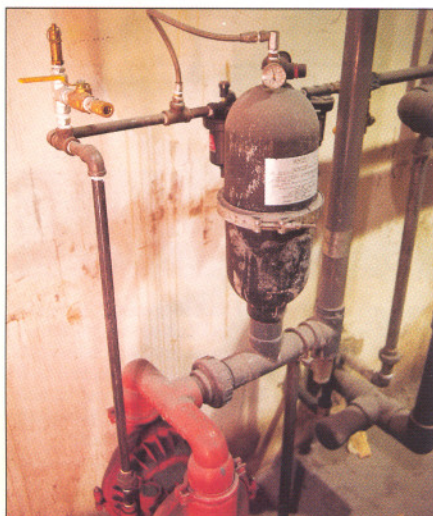
In this case, the SENTRY II size suppressor is just barely adequate and in fact will only remove about 80% of pulsation. A SENTRY I is called for. **NOTE: As a rule, the suppressor capacity should be at least one and one half times the per stroke capacity of the pump.**





## Leak Prevention and Quality Products

A very large manufacturer, in the Southwest, of ultra pure acids for the semiconductor industry uses Blacoh SENTRY dampeners to prevent pipe vibration and fatigue. Fatigue which would ultimately lead to pipe and connection failure — spilling acid into the environment. The manufacturer uses PVDF diaphragm pumps with Teflon® diaphragms to transfer acid and other chemicals for both final product packaging and waste treatment. Due to the highly corrosive nature of the product, all PVDF pipe and connections are used throughout the plant. To prevent the violent pipe vibration produced by the reciprocating action of the diaphragm pumps, each is fitted with a Blacoh SENTRY pulsation dampener. The SENTRY dampeners match the pump materials of PVDF body and Teflon® bellows, and even though the Teflon® diaphragms in the pumps must be replaced every few months, the SENTRY Teflon® bellows have been in service for over three years without the need for replacement. By providing industry with quality products proven in field service such as this, it is no wonder that Blacoh is the leader in industrial pulsation control and can unconditionally warranty the SENTRY Teflon® bellows for a full three years of service life.



## Meter Accuracy and Reliable Service

A major acrylic latex resin manufacturer located in the Northwest is currently utilizing Blacoh SENTRY I surge suppressors to dampen the pulsation that is produced by the air operated double diaphragm pumps which are used to transfer the latex resins throughout the plant. The manufacturer uses Neptune liquid flow meters to measure product flow for their processing. The Blacoh SENTRY I model 101B Surge Suppressor (shown here) removes the line surges and pulsations to allow the Neptune meters to accurately measure product flow. This accuracy resulted in less downtime and an increase in production without an increase in labor or additional equipment. For over a decade, this manufacturer has relied on Blacoh SENTRY surge suppressors and pulsation dampeners to provide reliable and maintenance free service while solving their pump pulsation problems.



## Smooth Flow and Less Maintenance

A leader in the circuit board manufacturing industry uses Blacoh SENTRY pulsation dampeners for everything from the transfer of etching acids to waste water. With Blacoh's extensive variety of shell and bladder material and space saving design, SENTRY dampeners fill their need throughout the plant inside and out. The smooth and continuous flow produced by the SENTRY dampeners is crucial when pumping toxic fluids such as sulfuric acid. The manufacturer has equipped their transfer pumps with SENTRY dampeners to change the transfer pumps' pulsating flows to steady flows, removing the danger of acid splashing, pipe breakage and joint loosening. The benefits of the SENTRY dampener do not end here. When the pulsating flow is removed, so is the stress and strain of the pump working against its own pulsations. By removing this strain, pump efficiency is increased. Furthermore, with the reduced strain on the pumps' components resulting in longer diaphragm and ball valve life, the plant incurs less maintenance downtime and less employee exposure to toxic chemicals.



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