ENGINEERING TOMORROW

Data sheet

APM motor

APM 0.8 / APM 1.0 / APM 1.2 / APM 1.8 / APM 2.0 / APM 2.5 / APM 2.9 for energy recovery

Table of Contents

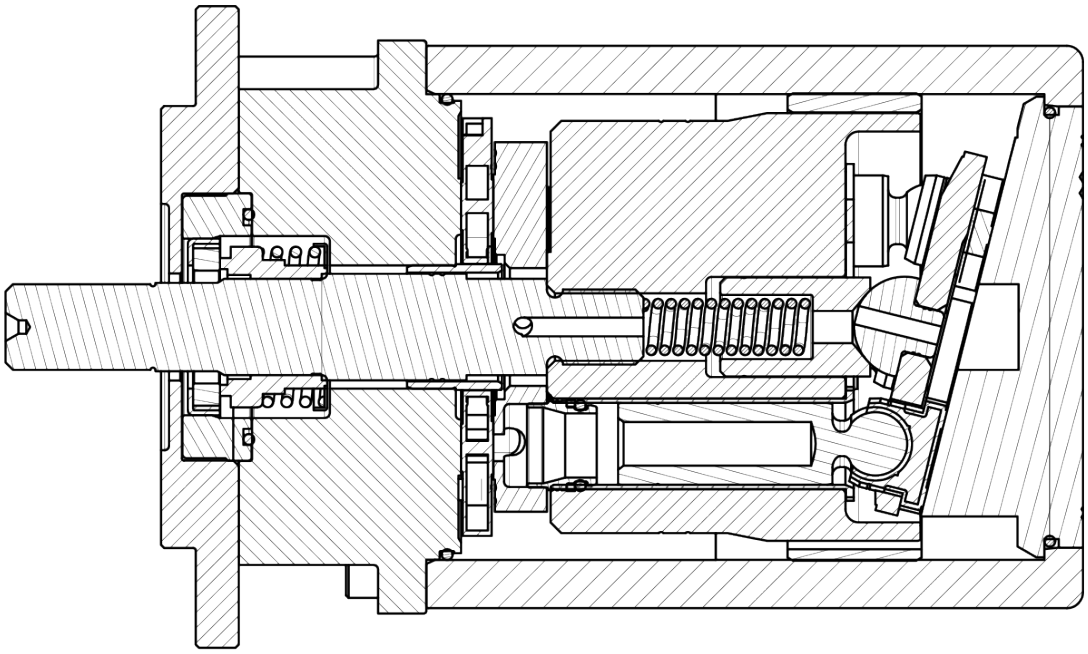
1. Introduction

APM motors are designed for energy recovery systems together with an APP hydraulic pump and a double shaft motor. APM motors convert hydraulic energy (pressure, flow) to mechanical energy (torque, speed).

This data sheet is valid for APM hydraulic motors. APM hydraulic motors are build to operate on salt water and are based on the axial piston principle with fixed displacement, enabling a very light and compact design. Lubrication of the moving parts is provided by the salt water itself. Shaft speed is proportional to the input flow.

The APM motor is not self-starting but needs a rotational force to start turning.

Below a sectional drawing as an example of an APM motor



2. Benefits

- Constant torque over a wide speed range
- Compact design
- Easy to install
- Long life under severe operating conditions
- Few wear parts and low maintenance costs
- No oil lubrication
- Non-corroding materials
- Made for RO applications

3. Technical data

3.1 APM 0.8 – 1.2

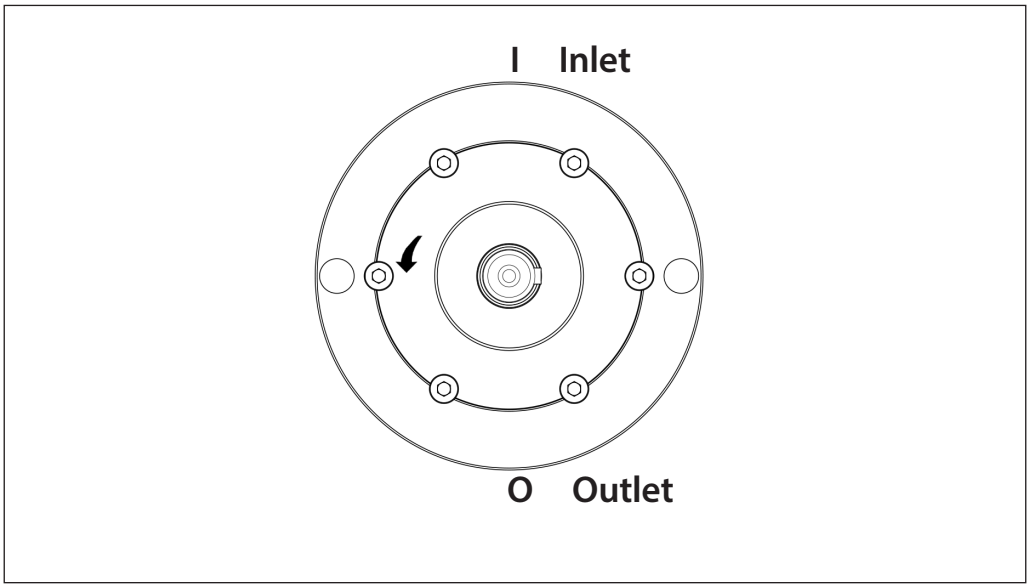
Motor size		APM 0.8	APM 1.0	APM 1.2
Code number APM CCW		180F1000	180F1001	180F1002
Geometric displacement	cm^3/rev.	4.07	5.08	6.30
	in^3/rev.	0.25	0.31	0.38
Pressure				
Max. inlet pressure continuous	barg	80	80	80
	psig	1160	1160	1160
Min. inlet pressure continuous	barg	10	10	10
	psig	145	145	145
Outlet pressure	barg	0.5 – 5	0.5 – 5	0.5 – 5
	psig	7.3 – 72.5	7.3 – 72.5	7.3 – 72.5
Speed				
Min. speed	rpm	700	700	700
Max. speed continuous	rpm	3450	3450	3450
Typical performance				
Max. waterflow	**m^3/h**	**0.92**	**1.12**	**1.37**
	l/min	15.3	18.6	22.9
	gpm	4.0	4.9	6.1
Max. power at max. speed cont. and max. pressure	kW	1.7	2.1	2.6
	HP	2.3	2.8	3.5
Max. torque at max. pressure	Nm	4.7	5.8	7.2
	lbf-ft	3.4	4.3	5.3
Technical specifications				
Sound pressurre level	dB(A)	74	74	74
Media temperature	°C	2 – 50	2 – 50	2 – 50
	°F	35.6 – 122	35.6 – 122	35.6 – 122
Ambient temperature	°C	0 – 50	0– 50	0 – 50
	°F	32 – 122	32 – 122	32 – 122
Weight (dry)	kg	5.2	5.2	5.2
	lb	11.5	11.5	11.5

3.2 APM 1.8 – 2.9

Motor size		APM 1.8	APM 2.0	APM 2.5	AMP 2.9
Code number APM CCW		180F1100	180F1101	180F1102	180F1103
Geometric displacement	cm^3/rev.	9.31	10.0	12.5	15.3
	in^3/rev.	0.57	0.61	0.76	0.93
Pressure					
Max. inlet pressure continuous	barg	80	80	80	80
	psig	1160	1160	1160	1160
Min. inlet pressure continuous	barg	10	10	10	10
	psig	145	145	145	145
Outlet pressure	barg	0.5 – 5	0.5 – 5	0.5 – 5	0.5 – 5
	psig	7.3 – 72.5	7.3 – 72.5	7.3 – 72.5	7.3 – 72.5
Speed					
Min. speed	rpm	700	700	700	700
Max. speed continuous	rpm	3450	3450	3450	3000
Typical performance					
Max. waterflow	m^3/h	2.03	2.18	2.69	2.83
	l/min	33.9	36.4	44.8	47.2
	gpm	9.0	9.6	11.8	12.5
Max. power at max. speed cont. and max. pressure	kW	3.9	4.2	5.3	5.6
	HP	5.2	5.7	7.1	7.6
Max. torque at max. pressure	Nm	10.8	11.7	14.7	18.0
	lbf-ft	8.0	8.6	10.8	13.2
Technical specifications					
Sound pressure level	dB(A)	77	77	77	81
Media temperature	°C	2 – 50	2 – 50	2 – 50	2 – 50
	°F	35.6 – 122	35.6 – 122	35.6 – 122	35.6– 122
Ambient temperature	°C	0 – 50	0 – 50	0 – 50	0– 50
	°F	32 – 122	32 – 122	32 – 122	32 – 122
Weight (dry)	kg	8.6	8.6	8.6	8.6
	lb	19	19	19	19

4. Direction of rotation

Connections and direction of rotation appear from the product label on the motors (see also the below drawing).



Motor variants
APM motors are optimezed for operation in one direction: CCW

5. Shaft load

Any axial and/or radial loads on the shaft must be avoided.

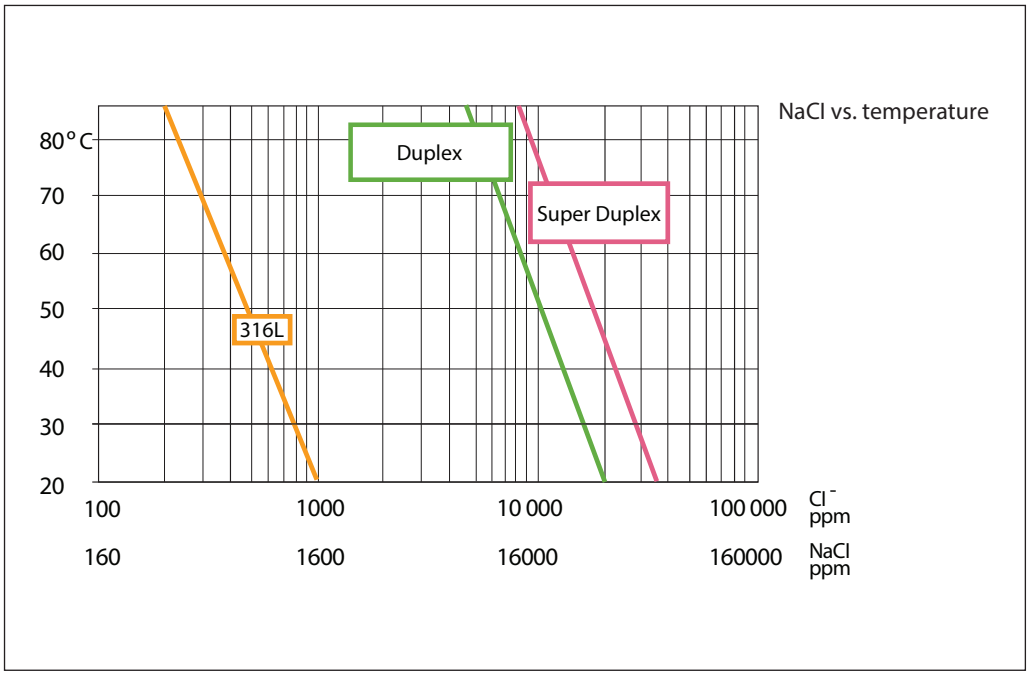
6. Temperature and corrosion

Fluid temperature: Min. +2 °C to max. +50 °C (Min. +35.6 °F to max. +122 °F)
Ambient temperature: Min. 0 °C to max. +50 °C (Min. +32 °F to max. +122 °F)
Storage temperature: Min. -40 °C to + 70 °C - provided that the APM is drained of fluid and stored “plugged”.

Antifreeze protection is required at temperatures below 0 °C.

Danfoss recommends using Dowcal N from Dow Chemical Company or Chillsafe mono propylene glycol from Arco Chemical Company.

The chart below illustrates the corrosive resistance of different types of stainless steel related to NaCl concentration and temperature. All critical parts of the APM motors are made of Duplex and Super Duplex. If the APM motor is operated above the Duplex line, always flush the APM with fresh water at operation stop to minimize the risk of crevice corrosion.



7. Noise level

Generally, noise will be reduced if speed is reduced and vice versa. Use flexible hoses in order to minimize vibrations and noise.

Since the APM motor typically is mounted on a bell housing or frame, the noise level can only be determined for complete unit (system).

It is therefore very important that the energy recovery unit is mounted correctly on a frame with vibration absorber to minimize vibrations and noise.

The noise level is influenced by:

- The speed of the pump/motor. High rpm creates more noise than low rpm
- Rigid mounting of the pump/motor generates more noise than flexible mount
- Pipe mounting direct to the pump/motor increases the noise level compared to a flexible hose

8. Filtration

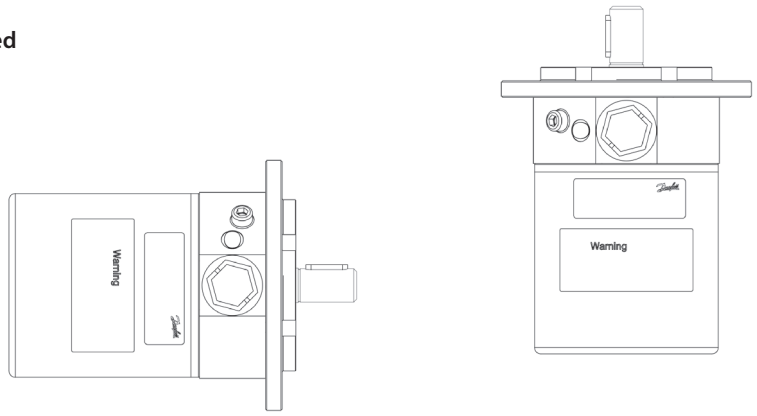
Proper filtration is crucial for the performance maintenance and warranty.
The water supplied must be filtered: 10 µm absolute, ß10-value > 5000 filter is recommended.

For further information on filters, please contact Danfoss High Pressure Pumps sales department.

9. Orientation

The drawing shows preferred acceptable, and not acceptable orientations of the motor.

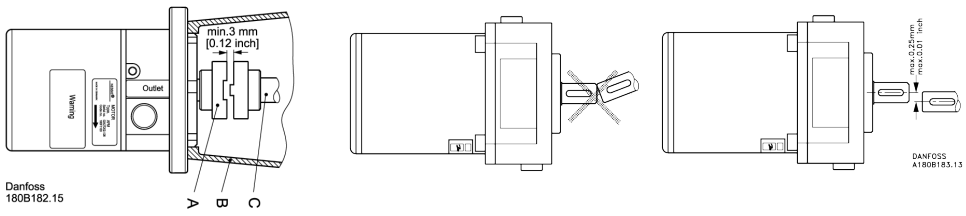
Preferred



Not acceptable

10. Installation

It is recommended to use flexible coupling and ensure that the gab between the two metal parts of the coupling is min. 3 mm.

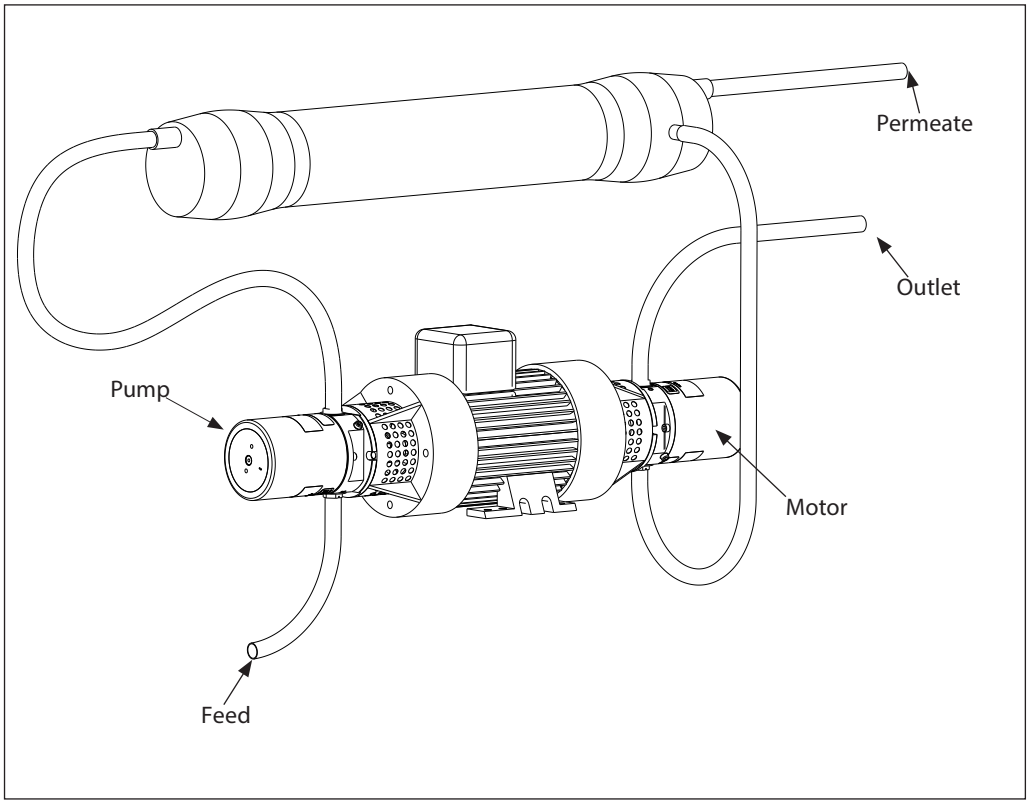


A: Elastic coupling
B: Bell housing
C: Motor shaft

11. Preferred system design

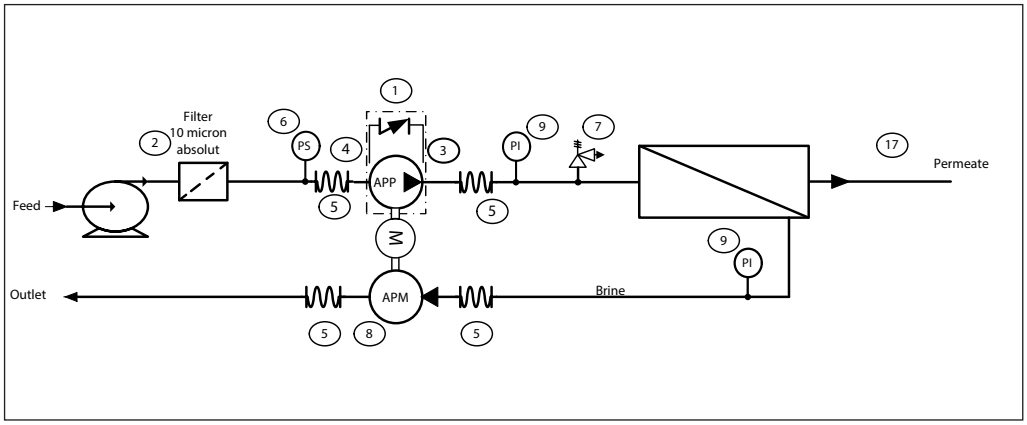
APM is used for energy recovery unit which consists of an APP pump and an APM motor, both connected to a double shafted electric motor. Energy recovery is obtained when high-pressure brine from the membranes is fed to the APM that converts the energy in the pressurized brine to mechanical energy to be reused by the electric motor. As the APM has a fixed volumetric displacement, the recovery rate will be fixed.

System example



The design of the system must ensure that self emptying of the water motor during standstill is avoided. Always place the outlet line higher than the water motor.
Air in the water will cause cavitation and damage the water pump and the water motor.

11.1 Membrane system with energy recovery



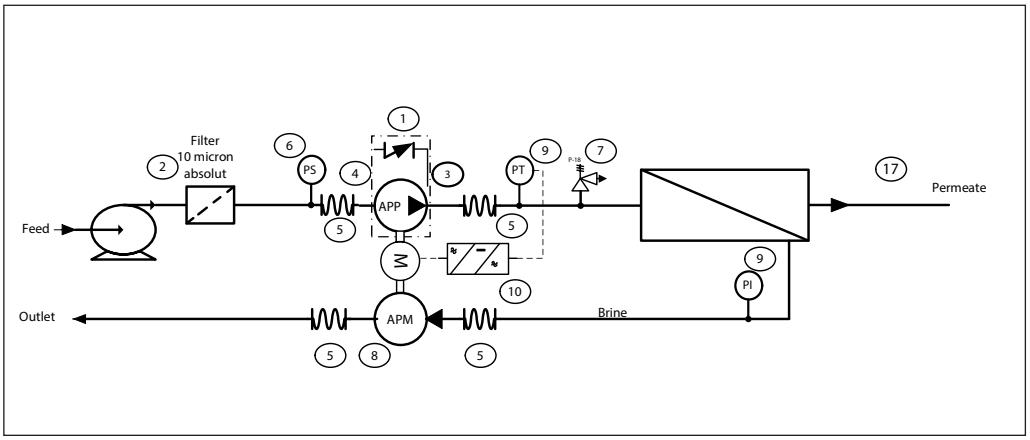
In order to eleminate the risk of damage and cavitation, observe the following guidelines:

1. For easy system bleeding without starting up the system, the APP pump has an integrated flushing valve (1).
2. Place an inlet filter (2) in front of the APP pump (3). Please consult section 8, "Filtration" guidance on how to select the right filter.

Important:
Thoroughly clean pipes and flush system prior to start-up — the APP pump and the APM must be bypassed

3. Place a monitoring pressure switch (6) set at min. 1 bar between filter and pump inlet. The monitoring switch must stop the pump at pressures lower than 1 bar (14.5 psi). At 3000 rpm — use 2 bar (29 psi) as set point.
4. Dimension the inlet and outlet lines to obtain minimum pressure loss (large flow, minimum pipe length, minimum number of bends/connections, and fittings with small pressure losses).
5. Always maintain a positive pressure at the pump inlet (4) of min. 0.5 bar (7.3 psi) and max. 5 bar (72.5 psi). At speeds above 3000 rpm the pressure at the inlet of the water pump must be min. 2 bar (29 psi).
6. Use flexible hoses (5) to minimize vibrations and noise.
7. Install a safety valve (7) in order to avoid system damage as the Danfoss APP pump creates pressure and flow immediately after start-up, despite any counter pressure.
8. Always maintain a pressure at the motor inlet (8) of min. 10 bar (145 psi) and max. 80 bar (1160 psi).
9. As the pressure on the outlet line must not exceed 5 bar (72.5 psi), do not throttle the water motor outlet.

11.2 Membrane system with energy recovery and VFD



In order to eleminate the risk of damage and cavitation, observe the following guidelines:

1. For easy system bleeding without starting up the system, athe APP pump has an integrated flushing valve (1).
2. Place an inlet filter (2) in front of the APP pump (3). Please consult section 8, "Filtration" guidance on how to select the right filter.

Important:
Thoroughly clean pipes and flush system prior to start-up — the APP pump and the APM must be bypassed

3. Place a monitoring pressure switch (6) set at min. 1 bar between filter and pump inlet. The monitoring switch must stop the pump at pressures lower than 1 bar (14.5 psi). At 3000 rpm — use 2 bar (29 psi) as set point.
4. Dimension the inlet and outlet lines to obtain minimum pressure loss (large flow, minimum pipe length, minimum number of bends/connections, and fittings with small pressure losses).
5. In order to eliminate the risk of damage and cavitation, a positive pressure at the pump inlet (4) is always to be maintained at min. 0.5 bar (7.3 psi) and max. 5 bar (72.5 psi). At speeds above 3000 rpm the pressure at the inlet of the water pump must be min. 2 bar (29 psi)
6. Use flexible hoses (5) to minimize vibrations and noise.
7. Always maintain a pressure at the motor inlet (8) of min. 10 bar (145 psi) and max. 80 bar (1160 psi).
8. As the pressure on the outlet line must not exceed 5 bar (72.5 psi), do not throttle the water motor outlet.
9. Using a VFD (10) makes it possible to control the rotation speed, ramp up and ramp down of the electric motor. By altering the rotation speed, the permeate production can be changed to obtain optimum energy recovery.
10. Install a pressure transmitter (9) to measure the pressure at the membran inlet. Use the signal from the pressure transmitter to obtain an automatic pressure-controlled adjustment of the VFD and optimum utilization and load of the membrane.

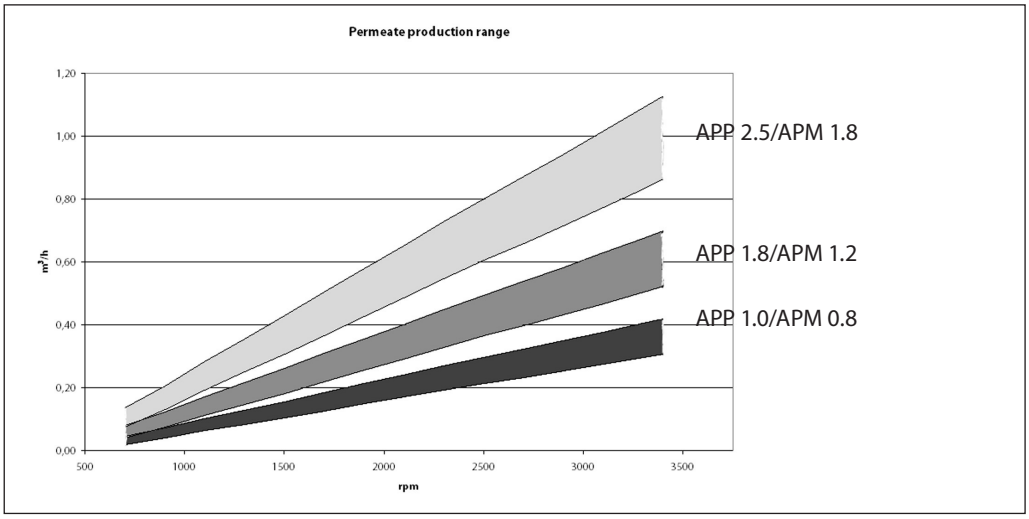
12. Combinations

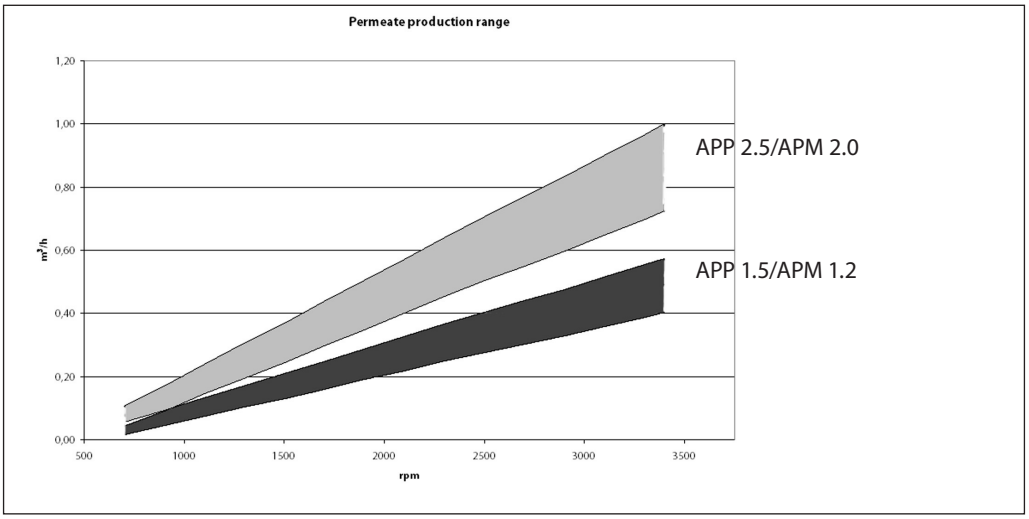
12.1 Examples of motor / pump combinations

APP pump/AMP motor		APP 1.0/APM 0.8	APP 1.5/APM 1.2	APP 1.8/APM 1.2	APP 2.5/APM 2.0	APP 2.5/APM 1.8
1450 rpm						
Feed flow	m^3/h (gpm)	0.50 (2.2)	0.80 (3.5)	0.85 (3.7)	1.25 (5.5)	1.25 (5.5)
Recovery rate	%	29	28	32	29	32
Permeate (± 10%)	m^3/h (gpm)	0.14 (0.6)	0.22 (1.0)	0.27 (1.2)	0.36 (1.6)	0.40 (1.8)
Electric motor (4 pole)		1.1 kW, IEC 90	1.5 kW, IEC 90	1.5 kW, IEC 90	2.2 kW, IEC 100	2.2 kW, IEC 100
2900 rpm						
Feed flow	m^3/h (gpm)	1.05 (4.6)	1.55 (6.8)	1.65 (7.3)	2.55 (11.2)	2.55 (11.2)
Recovery rate	%	29	28	32	29	32
Permeate (± 10%)	m^3/h (gpm)	0.30 (1.3)	0.43 (1.9)	0.52 (2.3)	0.74 (3.3)	0.82 (3.6)
Electric motor (2 poles)		2.2 kW, IEC 90	3 kW, IEC 100	3 kW, IEC 100	5.5 kW IEC 132	5.5 kW IEC 132

12.2 Flow

1 gpm = 3.79 l/min
1 l/min = 0.26 gpm
1 m^3/h = 4.40 gpm
1 gpm = 0.23 m^3/h

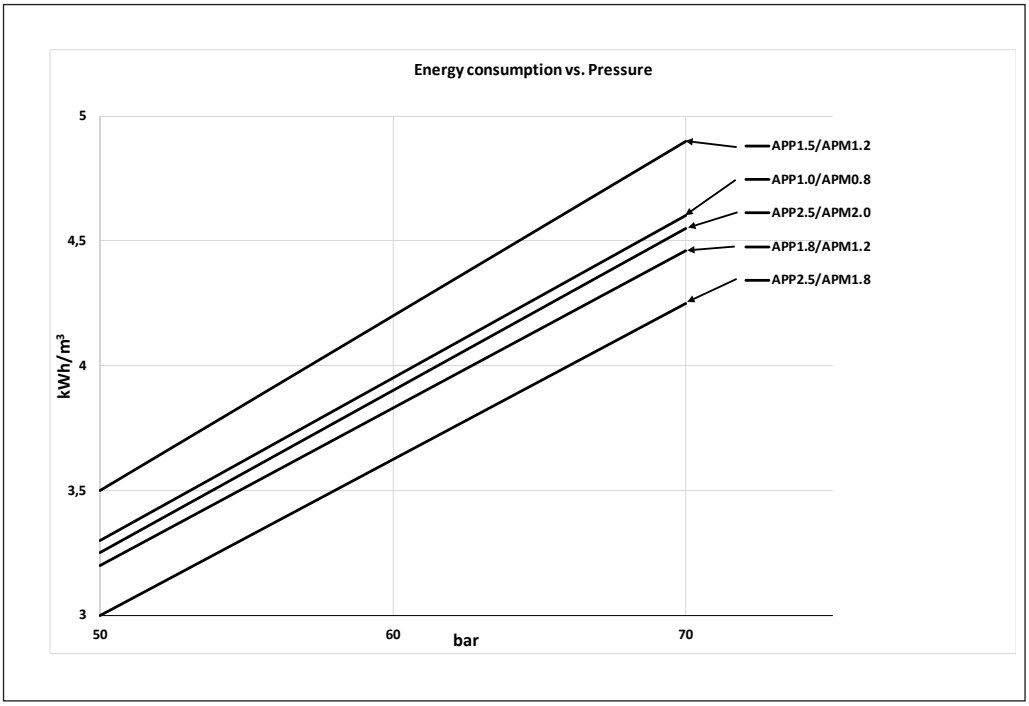




Due to tolerances of both the pumps and the motors, permeate production will vary according to the figures above.

12.3 Energy consumption vs. pressure

A variation of up to 20% may occur depending on the rpm and the efficiencies of the pump and the motor.
The curves below are calculated using an efficiency of the electric motor of 86% and provided that the pressure at the inlet of the APM motor is 1 bar less than the pressure from the APP pump.



12.4 Power consumption

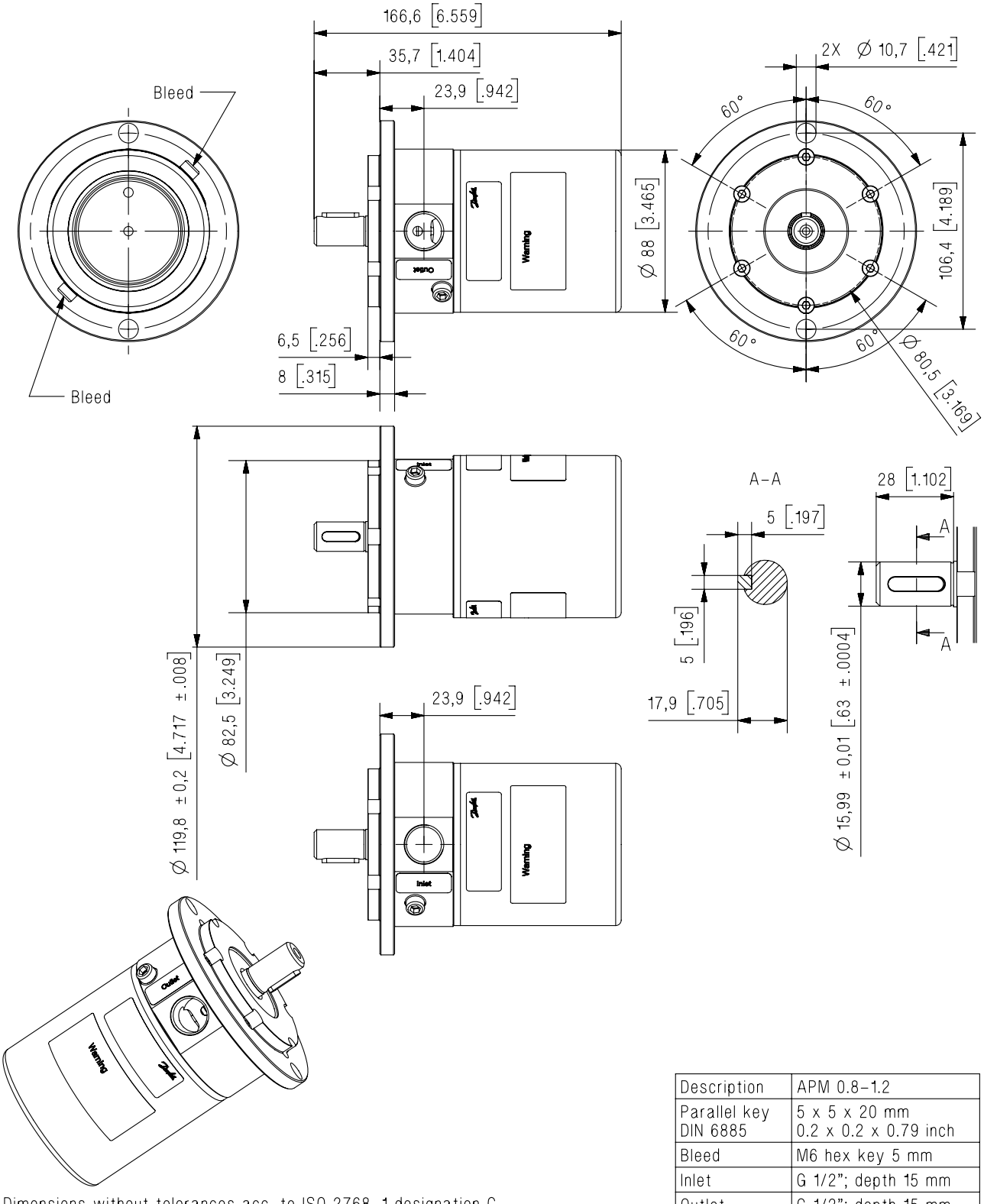
1 hp hr = 0.75 kWh
1 kWh = 1.34 hp hr

Motor / pump combination		APP 1.0/ APM 0.8 kWh	APP 1.5/ APM 1.2 kWh	APP 1.8/ APM 1.2 kWh	APP 2.5/ APM 2.0 kWh	APP 2.5/ APM 1.8 kWh
Recovery rate (%)		29	28	32	29	32
50 bar (725psi)	1450 rpm	0.6	0.9	0.9	1.4	1.5
50 bar (725 psi)	2900 rpm	1.2	1.7	1.9	2.8	3.0
60 bar (870 psi)	1450 rpm	0.7	1.0	1.2	1.7	1.5
60 bar (870 psi)	2900 rpm	1.5	2.1	2.3	3.4	3.5
70 bar (1015 psi)	1450 rpm	0.8	1.2	1.3	2.0	2.1
70 bat (1015 psi)	2900 rpm	1.7	2.4	2.7	3.8	4.0

The figures in the table above are calculated using an efficiency of the electric motor of 86% and provided that the pressure at the inlet of the APM motor is 1 bar less than the pressure from the APP pump.

13. Dimensions

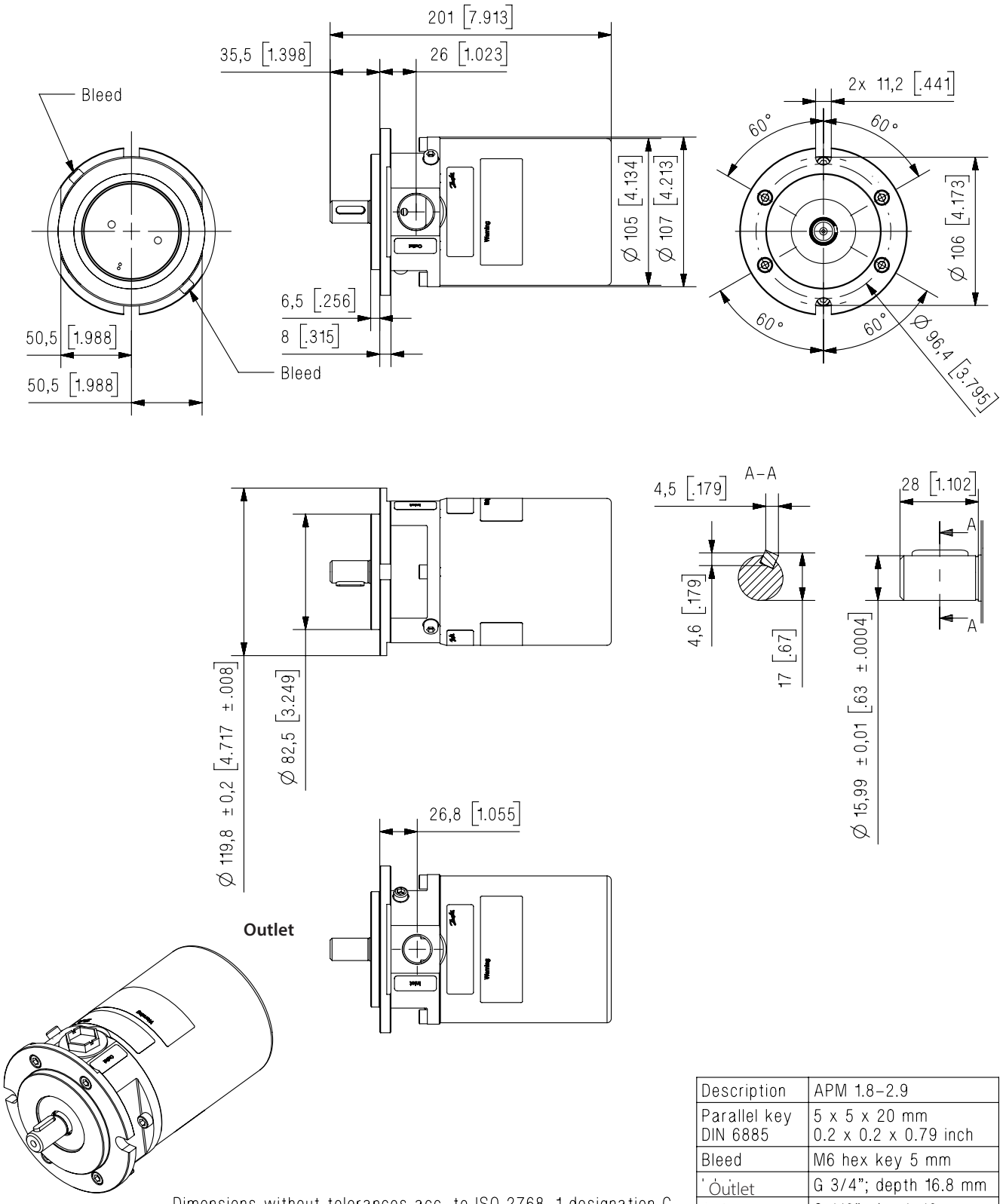
13.1 APM 0.8 – 1.2



Dimensions without tolerances acc. to ISO 2768–1 designation C.

Description	APM 0.8–1.2
Parallel key DIN 6885	5 x 5 x 20 mm 0.2 x 0.2 x 0.79 inch
Bleed	M6 hex key 5 mm
Inlet	G 1/2"; depth 15 mm
Outlet	G 1/2"; depth 15 mm

13.2 APM 1.8 – 2.9



Dimensions without tolerances acc. to ISO 2768-1 designation C.

Description	APM 1.8–2.9
Parallel key DIN 6885	5 x 5 x 20 mm 0.2 x 0.2 x 0.79 inch
Bleed	M6 hex key 5 mm
Outlet	G 3/4"; depth 16.8 mm
Inlet	G 1/2"; depth 16 mm

14. Service

Warranty
Danfoss APM motors are designed for long operation, low maintenance and reduced lifecycle costs.

Provided that the motorp has been running according to the Danfoss specifications, Danfoss guarantees 8,000 hours service-free operation, however, max. 18 months from date of production.

If Danfoss recommendations concerning system-design are not followed, it will strongly influence the life of the APM motors.
Other factors that affect motor performance and lifetime include:

- Running the motor at speed outside specifications.
- Supplying the motor with water at temperature higher than recommended.
- Running the motor at inlet pressure outside specifications.
- Running the motor at outlet pressure outside the specifications.

Maintenance
Periodic inspections are required to ensure worn parts (if any), are replaced in due time. Operational conditions such as water quality should be taken into consideration when determining the frequency of the inspections. Danfoss recommends yearly inspections.
It is recommended to order the purpose-designed tool kit.

Motor shutdown:
The APM motors are made of Duplex/Super Duplex materials with excellent corrosion properties. It is, however, always recommended to flush the motor with freshwater when the system is shut down.
When stopping the motor for more than 1 day flush the motor with permeate by rotating the motor for 10 sec. The motor can be flushed with biocide like the membranes. The biocide must be compatible with the materials used in our motors.

Repair assistance
In case of irregular function of the APM motor, please contact Danfoss High Pressure Pumps.

If the recommendations in the manual are not followed, Danfoss reserves the right to void the warranty.

Danfoss A/S
High Pressure Pumps
DK-6430 Nordborg
Denmark