



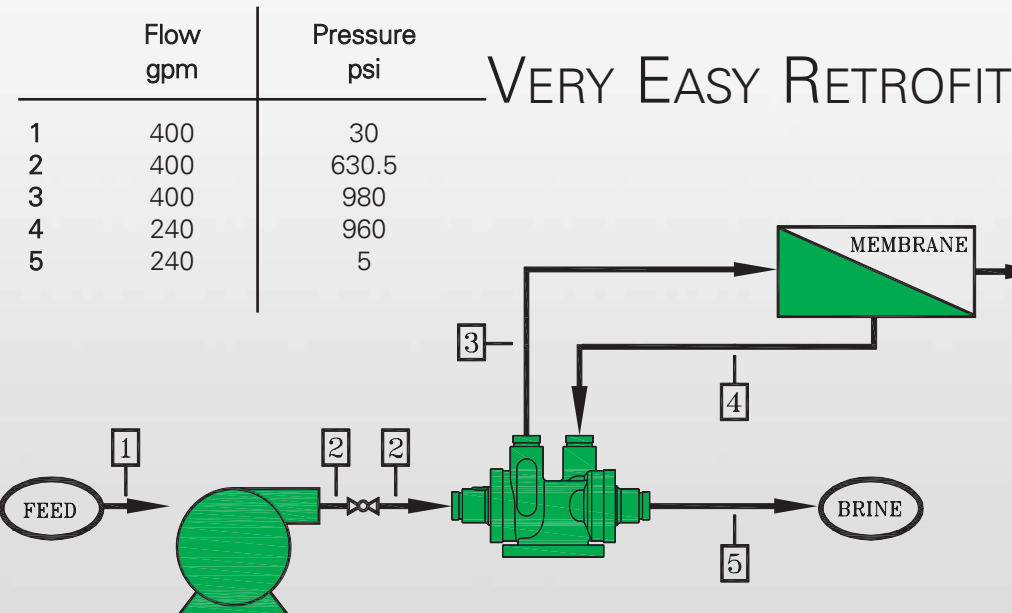
**PUMPENGINEERING INC.**  
 Harnessing the Power of Liquid Energy

## HALO TURBOCHARGER LOWEST COST ENERGY RECOVERY ENERGY PAYBACK 6-12 MONTHS

The HALO TurboCharger is a high performance, low cost turbocharger that makes energy recovery affordable for *all* sea water reverse osmosis users. The HALO Turbo has a pump component that adds pressure to the feed stream coming from the high pressure pump and a turbine component that recovers the brine energy coming from the membrane module.



The figure below illustrates the operation of the HALO Turbo. In our example the entire flow of 400 gpm is given a 349.5 psi pressure boost by the HALO Turbo. The 240 gpm of brine at 960 psi is used by the turbine to drive the pump of the HALO. The high pressure pump discharge pressure is now reduced to 630.5 psi.



**HTC AT**  
 ADVANCED TECHNOLOGY



**LPT**  
 LOW PRESSURE



**HPT**  
 HIGH PRESSURE



**HALO**



HARNESING THE POWER OF LIQUID ENERGY

## Operation Features and Benefits of the HALO TurboCharger

Besides high efficiency energy recovery, the HALO Turbo brings many other benefits to the RO system designer and user.

1. No flow pulsation, no water hammer, no vibration, and low noise are features of HALO Turbo operation.
2. Very reliable operation - designed with no shaft seals and water lubricated bearings ensures years of trouble free service.
3. If service is required, a HALO Turbo can be completely overhauled in the field in only one to two hours.
4. The HALO boost pressure significantly reduces the high pressure pump size (number of stages or frame size), and reduces the size of the motor, motor starter or VFD, transformers, and electrical switch gear.
5. Reduces installation cost - the HALO Turbo, which is very compact can be placed right next to the membrane rack. Also there is no need for additional pumps and controls such as used with flow work exchangers.
6. The HALO can discharge brine at any pressure - no brine sumps or pumps as required by impulse turbines.
7. The HALO can be used with any type of feed pump - no special double shaft motors necessary.

## Custom Design & Manufacturing

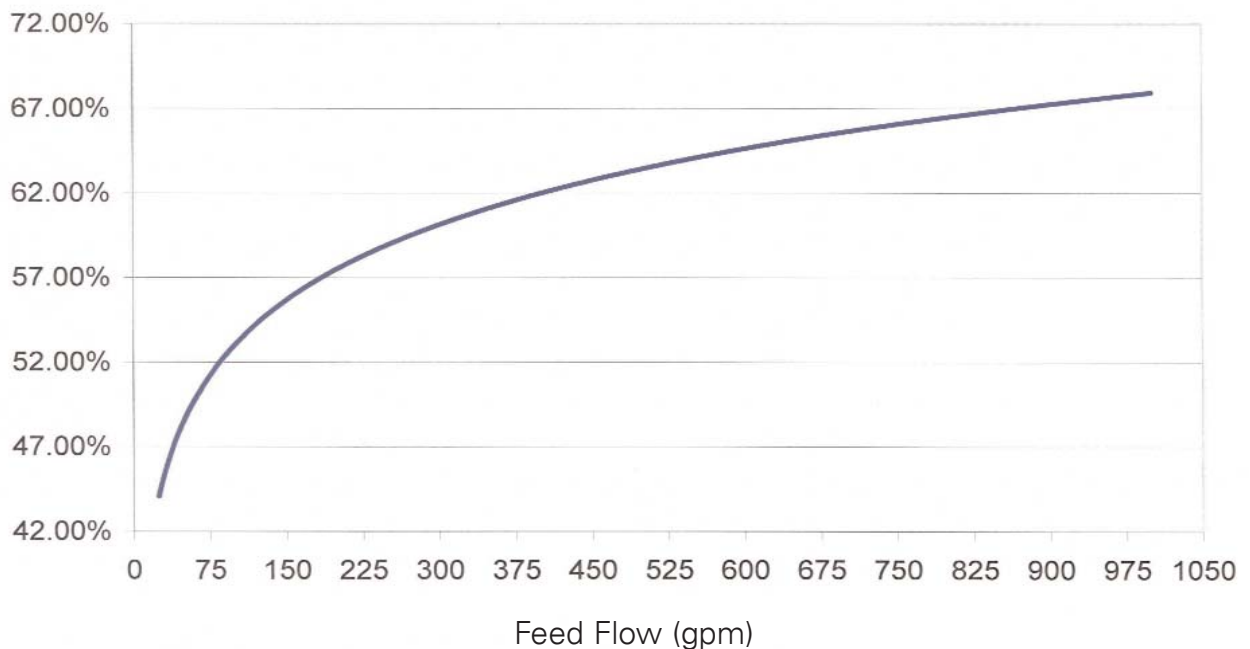
The HALO Turbo hydraulic flow passages (impeller geometry, volutes, diffuser, nozzles) are designed and manufactured on an individual order basis. Using advanced turbo machine design and computational fluid dynamics software, 3D CAD & CAM software and 5 axis CNC milling machines, PEI is able to individually create the most efficient HALO Turbo for the customer's unique operating conditions.

## Materials of Construction

Rotor:	Duplex 2507
Bearings:	Metallized Carbon M101
Casings:	316L SS or Duplex 2205

## HALO Efficiency Curve

(nte)



## HALO Turbo Performance

The useful work of the Halo Turbo is expressed as the "Boost Pressure". This is the pressure rise that occurs between the Turbo's pump side inlet and pump side discharge. To apply the Turbo to an RO system, the boost pressure must be calculated.

Use the HALO Efficiency Curve to find the approximate Hydraulic Transfer Efficiency for the Turbo. For example, at a feed flow rate of 400 gpm the HALO Turbo displays an nte of about 61%.

Knowing the nte makes calculation of the Turbo pressure boost ( $\Delta P$ ) very simple:

$$\Delta P = (\text{Nte}) (\text{Rr}) (\text{Pb} - \text{Pe})$$

Where Rr = ratio of brine flow to feed flow  
Pb = brine pressure at turbine inlet  
Pe = exhaust pressure of Turbo  
(brine pressure leaving Turbo)

$$Q_b = 240 \text{ gpm ( brine flow)}$$

$$Q_p = 160 \text{ gpm (product flow)}$$

$$y = 40\% \text{ (recovery ratio)}$$

$$Rr = 60\% \text{ (reject ratio)}$$

$$P_m = 980 \text{ psi (membrane pressure)}$$

$$P_b = 960 \text{ psi (brine pressure)}$$

$$P_e = 5 \text{ psi (brine exhaust pressure)}$$

Now substituting numerical data into our formula for the 400gpm (90.8m<sup>3</sup>/hr) example as follows:

$$\Delta P = (\text{Nte}) (\text{Rr}) (\text{Pb} - \text{Pe})$$

$$\Delta P = (.61) (.60) (960 - 5)$$

$$\Delta P = 349.5 \text{ psi}$$

To calculate the necessary RO high pressure pump discharge pressure, simply subtract the Turbo boost pressure ( $\Delta P$ ) from the membrane pressure ( $P_m$ ).

$$P_m - \Delta P = \text{Pump Discharge Pressure}$$

$$980 \text{ psi (67.5 bar)} - 349.5 \text{ psi (24.1 bar)} = 630.5 \text{ psi (43.48bar)}$$

If a positive displacement pump is used for the high pressure pump, it will provide the correct pressure of 630.5 psi (43.48bar) automatically.

If a centrifugal pump is used for the high pressure pump, then it should be sized to provide a discharge pressure of 630.5 psi (43.48bar).

### HALO-50

**Capacity** 35 gpm to 60 gpm @ 1000 psi  
7.95 m<sup>3</sup>/h to 13.63 m<sup>3</sup>/h @ 69 bar

**Delivery** Four (4) weeks standard delivery.

### HALO-75

**Capacity** 60 gpm to 85 gpm @ 1000 psi  
13.63 m<sup>3</sup>/h to 19.30 m<sup>3</sup>/h @ 69 bar

**Delivery** Four (4) weeks standard delivery.

### HALO-100

**Capacity** 85 gpm to 130 gpm @ 1000 psi  
19.31 m<sup>3</sup>/h to 29.53 m<sup>3</sup>/h @ 69 bar

**Delivery** Four (4) weeks standard delivery.

### HALO-150

**Capacity** 130 gpm to 180 gpm @ 1000 psi  
29.53 m<sup>3</sup>/h to 40.88 m<sup>3</sup>/h @ 69 bar

**Delivery** Four (4) weeks standard delivery.

### HALO-225

**Capacity** 180 gpm to 270 gpm @ 1000 psi  
40.88 m<sup>3</sup>/h to 81.32 m<sup>3</sup>/h @ 69 bar

**Delivery** Four (4) weeks standard delivery.

### HALO-300

**Capacity** 270 gpm to 350 gpm @ 1000 psi  
61.32 m<sup>3</sup>/h to 79.49 m<sup>3</sup>/h @ 69 bar

**Delivery** Five (5) weeks standard delivery.

### HALO-450

**Capacity** 350 gpm to 525 gpm @ 1000 psi  
74.49 m<sup>3</sup>/h to 119.24 m<sup>3</sup>/h @ 69 bar

**Delivery** Five (5) weeks standard delivery.

### \*HALO-600

**Capacity** 525 gpm to 750 gpm @ 1000 psi  
119.25 m<sup>3</sup>/h to 170.4 m<sup>3</sup>/h @ 69 bar

**Delivery** Five (5) weeks standard delivery.

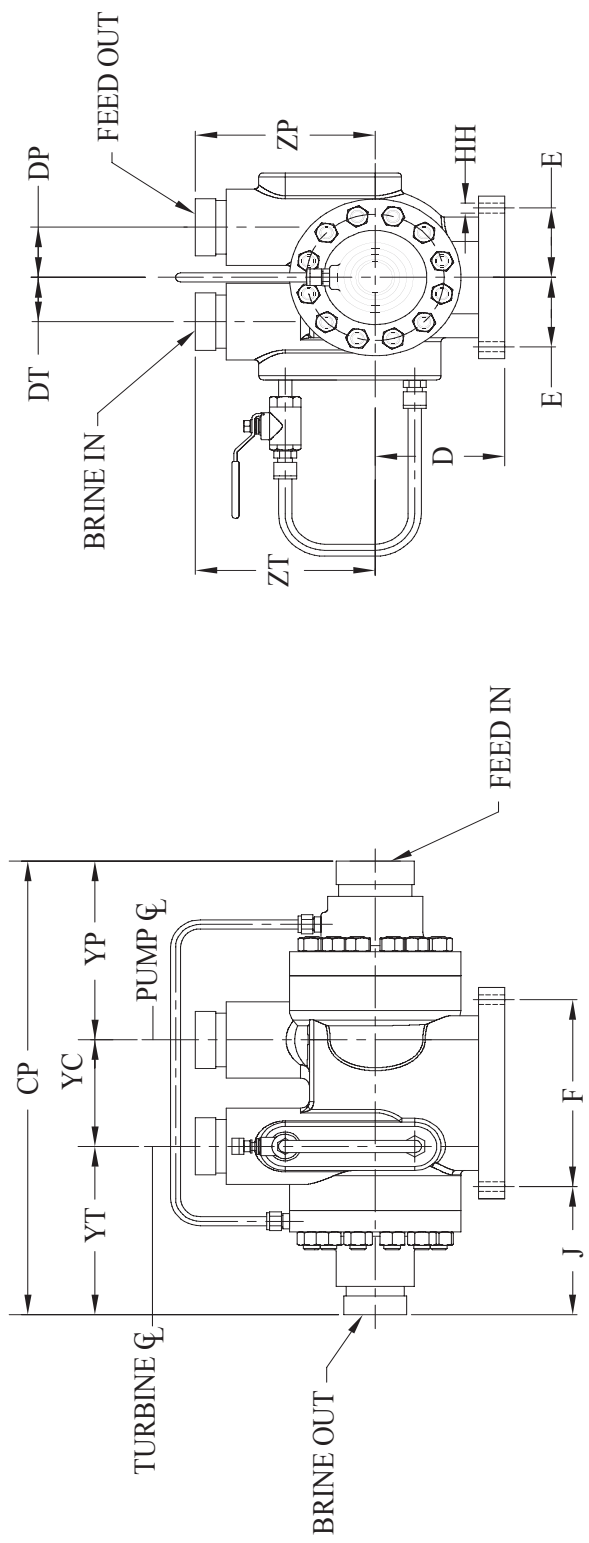
### \*HALO-900

**Capacity** 750 gpm to 1050 gpm @ 1000 psi  
170.4 m<sup>3</sup>/h to 238.5 m<sup>3</sup>/h @ 69 bar

**Delivery** Five (5) weeks standard delivery.

*Expediated delivery service available on all models*

*\*Available March, 2005*



MODEL	PIPE SIZE											DP		
	BRINE FEED	CP	YC	YT	YP	J	F	D	E	ZT	ZP		HH	DT
HALO-50	1"	10.50	2.50	3.94	4.06	3.44	3.63	2.56	2.00	3.25	3.25	13/32	.81	.97
HALO-75	1-1/4"	11.12	2.50	4.31	4.31	3.81	3.63	2.63	2.19	3.75	3.75	13/32	.84	1.03
HALO-100	1-1/4"	11.94	2.94	4.44	4.56	3.94	4.06	2.88	2.25	4.00	4.00	13/32	1.16	1.25
HALO-150	1-1/2"	15.03	3.83	5.56	5.94	4.31	6.38	3.56	2.68	5.00	5.00	17/32	1.44	1.66
HALO-225	1-1/2"	16.28	4.38	5.91	6.00	4.50	7.19	3.72	3.00	5.25	5.88	17/32	1.50	1.81
HALO-300	2"	17.50	4.69	6.19	6.63	4.81	7.44	4.38	3.31	6.00	6.00	21/32	1.81	2.16
HALO-450	2"	19.25	5.13	6.81	7.31	5.19	8.38	4.63	3.63	6.00	7.00	25/32	2.06	2.44
HALO-600	3"	20.94	5.50	7.81	7.63	6.00	8.50	5.63	4.19	8.00	8.00	25/32	2.75	3.31
HALO-900	3"	23.25	6.13	8.38	8.75	6.63	9.00	6.25	4.88	8.00	9.00	25/32	3.00	3.50