Vane motors
Single & double
M3B - M4 / M4S series
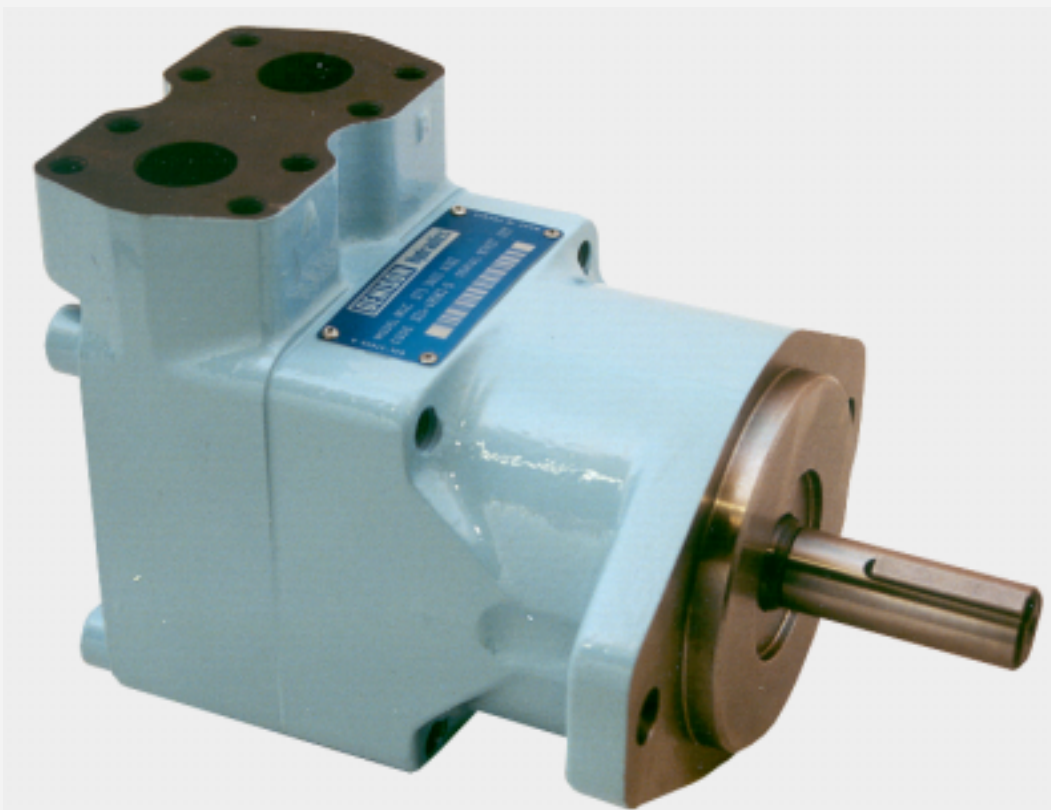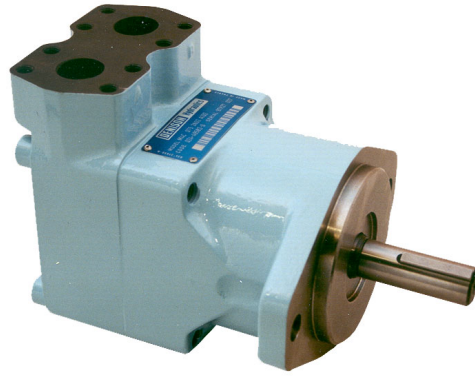
HIGH STARTING TORQUE EFFICIENCY

The high starting torque efficiency of vane type motors makes them especially applicable in load hoist winch drives, swing drives and propulsion drives. This high starting torque efficiency allows the motor to start under high load without pressure overshoots, jerks and high instantaneous horsepower loads.

HIGH VOLUMETRIC EFFICIENCY

Vane motors begin life with high volumetric efficiency and maintain that efficiency throughout their operating life.

LOW TORQUE RIPPLE AT LOW SPEED

When operating at very low speeds on applications such as swing and load hoist drives, the vane motor exhibits very low torque ripple.

2 AND 3-SPEED VERSIONS AVAILABLE

The M4DC, because of its unequal size cartridges, allows the use of-3 speed operation. This makes them more applicable in traction drive circuits to replace manually shifted gear-boxes. 2-speed motors are available in a wider range of ratios than standard gear motors.

BALANCED DESIGN

Vane, rotor and cam ring are pressure balanced to increase life and efficiency over full speed range.

INTERCHANGEABLE ROTATING GROUPS

Rotating groups may be easily replaced to renew the motor or change displacement to suit altered requirements for speed or torque.

REVERSIBLE ROTATION

The motors may be stopped or reversed repeatedly and rapidly driving or braking the connected shaft load at controlled torque levels.

WIDE SPEED RANGE

Starting to maximum RPM, with full torque capability during acceleration.

PORTS AND MOUNTING

Conform fully to SAE J744c (ISO-3019-1) standards to simplify refitting and installation.

FIRE RESISTANT FLUIDS

Are easily used in the standard M3B and M4* versions of these motors. These include phosphate or organic ester fluids and blends, water-glycol solutions and water-oil invert emulsions.

M3B AND M4* SERIES MOTORS

The M3B and M4* have been designed especially for severe duty applications which require high pressure up to 3400 PSI, high speed up to 4000 RPM and low fluid lubricity (HF-1, HF-2A, HF-3, HF-4, HF-5).

TECHNICAL DATA - M3B AND M4* SERIES

Series	Size	Displ.	Theor. Displ. V_i in³/rev.	Torque T in.lbf/PSI	Power at 100 Rev/min HP/100 PSI	Torque T in.lbf	Power P HP
						n = 2000 RPM at Δ p 2500 PSI	
M3	B B1	009	.56	0.08	0.014	174.3	5.8
		012	.75	0.11	0.018	236.3	7.8
		018	1.13	0.19	0.030	412.4	13.4
		027	1.70	0.30	0.046	680.5	21.8
		036	2.26	0.38	0.060	902.6	28.3
M4	C C1 SC SC1	024	1.49	0.24	0.037	535.4	17.0
		027	1.72	0.28	0.043	619.5	19.7
		031	2.11	0.33	0.054	768.0	24.1
		043	2.84	0.45	0.072	1062.0	33.6
		055	3.59	0.57	0.091	1318.6	41.8
		067	4.34	0.69	0.111	1504.5	47.7
		075	4.89	0.78	0.120	1752.2	55.6
	D D1 SD SD1	062	3.97	0.63	0.102	1460.0	46.4
		074	4.69	0.75	0.120	1770.0	56.2
		088	5.56	0.88	0.139	2088.5	66.2
		102	6.44	0.96	0.166	2336.3	74.1
		113	7.12	1.13	0.185	2655.0	84.2
		128	8.08	1.28	0.203	3009.0	95.5
		138	8.81	1.40	0.222	3292.0	104.5
	E E1 SE/SE1	153	9.67	1.54	0.240	3522.0	111.8
		185	11.69	1.86	0.296	4283.2	136.0
		214	13.55	2.16	0.342	5017.7	159.3
	DC DC1 SDC SDC1	See M4C/C1/SC/SC1 and M4D/D1/SD/SD1					

Internal drain : All these motors may be equiped with internal drain. Then the model numbers will be M3B1, M4C1, M4SC1, M4D1, M4SD1, M4E1, M4SE1, M4DC1, M4SDC1.

For further information or if the performance characteristics outlined above do not meet your own particular requirements, please consult your local DENISON Hydraulics office.

GENERAL CHARACTERISTICS

	Mounting standard	Weight without connector and bracket - lbs	Moment of inertia lb.in²	Option for inlet and outlet port	
M3B	SAE J744c ISO/3019-1 SAE A	17.6	1.03	SAE threaded SAE 4 bolt J718c ISO/DIS 6162-1 - 3/4" BSPP threaded	
M4C/SC	SAE J744c ISO/3019-1 SAE B	34.0	2.7	SAE threaded SAE 4 bolt J718c ISO/DIS 6162-1 - 1"	
M4D/SD	SAE J744c ISO/3019-1 SAE C	59.5	1.4	SAE threaded SAE 4 bolt J718c ISO/DIS 6162-1 - 1"1/4	
M4E/SE	SAE J744c ISO/3019-1 SAE C	99.0	20.0	SAE threaded SAE 4 bolt J718c ISO/DIS 6162-1 - 2"	
M4DC/SDC	SAE J744c ISO/3019-1 SAE C	88.0	10.0	SAE 4 bolt J718c ISO/DIS 6162-1 - 1"1/4	**P2 = See M4C/M4SC**

MAXIMUM SPEED, PRESSURE RATINGS - M3B AND M4* SERIES

Series	Size	Displ.	Max. pressure HF-0 HF-2 (PSI)	HF-2A (PSI)	HF-1 (PSI)	HF-3 HF-5 (PSI)	HF-4 (PSI)	Operating pressure range drain (PSI)	Max. speed for low loaded condition [1] (RPM)	HF-0, HF-2 Cont. (RPM)	HF-0, HF-2 Int.[2] (RPM)	HF-2A Cont. (RPM)	HF-2A Int.[2] (RPM)	HF-1 Cont. (RPM)	HF-1 Int.[2] (RPM)
M3	B B1	009	2500					22	4000	3000	3600				
		012	3000												
		018	3000												
		027	3000												
		036	3000												
M4	C C1	024	2500	2500	2500			50	4000	2500	3600	2500	3000	2000	2500
		027	2500	2500	2500										
		031	2500	2500	2500										
		043	2500	2500	2500										
		055	2500	2500	2500										
		067	2500	2500	2500										
		075	2500	2500	2500										
	SC SC1	024	3400	3000	2500	2500	2000								
		027	3400	3000	2500	2500	2000								
		031	3400	3000	2500	2500	2000								
		043	3400	3000	2500	2500	2000								
		055	3000	3000	2500	2500	2000								
		067	3000	3000	2500	2500	2000								
		075	2500	2500	2500	2500	2000								
	D D1	062	2500	2500	2000				4000	2500	3000	2500	2800	2000	2500
		074	2500	2500	2000										
		088	2500	2500	2000										
		102	2500	2500	2000										
		113	2500	2500	2000										
		128	2500	2500	2000										
		138	2500	2500	2000										
	SD SD1	062	3400	2700	2000	2000	2000								
		074	3400	2700	2000	2000	2000								
		088	3400	2700	2000	2000	2000								
		102	3000	2700	2000	2000	2000								
		113	3000	2700	2000	2000	2000								
		128	2700	2700	2000	2000	2000								
		138	2500	2500	2000	2000	2000								
	E E1	153	2500	2500	2000				3600	2500	3000	2500	2800	1800	2200
		185	2500	2500	2000										
		214	2500	2500	2000										
	SE SE1	153	2700	2500	2000	2000	2000								
		185	2600	2500	2000	2000	2000								
		214	2500	2500	2000	2000	2000								
	DC DC1	All models	2500	2500	2000				4000	2500	3000	2500	2800	2000	2500
	SDC SDC1	D-062 at 088	3400	2700	2000	2000	2000								
		C-024 at 043	3400	2700	2000	2000	2000								
		D-102	3000	2700	2000	2000	2000								
		D-113	3000	2700	2000	2000	2000								
		C-055	3000	2700	2000	2000	2000								
		C-067	3000	2700	2000	2000	2000								
		D-128	2500	2500	2000	2000	2000								
		D-138	2500	2500	2000	2000	2000								
		C-075	2500	2500	2000	2000	2000								

1) Low loaded condition 500 PSI for M3 and M4, 1160 PSI max. for M4S (see page 6).
2) Intermittent speed - Do not exceed 6 seconds per minute of operation.
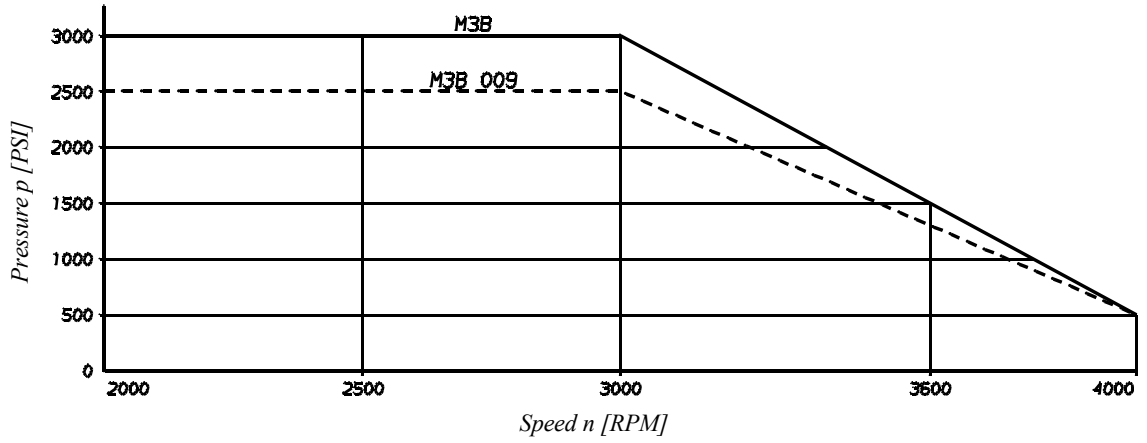HF-0, HF-2 = Antiwear petroleum base. HF-2A = Crankcase. HF-1 = Non antiwear petroleum base. HF-5 = Synthetic fluids.
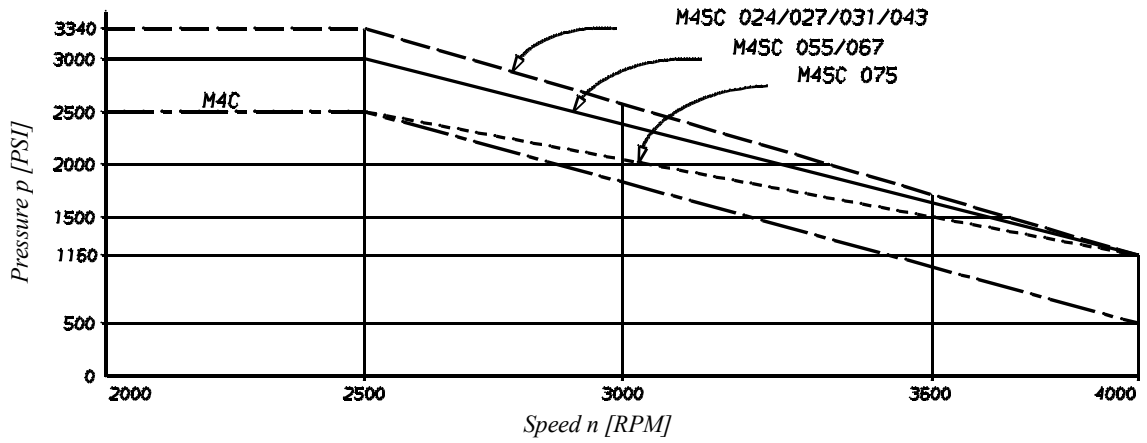HF-3 = Water in oil emulsions. HF-4 = Water glycols.
Internal drain : All these motors may be equiped with internal drain. Then the model numbers will be M3B1, M4C1, M4SC1, M4D1, M4SD1, M4E1, M4SE1, M4DC1, M4SDC1.

M3B

M4C/M4SC

M4D/M4SD
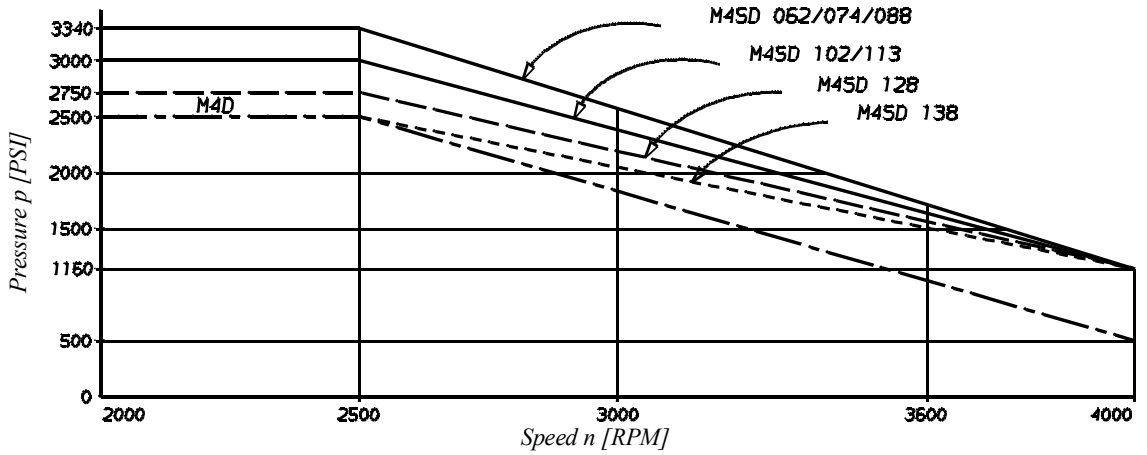
M4E/M4SE
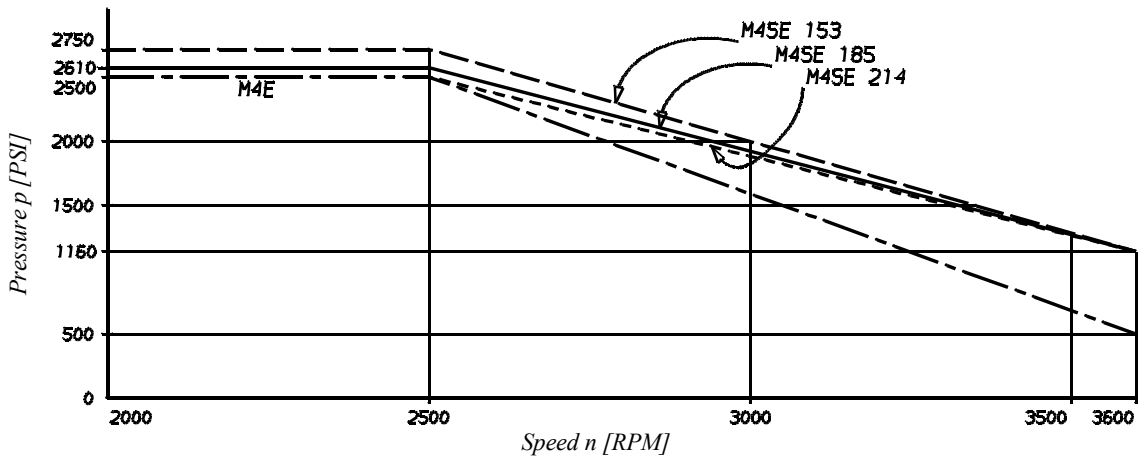
Performances required

Torque T *[in.lbf]*   *1240*

Pump flow (available)

at 115 SUS q_{Ve} *[GPM]*   *30.4*

Speed n *[RPM]*   *1500*

Pressure p *[PSI]*   *2500*

1. Check if available power is compatible with required power (0.85 estimated overall efficiency).

$$0.85 \ x \ \frac{Q_{Ve} \, x \, p}{1714} \geq \frac{T \, x \, RPM}{63025}$$

$$0.85 \ x \ \frac{30.4 \, x \, 2500}{1714} \geq \frac{1240 \, x \, 1500}{63025}$$

$$37.7 > 29.5$$

Two ways of calculation :

2a. Calculate V_i from T required torque

$$V_i = \frac{2 \, \pi \, x \, T}{p} = \frac{2 \, \pi \, x \, 1240}{2500} = 3.12 \ in^3/rev.$$

3a. Motor choose from V_i immediately greater
M4C 055 V_i = 3.59 in³/rev.

4a. Check real motor pressure for
T = 1240 in.lbf around 1500 RPM
M4C 055 T = 1240 in.lbf n = 1500 RPM
p = 2370 PSI (see page 15)

5a. Flow loss M4C 055 at 2370 PSI at 115 SUS
q_{Vs} = 4.2 GPM (see page 22)
Real flow used by the motor :
q_V = q_{Ve} - q_{Vs} = 30.4 - 4.2 = 26.2 GPM

6a. Real speed of the motor :

$$n = \frac{q_V \, x \, 231}{V_i} = \frac{26.2 \, x \, 231}{3.59} = 1686 \ RPM$$

2b. Calculate V_i from q_{Ve} available flow

$$V_i = \frac{30.4 \, x \, 231}{1500} = 4.68 \ in^3/rev.$$

3b. Motor choose from V_i immediately smaller
M4C 067 V_i = 4.34 in³/rev. (see page 22)

4b. Check motor press. with T = 1240 in.lbf at 1500 RPM
M4C 067 T = 1240 in.lbf n = 1500 RPM
p = 2030 PSI (see page 15)

5b. Flow loss of M4C 067 at 2030 PSI at 115 SUS
q_{Vs} = 3.7 GPM (see page 22)
Real flow used by the motor :
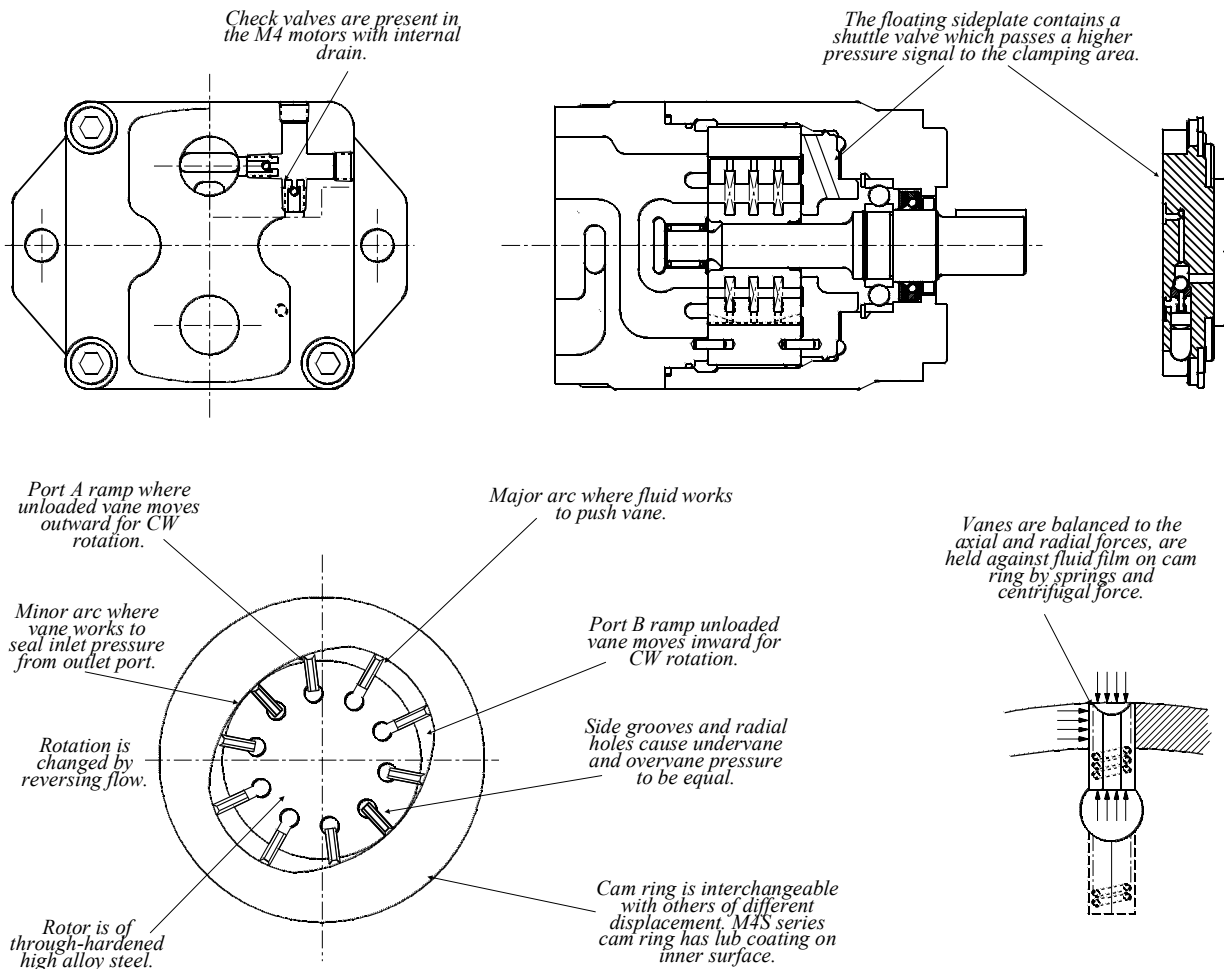*q_V = q_{Ve} - q_{Vs} = 30.4 - 3.7 = 26.7 GPM*

6b. Real speed of the motor :

$$n = \frac{q_V \, x \, 231}{V_i} = \frac{26.7 \, x \, 231}{4.34} = 1420 \ RPM$$

Real performances

V_i	=	3.59 in³/rev.
n	=	1680 RPM
T	=	1240 in.lbf
p	=	2370 PSI

} *M4C 055*

Real performances

V_i	=	4.34 in³/rev.
n	=	1420 RPM
T	=	1240 in.lbf
p	=	2030 PSI

} *M4C 067*

In each case always choose the smallest motor which will operate at the highest speed and pressure, and offers the most efficient solution.

Check valves are present in the M4 motors with internal drain.

The floating sideplate contains a shuttle valve which passes a higher pressure signal to the clamping area.

Port A ramp where unloaded vane moves outward for CW rotation.

Major arc where fluid works to push vane.

Vanes are balanced to the axial and radial forces, are held against fluid film on cam ring by springs and centrifugal force.

Minor arc where vane works to seal inlet pressure from outlet port.

Port B ramp unloaded vane moves inward for CW rotation.

Rotation is changed by reversing flow.

Side grooves and radial holes cause undervane and overvane pressure to be equal.

Rotor is of through-hardened high alloy steel.

Cam ring is interchangeable with others of different displacement. M4S series cam ring has lub coating on inner surface.

**OPERATION -
SINGLE CARTRIDGE**

- The motor shaft is driven by the rotor. Vanes, closely fitted into the rotor slots move radially to seal against the cam ring. The ring has two major and two minor radial sections joined by transitional sections called ramps. These contours and the pressures exposed to them are balanced diametrically.

- Light springs urge the vanes radially against the cam contour assuring a seal at zero speed so the motor can develop starting torque. The springs are assisted by centrifugal force at higher speeds. Radial grooves and holes through the vanes equalize radial hydraulic forces on the vanes at all times. Fluid enters and leaves the motor cartridge through opening in the side plates at the ramps. Each motor port connects to two diametrically opposed ramps. Pressurized fluid entering at Port A torques the rotor clockwise. The rotor transports it to the ramp openings which connect to Port B from which it returns to the low pressure side of the system. Pressure at Port B torques the rotor counter-clockwise.

- The rotor is separated axially from the sideplate surfaces by the fluid film. The front sideplate is clamped against the cam ring by the pressure, maintains optimum clearance as dimensions change with temperature and pressure. A 3-way shuttle valve in the sideplate causes clamping pressure in Port A or B, whichever is the highest.

- Materials are chosen for long life efficiency. Vanes, rotor and cam ring are made out of hardened high alloy steels. Cast semi-steel sideplates are chemically etched to have a fine crystalline surface for good lubrication at start-up.

PORTS
EXTERNALLY DRAINED
SINGLE CARTRIDGE MOTORS

These motors may be alternately pressurized at Ports A & B to 3400 PSI max. Whichever port is at low pressure should not be subjected to more than 500 PSI. If it is necessary to exceed these limitations, please contact DENISON Hydraulics for application assistance.

INTERNALLY DRAINED
TANDEM CARTRIDGE MOTORS

These motors must have a drain line connected to the center housing drain connection of sufficient size to prevent back pressure in excess of 50 PSI, and returned to the reservoir below the surface of the oil as far away from the supply pump suction as possible. Model M4DC1 does not require an external drain line, howeever the outlet pressure must not exceed 50 PSI.

INTERNALLY DRAINED MOTORS
(M4C1, M4D1, M4E1, M4DC1)

May be alternately pressurized at Ports A & B to 3400 PSI max. Whichever port is at low pressure must not be subjected to more than 22 PSI for M3B, 50 PSI for M4* (pressure peak 100 PSI).
To insure maximum motor performance in conjunction with your specific application, consult your DENISON Hydraulics Representative if your application requires :
• minimum speed of less than 100 RPM,
• indirect drive,
• overrunning loads,
• braking or retarding.

M4S SEVERE DUTY MOTORS

M4S motors are recommended to be used when back pressure is over 2000 PSI and speed is over 2000 RPM. They are also recommended when fluid viscosity can be under 115 SUS and speed over 2000 RPM. For such severe duty applications M4S motors will exhibity longer life time at high efficiency.

RECOMMENDED FLUIDS

Petroleum based antiwear R & O fluids.
These fluids are the recommended fluids for M3B and M4* series motors. Maximum catalog ratings and performance data are based on operation with these fluids. These fluids are covered by DENISON Hydraulics HF-0 and HF-2 specifications.
Acceptable alternate fluids :

ACCEPTABLE ALTERNATE
FLUIDS

The use of fluids other than petroleum based antiwear R & O fluids requires that the maximum ratings of the motors will be reduced. In some cases, the minimum replenishment pressures must be increased. Refer to the following chart and the operating characteristics chart for each M3B and M4* motor model for specific details of the reduced ratings.

VISCOSITY

Max. (cold start, low speed & pressure)_____ 3900 SUS
Max. (full speed & pressure) _____ 500 SUS
Optimum (max. life)_____ 140 SUS
Min. (full speed & pressure for HF-1 fluid)_____ 89 SUS
Min. (full speed & pressure for HF-0 & HF-2 fluids) _____ 59 SUS

VISCOSITY INDEX

90° min. Higher values extend range of operating temperatures and life time.
Maximum fluid temperature (θ) °F
HF-0, HF-1, HF-2_____ + 176°
Minimum fluid temperature (θ) °F
HF-0, HF-1, HF-2_____ - 0.4°

FLUID CLEANLINESS

The fluid must be cleaned before and during operation to maintain contamination level of NAS 1638 class 8 (or ISO 18/14) or better. Filters with 25 micron (or better, ß10 ≥ 100) nominal ratings may be adequate but do not guarantee the required cleanliness levels.

OPERATING TEMPERATURES
AND VISCOSITIES

Operating temperatures are a function of fluid viscosities, fluid type, and the pump. Fluid viscosity should be selected to provide optimum viscosity at normal operating temperatures. For cold starts the pumps should be operated at low speed and pressure until fluid warms up to an acceptable viscosity for full power operation.
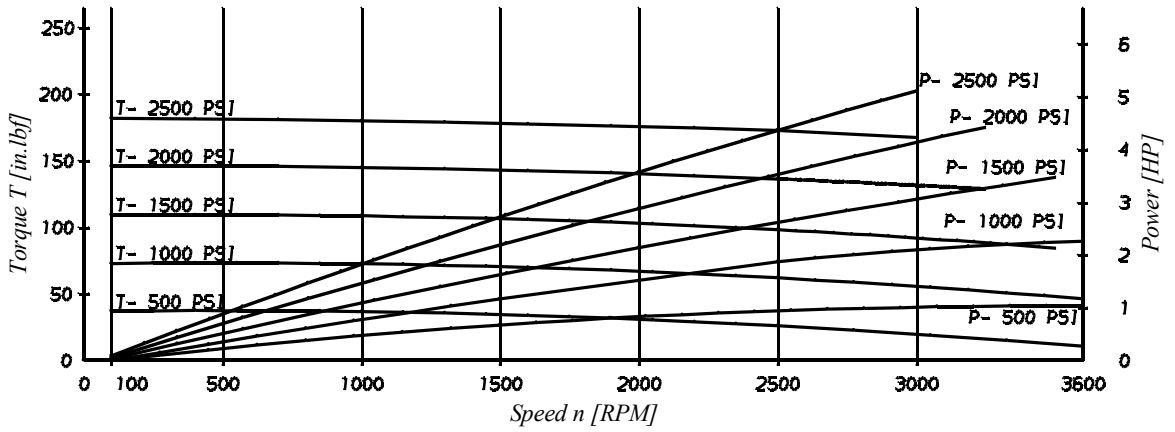
WATER CONTAMINATION IN
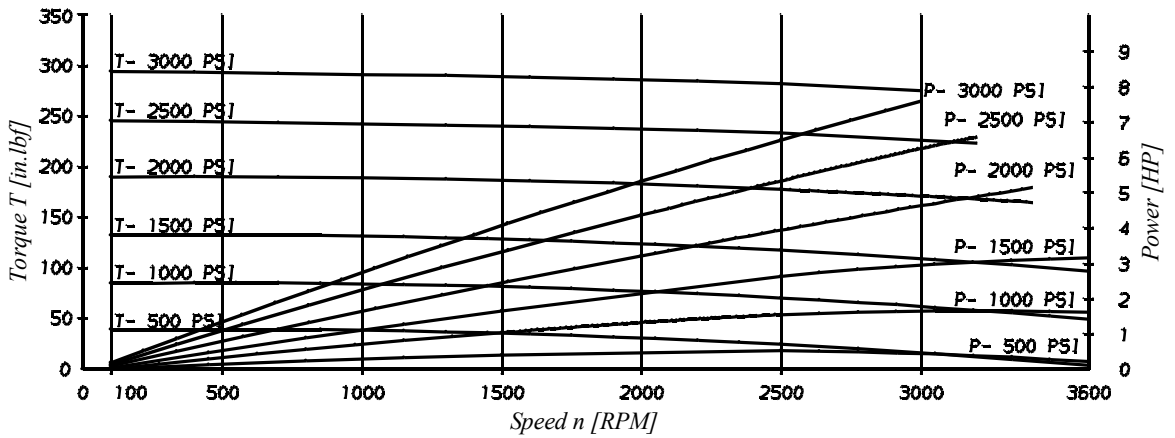**THE FLUID**

Maximum acceptable content of water.
• 0,10 % for mineral base fluids.
• 0,05 % for synthetic fluids, crankcase oils, biodegradable fluids.
If amount of water is higher then it should be drained off the circuit.

M3B 009

M3B 012

M3B 018
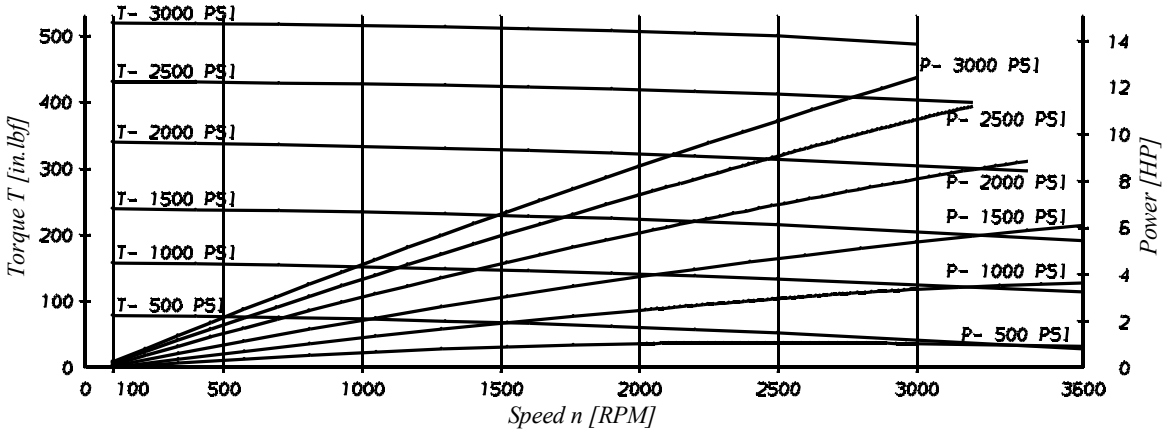
M3B 027
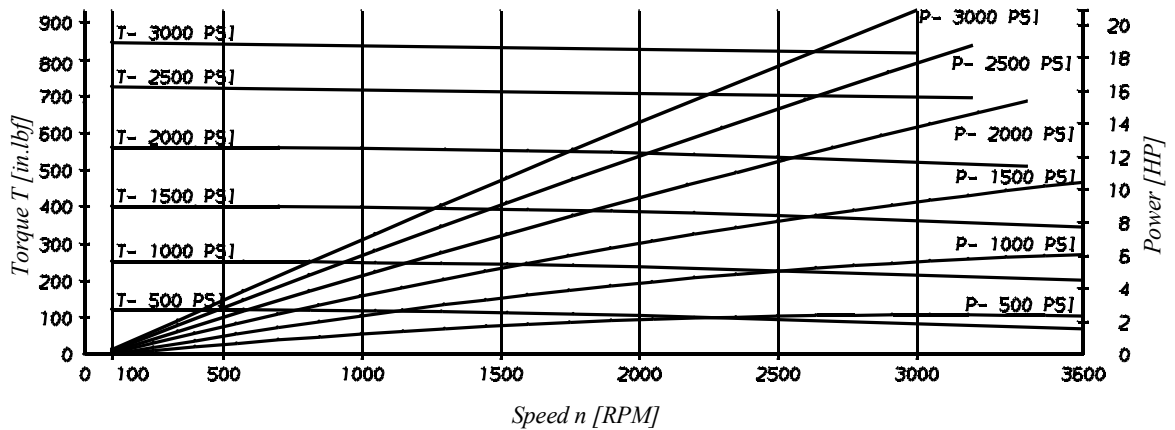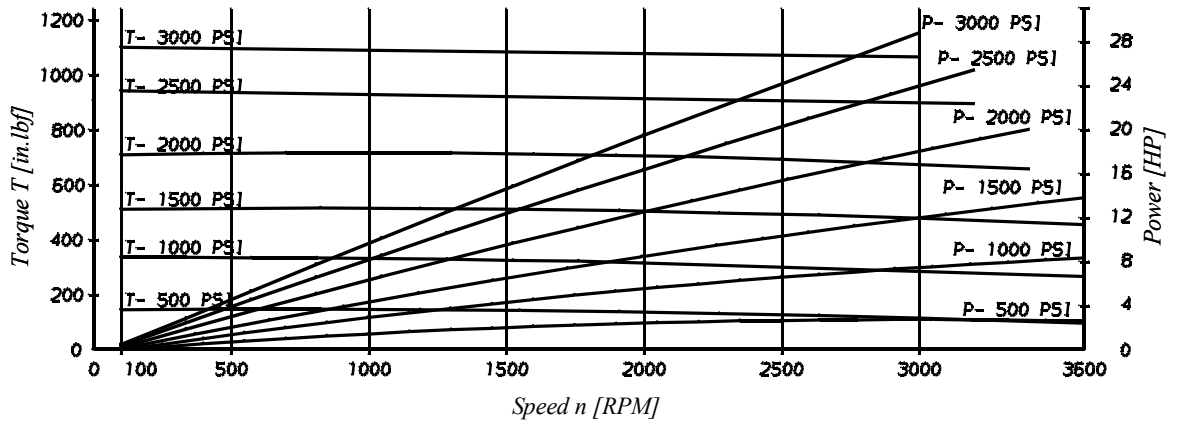
M3B 036

Model No.   **M3B1**
            M3B - 036 - 1 N 00 - B 1 01 ..

Series external drain —————

Series internal drain —————

Torque —
009 = .08 in.lb/PSI
012 = .11 in.lb/PSI
018 = .19 in.lb/PSI
027 = .30 in.lb/PSI
036 = .38 in.lb/PSI

Type of shaft —
1 = keyed (non SAE)
3 = splined (SAE A)
4 = splined (SAE B)

Rotation —
N = bi-directional

Modification

Port connections
00 = SAE threaded port
      SAE drain
01 = SAE 4 bolt flange
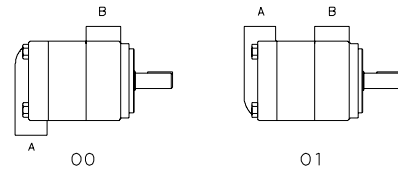   BSPP drain
02 = BSPP threaded port
      BSPP drain

Seal class
1 = S1 - BUNA N
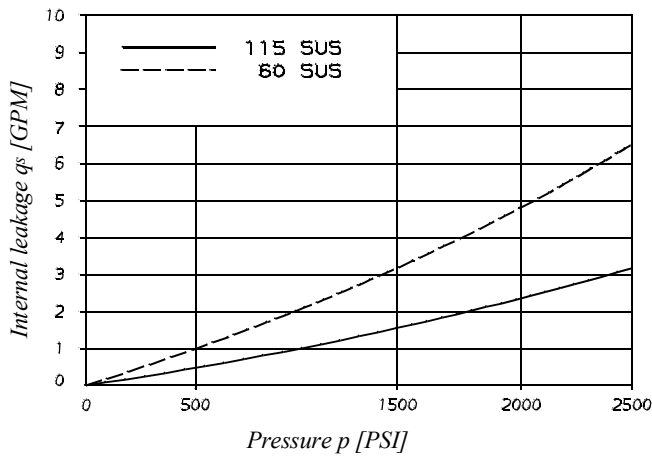4 = S4 - EPDM
5 = S5 - VITON

Design letter

Porting combination
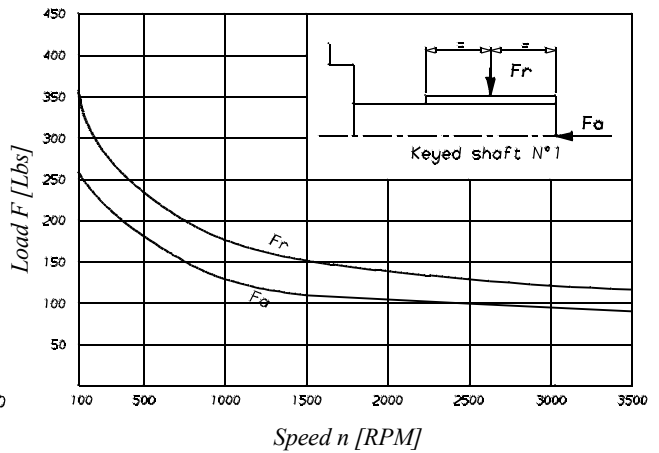00 = standard

View from shaft end :

CW rotation   A = inlet   CCW rotation   A = outlet
                   B = outlet   B = inlet

INTERNAL LEAKAGE

- 115 SUS
- 60 SUS

Internal leakage q_s [GPM] vs Pressure p [PSI]

PERMISSIBLE RADIAL AND AXIAL LOADS

Load F [Lbs] vs Speed n [RPM]

Keyed shaft N°1

Do not apply Fr and Fa loads simultaneously

OPERATING CHARACTERISTICS - TYPICAL [115 SUS]

Model	Volumetric displacement V_i	Input flow at n = 2000 RPM		Torque T at n = 2000 RPM	Power output at n = 2000 RPM
		Theorical	at 2500 PSI Δ p	at 2500 PSI Δ p	at 2500 PSI Δ p
	in³/rev.	GPM	GPM	in.lbf	HP
M3B 009	.56	4.9	8.0	174.3	5.8
M3B 012	.75	6.5	9.7	236.3	7.8
M3B 018	1.13	9.8	12.9	412.4	13.4
M3B 027	1.70	14.7	17.8	680.5	21.8
M3B 036	2.26	19.6	22.8	902.6	28.3

PORT CONNECTION 02

3/4" BSPP-.75 DEEP

PORT CONNECTION 00

SAE 12 (1 1/16"-12 UNF)

Shaft code 4
SAE B Splined shaft
Class 1- J498b
16/32 d.p.-13 teeth
30° pressure angle
Flat root side fit

.06 x 45°
1.75
1.00
.30

4.00
5.12
4.119
.44

Shaft code 3
SAE A Splined shaft
Class 1- J498b
16/32 d.p.-9 teeth
30° pressure angle
Flat root side Fit

.06 x 45°
.59
.44
1.24
.30

PORT CONNECTION 01

INLET & OUTLET .75 DIA
3/8" 16 UNC-2B .75 DEEP-8 HOLES
.87
1.87
4.11

Shaft code 1
(Keyed, non SAE)

KEY .187/.185
2.19
1.248
.30
1.31
.250 MAX
5.74
3.62

3.250 DIA
3.248
1.85 DIA
.831 MAX
.750 DIA
.748
.06 x 45°
.03 x 45°
1.56

B
A

DRAIN PORT 3/8" DIA BSPP
(SAE 6 9/16"-18 UNF - 00 PORT CONNECTION)
2.75
2.00

Parker Hannifin
Denison Vane Pump Division
Vierzon - France