Hydre-MAC

Radial piston motors

Powering Business Worldwide

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Introduction

Hydre-MAC™ Radial piston motor

Direct drive variable speed machines benefit dramatically from Eaton's new radial piston hydraulic motor. Class leading torque density decreases machine structural element costs, and reduces machine footprint. Superior mechanical efficiency further reduces energy consumption across a 2000:1 speed ratio while delivering full torque to the machine shaft. Over 90% stall torque efficiency allows the designer to avoid over-sizing the motor, and lowers overall maximum pressure requirements of the system.

The low inertia design features enable instant stopping and reversing for highly dynamic applications and prevents torque spikes which could damage the machine elements and bearings. Shaft mounted and torque arm restrained features lowers coupling and mounting costs associated with extremely high torque applications. Multiple port configurations and locations offer the machine designer myriad solutions for the ultimate in flexibility. Integral multi-disc brake, torque arm kits and speed encoder options further expand the possibilities enabling the machine designer constraint free solutions.

Applications

Pulp and paper
- Pulp washers
- Digesters
- De-barkers
- Conveyors

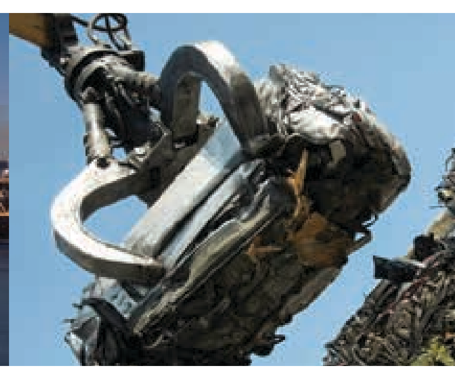
Mining
- Bucket wheel reclaimers
- Apron feeders
- Breakers

Recycling
- Shredders

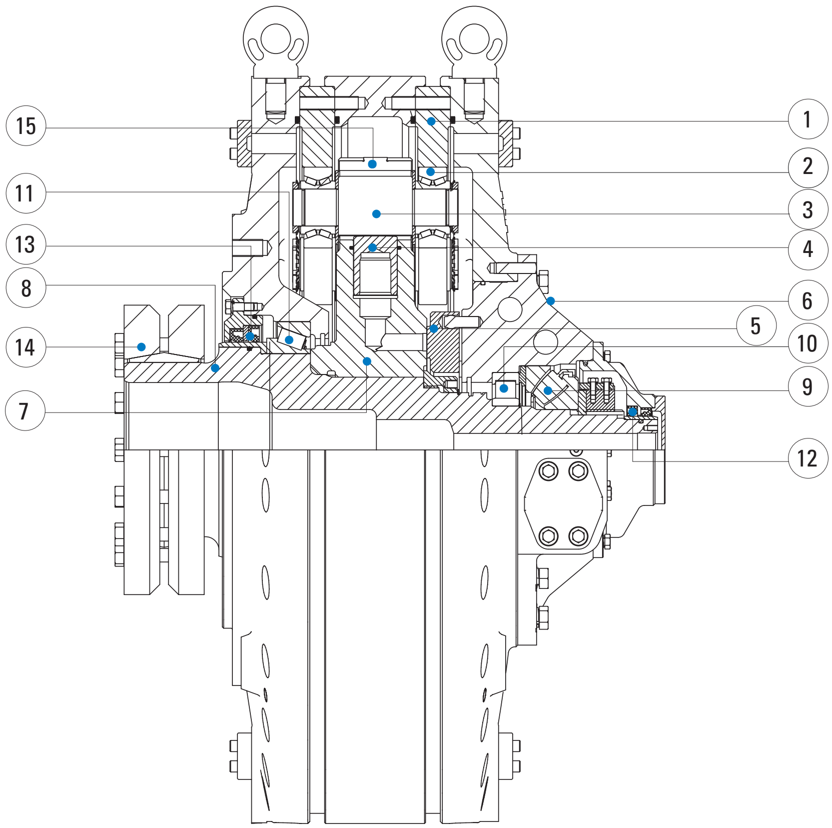
Marine
- Cutter wheel dredges
- Winches

Features and benefits

- High Efficiency lowers operating costs
- Replaceable wear surfaces lowers maintenance costs by extending maintenance intervals
- Very low pressure drop delivers more output torque
- Symmetrical design reduces uneven loading to increase operating life



Funtional description



1 Cam ring
2 Cam follower bearing
3 Crosshead assembly
4 Piston
5 Valve plate
6 Manifold
7 Rotor
8 Output shaft
9 Thrust bearing
10 Radial bearing
11 Output shaft bearing
12 Inboard shaft seal
13 Outboard shaft seals
14 Shrink disc coupling
15 Bearing plate

Eaton's Hydre-MAC hydraulic motors are radial piston, cam lobe type. The housing is stationary, and can be mounted by a mechanical flange, foot or torque arm arrangement. Pressurized fluid, entering one or both of the inlet ports is directed thru the manifold housing thru a series of passageways and valve plate to sealed pistons, located in a rotating block called the rotor, or cylinder block. As oil is moving into the piston chamber, called the cylinder, or piston bore, the piston moves outward radially. The piston, in turn, pushes against a guide block called the crosshead assembly which has two rolling element bearings located on either end. These bearings roll down the cam slope causing rotation of the shaft. As the bearings roll down the cam slope, a reaction force is exerted upon the guide slot in the rotor through replaceable low friction plain bearing surfaces. After the pistons finish the extension stroke, the cam profile returns them to the starting position, and the oil flows outward from the pistons, thru the valve plate and manifold and out the return port.The rotor is connected to the shaft and as it rotates due to cam reaction forces, the output shaft rotates and exerts a rotational force on the machine shaft. Output torque is proportional to system pressure. Drain ports are supplied to allow leakage oil to exit the motor from the highest point, ensuring all bearings will remain submerged in lubricating oil.

Key technical differentiators

Converting fluid power to rotating mechanical energy efficiently and reliably has proven to be challenging. Eaton's Hydre-MAC radial piston motor was developed to overcome these challenges to deliver industry leading reliability, serviceability, efficiency and availability.

Balanced design – long reliable operating life

With 8 cam lobes and up to 18 pistons, the internal forces on the main bearings are balanced, freeing up the main bearings for external loads induced by mounting attitude and machine design.

Constant flow cam ring profile – ultra smooth low speed performance increases efficiency

The cam ring profile has been designed to eliminate torque ripple by preventing working piston overlap at the valve plate interface. In fact, each piston has significant dwell time at bottom and top of stroke while rotating, maintaining an equal number of pistons always doing work, resulting in constant displacement.

Floating, sealed pistons – practically unlimited piston life and superior mechanical efficiency

The pistons are designed to float in the bore, never side loaded, insuring reliabilty and long life. The floating design further increases mechanical efficiency by allowing all fluid power energy to be converted to linear motion, finally resulting in rotary motion with virtually no losses. Further, the piston seals are designed to prevent leakage which increases volumetric efficiency substantially.

Large bearings – reliable long life

All the main shaft bearings on the motor are over-sized for long life. The thrust bearing design does not require different oil than the system hydraulic fluid, and does not require flushing. All bearings are submerged in case oil under all installation conditions.

Replaceable bearing plates – uncompromising serviceability

The pistons push outward against a cross-head assembly containing the cam follower bearings. These crosshead assemblies slide in and out of the rotor slots on specially designed plain bearing surfaces, reducing friction, and converting linear motion to rotary motion without side-loading the pistons. These plain bearing surfaces, while replaceable, are designed to prevent catastrophic contamination related failure events by introducing a sacrificial element that can easily be replaced at low cost. This feature also enables reduced frequency low viscosity events, possibly caused by cooling system failure, without permanent damage to the motor.

Valve plate – extremely high volumetric efficiency and very low case flow

The valve plate is designed to prevent excess fluid flow and pressure loss by combining multiple features such as flatness, hardness, surface finish and balance. Precision ports large enough to pass very large amounts of fluid at nearly zero pressure drop further contribute to extremely high mechanical and volumetric efficiency. The precise balance of the design nearly eliminates excess case flow during high pressure events, and reduces the need for accumulators in highly dyamic applications such as shredders and other processing equipment

Cam follower bearing diameter – reliable, predicable operating life

Large diameter cam follower bearings lower cam surface stresses, ensuring very long cam life. Cam follower bearing life is easily calculated and is a very reliable indicator of operating life .

Specifications

		Units	RCC1013	RCC1016	RCD1020	RCD1025	RCE1030	RCE1036	RCF1042	RCF1050
Displacement		cc/rev	12789	16080	20160	25320	30580	35460	42180	50670
		(in^3/rev)	(780)	(982)	(1231)	(1546)	(1867)	(2165)	(2575)	(3093)
Pressure	Maximum[1]	bar (psi)	350 (5075)							
	Peak[2]		420 (6090)							
Speed	Continuous	Rpm	65	50	45	40	35	32	28	25
	Maximum[3]		100	85	70	60	50	42	38	35
Torque	Theoretical	Nm/bar	203	255	320	402	486	563	671	805
		lb.ft/100psi	1031	1295	1625	2041	2467	2858	3406	4087
Power	Continuous	kW (HP)	348 (467)	337 (453)	381 (511)	425 (570)	449 (602)	476 (639)	496 (665)	531 (713)
	Peak[3]		895 (1200)	798 (1070)	823 (1104)	887 (1189)	892 (1196)	869 (1165)	935 (1254)	1035 (1388)
Case pressure	Continuous	bar (psi)	3.5 (50)							
	Maximum		5 (72)							
Temperature	Minimum	°C (°F)	-20 (-4)							
	Maximum		75 (167)							
Charge Pressure	Normal									
	Dynamic braking[4]	bar (psi)	11 (160)	11 (160)	14 (201)	14 (201)	17 (247)	17 (247)	20 (290)	20 (290)

[1] Continuous pressure above 250 bar requires flushing, specifically when operating more than 50% of continuous speed
[2] Not to exceed 1% of duty cycle
[3] Flushing required
[4] At continuous speed

Hydraulic fluid	Recommended operating viscosity range cSt (SUS)	Minimum continuous viscosity	Maximum Viscosity at startup cSt (SUS)	FZG (90) Wear test according to DIN 51354, IP 334
Premium anti-wear hydraulic fluid	40-100	25	1000	Stage 11 pass

Model code

RCC1	013	M	S	1	0	0	B	00	00	1	1	A
Series	**Displacement**	**Mounting Interface**	**Output Shaft**	**Ports**	**Brake**	**Flanged valves**	**Seals**	**No Option**	**Special Features**	**Paint**	**Name plate**	**Design**
1, 2, 3, 4	5, 6, 7	8	9	10	11	12	13	14, 15	16, 17	18	19	20

		Motor size	013	016	020	025	030	036	042	050
1 2 3 4		**Radial piston single cam ring motor**								
RCC1	-	C Frame (013, 016 displacements)	●	●	X	X	X	X	X	X
RCD1	-	D Frame (020, 025 displacements)	X	X	●	●	X	X	X	X
RCE1	-	E Frame (030, 036 displacements)	X	X	X	X	●	●	X	X
RCF1	-	F Frame (042, 050 displacements)	X	X	X	X	X	X	●	●
5 6 7	-	**Displacement**								
013	-	12,780 cc/rev (781 in3/rev)	●	X	X	X	X	X	X	X
016	-	16,080 cc/rev (982 in3/rev)	X	●	X	X	X	X	X	X
020	-	20,160 cc/rev (1231 in3/rev)	X	X	●	X	X	X	X	X
025	-	25,320 cc/rev (1546 in3/rev)	X	X	X	●	X	X	X	X
030	-	30,580 cc/rev (1867 in3/rev)	X	X	X	X	●	X	X	X
036	-	35,460 cc/rev (2165 in3/rev)	X	X	X	X	X	●	X	X
042	-	42,180 cc/rev (2575 in3/rev)	X	X	X	X	X	X	●	X
050	-	50,670 cc/rev (3093 in3/rev)	X	X	X	X	X	X	X	●
8	-	**Mounting interface**								
M	-	Metric Pilot, UNC threaded	●	●	●	●	●	●	●	●
9	-	**Output shaft**								
S	-	Hollow Shaft with Shrink Disc	●	●	●	●	●	●	●	●
D	-	Solid Shaft, External Spline	○	○	○	○	○	○	○	○
G	-	Solid Shaft, External Spline, both sides	○	○	○	○	○	○	○	○
F	-	Hollow Shaft, Female spline	○	○	○	○	○	○	○	○
10	-	**Ports**								
1	-	Opposite Side, 2" SAE J518 (code 62) UNC	●	●	●	●	●	●	●	●
2	-	Opposite Side, 2" SAE J518 (code 62) Metric	○	○	○	○	○	○	○	○
11	-	**Brake**								
0	-	Without Brake	●	●	●	●	●	●	●	●
A	-	With Multi-disc brake	○	○	○	○	○	○	○	○

		Motor size	013	016	020	025	030	036	042	050
12		**Flanged Valves**								
0	-	No flanged valves	●	●	●	●	●	●	●	●
1		Cross port relief, dual acting	○	○	○	○	○	○	○	○
2		Brake release, internal hydraulic pilot	○	○	○	○	○	○	○	○
3		Brake release, internal electro-hydraulic pilot	○	○	○	○	○	○	○	○
4		Brake release, external hydraulic pilot	○	○	○	○	○	○	○	○
5		Counterbalance valve, 1 direction	○	○	○	○	○	○	○	○
6		Counterbalance valve, 2 directions	○	○	○	○	○	○	○	○
13	-	**Seals**								
B	-	Standard - Nitrile (Buna-N)	●	●	●	●	●	●	●	●
V	-	Fluorocarbon	○	○	○	○	○	○	○	○
E	-	EPR	○	○	○	○	○	○	○	○
14 15	-	**Option not used**								
00	-	No options	●	●	●	●	●	●	●	●
16 17		**Special features**								
00	-	None	●	●	●	●	●	●	●	●
01	-	Under water shaft seal arrangement	○	○	○	○	○	○	○	○
02	-	Without shrink disc coupling	○	○	○	○	○	○	○	○
18	-	**Paint**								
0	-	No Paint (rust preservative coating)	●	●	●	●	●	●	●	●
1	-	Eaton blue enamel topcoat	●	●	●	●	●	●	●	●
2	-	Paintable primer only	○	○	○	○	○	○	○	○
3	-	Eaton blue 2 part epoxy	○	○	○	○	○	○	○	○
19	-	**Nameplate**								
1		Eaton nameplate	●	●	●	●	●	●	●	●
20	-	**Design**								
A	-	Design code A	●	●	●	●	●	●	●	●

Note:

● Preferred standard option

○ Special option on request

X Not available

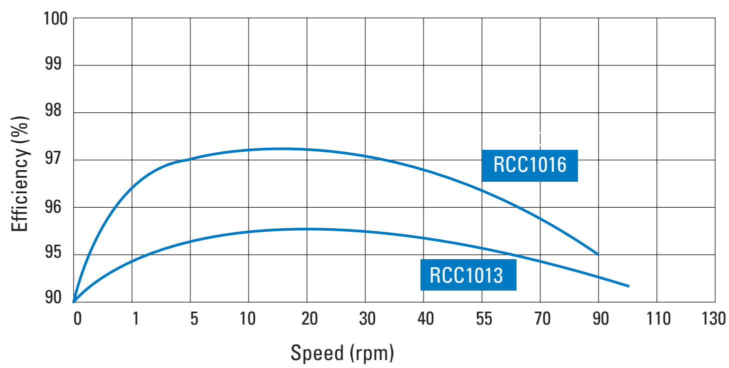
Standard part numbers

			Displacement		Speed		Power (max)	
Eaton model size	**Part number**	**Model code**	**Liters/rev**	**in³/rev**	**Continuous**	**Max**	**kW**	**HP**
RCC1013	995RC00001A	RCC1013MS100B000011A	12.78	780	65	100	895	1200
RCC1016	995RC00003A	RCC1016MS100B000011A	16.08	982	50	85	798	1070
RCD1020	996RC00001A	RCC1020MS100B000011A	20.16	1231	45	70	823	1104
RCD1025	996RC00002A	RCC1025MS100B000011A	25.32	1546	40	60	887	1189
RCE1030	997RC00001A	RCC1030MS100B000011A	30.58	1867	35	50	892	1196
RCE1036	997RC00002A	RCC1036MS100B000011A	35.46	2165	32	42	869	1165
RCF1042	998RC00001A	RCC1042MS100B000011A	42.18	2575	28	38	935	1254
RCF1050	998RC00002A	RCC1050MS100B000011A	50.67	3093	25	35	1035	1388

Performance – RCC1013 and RCC1016

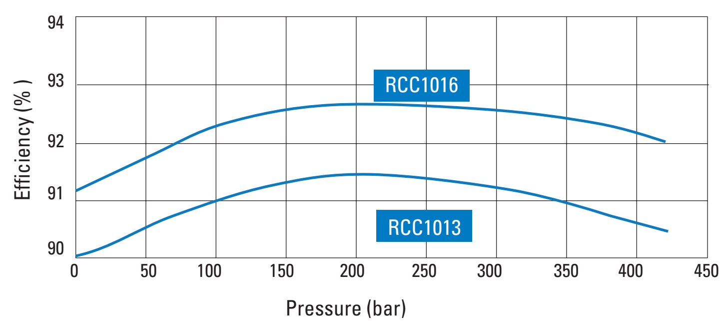
Mechanical efficiency vs. operating speed

Graph indicates percentage of torque relative to differential pressure available at the output shaft.



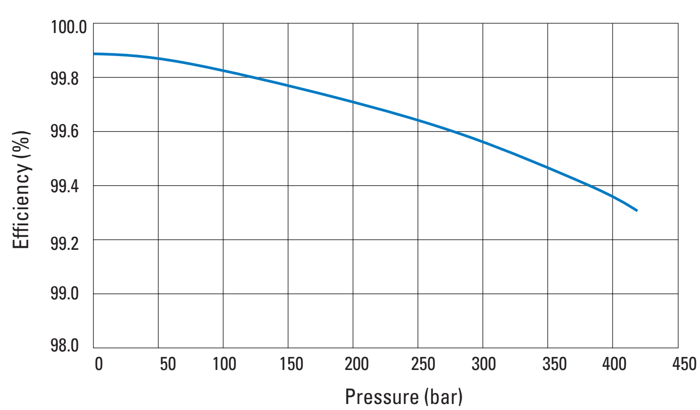
Stall torque efficiency vs. operating pressure

Graph indicates percentage of torque relative to differential pressure available at the output shaft when stalling occurs



Volumetric efficiency vs. operating pressure

Graph indicates percentage of oil flow that passes thru the motor without contributing to rotation. 50% of indicated value is considered to be cross-port leakage with the remainder leaking to case.

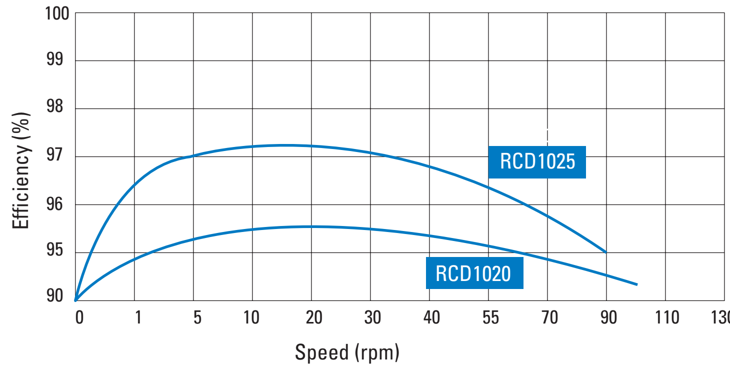


* Values shown are typical

Performance – RCD1020 and RCD1025

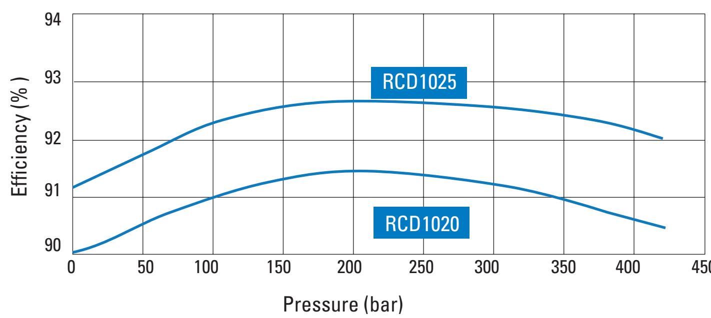
Mechanical efficiency vs. operating speed

Graph indicates percentage of torque relative to differential pressure available at the output shaft.



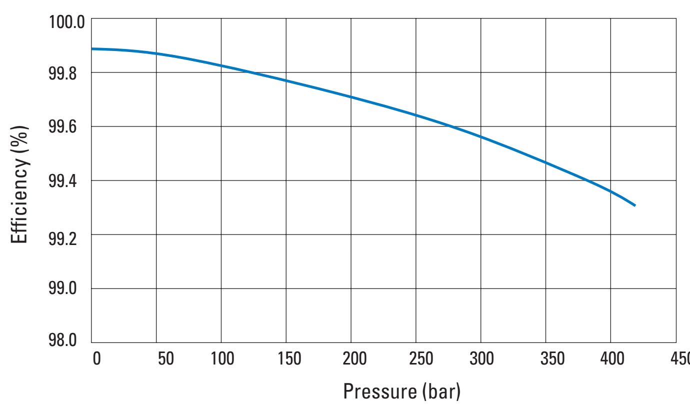
Stall torque efficiency vs. operating pressure

Graph indicates percentage of torque relative to differential pressure available at the output shaft when stalling occurs



Volumetric efficiency vs. operating pressure

Graph indicates percentage of oil flow that passes thru the motor without contributing to rotation. 50% of indicated value is considered to be cross-port leakage with the remainder leaking to case.

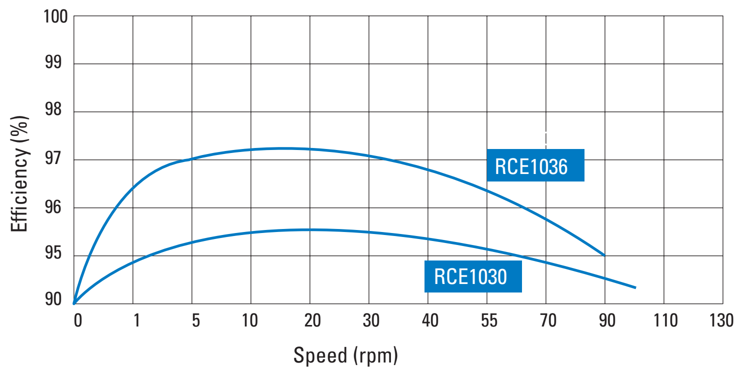


* Values shown are typical

Performance – RCE1030 and RCE1036

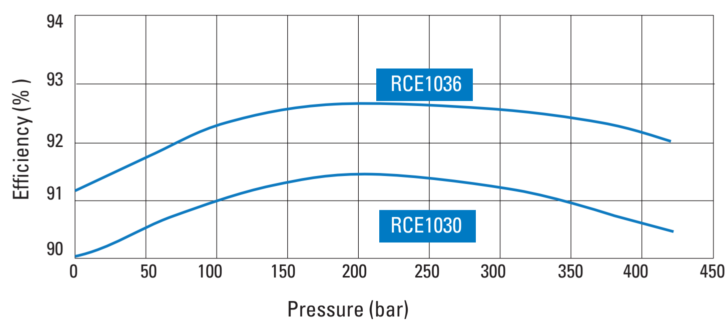
Mechanical efficiency vs. operating speed

Graph indicates percentage of torque relative to differential pressure available at the output shaft.



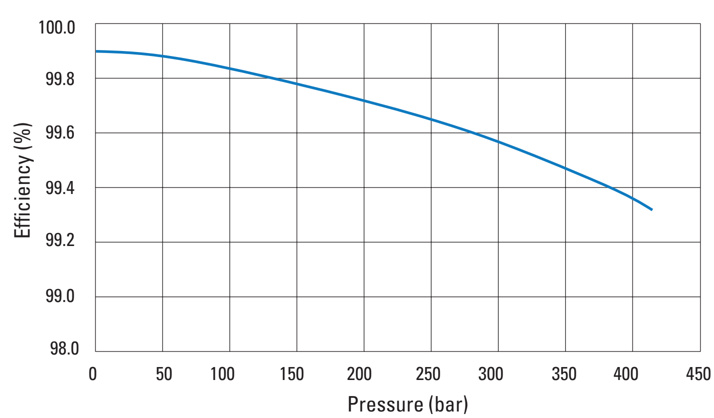
Stall torque efficiency vs. operating pressure

Graph indicates percentage of torque relative to differential pressure available at the output shaft when stalling occurs



Volumetric efficiency vs. operating pressure

Graph indicates percentage of oil flow that passes thru the motor without contributing to rotation. 50% of indicated value is considered to be cross-port leakage with the remainder leaking to case.

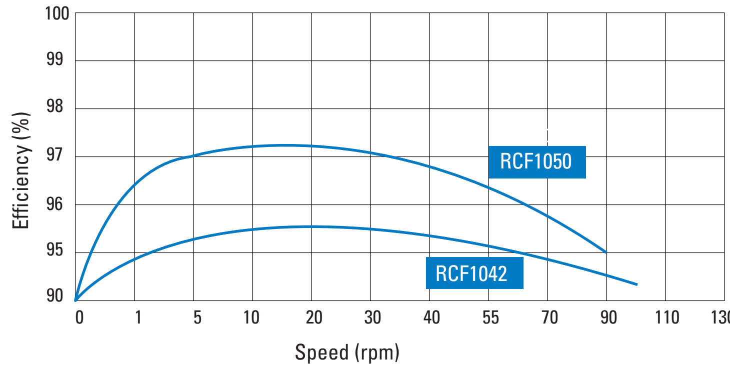


* Values shown are typical

Performance – RCF1042 and RCF1050

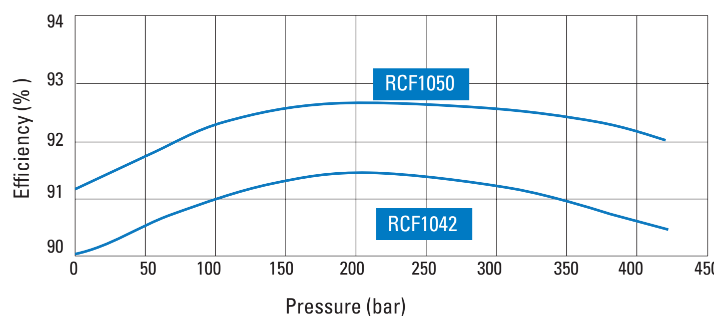
Mechanical efficiency vs. operating speed

Graph indicates percentage of torque relative to differential pressure available at the output shaft.



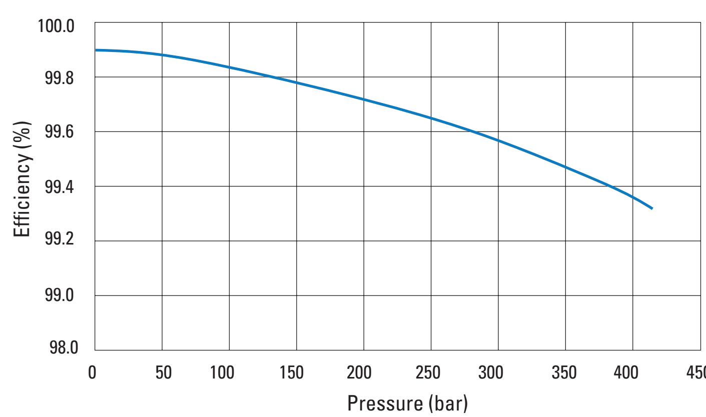
Stall torque efficiency vs. operating pressure

Graph indicates percentage of torque relative to differential pressure available at the output shaft when stalling occurs



Volumetric efficiency vs. operating pressure

Graph indicates percentage of oil flow that passes thru the motor without contributing to rotation. 50% of indicated value is considered to be cross-port leakage with the remainder leaking to case.

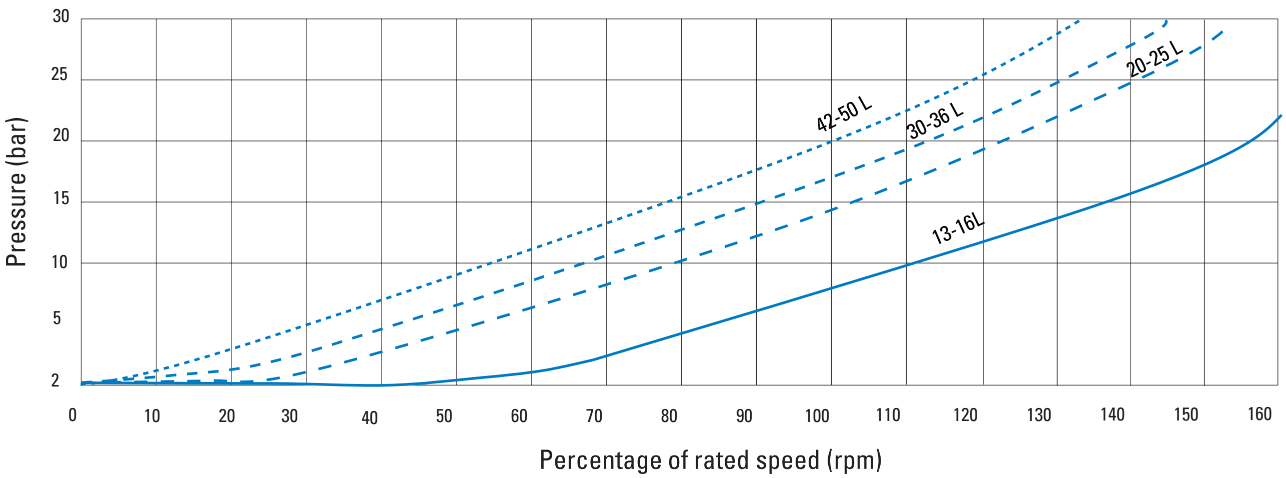


* Values shown are typical

Performance

Requirements for back pressure (charge pressure) and boost pressure (supercharge pressure)

When motors are operating in braking mode or they are subjected to over-running load, to ensure correct operation, a charge pressure must be provided. The chart below provides information on the charge pressure requirement

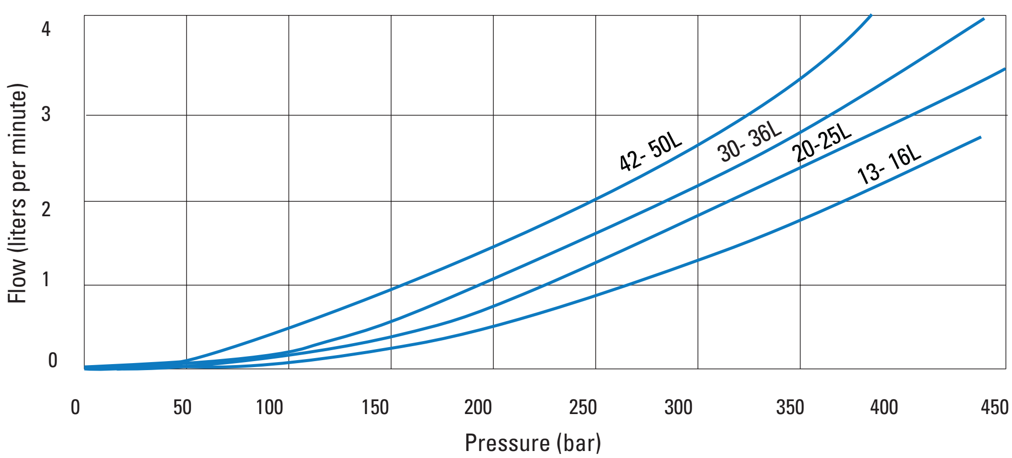


The graph shows the minimum charge pressure which must be maintained at the low pressure (suction) port of the motor when acting as a hydrostatic braking unit (pumping mode). When using motors in normal driving mode it is advisable to maintain charge pressure minimum of 2 bar (30 psi).

Volumetric loss – case drain flow rate

The chart below shows typical case drain flow rates at 50 cSt Viscosity independent of speed.

cSt Viscosity independent of speed.



Drain flow is not a reliable indicator of useful life.

Monitor reservoir cleanliness and viscosity. A good off-line filtration system is best value.

Circulate continuously this clean oil thru the motor to wash out particles. Exact flow rate is not critical and typically 12-16 lpm (3-5 gpm) is adequate for any motor size.

Capturing any magnetic particles by using a magnetic monitoring device, over time, gives best indication as to the health of the motor.

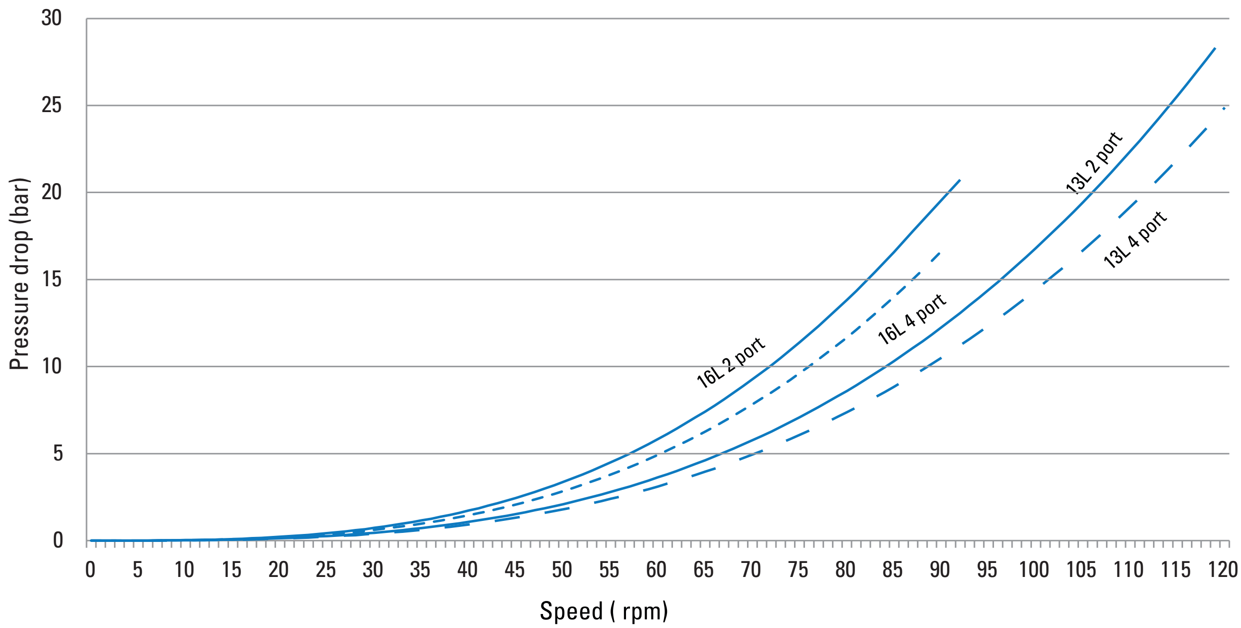
Record the speed and pressure of the motor.

Calculate, with the variables above, the projected life of the motor, using the bearing formulae from the bearing manufacturer. Remove the motor from service at 90% of calculated bearing life, and replace the bearings as needed.

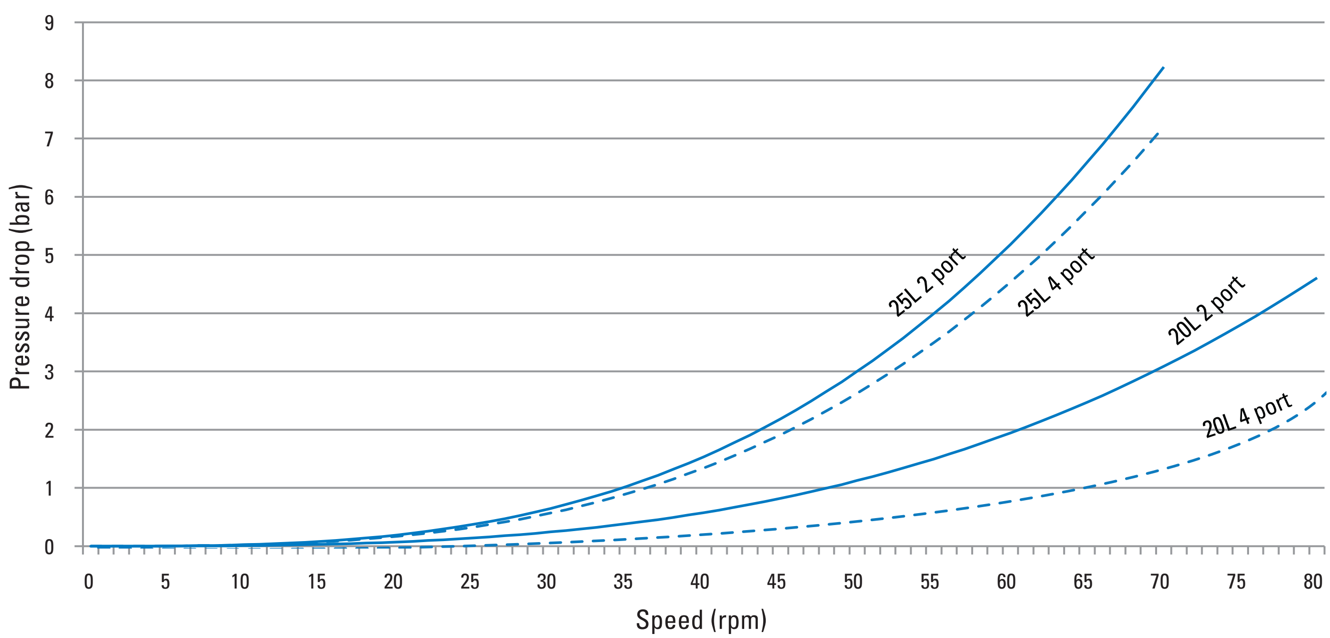
Additionally, bearing life formula are found in ATS-780, available from Eaton Engineering.

No load pressure drop – motors from RCC1013 and RCC1016

Graph indicates pressure loss due to non-laminar flow inside the manifold at 50 cSt. This pressure is additive to charge pressure, but should not be sole source of charge pressure.

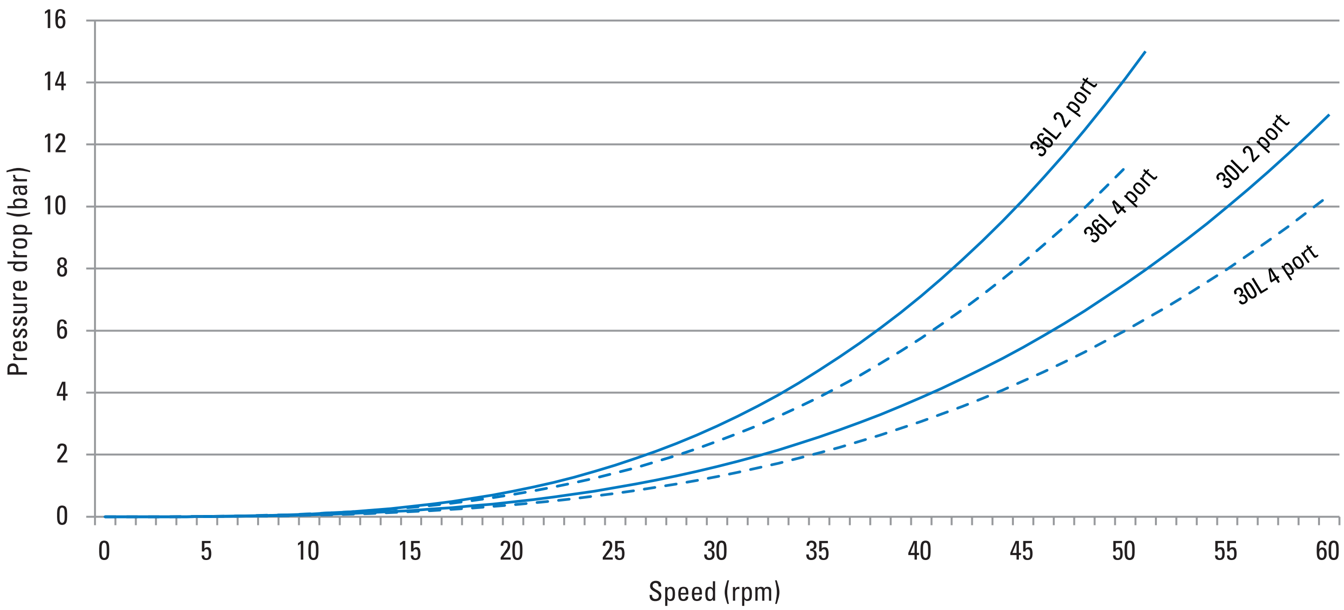


No load pressure drop – motors from RCD1020 to RCD1025

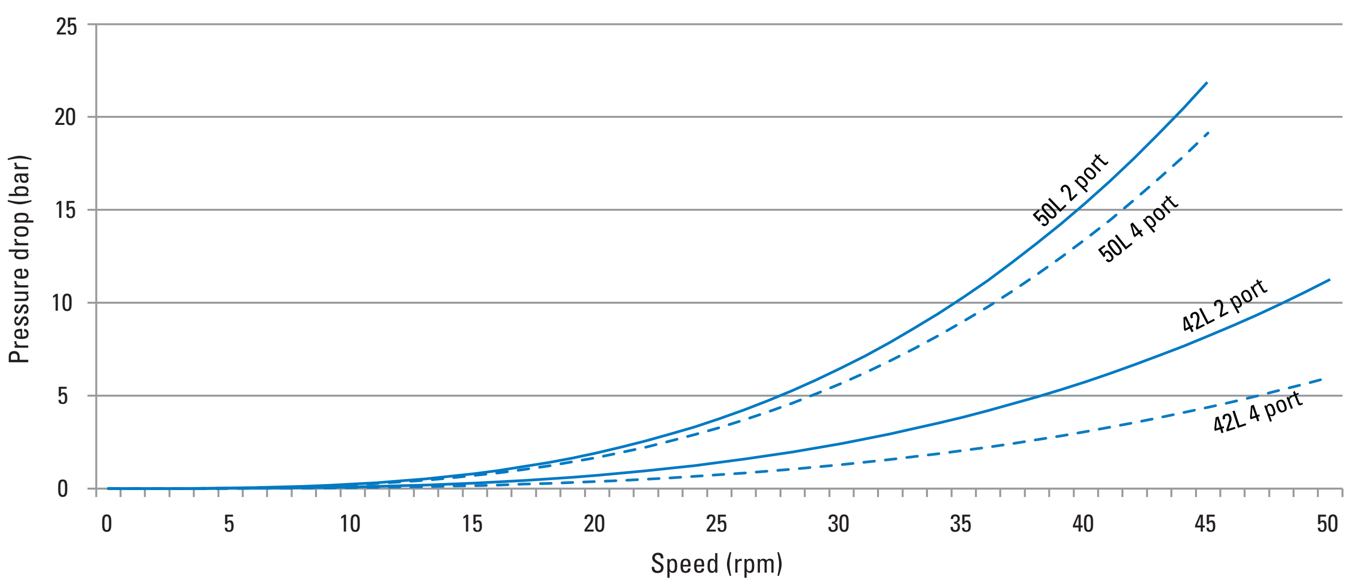


No load pressure drop – motors from RCE1030 and RCE1036

Graph indicates pressure loss due to non-laminar flow inside the manifold at 50 cSt. This pressure is additive to charge pressure, but should not be sole source of charge pressure.

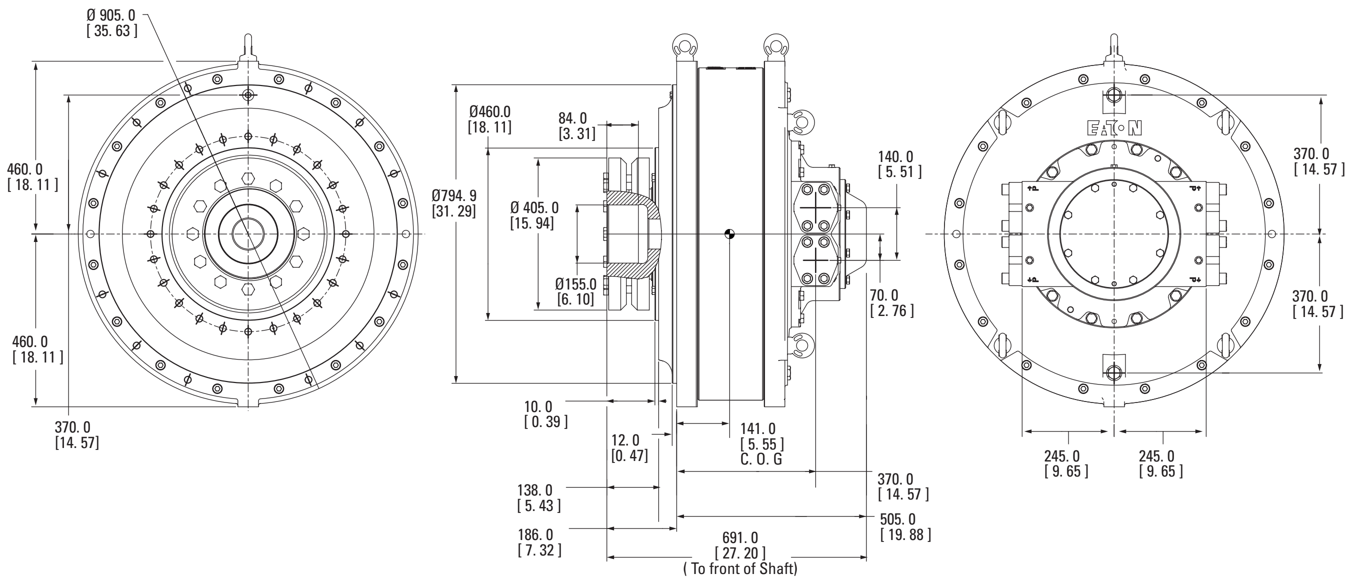


No load pressure drop – motors from RCF1042 to RCF1050

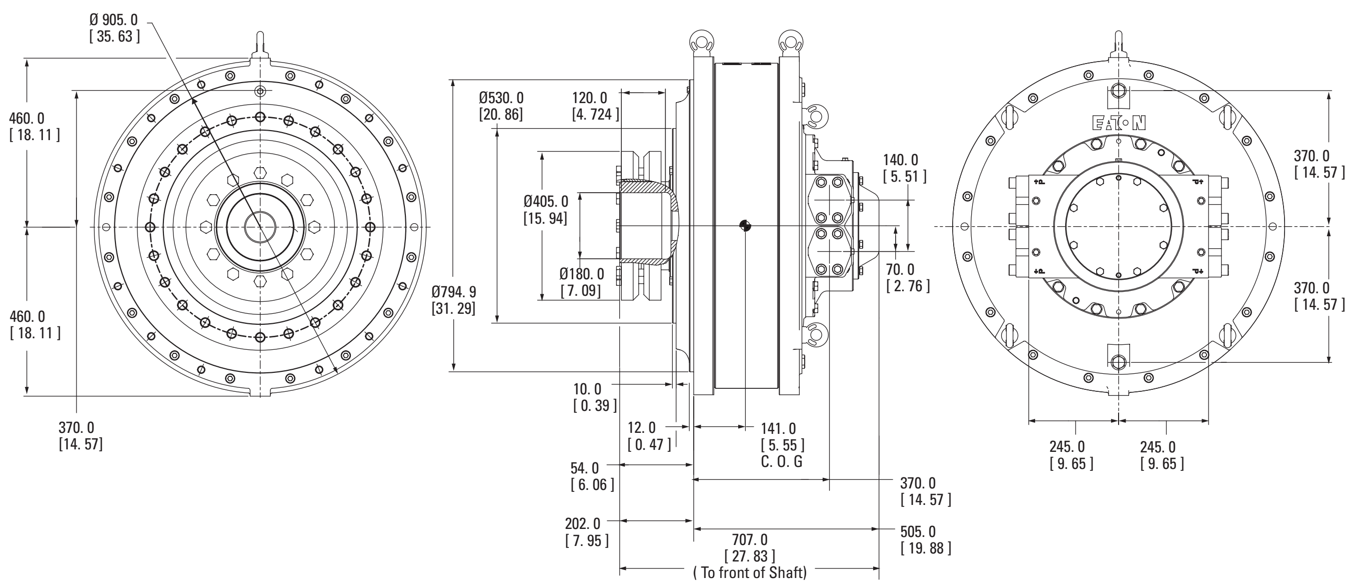


Dimensions

RCC1013 with hollow shaft and shrink disc coupling

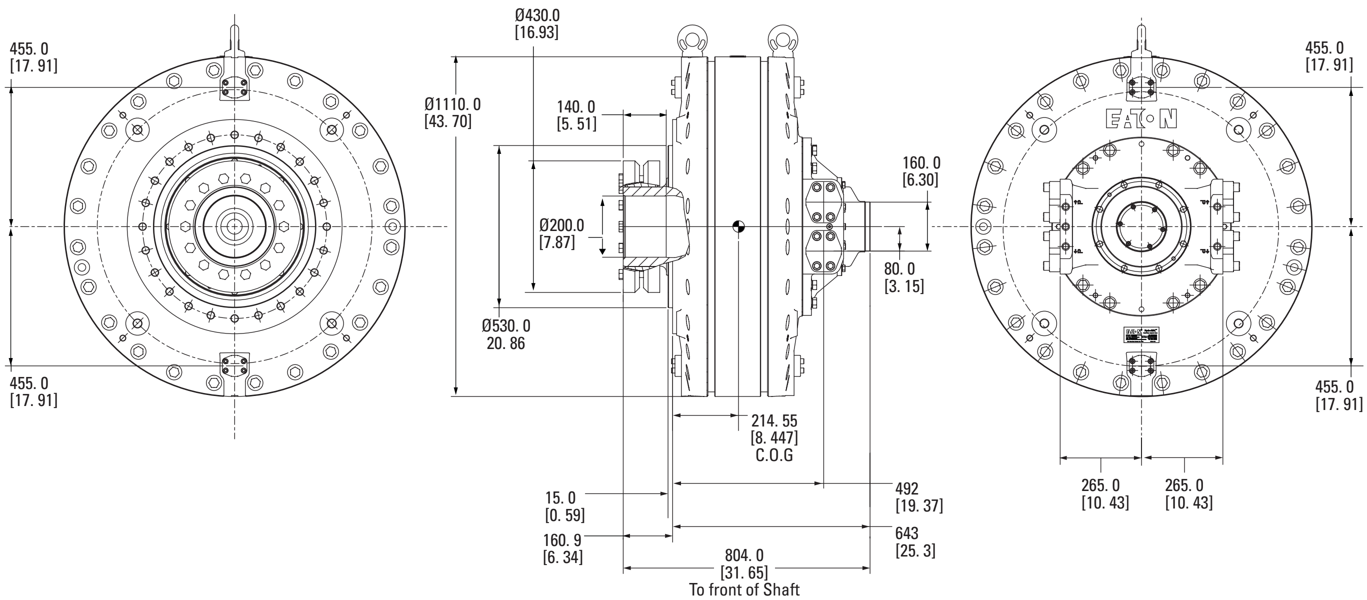


RCC1016 with hollow shaft and shrink disc coupling

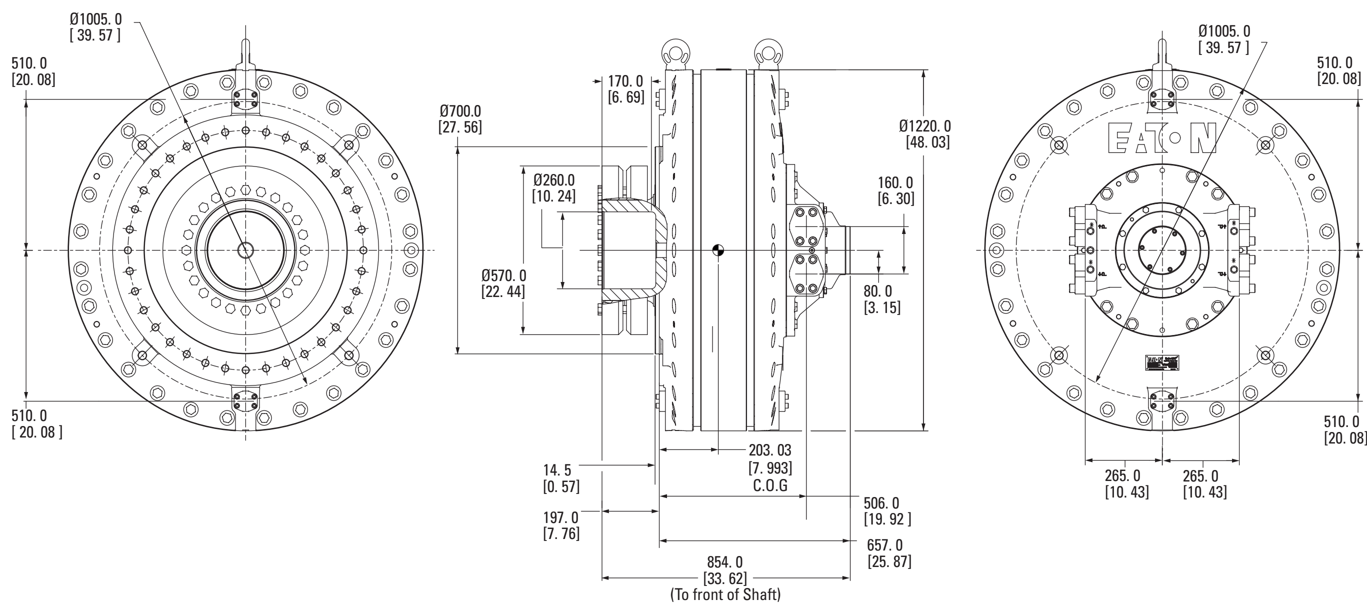


Dimensions

RCD1020 and RCD1025 with hollow shaft and shrink disc coupling

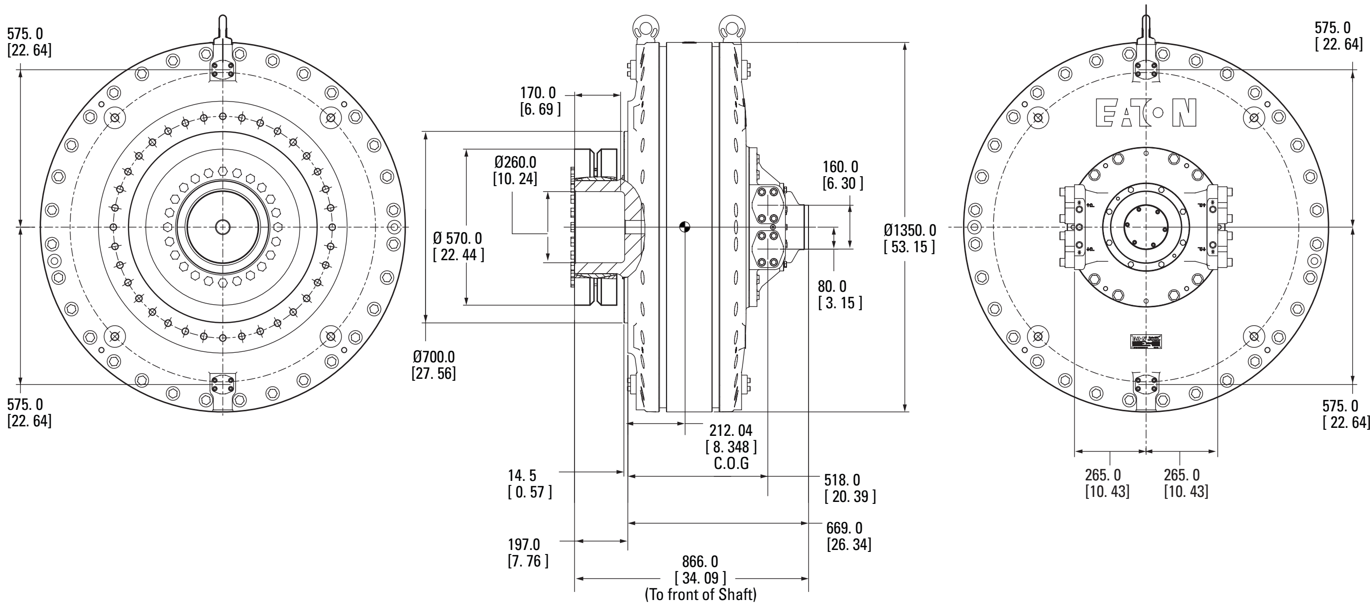


RCE1030 and RCE1036 with hollow shaft and shrink disc coupling



Dimensions

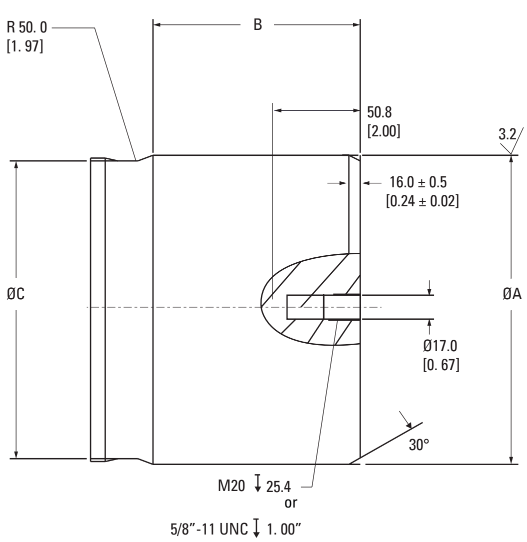
RCF1042 and RCF1050 with hollow shaft and shrink disc coupling



Motor weights	Motor weights with shrink disc
Series	kg [lbs]
RCC1013 - RCC1016	1350 [2976.24]
RCD1020 - RCD1025	2125 [4684.82]
RCE 1030 – RCE1036	2760 [6084.76]
RCF 10342 – RCF1050	3240 [7142.98]

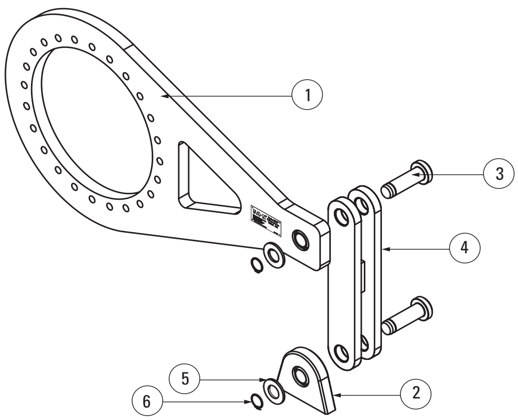
Driven shafts

Machine shafts should be constructed of alloy steel with minimum yield strength greater than 65,000 psi

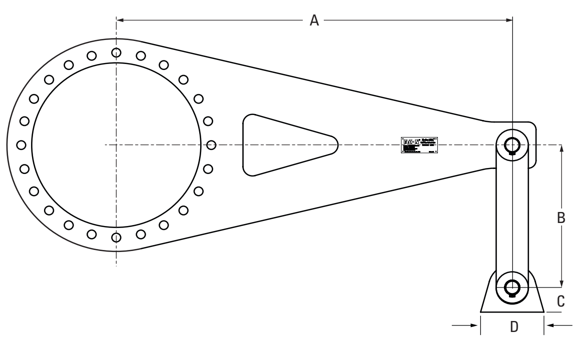


Hydre-MAC motor	Dimension mm (inch)		
Series	A	B	C
RCC1013	154.986/154.946	89.00	149.0
	[6.1018/6.1002]	[3.50]	[5.87]
RCC1016	179.986/179.946	120.0	174.0
	[7.0860/7.0845]	[4.72]	[6.85]
RCD1020 – RCD1025	199.985/199.939	150.0	194.0
	[7.8734/7.8716]	[5.91]	[7.64]
RCE1030 – RCE1036	259.983/259.931	190.0	254.0
RCF1042-RCF1050	[10.2355/10.2335]	[7.48]	[10.00]

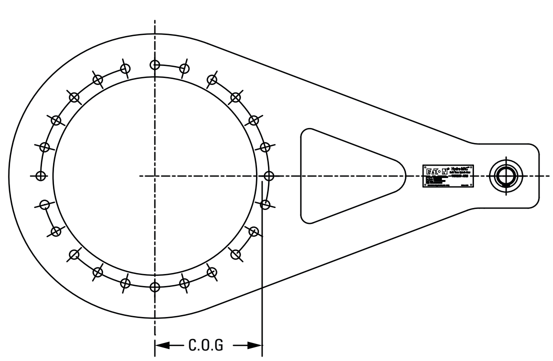
Optional accessories torque arm kit



Item	Description	Qty
1	Torque arm	1
2	Anchor	1
3	Pin	2
4	Pivot link	1
5	Washer	2
6	Retaining ring	2



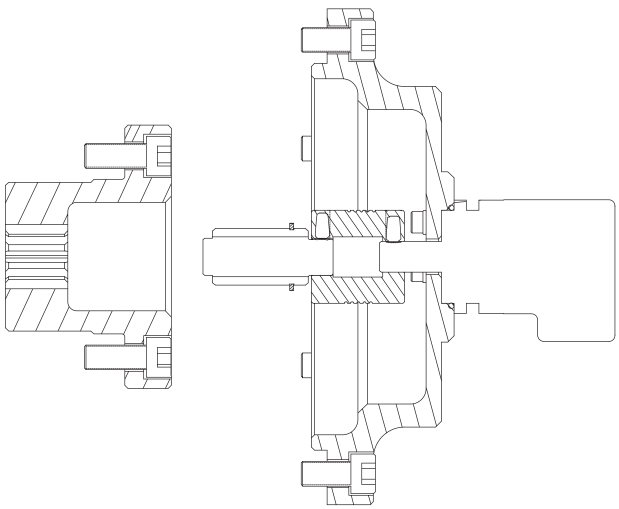
Torque arm	Motor	Torque arm kit	Dimensions mm [inches]			
Model	**Model number**	**Part number**	**A**	**B**	**C**	**D**
TACC	RCC1013	9901120-000	800 [31.50]	355 [13.98]	80 [3.15]	200 [7.87]
TACD	RCC1016, RCD1020, RCD1025	9901121-000	1250 [49.21]	465 [18.30]	80 [3.15]	200 [7.87]
TAEF	RCE1030, RCE1036 RCF1042, RCF1050	9901122-000	1500 [59.05]	465 18.30]	80 [3.15]	200 [7.87]



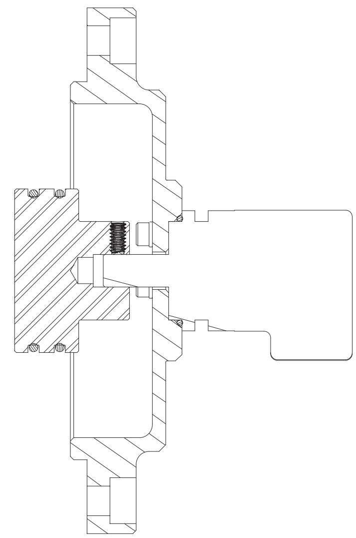
Torque arm Series	C.O.G. mm [inch]	Weight kg[lbs]
TACC	237.24 [9.340]	93.4 [205.92]
TACD	483.82 [19.048]	129.8 [286.16]
TAEF	507.38 [19.975]	186.2 [410.50]

Optional accessories Encoders

Standard encoder kit Avtron sensor (includes encoder and all mounting hardware Avtron model: A6VM A 6 C 2 A A 5 K 000 12 bit, 4096 ppr, 4-20mA

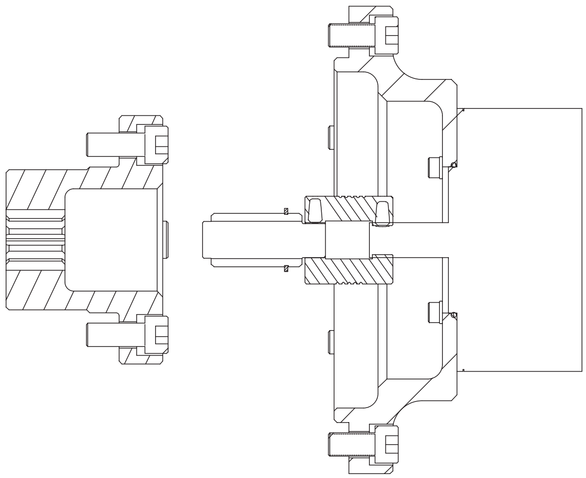


9901027-001
For 20-50L motors

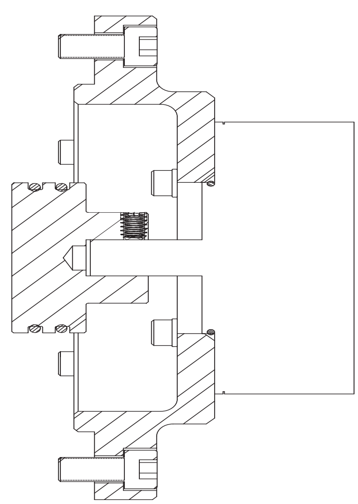


9901027-003
For 13-16L motors

Option retrofit kit L+B sensor (includes all mounting hardware, without encoder)



9901027-000
For 20-50L motors



9901027-002
For 13-16L motors

Application information

Hydraulic fluid selection

Hydre-MAC motors are generally intended for operation on conventional petroleum based oils, which should contain additives to improve the anti-wear performance, oxidation resistance, corrosion protection and foam suppression properties. The oil must have FZG (90) fail stage minimum 11 described in IP 334 (DIN 51354). The water content must be less than 0.1%.

General recommendations

Viscosity at normal operating temperatures	40 - 100 cSt
Minimum viscosity in operation	25 cSt
Maximum viscosity in operation	1000 cSt
Flash point	Not below 170°C
Pour point	-30° C
Normal operating system temperature range	15° - 60° C

Oil viscosity will vary considerably with temperature, it is important therefore to choose an operating fluid which will give the required viscosity at the expected system operating temperature.

It should be noted that high system temperatures may cause a deterioration of the hydraulic fluid resulting in reduced lubrication properties and a consequent reduction in motor and seal life.

In installations where motors are in continuous operation it may be necessary (due to the relatively low internal leakage) to provide a flow of approximately 5 liters/min of clean filtered system fluid through the motor casing for cooling purposes by utilizing two of the drain ports.

With high environmental temperatures and with the motor in continuous operation it may be necessary to incorporate a cooler in the circuit to keep the oil viscosity within the recommended limits.

Fluid cleanliness

Experience has shown that failures that occur in hydraulic equipment are frequently attributable to the presence of contamination in the system. Before connecting the hydraulic motor to the system all hoses, fittings and pipework must be thoroughly cleaned and the fluid filtered. Non-welded type piping systems are preferred. Where welded pipe is utilized, proper cleaning procedures must be followed, including record stating the ISO cleanliness level achieved before starting the system.

It is recommended that the contamination level be kept within ISO 4406 16/13 (NAS 7) and should not exceed ISO 4406 19/15 (NAS 10).

The hydraulic system must be continuously filtered to this level during operation.

Temperature

It is recommended that motors are operated within the values given below. The values reflect case temperature .

Recommended Temperature Range 25°C to 50°C.

Maximum Operating Temperature +75°C.

Minimum Operating Temperature -20°C.

Operation above the maximum or below the minimum operating temperature may cause permanent damage.

Fire resistant fluids

When Hydre-MAC motors are to operate on fire resistant (FR) or high water based fluids (HWBF) some limitations will apply. Depending on the fluid to be used there may be changes to the motor construction or limitations to the speed and pressure ratings as well as changes to seal materials. The table below gives a summary of the requirements.

Fluid	Motor construction	Maximum pressure (bar)	Maximum speed (rpm)	Life factor	Seal material
OX40	HWBF Version	250	Not to exceed motor rated speed	0.10	Standard (nitrile)
Water Glycol	HWBF Version	250	Not to exceed motor rated speed	0.20	Standard (nitrile)
5/95 Oil-in-water dilute emulsion	HWBF Version	200	Not to exceed motor rated speed	0.10	Standard (nitrile)
40/60 Water-in- oil emulsion	Standard	200	Standard motor ratings apply	0.50	Standard (nitrile)
Phosphate Esters	Standard	350	Standard motor ratings apply	0.50	Special (Viton)

Case flushing

Hydre-MAC motors have extremely high volumetric efficiency which reduces the leakage oil. Operating Hydre-MAC motors above 50% of rated speed and/or 200 bar necessitates additional flushing oil to be introduced into the lower case drain port to maintain case temperature requirements. The oil should be clean and cooler than loop oil (avoid using oil flushed out of the loop thru a hot-oil shuttle valve, unless loop temperature is within desired operating limits) and of sufficient flow rate to keep the motor case within normal operating temperature range.

Application data sheet

For additional application assistance, please fill out the requested information below and submit to **IndustrialDrivesAE@eaton.com** for a timely and thorough response.

Customer name ____

Project name ____

Application name ____

Duty cycle parameters: (for constant duty cycle, use single operation)

Parameter	Units	Operation 1	Operation 2	Operation 3	Operation 4	Operation 5
Speed	Rpm					
Continuous pressure	bar (psi)					
Time fraction	%					
Oil temperature	ºC					
Charge pressure	bar					
Viscosity	cSt					

Environment ____

Elevation ____

Coating requirements ____

Brake torque ____

Brake actuation duty cycle ____

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Printed in USA
Document No. E-MOPI-CC002-E
February 2016