Table of Contents

Introduction

This catalog introduces a new line of enhanced performance variable displacement pressure compensated vane pumps from Bosch.

The pumps are designed to meet the requirements of the machine tool, general machinery, and other markets where low noise, high performance and competitive pricing are needed.

The design of the VPV series of vane pumps utilizes 30 years of field and manufacturing experience from the current Bosch vane pump line. State-of-the-art technologies and materials were utilized while retaining the superior features of the existing designs. Additional goals were to create a pump with the international market in mind and to incorporate the extremely high quality standards the Bosch name has come to exemplify.

Keeping in mind market expectations, Bosch developed a pump with the following improvements and features:

1. High reliability with fewer parts.
2. Significant advances in noise reduction.
3. High volumetric and overall efficiency.
4. Excellent durability.
5. Modern appearance.
6. Improved ring and vane wear technology.
7. Very good response and recovery times.
8. Generally reduced envelope size.
9. Redesigned controls with shock clipper.
10. Conforms to the latest SAE, ISO, NFPA, and ANSI standards.
11. Combination capability - full horsepower may be transferred to pump 2. Combinations of construction of multiple pumps may be required to be de-rated.

Benefits

- LOW COST - Competitively priced with other manufacturers of vane pumps and economy axial piston pumps.
- EXCEPTIONALLY QUIET - Helps machinery builders meet government and purchased sound level requirements.
- CONTINUOUS DUTY RATING - @ 3,000 PSI - High performance and long life design for 10,000 plus hours.
- HIGHLY EFFICIENT FAST RESPONSE & RECOVERY - Exceptional reaction time for critical system demands.
- PRESSURE COMPENSATED - Controls pump delivery to circuit demand thereby conserving energy.
- HIGH STRENGTH - Computer optimized casting design.
- HYDRODYNAMIC JOURNAL BEARINGS - Provides long life and quiet operation.
- NO PREFILL REQUIREMENTS - Pump case prefill not required for initial start-ups.
- REPAIRABLE - Repair kits and parts available from local distribution centers or the factory.
- CONTROL OPTIONS - Single stage; two-stage, remote control; solenoid multi-pressure; load sensing; solenoid; torque limiting and elecronic proportional.
- SHOCK CLIPPER - Reduces shock pressure by up to 50% increasing system component life and system stability. Must be plumbed on VPV 16, 25, & 32. The shock clipper is integrated into VPV 45, 63, 80, 100, 130, & 164 and drains to the case drain. See page 97.

Specifications

General		VPV 16	VPV 25	VPV 32
Displacement (Nominal)		1 in^3/rev (16 cm^3/rev)	1.5 in^3/rev (25 cm^3rev)	2 in^3/rev (32 cm^3/rev)
Displacement (Actual)		1.06 in^3/rev (16.8 cm^3/rev)	1.66 in^3/rev (27.4 cm^3rev)	2.04 in^3/rev (32 cm^3/rev)
Flow at 1750 RPM[1]		7.57 GPM (28.6 L/min)	11.36 GPM (43.0 L/min)	15.15 GPM (57.3 L/min)
Maximum continuous pressure		3000 psi (210 bar)		
Pressure compensating range	Single stage	200-3000 psi (14-210 bar) Minimum pressure of 190 PSI		
	Two stage	300-3000 psi (20-210 bar) Minimum pressure of 290 PSI		
Maximum transient spike pressure		3800 psi (260 bar)	4000 psi (280 bar)	
Maximum case pressure		10 psi (0.7 bar)		
Speed range		1150-1800 RPM		
Direction of rotation (viewed from shaft end)		Right hand (clockwise)		
Case drain flow while compensating @ 1800 RPM	1000 psi (70 bar)	0.6 GPM (2.3 L/min)	0.6 GPM (2.3 L/min)	
	2000 psi (140 bar)	0.9 GPM (3.4 L/min)	1.1 GPM (4.2 L/min)	
	3000 psi (210 bar)	1.26 GPM (4.8 L/min	1.4 GPM (5.3 L/min)	
Maximum inlet vacuum at sea level		6 in. HG (152 mm HG)		
Mounting[2] - SAE 2-bolt flange (ISO 3019/1)		S.A.E. 'A' 2-bolt flange	S.A.E. 'B' 2-bolt flange	
Mounting Position		Unrestricted		
Port sizes	Inlet	#16 S.A.E.	#24 S.A.E	
	Outlet	#12 S.A.E.	#16 S.A.E.	
	Case drain	#8 S.A.E.		
	Clipper control drain (optional)	#6 S.A.E.		
	Remote control (optional)	#4 S.A.E.		
Drive		Pump to be connected to prime mover by means of a flexible coupling that is aligned to a maximum of .006" (.152mm) total indicator reading. No overhung or side loads permitted. Alignments greater than .006" indicator reading could cause increased noise and vibration as well as premature shaft seal wear resulting in leakage.		
Fluid recommendations		A premium quality hydraulic oil with anti-wear additives is recommended, but not required. Refer to publication S-106 "Petroleum Hydraulic Fluids" for a list of fluids which meet or exceed the necessary lubrication requirements. Consult factory for use with water base fire resistant fluids.		
Fluid viscosity at operating temperature	Minimum	100 SUS (21 cSt)		
	Maximum	1000 SUS (216 cSt)		
	Optimum	150-250 SUS (32-54 cSt)		
	Maximum start-up	4000 SUS (864 cSt)		
Fluid temperature		Normal inlet fluid temperature should not exceed 140°F (60° C). Always select a fluid for optimum viscosity at operating temperature. Consult factory for applications assistance when inlet fluid temperatures over 140° F (60° C) are expected.		
Seals		Fluorocarbon Standard		
Filtration		Fluid cleanliness per ISO/DIS 4406 should be 18/15 or better for pressures of 2000 psi or less. For continuous operating pressures of 2000 to 3000 psi, fluid cleanliness should be 17/13 or better.		
Response time (circuit dependent)	Full flow to minimum flow	20-35 ms	20-35 ms	
Recovery time (circuit dependent)	Minimum flow to full flow	50-135 ms – single stage compensator	70-185 ms – single stage compensator	
Weight	Single stage	34 lbs. (16.5 kg)	61 lbs. (28 kg)	
	Two stage	38 lbs. (17.3 kg)	65 lbs. (28.5 kg)	

[1] Flows are actual. Volumetric efficiencies shown in technical data taken into account.
[2] Metric 4-bolt flange available (ISO 3019/2) available. Please consult factory.

Specifications

General		VPV 45	VPV 63	VPV 80
Displacement (Nominal)		2.75 in^3/rev (45 cm^3/rev)	3.84 in^3/rev (63 cm^3rev)	4.88 in^3/rev (80 cm^3/rev)
Displacement (Actual)		2.88 in^3/rev (47.3 cm^3/rev)	3.93 in^3/rev (64.4 cm^3rev)	5.02 in^3/rev (82.3 cm^3/rev)
Flow at 1750 RPM[1]		20.83 GPM (72.84 L/min)	29.10 GPM (110.1 L/min)	36.97 GPM (139.9 L/min)
Maximum continuous pressure		3000 psi (210 bar)		
Pressure compensating range	Two stage	350-3000 psi (24-210 bar) Minimum pressure of 300 PSI		
Maximum transient spike pressure		4000 psi (280 bar)		
Maximum case pressure		10 psi (0.7 bar)		
Speed range		1150-1800 RPM		
Direction of rotation (viewed from shaft end)		Right hand (clockwise)		
Case drain flow	1000 psi (70 bar)	1.5 GPM (5.7 L/min)	1.4 GPM (5.3 L/min)	1.4 GPM (5.3 L/min)
while compensating	2000 psi (140 bar)	1.9 GPM (7.2 L/min)	1.8 GPM (6.8 L/min)	1.8 GPM (6.8 L/min)
@ 1800 RPM	3000 psi (210 bar)	2.5 GPM (9.5 L/min)	2.4 GPM (9.1 L/min)	2.3 GPM (8.7 L/min)
Maximum inlet vacuum at sea level		6 in. HG (152 mm HG)		
Mounting[2] - SAE 2-bolt flange (ISO 3019/1)		S.A.E. 'C' 2-Bolt flange		
Mounting Position		Unrestricted		
Port sizes	Inlet	2" S.A.E.		
	Outlet	1 1/4" S.A.E. flange		
	Case drain	S.A.E. = #8 S.A.E.		
	Remote control (optional)	S.A.E. = #4 S.A.E.		
Drive		Pump to be connected to prime mover by means of a flexible coupling that is aligned to a maximum of .006" (.152mm) total indicator reading. No overhung or side loads permitted. Alignments greater than .006" indicator reading could cause increased noise and vibration as well as premature shaft seal wear resulting in leakage.		
Fluid recommendations		A premium quality hydraulic oil with anti-wear additives is recommended, but not required. Refer to publication S-106 "Petroleum Hydraulic Fluids" for a list of fluids which meet or exceed the necessary lubrication requirements. Consult factory for use with water base fire resistant fluids.		
Fluid viscosity at operating temperature	Minimum	150 SUS (32 cSt)		
	Maximum	1000 SUS (216 cSt)		
	Optimum	200-300 SUS (43-65 cSt)		
	Maximum start-up	4000 SUS (864 cSt)		
Fluid temperature		Normal inlet fluid temperature should not exceed 140°F (60° C). Always select a fluid for optimum viscosity at operating temperature. Consult factory for applications assistance when inlet fluid temperatures over 140° F (60° C) are expected.		
Seals		Fluorocarbon Standard		
Filtration		Fluid cleanliness per ISO/DIS 4406 should be 18/15 or better for pressures of 2000 psi or less. For continuous operating pressures of 2000 to 3000 psi, fluid cleanliness should be 17/13 or better.		
Response time (circuit dependent)	Full flow to minimum flow	20-40 ms		
Recovery time (circuit dependent)	Minimum flow to full flow	100-250 ms – two stage compensator		
Weight	Single stage	120 lbs. (55 kg)		
	Two stage	128 lbs. (58 kg)		

[1] Flows are actual. Volumetric efficiencies shown in technical data taken into account.

[2] Metric 4-bolt flange available (ISO 3019/2) available. Please consult factory.

Specifications

General		VPV 100	VPV 130	VPV 164
Displacement (Nominal)		6.1 in^3/rev (100 cm^3/rev)	7.9 in^3/rev (130 cm^3rev)	10.0 in^3/rev (164 cm^3/rev)
Displacement (Actual)		6.0 in^3/rev (99 cm^3/rev)	8.0 in^3/rev (131 cm^3rev)	10.0 in^3/rev (164 cm^3/rev)
Flow at 1750 RPM[1]		45.4 GPM (171.8 L/min)	59.85 GPM (226.5 L/min)	75.76 GPM (286.7 L/min)
Maximum continuous pressure		3000 psi (210 bar)		3000 psi (210 bar)
Pressure compensating	Two stage	350-3000 psi (24-210 bar)		350-3000 psi (24-210 bar)
Maximum transient spike pressure		4000 psi (280 bar)		4000 psi (280 bar)
Maximum case pressure		10 psi (0.7 bar)		
Speed range		1150-1800 RPM		
Direction of rotation (viewed from shaft end)		Right hand (clockwise)		
Case drain flow	1000 psi (70 bar)	1.5 GPM (5.7 L/min)	1.6 GPM (6.0 L/min)	1.7 GPM (6.4 L/min)
while compensating	2000 psi (140 bar)	2.0 GPM (7.6 L/min)	2.2 GPM (8.3 L/min)	2.3 GPM (8.7 L/min)
@1800 RPM	3000 psi (210 bar)	2.5 GPM (9.5 L/min)	3.0 GPM (11.3 L/min)	3.1 GPM (11.7 L/min)
Maximum inlet vacuum at sea level		6 in. HG (152 mm HG)		
Mounting[2] - SAE 2-bolt flange (ISO 3019/1)		S.A.E. 'D', 2-bolt flange		
Mounting Position		Unrestricted		
Port sizes	Inlet	2 1/2" S.A.E.		
	Outlet	1 1/2" S.A.E.		
	Case drain	S.A.E. = #8 S.A.E.		
	Remote control (optional)	#4 S.A.E.		
Drive		Pump to be connected to prime mover by means of a flexible coupling that is aligned to a maximum of .006" (.152mm) total indicator reading. No overhung or side loads permitted. Alignments greater than .006" indicator reading could cause increased noise and vibration as well as premature shaft seal wear resulting in leakage.		
Fluid recommendations		A premium quality hydraulic oil with anti-wear additives is required*. Refer to publication S-106 "Petroleum Hydraulic Fluids" for a list of fluids which meet or exceed the necessary lubrication requirements. Consult factory for use with water base fire resistant fluids. *Such as Mobil DTE-26, or similar, for pressures over 2000 psi.		
Fluid viscosity at operating temperature	Minimum	150 SUS (32 cSt)		
	Maximum	1000 SUS (216 cSt)		
	Optimum	200-300 SUS (42-65 cSt)		
	Maximum start-up	4000 SUS (864 cSt)		
Fluid temperature		Normal inlet fluid temperature should not exceed 140°F (60° C). Always select a fluid for optimum viscosity at operating temperature. Consult factory for applications assistance when inlet fluid temperatures over 140° F (60° C) are expected.		
Seals		Fluorocarbon Standard		
Filtration		Fluid cleanliness per ISO/DIS 4406 should be 18/15 or better for pressures of 2000 psi or less. For continuous operating pressures of 2000 to 3000 psi, fluid cleanliness should be 17/13 or better.		
Response time (circuit dependent)	Full flow to minimum flow	20-50 ms		
Recovery time (circuit dependent)	Minimum flow to full flow	250-500 ms – two stage compensator		
Weight	Single stage	240 lbs. (109 kg)		
	Two stage	248 lbs. (112.7 kg)		

[1] Flows are actual. Volumetric efficiencies shown in technical data taken into account.

[2] Metric 4-bolt flange available (ISO 3019/2) available. Please consult factory.

Ordering Guide

Code Structure

The alpha-numeric ordering code system enables any particular type of pump to be specified. Preferred type are also identified by a 10-digit part number for computerized ordering.

Item No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Pump 1	0513	R	18	C	3	V	P	V	32	S	M	21	F	Z	B02
Pump 2***						V	P	V	32	S	M	21	F	Z	B02
Pump 3 (Gear Pump)						HY/Z	F	S11/	14	R	254				

Item No	Code	
1		**Code Digit**
	0513	Vane Pump, stand alone version single pump or combination
2		**Direction of Rotation**
	R	Clockwise, viewed from shaft end
3		**Speed**
	12	maximum speed; e.g. 1150 rpm = 12
	15	1450 rpm = 15
	18	1750 rpm = 18
4		**Drive Shaft**
	A	Key to DIN 6885
	C	Key to SAE Standard
	D	Spline to SAE 744C
5		**Bearing Arrangement / Mounting Flange**
	3	Standard bearing arrangement, mounting flange to SAE standards
	7	Standard bearing arrangement, mounting flange to DIN ISO 3019/2
6		**Principle of Operation**
	V	Vane Type
7		**Mode of Operation**
	P	Pump
8		**Type of Construction**
	V	Variable displacement pump (open circuit)
	K	Fixed Displacement Pump (available in 1998)
9		**Displacement**
	16	16 cc/rev = .98 cu in/rev
	25	25 cc/rev = 1.53 cu in/rev
	32	32 cc/rev = 1.95 cu in/rev
	45	45 cc/rev = 2.75 cu in/rev
	63	63 cc/rev = 3.84 cu in/rev
	80	80 cc/rev = 4.88 cu in/rev
	100	100 cc/rev = 6.10 cu in/rev
	130	130 cc/rev = 7.93 cu in/rev
	164	164 cc/rev = 10.00 cu in/rev

*** When trailing pump is another VPV pump, it can be coded by selecting items 6 through 15 for the alpha-numeric description. Consult factory for other models and descriptions of trailing pumps.

Price and Part Numbers

See VPV Pump Identification Guide, Publication # 9 535 233 782 for SAE, and 9 535 233 785 for metric pumps.

Product Literature Disclaimer

Specifications and/or dimensions are subject to change without prior notice. Please consult factory.

Ordering Guide, cont.

Item No	Code	
10		**Housing**
	S	210 bar = 3000 psi.
11		**Operating Fluid**
	C	Water glycol
	M	Mineral Oil
	D	Phosphate ester
12		**Operating Pressure**
	14	Maximum operating pressure; e.g. 14 = 140 bar = 2000 psi
	21	21 = 210 bar = 3000 psi
13		**Control / Regulator**
	F	Pressure regulator - single stage 16/25/32cc only
	G	Pressure regulator - single stage - lockable 16/25/32cc only
	H	Pressure regulator - two stage - with remote option
	J	Combined pressure/flow compensator (load sense)
	S	Torque limiter (available in 45 to 164cc pumps only)
	T	Proportional P/Q (available 1998)
		Solenoid Operated Two Press. Norm. (Normally open)/Normally Low Pressure/Energize to High
	XA	115V N.O. w/DIN 43650 & quick connect (compression fitting) w/sentinel light
	XB	220V N.O. w/DIN 43650 & quick connect (compression fitting) w/sentinel light
	XC	12V N.O. w/DIN 43650 & quick connect (compression fitting) w/sentinel light
	XD	24V N.O. w/DIN 43650 & quick connect (compression fitting) w/sentinel light
	XE	115V N.O. w/flying leads
	XF	220V N.O. w/flying leads
	XG	12V N.O. w/flying leads
	XH	24V N.O. w/flying leads
	XJ	115V N.O. w/DIN 43650 & NG6
	XK	220V N.O. w/DIN 43650 & NG6
	XL	12V N.O. w/DIN 43650 & NG6
	XM	24V N.O. w/DIN 43650 & NG6
	XN	115V N.O. w/flying leads & NG6
	XO	220V N.O. w/flying leads & NG6
	XP	12V N.O. w/flying leads & NG6
	XR	24V N.O. w/flying leads & NG6
		Solenoid Operated Two Press. Norm. (Normally closed)/Normally High Pressure/Energize to Low
	YA	115V N.C. w/DIN 43650 & quick connect (compression fitting) w/sentinel light
	YB	220V N.C. w/DIN 43650 & quick connect (compression fitting) w/sentinel light
	YC	12V N.C. w/DIN 43650 & quick connect (compression fitting) w/sentinel light
	YD	24V N.C. w/DIN 43650 & quick connect (compression fitting) w/sentinel light
	YE	115V N.C. w/flying leads
	YF	220V N.C. w/flying leads
	YG	12V N.C. w/flying leads
	YH	24V N.C. w/flying leads
	YJ	115V N.C. w/DIN 43650 & NG6
	YK	220V N.C. w/DIN 43650 & NG6
	YL	12V N.C. w/DIN 43650 & NG6
	YM	24V N.C. w/DIN 43650 & NG6
	YN	115V N.C. w/flying leads & NG6
	YO	220V N.C. w/flying leads & NG6
	YP	12V N.C. w/flying leads & NG6
	YR	24V N.C. w/flying leads & NG6

Ordering Guide, cont.

Item No	Code	
13		**Solenoid Operated Vent Two Press. Norm. (Normally vented)/Energize to Pressure**
(cont.)	ZA	115V N.V. w/DIN 43650 & quick connect (compression fitting) w/sentinel light
	ZB	220V N.V. w/DIN 43650 & quick connect (compression fitting) w/sentinel light
	ZC	12V N.V. w/DIN 43650 & quick connect (compression fitting) w/sentinel light
	ZD	24V N.V. w/DIN 43650 & quick connect (compression fitting) w/sentinel light
	ZE	115V N.V. w/flying leads
	ZF	220V N.V. w/flying leads
	ZG	12V N.V. w/flying leads
	ZH	24V N.V. w/flying leads
		Solenoid Operated Vented Norm. High (Normally closed)/Normally at Pressure/Energize to Vent
	WA	115V N.C. w/DIN 43650 & quick connect (compression fitting) w/sentinel light
	WB	220V N.C. w/DIN 43650 & quick connect (compression fitting) w/sentinel light
	WC	12V N.C. w/DIN 43650 & quick connect (compression fitting) w/sentinel light
	WD	24V N.C. w/DIN 43650 & quick connect (compression fitting) w/sentinel light
	WE	115V N.C. w/flying leads
	WF	220V N.C. w/flying leads
	WG	12V N.C. w/flying leads
	WH	24V N.C. w/flying leads
14		**Accessories**
	S	Special (Consult Factory)
	Y	Maximum delivery limiter
	Z	No other accessories
15	B01	**Design Series**
	P1	Pump 1 of a quick combination unit (adapter kit & coupling required to create a combination-see page 81)

Gear Pump Guide

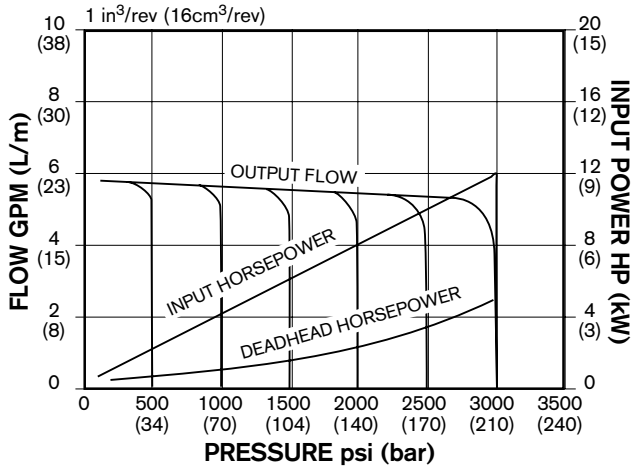
Item No	Code	
6		**Principle of Operation**
	HY/Z	Hydraulic Gear Pump
7		**Size Range**
	F	4 cc to 22.5cc
8		**Type of Construction**
	S11	Standard version
	S21	Duo (low noise version)
9		**Displacement**
	4	4 cc/rev = .244 cu in/rev
	5.5	5.5 cc/rev = .335 cu in/rev
	8	8 cc/rev = .488 cu in/rev
	11	11 cc/rev = .671 cu in/rev
	14	14 cc/rev = .854 cu in/rev
	16	16 cc/rev = .976 cu in/rev
	19	19 cc/rev = 1.159 cu in/rev
	22.5	22.5 cc/rev = 1.372 cu in/rev
10		**Direction of Rotation**
	R	Right hand (clockwise)
11		**Details**
	254	SAE “A” flange, 2 bolt, SAE keyed shaft
	253	SAE “A” flange, 2 bolt, ANSI spline shaft, 9 T, 16/32 pitch

On the following pages are line graphs of the Performance Characteristics for each of the pumps in our series. Characteristics are shown at 1200 PSI, 1500 PSI and 3000 PSI. Since different geographical areas require different data, please refer to the appropriate graph.

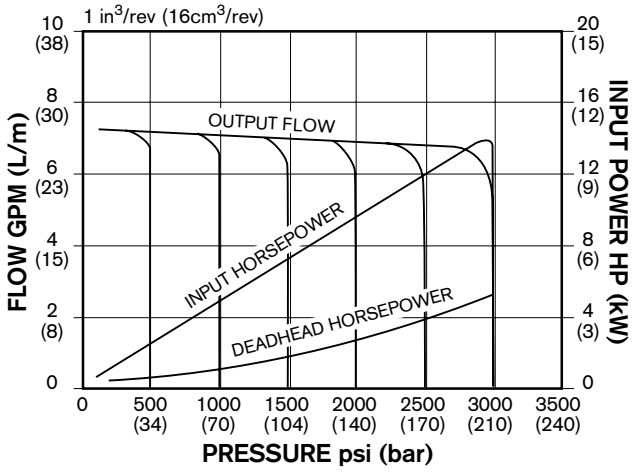
Performance Characteristics - VPV 16 to 3000 PSI (210 Bar)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

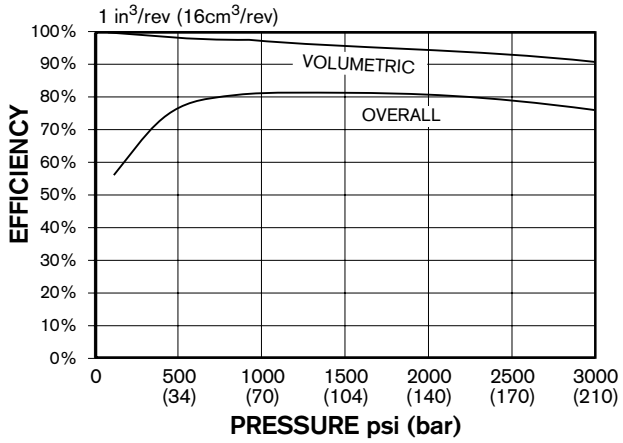
OUTPUT FLOW & POWER @ 1200 rpm



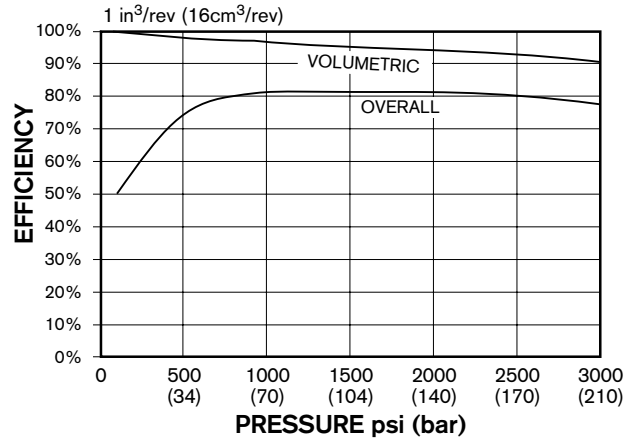
OUTPUT FLOW & POWER @ 1500 rpm



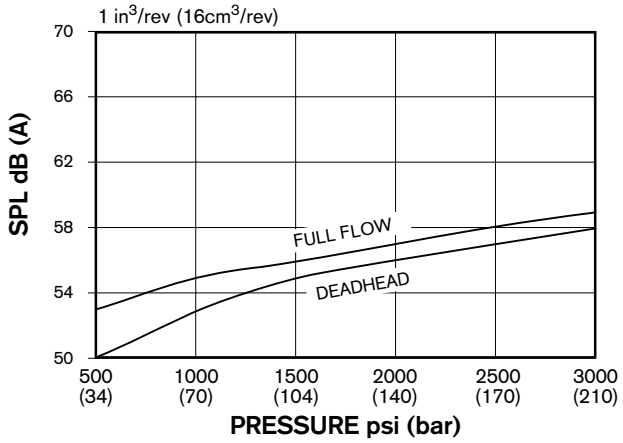
EFFICIENCY @ 1200 rpm



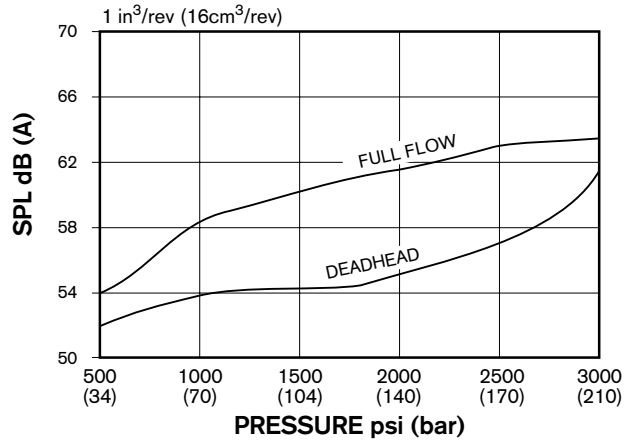
EFFICIENCY @ 1500 rpm



SOUND PRESSURE @ 1200 rpm



SOUND PRESSURE @ 1500 rpm

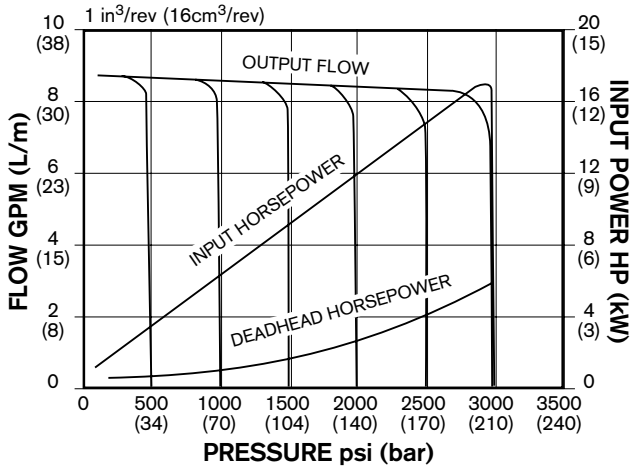


Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.

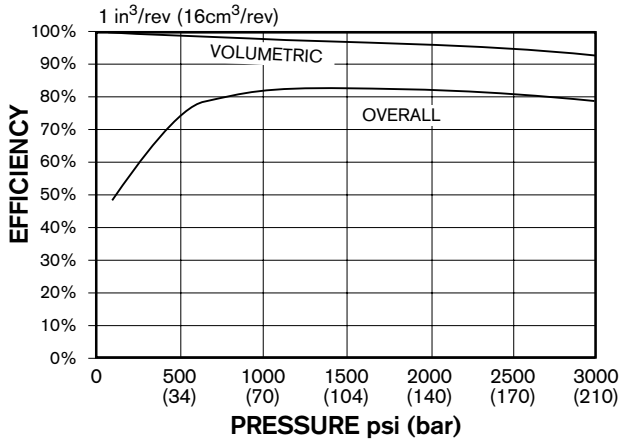
Performance Characteristics - VPV 16 to 3000 PSI (210 Bar) (continued)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

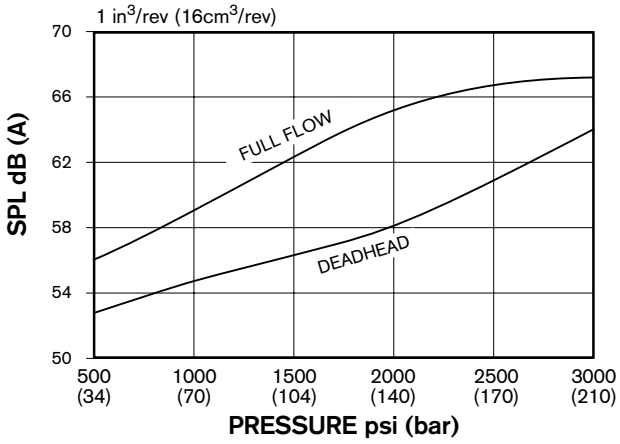
OUTPUT FLOW & POWER @ 1800 rpm



EFFICIENCY @ 1800 rpm



SOUND PRESSURE @ 1800 rpm

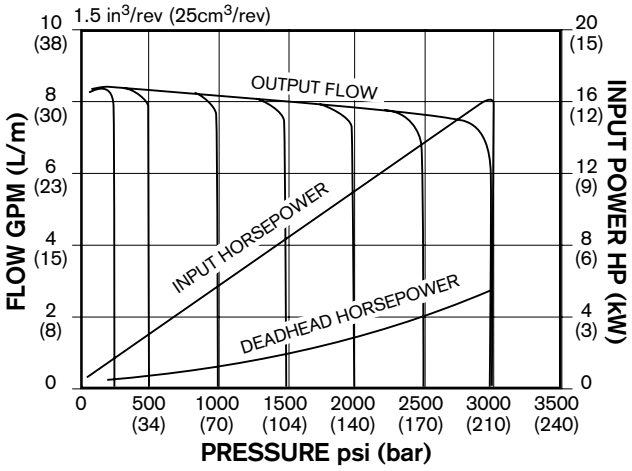


Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.

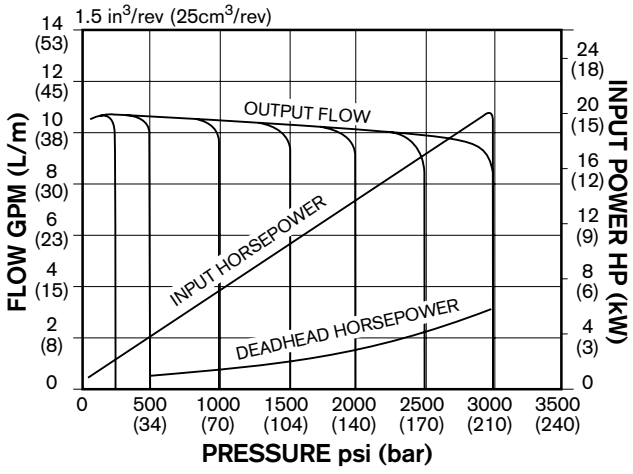
Performance Characteristics - VPV 25 to 3000 PSI (210 Bar)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

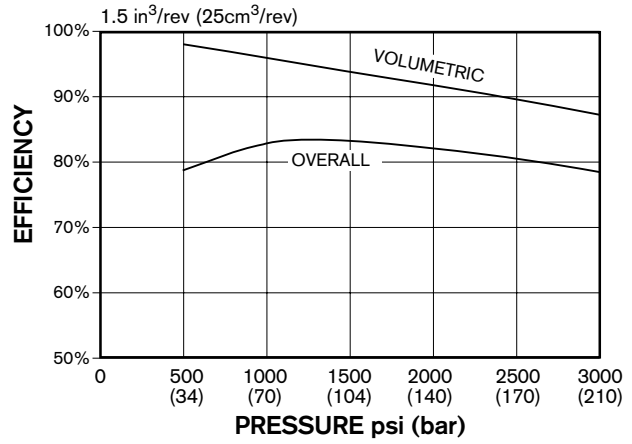
OUTPUT FLOW & POWER @ 1200 rpm



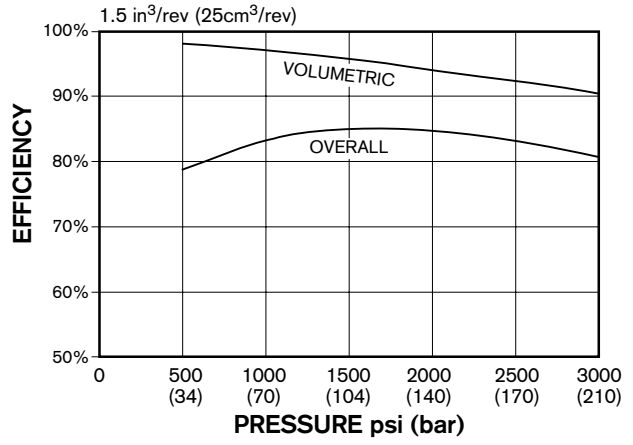
OUTPUT FLOW & POWER @ 1500 rpm



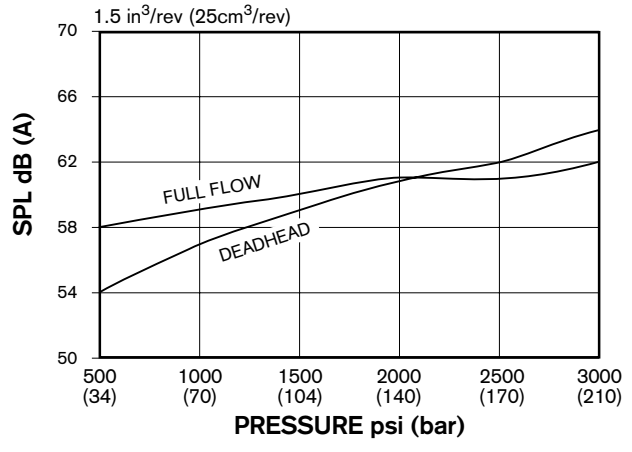
EFFICIENCY @ 1200 rpm



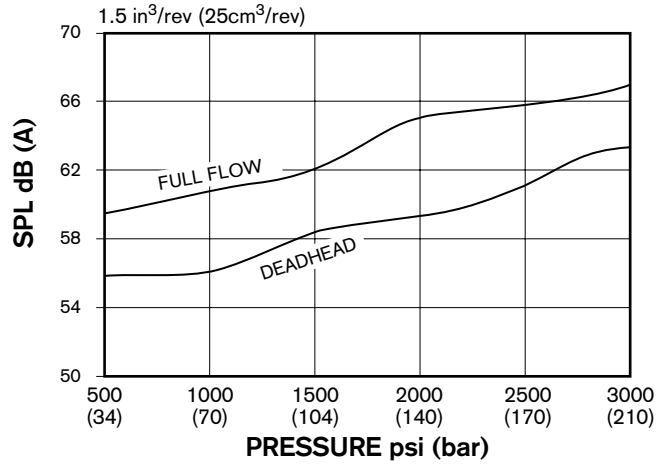
EFFICIENCY @ 1500 rpm



SOUND PRESSURE @ 1200 rpm



SOUND PRESSURE @ 1500 rpm

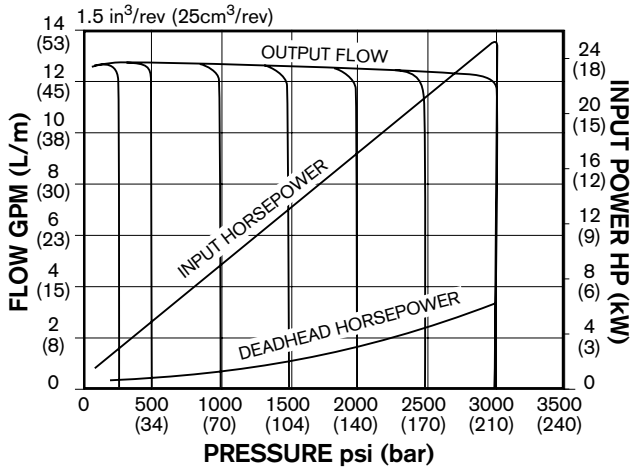


Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.

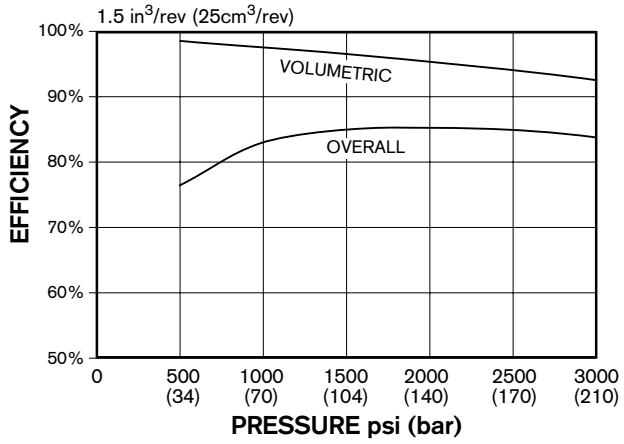
Performance Characteristics - VPV 25 to 3000 PSI (210 Bar) (continued)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

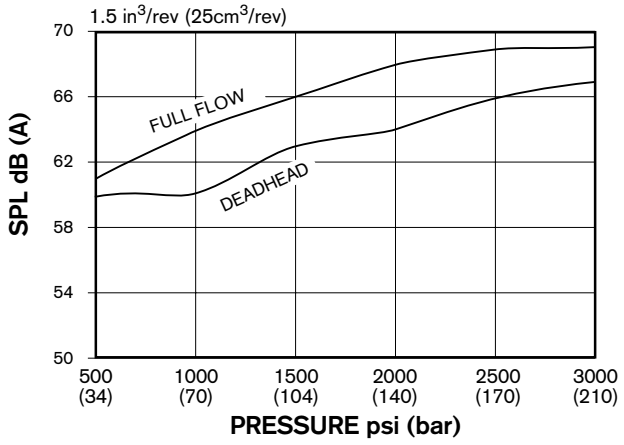
OUTPUT FLOW & POWER @ 1800 rpm



EFFICIENCY @ 1800 rpm



SOUND PRESSURE @ 1800 rpm

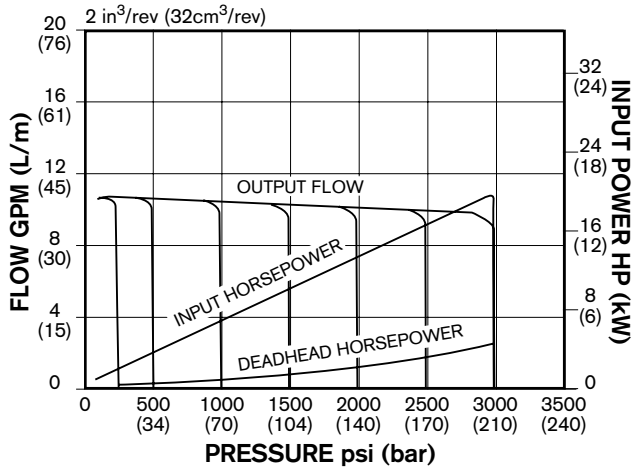


Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.

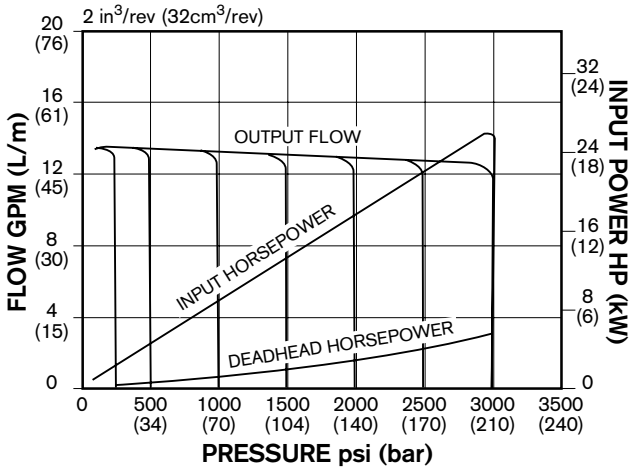
Performance Characteristics - VPV 32 to 3000 PSI (210 Bar)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

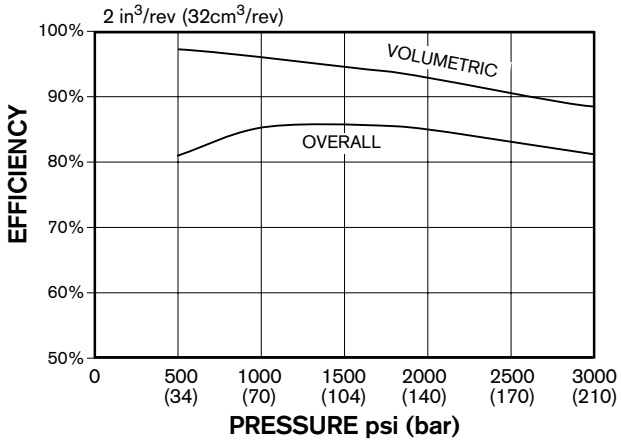
OUTPUT FLOW & POWER @ 1200 rpm



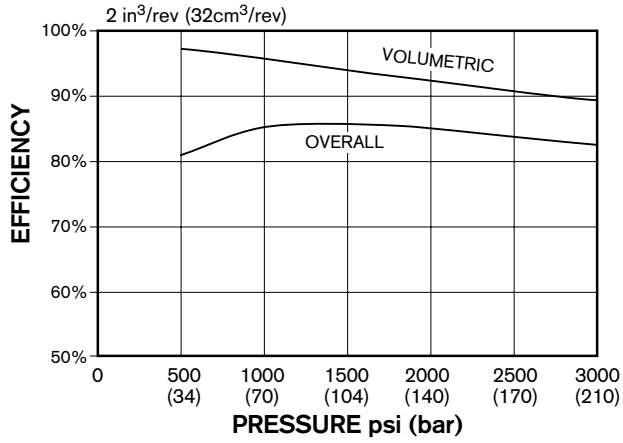
OUTPUT FLOW & POWER @ 1500 rpm



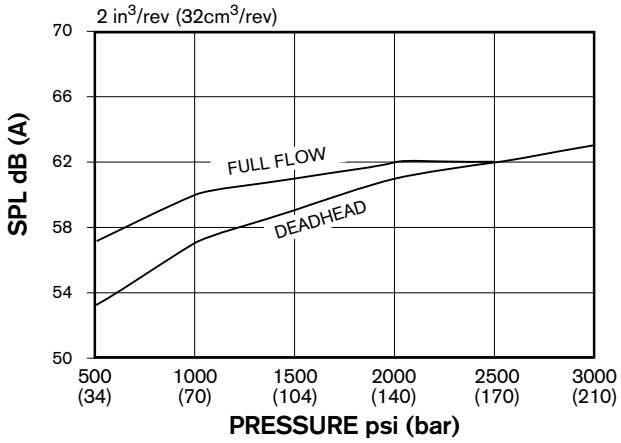
EFFICIENCY @ 1200 rpm



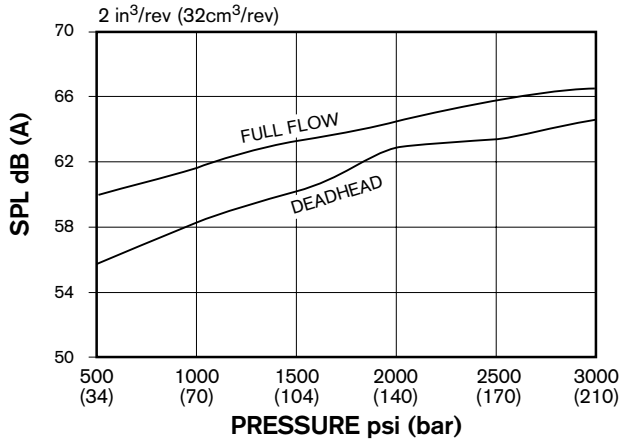
EFFICIENCY @ 1500 rpm



SOUND PRESSURE @ 1200 rpm



SOUND PRESSURE @ 1500 rpm

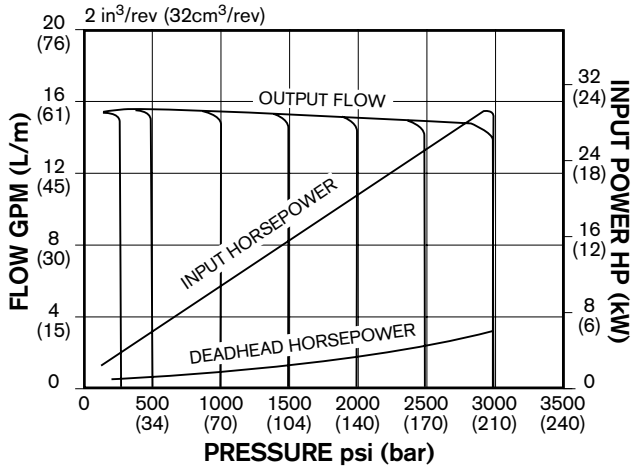


Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.

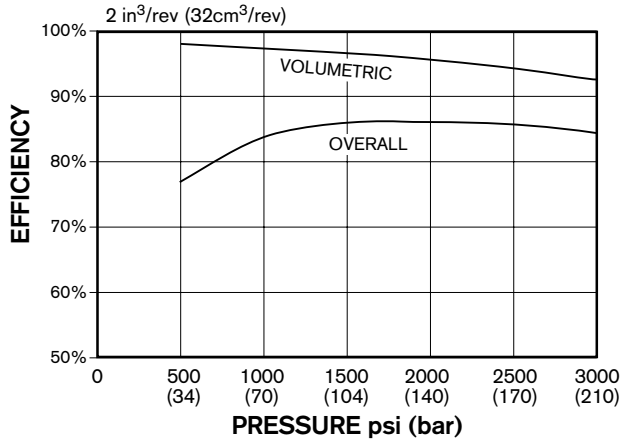
Performance Characteristics - VPV 32 to 3000 PSI (210 Bar) (continued)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

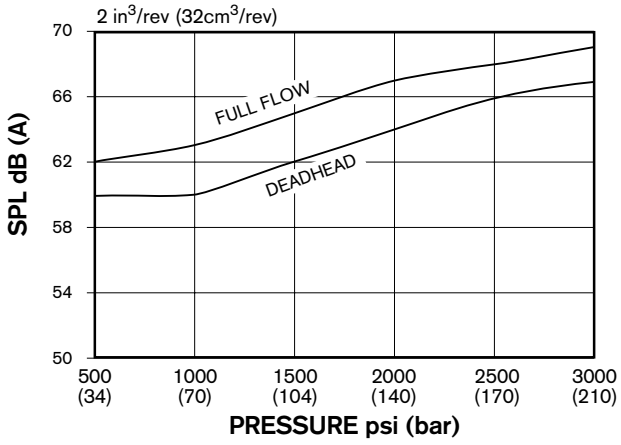
OUTPUT FLOW & POWER @ 1800 rpm



EFFICIENCY @ 1800 rpm



SOUND PRESSURE @ 1800 rpm

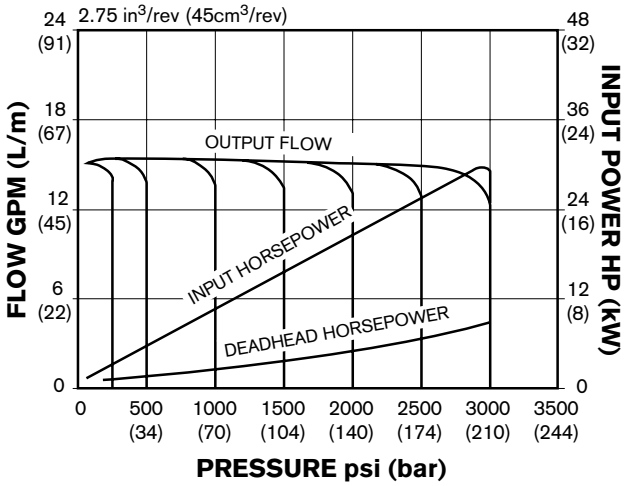


Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.

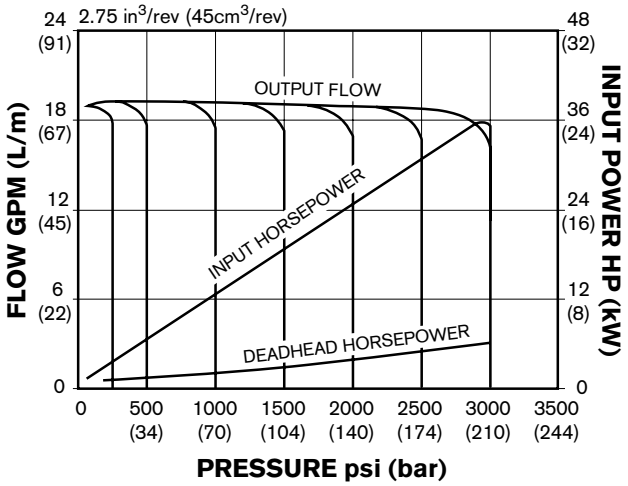
Performance Characteristics - VPV 45 to 3000 PSI (210 Bar)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

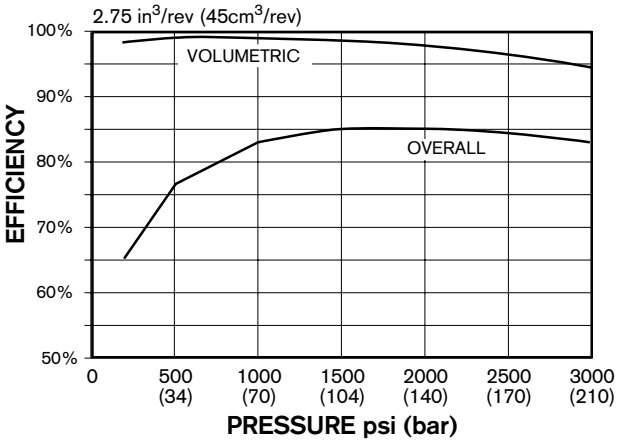
OUTPUT FLOW & POWER @ 1200 rpm



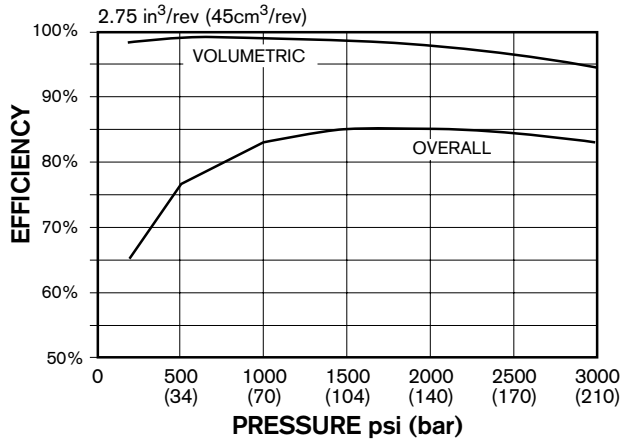
OUTPUT FLOW & POWER @ 1500 rpm



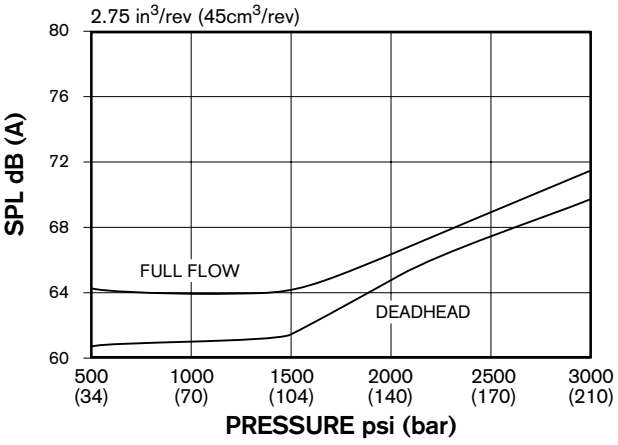
EFFICIENCY @ 1200 rpm



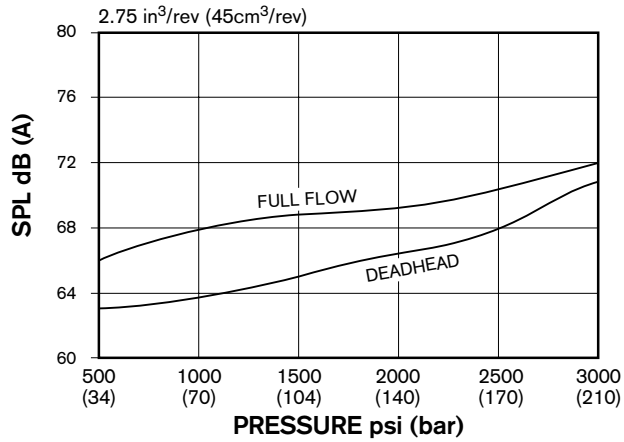
EFFICIENCY @ 1500 rpm



SOUND PRESSURE @ 1200 rpm



SOUND PRESSURE @ 1500 rpm

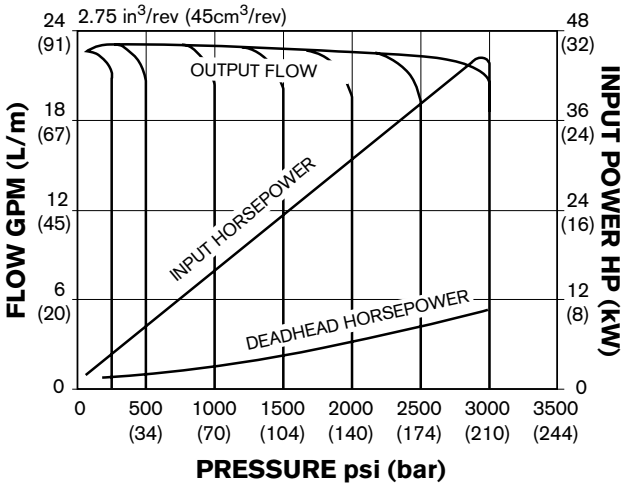


Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.

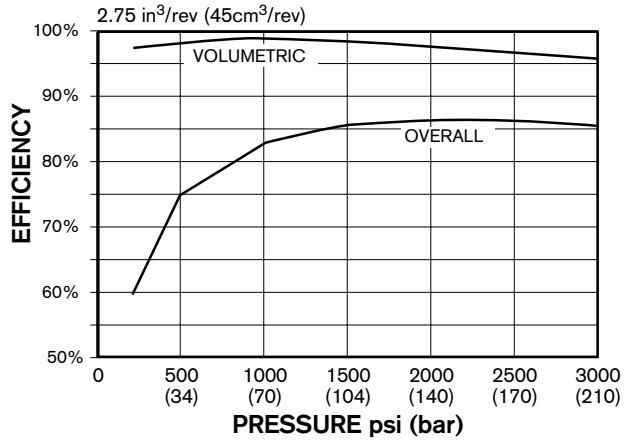
Performance Characteristics - VPV 45 to 3000 PSI (210 Bar) (continued)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

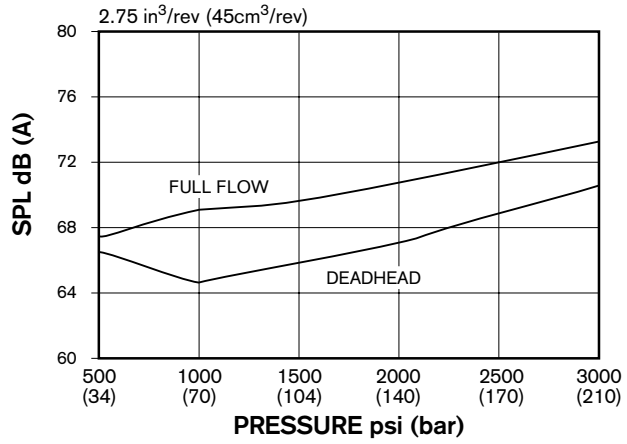
OUTPUT FLOW & POWER @ 1800 rpm



EFFICIENCY @ 1800 rpm



SOUND PRESSURE @ 1800 rpm

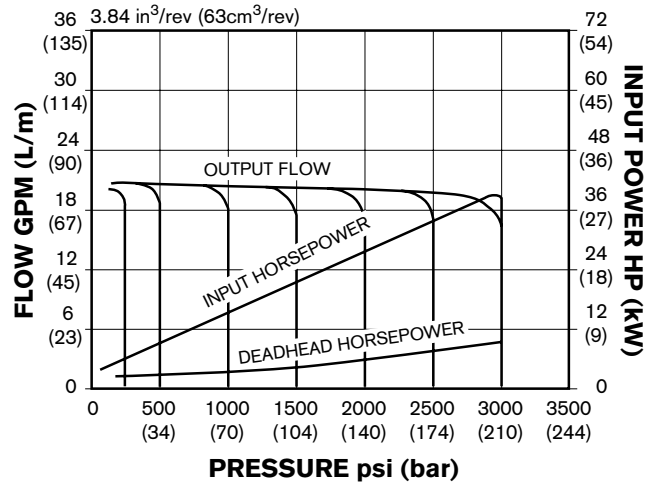


Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.

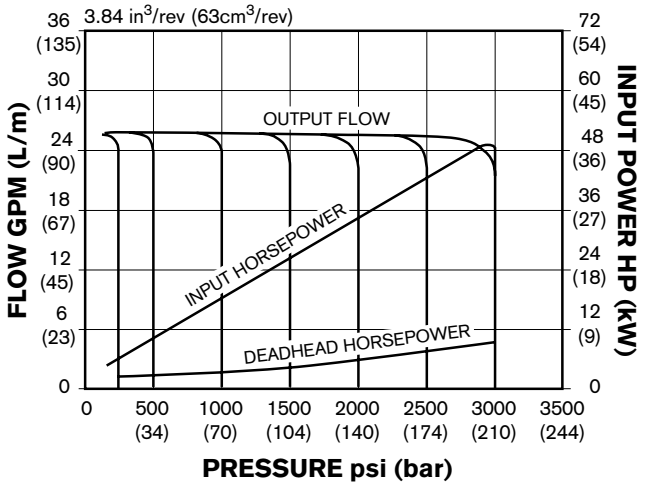
Performance Characteristics - VPV 63 to 3000 PSI (210 Bar)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

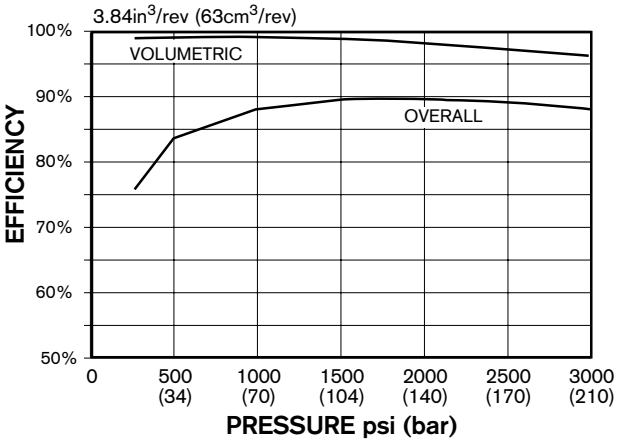
OUTPUT FLOW & POWER @ 1200 rpm



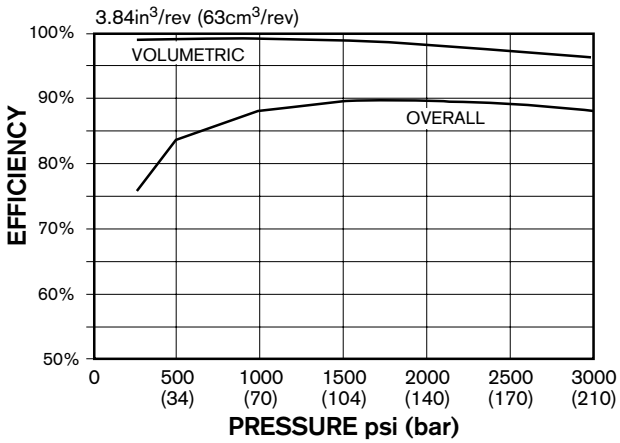
OUTPUT FLOW & POWER @ 1500 rpm



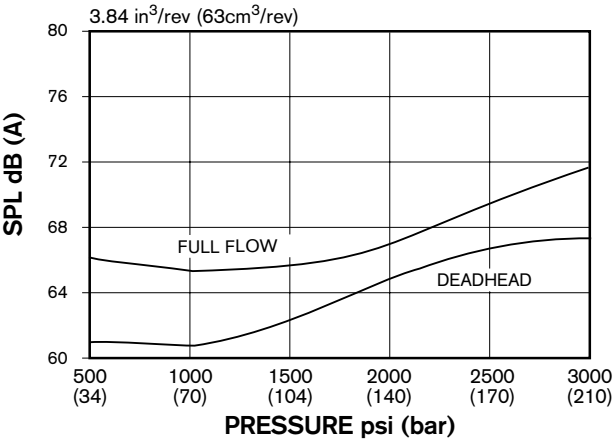
EFFICIENCY @ 1200 rpm



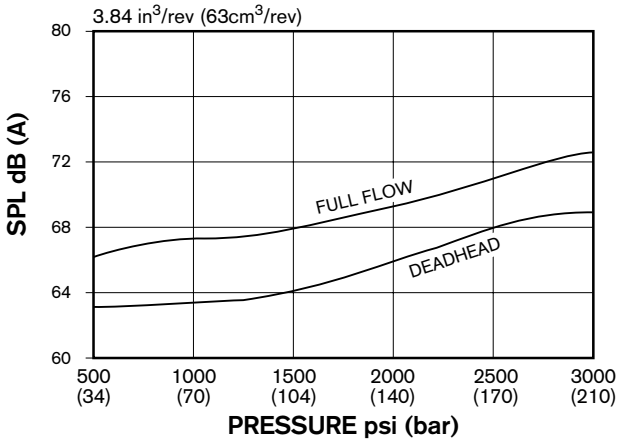
EFFICIENCY @ 1500 rpm



SOUND PRESSURE @ 1200 rpm



SOUND PRESSURE @ 1500 rpm

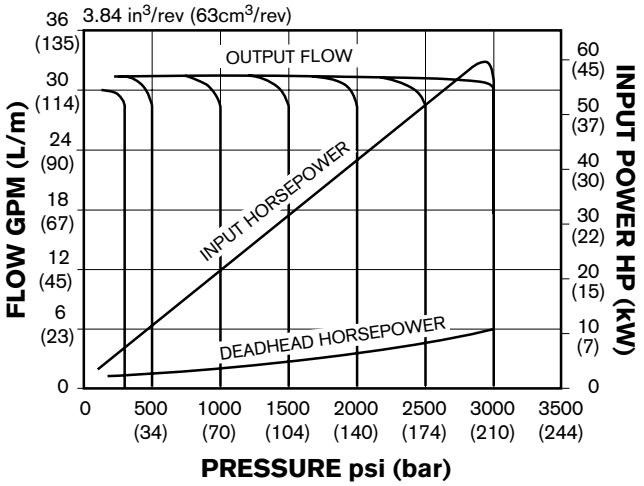


Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.

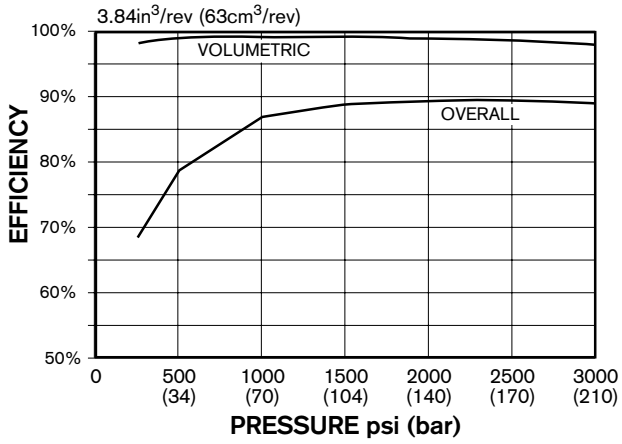
Performance Characteristics - VPV 63 to 3000 PSI (210 Bar) (continued)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

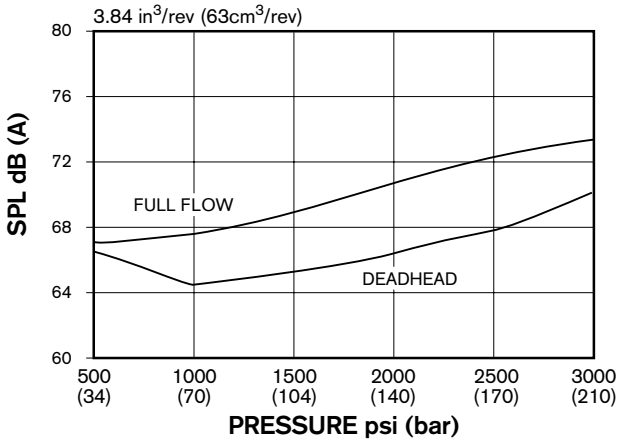
OUTPUT FLOW & POWER @ 1800 rpm



EFFICIENCY @ 1800 rpm



SOUND PRESSURE @ 1800 rpm

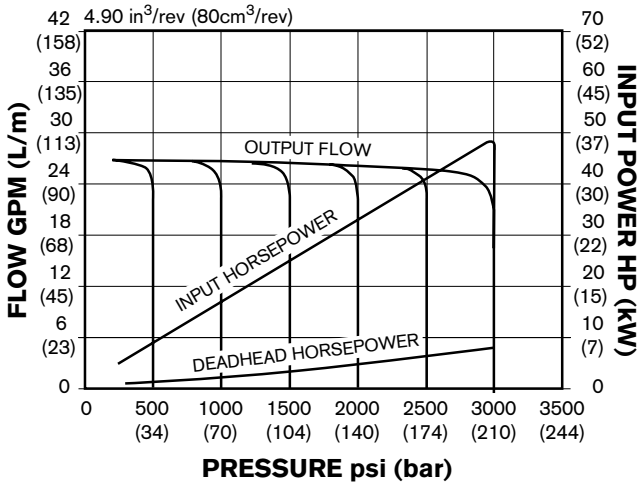


Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.

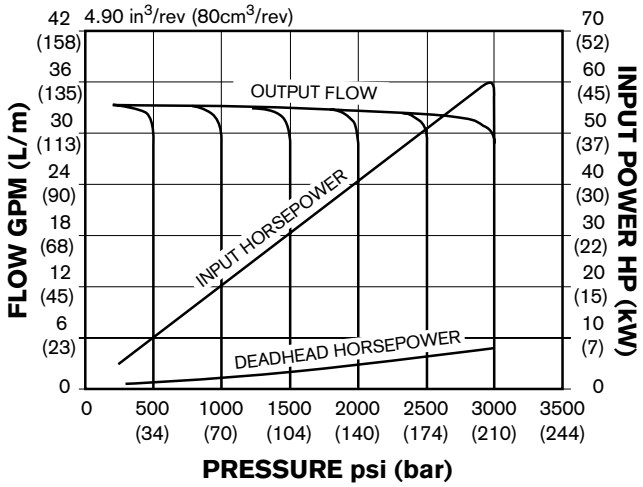
Performance Characteristics - VPV 80 to 3000 PSI (210 Bar)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

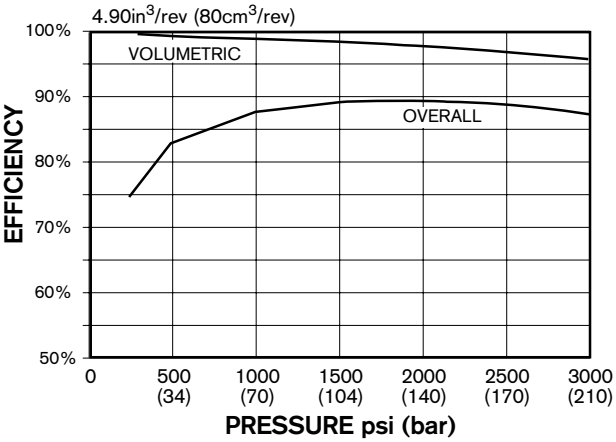
OUTPUT FLOW & POWER @ 1200 rpm



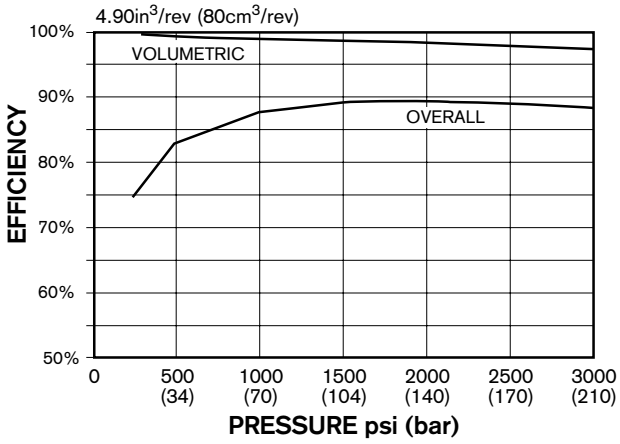
OUTPUT FLOW & POWER @ 1500 rpm



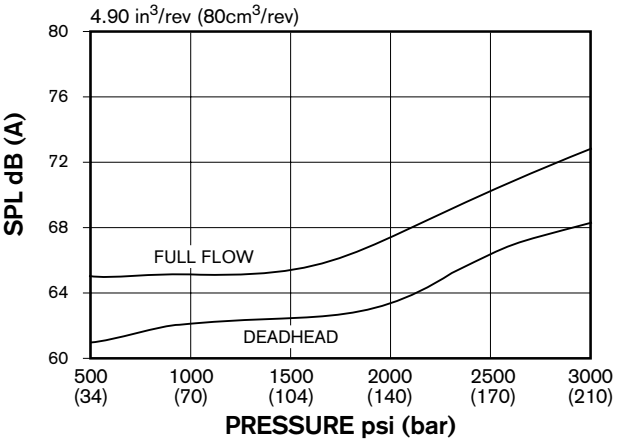
EFFICIENCY @ 1200 rpm



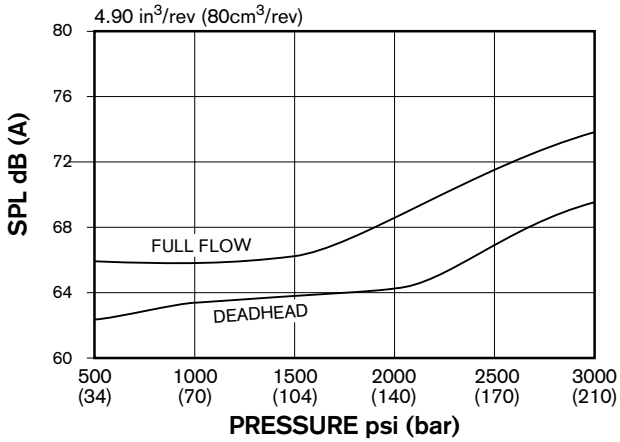
EFFICIENCY @ 1500 rpm



SOUND PRESSURE @ 1200 rpm



SOUND PRESSURE @ 1500 rpm

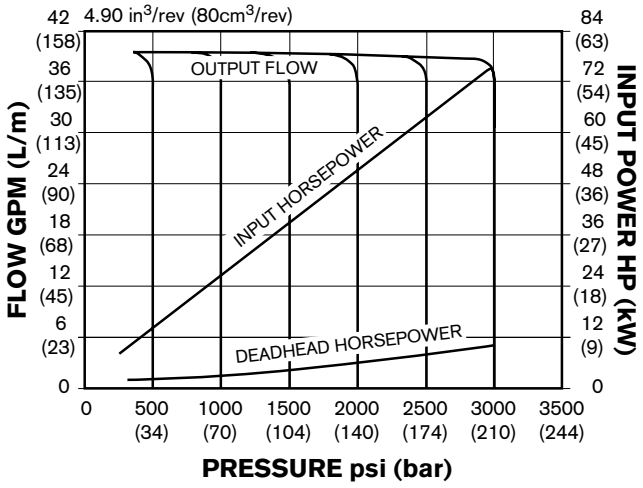


Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.

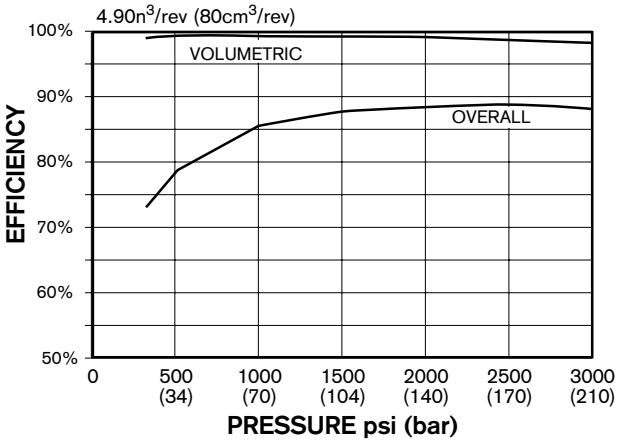
Performance Characteristics - VPV 80 to 3000 PSI (210 Bar) (continued)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

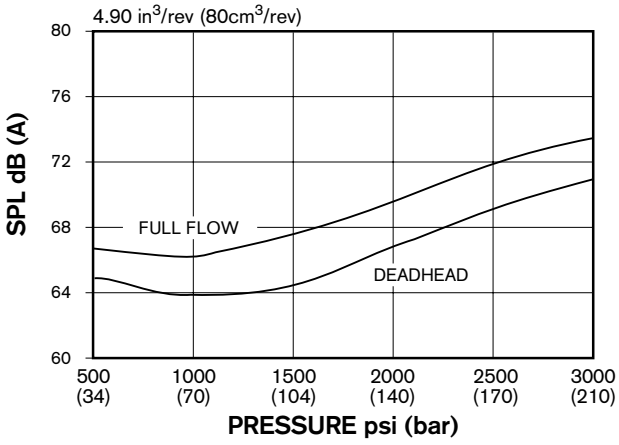
OUTPUT FLOW & POWER @ 1800 rpm



EFFICIENCY @ 1800 rpm



SOUND PRESSURE @ 1800 rpm

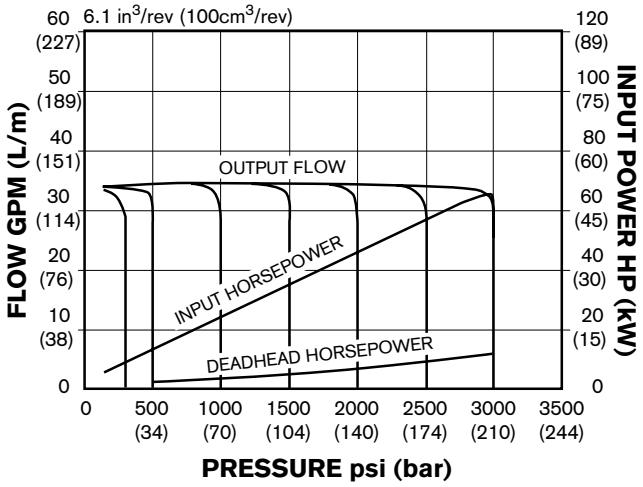


Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.

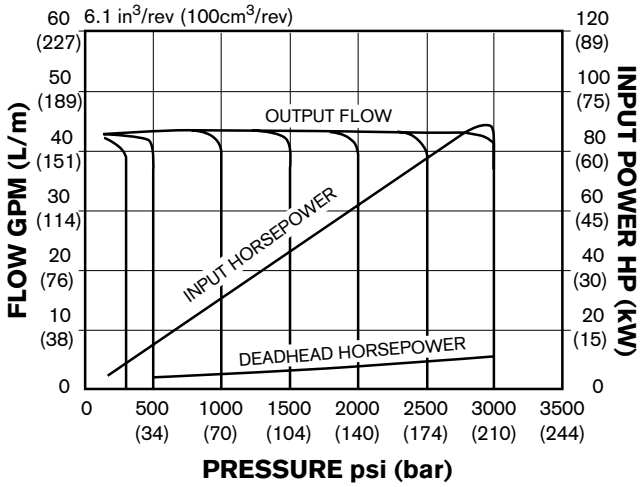
Performance Characteristics - VPV 100 to 3000 PSI (210 Bar)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

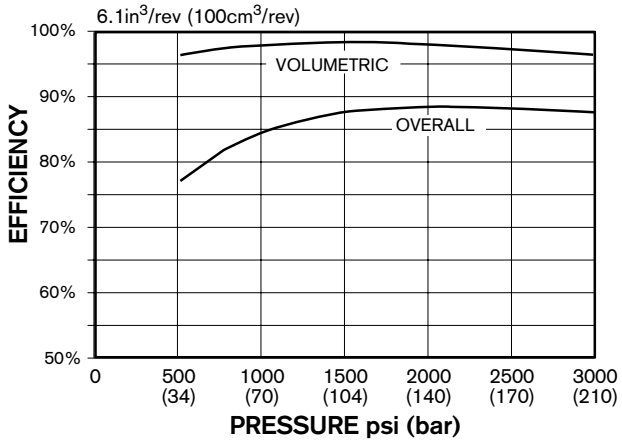
OUTPUT FLOW & POWER @ 1200 rpm



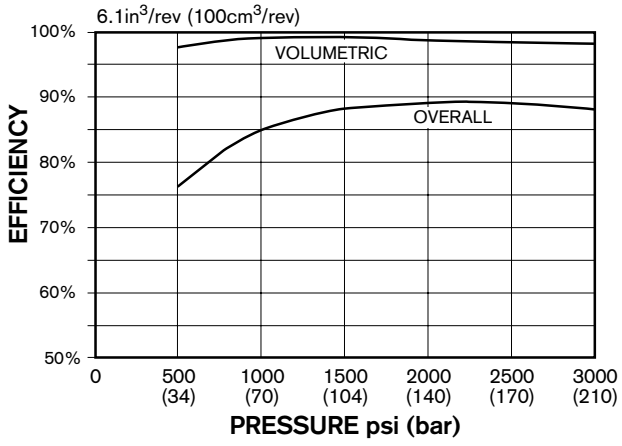
OUTPUT FLOW & POWER @ 1500 rpm



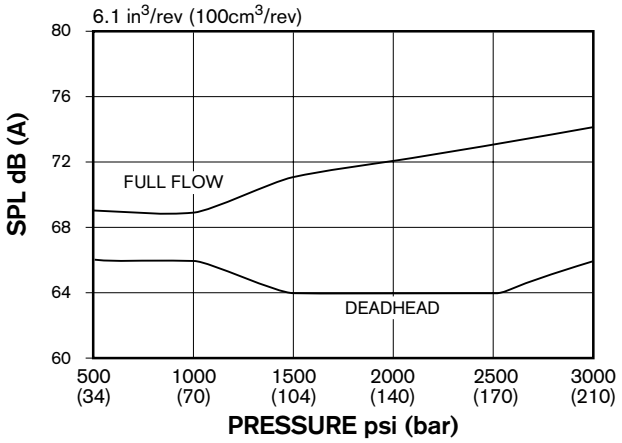
EFFICIENCY @ 1200 rpm



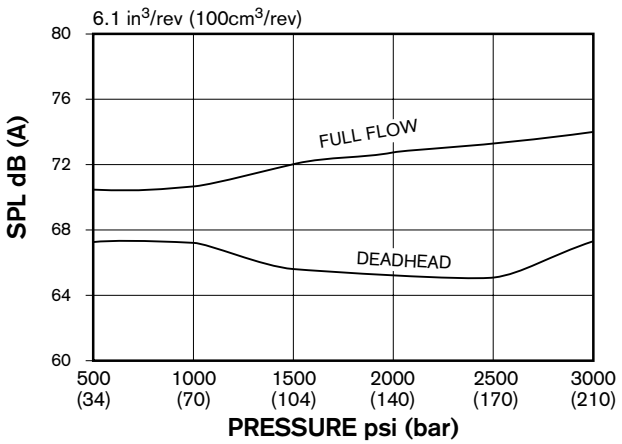
EFFICIENCY @ 1500 rpm



SOUND PRESSURE @ 1200 rpm



SOUND PRESSURE @ 1500 rpm

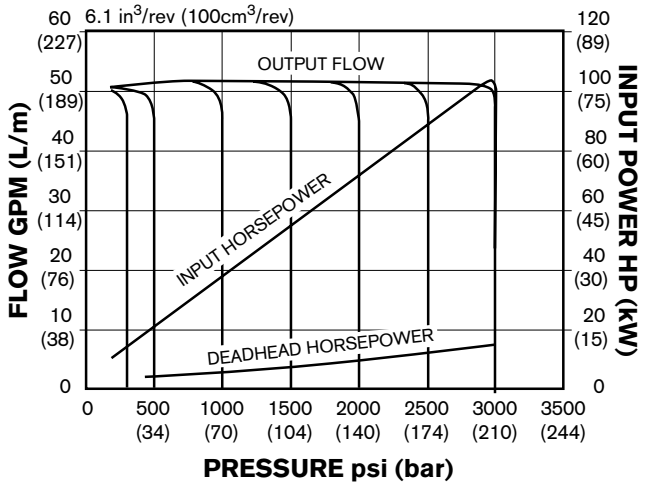


Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.

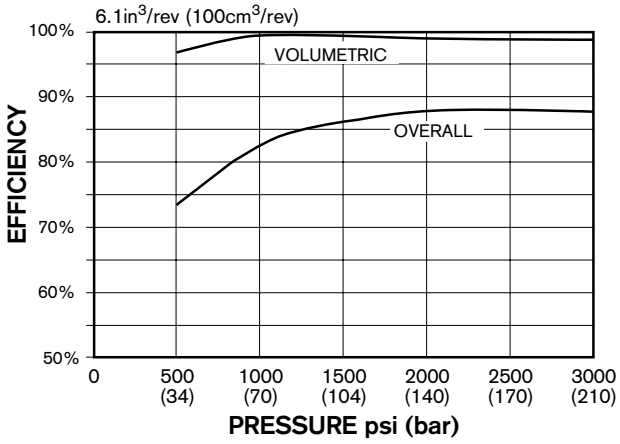
Performance Characteristics - VPV 100 to 3000 PSI (210 Bar) (continued)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

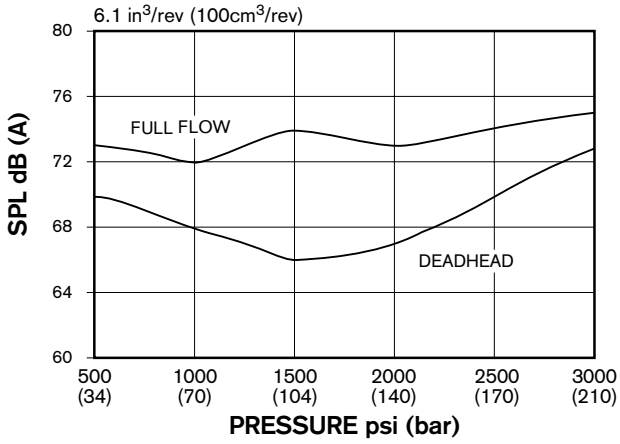
OUTPUT FLOW & POWER @ 1800 rpm



EFFICIENCY @ 1800 rpm



SOUND PRESSURE @ 1800 rpm

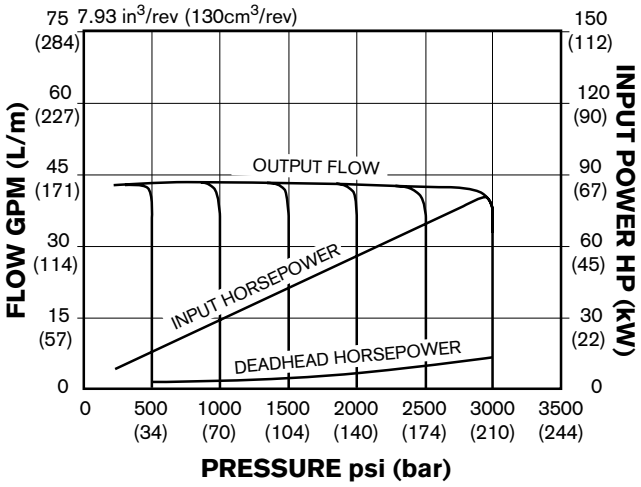


Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.

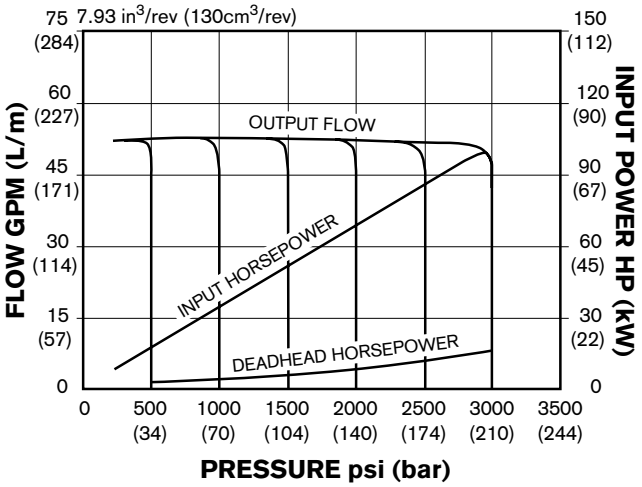
Performance Characteristics - VPV 130 to 3000 PSI (210 Bar)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

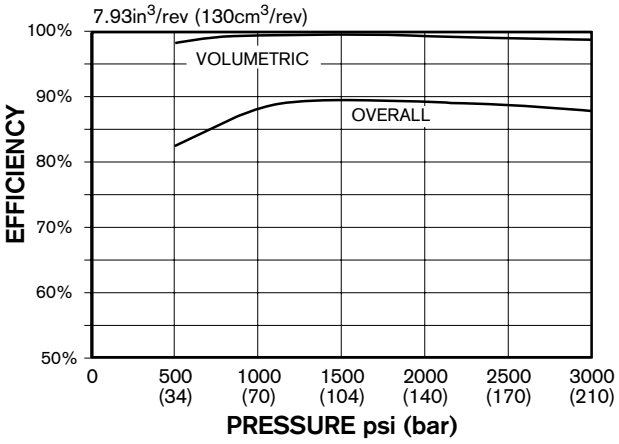
OUTPUT FLOW & POWER @ 1200 rpm



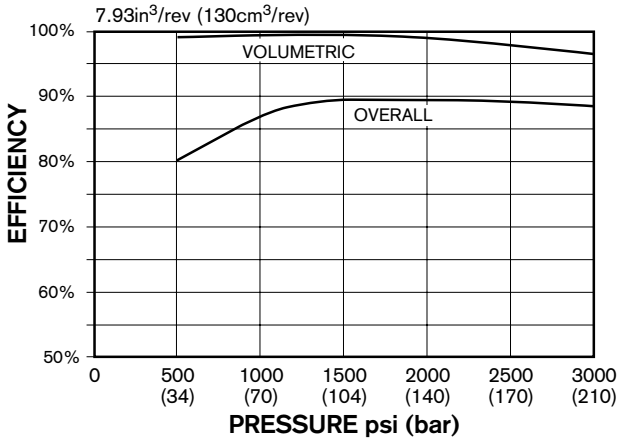
OUTPUT FLOW & POWER @ 1500 rpm



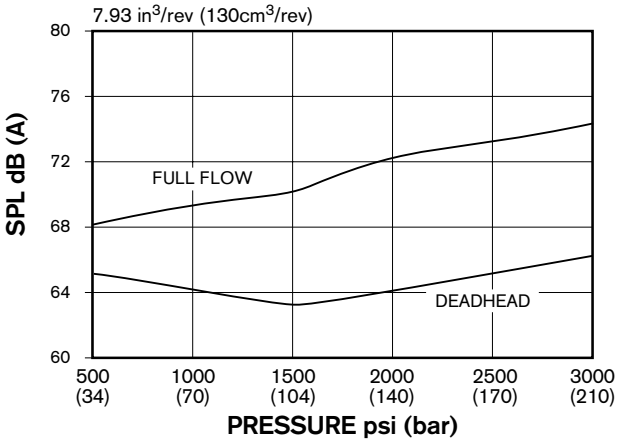
EFFICIENCY @ 1200 rpm



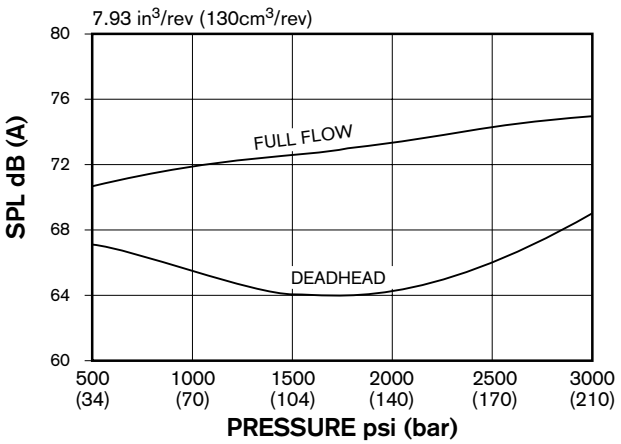
EFFICIENCY @ 1500 rpm



SOUND PRESSURE @ 1200 rpm



SOUND PRESSURE @ 1500 rpm

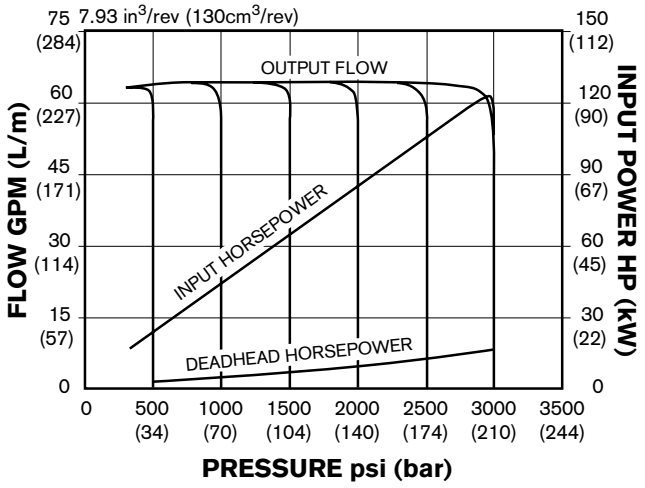


Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.

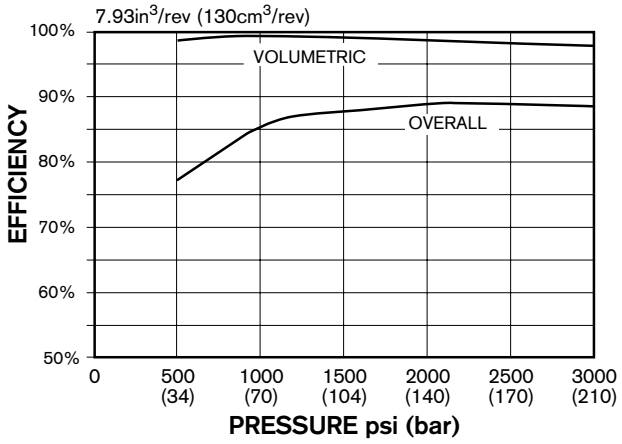
Performance Characteristics - VPV 130 to 3000 PSI (210 Bar) (continued)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

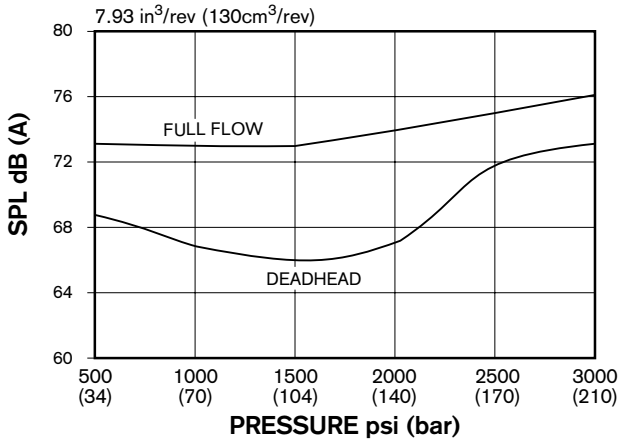
OUTPUT FLOW & POWER @ 1800 rpm



EFFICIENCY @ 1800 rpm



SOUND PRESSURE @ 1800 rpm

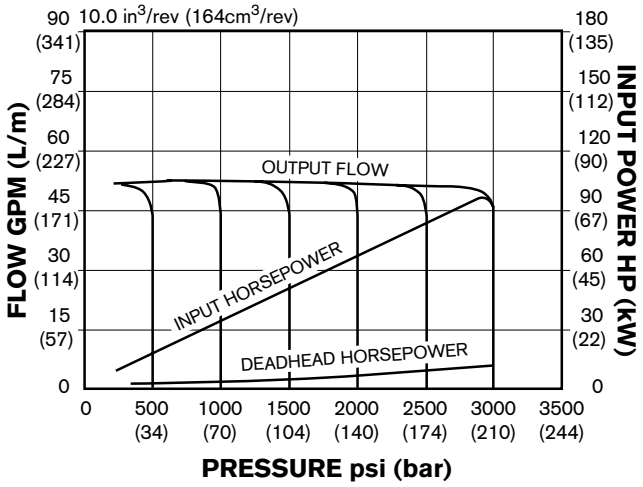


Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.

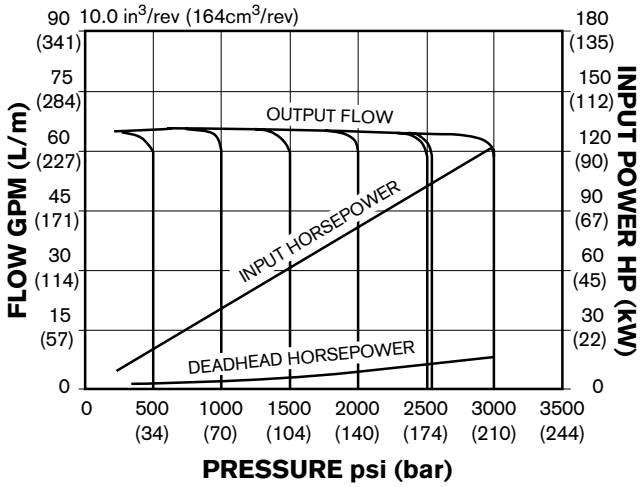
Performance Characteristics - VPV 164 to 3000 PSI (210 Bar)

Data plotted: with oil at 120°F (49°C) Viscosity at 120° = 140 SUS (29.6 cSt)

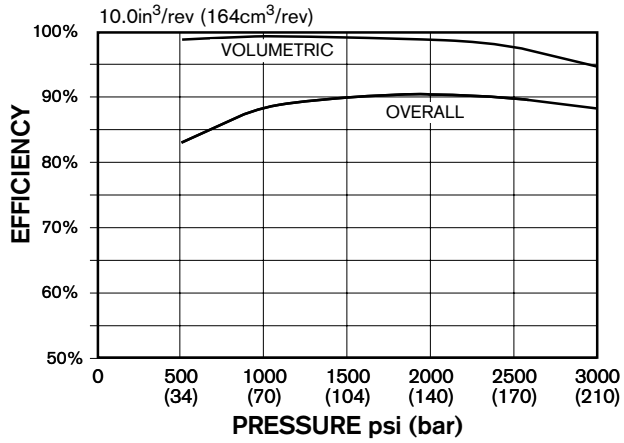
OUTPUT FLOW & POWER @ 1200 rpm



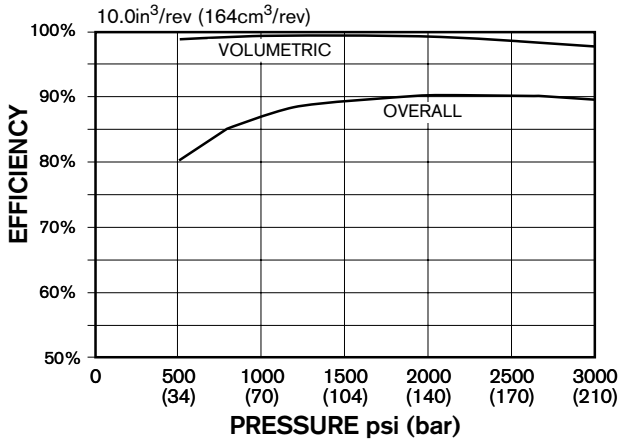
OUTPUT FLOW & POWER @ 1500 rpm



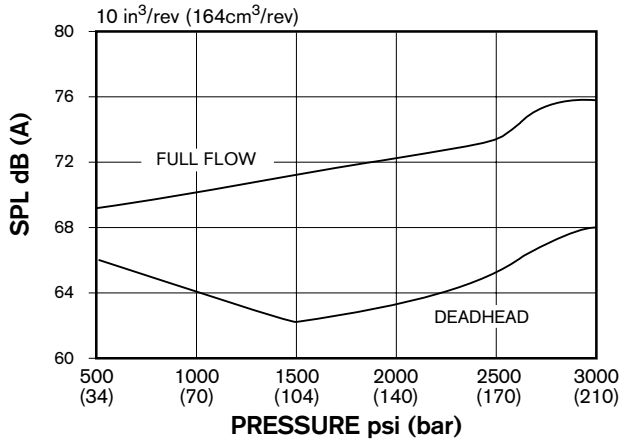
EFFICIENCY @ 1200 rpm



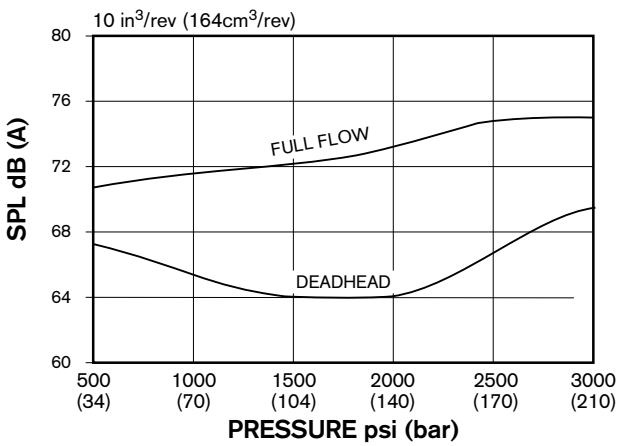
EFFICIENCY @ 1500 rpm



SOUND PRESSURE @ 1200 rpm



SOUND PRESSURE @ 1500 rpm



Sound pressure levels measured in a hemi-anchoic chamber w/microphone placed 1 meter away at discrete locations.
Sound pressure levels are spacially and time-weighted averaged.