GEAR PUMPS

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GEAR PUMPS

Group 0 and Group 1 | Technical Information

History of revisions

Date	Page	Changed	Rev.
24, June 2010	-	First edition	A
24, Feb 2011	1,2,10,68	Covers to blue color, Turolla brand name, Biofluids deleted.	B
30, Sept 2013	ALL	Layout and options lists, Group 0 catalog	C

Literature reference for gear products

Title	Type	Order number
General Aluminum Gear Pumps and Motors	Technical Information	L1016238
Group 2 Gear Pumps	Technical Information	L1016341
Group 3 Gear Pumps	Technical Information	L1016456
Group 1, 2 and 3 Gear Motors	Technical Information	L1016082
Hydraulic Fluids and Lubricants	Technical Information	L1021414

Index

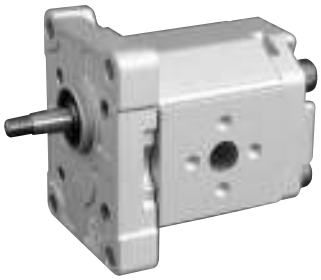
General information

Overview

The Turolla Group 0 and Group 1 is a range of peak performance fixed-displacement gear pumps. Constructed of a high-strength extruded aluminum body with aluminum cover and flange, all pumps are pressure-balanced for exceptional efficiency. The flexibility of the range, combined with high efficiency and low noise, makes the pumps in this series ideal for a wide range of applications, including: turf care, aerial lifts, material handling, and power packs.

TFP0NN 01FA

SNP1NN 01BA



SKP1NN 06SA

SNP1NN 03CA

Features and benefits

Gear pump attributes:

- Up to 16 displacements from 0,25 to 12 cm3/rev [from 0.015 to 0.732 in3/rev
- Continuous pressure rating up to 250 bar [3625 psi]
- Speeds up to 4000 min^{-1} (rpm)
- SAE, ISO, and DIN mounting flanges and shafts
- Compact, lightweight, quiet operation
- Group 1 units are available as unidirectional and bi-directional motors, also with integral relief valve
- You can combine groups 1, 2 and 3 to make multi-stage pumps

Group 0

OwerTFP0NN pumps provide flexibility, numerous displacements, features, and shaft/port options. The TFP0NN series has earned an excellent reputation for rugged, dependable performance at continuous pressures and speeds.
TFP0NN pumps are available in five displacements from 0.25 to 1.27 cm^3/rev [0.015 to 0.075 in^3/rev]. Complete information can be found by referring to the specific sections in this technical manual.

TFP0NN 01FA

Design

Constructed of high strength aluminum, the TFP0NN rotation is either clockwise or counterclockwise.

Features

Special features of Group 0 pumps include:

- Wide range of displacements
- Parallel shaft ends
- Standard mounting flange (European, 2-bolt)
- European port options

Technical data – Group 0 gear pumps

		Frame size				
		,25	,45	,57	,76	1,3
Displacement	cm^3/rev [in^3/rev]	0.25 [0.015]	0.45 [0.027]	0.57 [0.034]	0.76 [0.045]	1.27 [0.075]
Peak pressure	bar [psi]	200 [2900]	200 [2900]	200 [2900]	200 [2900]	200 [2900]
Rated pressure		180 [2600]	180 [2600]	180 [2600]	180 [2600]	180 [2600]
Minimum pressure at maximum speed		103 [1500]	103 [1500]	103 [1500]	103 [1500]	103 [1500]
Minimum speed at 103 bar [1500 psi]	min^{-1} (rpm)	500	500	500	500	500
Maximum speed		8000	8000	8000	7000	5000
Weight	kg [lb]	0.40 [0.88]	0.45 [1.00]	0.46 [1.01]	0.47 [1.03]	0.48 [1.06]
Moment of inertia of rotating components	x 10^{-6} kg•m^2 [x 10^{-6} lb•ft^2]	0.425 [10.09]	0.544 [12.91]	0.621 [14.74]	0.737 [17.49]	1.049 [24.89]
Theoretical flow at maximum speed	l/min [US gal/min]	2.00 [0.53]	3.60 [0.95]	4.56 [1.20]	5.32 [1.41]	6.35 [1.68]

1 kg•m^2 = 23.68 lb•ft^2

For applications requiring parameters beyond those listed above, contact Turolla.

Product code
Model code

A						/	B			C	D	E		F		G		H		I		J		K	L	/	M			N	0

A Family

TFP0NN	Std gear pump
TFR0NN	Reversible pump

B Displacement

0,25	Displacement 0,25cc
0,45	Displacement 0,45cc
0,57	Displacement 0,57cc
0,76	Displacement 0,76cc
1,3	Displacement 1,3cc

C Rotation

R	Right (Clockwise)
L	Left (Counterclockwise)
B	Reversible pump

D Project version

N	Standard gear version

E Mounting flange

Code	Description (Type of flange • Type of drive gear • Preferred ports for configuration)
01	Tang drive 5xD7,92/European 2-bolt flange

F Drive gear

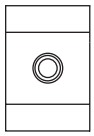
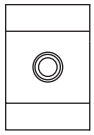
CA	Tang drive 5xØ7,92-European 2-bolt flange
FA	Parallel shaft 7,0 mm [0.276 in]/European 2-bolt flange

G Rear cover

P1	Standard cover for pump
P3	Standard cover for reversible pump

A B C D E F G H I J K L M N 0

H Inlet size I Outlet size

D1	M10x1 - Threaded metric port	
D3	M14x1,5 - Threaded metric port	
F2	1/4 GAS - Threaded BSP port	

J Ports positions & Special body

NN	Standard from catalogue

K Seals

N	Standard Buna Seal

L Screws

N	Std screws

M Set valve

NNN	No valve

N Type mark

N	Standard Turolla Marking
A	Standard Turolla Marking+Customer Code

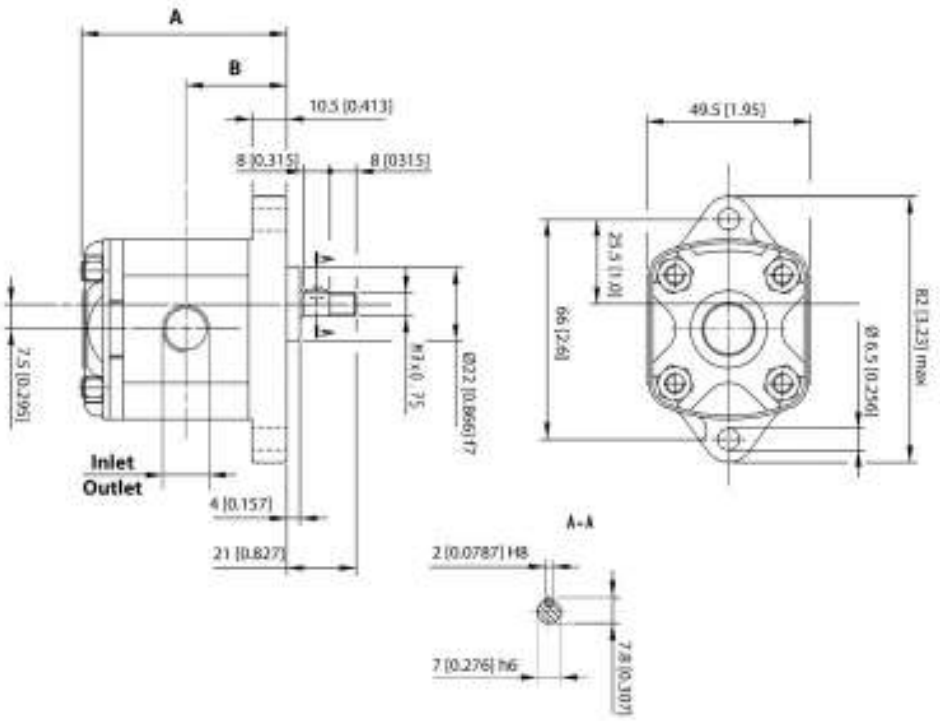
O Mark position

N	Std Marking position (on top)
A	Special Marking position on the bottom

Dimensions

TFP0NN – 01FA

Available 01FA configuration only.



TFP0NN dimensions

Frame size		,25	,45	,57	,76	1,3
Dimension	A	53.5 [2.10]	55.0 [2.16]	56.0 [2.20]	61.5 [2.42]	61.5 [2.42]
	B	26.5 [1.04]	27.3 [1.07]	27.8 [1.09]	30.5 [1.20]	30.5 [1.20]
Inlet/Outlet		M10 x 1				

Model code examples and maximum shaft torque

Flange/drive gear	Model code example	Maximum shaft torque
01FA	TFP0NN/,57RN01FAP1D1D1NNNN/NNNNN	4.5 N•m [39.8 lb•in]

For further details on ordering, see Model Code, pages 6-7.

Notes

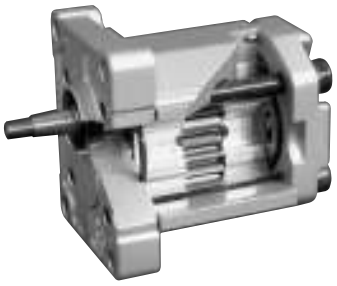
GROUP 1

Pump design

SEP1NN

SEP1NN is available in a limited displacement range. In addition to European flange and shaft configurations (code 01DA, 01BA, and 03CA), the range includes special shafts and flanges for power pack applications. SEP1NN has a lower pressure rating than SNP1NN and SKP1NN.

SNP1NN 01BA (cut away)



SNP1NN

SNP1NN is available in a limited displa-cement range but with higher-pressure ratings than the SEP1NN. This is because of DU bushings used in its design. SNP1NN pumps only include European flange and shaft configurations (code 01BA, 01DA, and 03CA).

SKP1NN

SKP1NN has a larger diameter shaft than either the SEP1NN or SNP2. It spans the complete displacement range at higher pressures than the SEP1NN and SNP1NN. Configurations include European and SAE flanges and shafts (code 02BB, 02FA, 06SA, and 06GA).

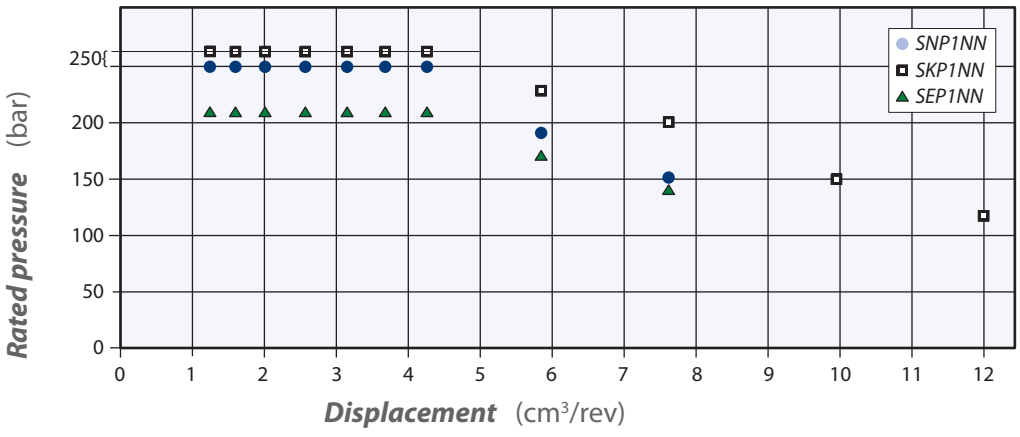
SNP1IN 03CA (cut away)

SNP1IN

Turolla offers an optional integral relief valve integrated in the rear cover. It is drained internally and directs all flow from the pump outlet to the inlet when the outlet pressure reaches the valve setting. SNI1 pumps only include European flange and shaft configurations (code 01BA, 01DA, and 03CA).

Pump displacements

Quick reference chart for *pump* displacements vs. rated pressure



General Information

Technical data

Specifications for the SNP1NN, SEP1NN and SKP1NN Group 1 gear pumps.

		Frame size										
		1,2	**1,7**	**2,2**	**2,6**	**3,2**	**3,8**	**4,3**	**6,0**	**7,8**	**010**	**012**
Displacement	cm^3/rev [in^3/rev]	1.18 [0.072]	1.57 [0.096]	2.09 [0.128]	2.62 [0.160]	3.14 [0.192]	3.66 [0.223]	4.19 [0.256]	5.89 [0.359]	7.59 [0.463]	9.94 [0.607]	12.00 [0.732]
SNP1NN												
Peak pressure	bar [psi]	270 [3915]	270 [3915]	270 [3915]	270 [3915]	270 [3915]	270 [3915]	270 [3915]	210 [3045]	170 [2465]		
Rated pressure		250 [3625]	250 [3625]	250 [3625]	250 [3625]	250 [3625]	250 [3625]	250 [3625]	190 [2760]	150 [2175]		
Minimum speed at 0-150 bar	min^{-1} (rpm)	800	800	600	600	600	600	500	500	500		
Min. speed at 150 bar to rated pressure		1200	1200	1000	1000	1000	1000	800	800	800		
Maximum speed		4000	4000	4000	4000	4000	4000	3000	3000	3000	–	–
SEP1NN												
Peak pressure	bar [psi]	230 [3335]	230 [3335]	230 [3335]	230 [3335]	230 [3335]	230 [3335]	230 [3335]	190 [2760]	160 [2320]		
Rated pressure		210 [3045]	210 [3045]	210 [3045]	210 [3045]	210 [3045]	210 [3045]	210 [3045]	170 [2465]	140 [2030]		
Minimum speed at 0-150 bar	min^{-1} (rpm)	800	800	600	600	600	600	500	500	500		
Min. speed at 150 bar to rated pressure		1200	1200	1000	1000	1000	1000	800	800	800		
Maximum speed		4000	4000	4000	4000	4000	4000	3000	3000	3000		
SKP1NN*												
Peak pressure	bar [psi]	270 [3915]	270 [3915]	270 [3915]	270 [3915]	270 [3915]	270 [3915]	270 [3915]	250 [3625]	220 [3190]	170 [2465]	140 [2030]
Rated pressure		250 [3625]	250 [3625]	250 [3625]	250 [3625]	250 [3625]	250 [3625]	250 [3625]	230 [3335]	200 [2900]	150 [2175]	120 [1740]
Minimum speed at 0-150 bar	min^{-1} (rpm)	800	800	800	800	800	800	600	600	600	600	600
Min. speed at 150 bar to rated pressure		1200	1200	1000	1000	1000	1000	1000	800	800	800	–
Maximum speed		4000	4000	4000	4000	4000	4000	3000	3000	3000	2000	2000
All (SNP1NN, SEP1NN, SKP1NN)												
Weight	kg [lb]	1.02 [2.26]	1.05 [2.31]	1.09 [2.40]	1.11 [2.45]	1.14 [2.51]	1.18 [2.60]	1.20 [2.65]	1.30 [2.87]	1.39 [3.06]	1.55 [3.42]	1.65 [3.64]
Moment of inertia of rotating components	x 10^{-6} $kg•m^2$ [x 10^{-6} $lb•ft^2$]	3.2 [77]	3.7 [89]	4.4 [105]	5.1 [120]	5.7 [136]	6.4 [152]	7.1 [168]	9.3 [220]	11.4 [271]	14.6 [347]	17.1 [407]
Theoretical flow at maximum speed	l/min [US gal/min]	4.72 [1.25]	6.28 [1.66]	8.36 [2.21]	10.48 [2.77]	12.56 [3.32]	14.64 [3.87]	12.57 [3.32]	17.67 [4.67]	22.77 [6.02]	19.88 [5.25]	24 [6.34]

1 $kg•m^2$ = 23.68 $lb•ft^2$

* SKP1NN is a special version of the SNP1NN. It is designed to accommodate an SAE 9T 20/40 DP tooth splined shaft for higher torque applications.

Caution

The rated and peak pressure mentioned are for pumps with flanged ports only. When threaded ports are required a de-rated performance has to be considered. To verify the compliance of an high pressure application with a threaded ports pump apply to a Turolla representative.

Product code
Model code

A B C D E F G H I J K L M N 0

A Family

SEA1NN	Gear pump with inlet port on body and outlet port on flange
SNB1NN	Gear pump with inlet port on cover and outlet port on flange replacement for SEB1 - use SNP1 body profile
SNP1NN	Standard gear pump
SNC1NN	Gear pump with inlet and outlet ports on rear cover
SNP1IN	Gear pump with internal drain relief valve
SKP1NN	High torque gear pump
SKP1IN	High torque gear pump with internal drain relief valve

B Displacement

1,2	1,18 cc
1,7	1,57 cc
2,2	2,09 cc
2,6	2,62 cc
3,2	3,14 cc

3,8	3,66 cc
4,3	4,19 cc
5,5	5,23 cc - special
6,0	5,89 cc
6,5	6,54 cc - special

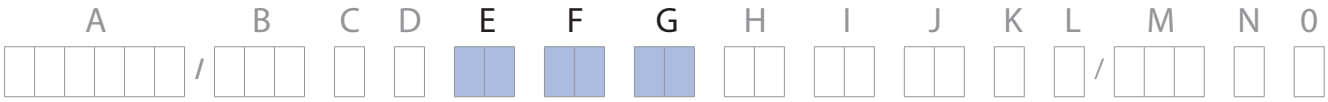
7,8	7,59 cc
010	9,94 cc
012	12,00 cc

C Rotation

L	Left rotation
R	Right rotation

D Project version

N	Standard gear pump
6	Short version - special



E Mounting flange

Code	Description (Type of flange • Type of drive gear • Preferred ports for configuration)
01	pilot Ø25,4+4 holes
02	pilot Ø30+4 holes
03	pilot Ø32+O-ring+2 holes through body
04	pilot Ø32+2 holes through body
06	SAE A-A pilot Ø50,8+ 2 holes
08	pilot Ø32+O-ring Outlet port+2 holes through body
B1	pilot Ø25,4+4 holes -special shaft seal slot
V6	SAE A-A pilot Ø45+ 2 holes

F Drive gear

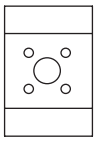
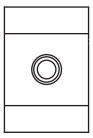
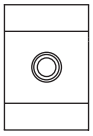
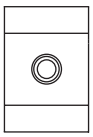
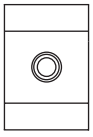
AA	Taper 1:5-M6-Key 2
BA	Taper 1:8-M7-Key 2,41
BB	Taper 1:8-M10x1-Key 3
BG	Taper 1:8-M7-Key 2,41-shaft for short version
CA	Tang 5x Ø10 FR03
CB	Tang 5x Ø13,5 FR03 - for SEA1NN only
CD	Tang 5x Ø11,5 distance from gear face 47,5 - for SEA1NN and SNB1NN
CE	Tang 6,63x Ø11 - for SKP1xN
CF	Tang 5x Ø11,5 distance from gear face 35
CM	Tang 5x Ø10-type 03 + w/o coupling
DA	Splined Z15-m0,75-alfa 30°-L14 - for SNP1xx
DB	Splined Z15-m0,75-alfa 30°-L14 - for SKP1xx
DC	Splined B12x9-L14-flange protrusion sb22-Z6-m1,60-alfa 30° - special - only for SNP1xx
DD	Splined B12x9-L20-flange protrusion sb40-Z6-m1,75-alfa 30° - special - only for SKP1xx
FA	Parallel Ø12-Thread M10x1-Key 3
GA	Parallel Ø12,7-Key 3.2
SA	SAE spline J498-9T-20/40 Flat Root Side FIT-L15,6
SG	SAE spline J498-8T-16/32 std-shaft for short version

G Rear cover

03	Cover 03
08	Cover 08 with Inlet port 3/8" Gas
BC	Intermediate flange with screw case and pilot Tipe 01 BCN
C1	Cover pump with front GAS Thread Inlet3/8 ; Outlet3/8
I1	Cover pump with relief valve
I3	Cover 03 with relief valve
P1	Std Cover pump

A B C D E F G H I J K L M N 0

H Inlet size I Outlet size

NN	Without inlet	
B1	8x30xM6	
B2	13x30xM6	
C1	8x26xM5	
C2	12x26xM5	
C3	13,5x30xM6	
D3	M14x1,5	
D5	M18x1,5	
D7	M22x1,5	
E3	9/16-18UNF	
E4	3/4-16UNF	
E5	7/8-14UNF	
F2	1/4 GAS	
F3	3/8 GAS	
F4	1/2 GAS	
H2	10xM12x1,5-ISO6149	
H4	12xM16x1,5-ISO6149	
H5	12xM18x1,5-ISO6149	
H7	13,5xM22x1,5-ISO6149	

J Ports positions & Special body

NN	Std from catalogue
DF	Distance from front flange = 41,9 mm
SA	Body width for side ports = 68 mm

K Seals

N	Standard NBR seal
A	Without shaft seal
B	With VITON seals
I	Two opposite shaft seals

L Screws

N	Std screws
B	GEOMET screws

M Set valve

NNN	No valve
V**	not defined-pressure no setting :oil ISO VG68-45°

N Type mark

N	Standard Turolla Marking
A	Standard Turolla Marking+Customer Code - Special
Z	Without Marking

O Mark position

N	Std Marking position (on top)
A	Special Marking position on the bottom

Determination of Nominal Pump Sizes

Determination of Nominal Pump Sizes

Use these formulae to determine the nominal pump size for a specific application:

	Based on SI units	Based on US units
Output flow:	$Q = \frac{Vg \cdot n \cdot \eta_v}{1000}$ l/min	$Q = \frac{Vg \cdot n \cdot \eta_v}{231}$ [US gal/min]
Input torque:	$M = \frac{Vg \cdot \Delta p}{20 \cdot \pi \cdot \eta_m}$ N•m	$M = \frac{Vg \cdot \Delta p}{2 \cdot \pi \cdot \eta_m}$ [lbf•in]
Input power:	$P = \frac{M \cdot n}{9550} = \frac{Q \cdot \Delta p}{600 \cdot \eta_t}$ kW	$P = \frac{M \cdot n}{63.025} = \frac{Q \cdot \Delta p}{1714 \cdot \eta_t}$ [hp]

Variables: SI units [US units]

V_g	=	Displacement per rev.	cm^3/rev [in^3/rev]
p_{HD}	=	Outlet pressure	bar [psi]
p_{ND}	=	Inlet pressure	bar [psi]
Δp	=	$p_{HD} - p_{ND}$	bar [psi]
n	=	Speed	min^{-1} (rpm)
η_v	=	Volumetric efficiency	
η_m	=	Mechanical (torque) efficiency	
η_t	=	Overall efficiency ($\eta_v \cdot \eta_m$)	

System Requirements

Pressure

The inlet vacuum must be controlled in order to realize expected pump life and performance. The system design must meet inlet pressure requirements during all modes of operation. Expect lower inlet pressures during cold start. It should improve quickly as the fluid warms.

Inlet pressure

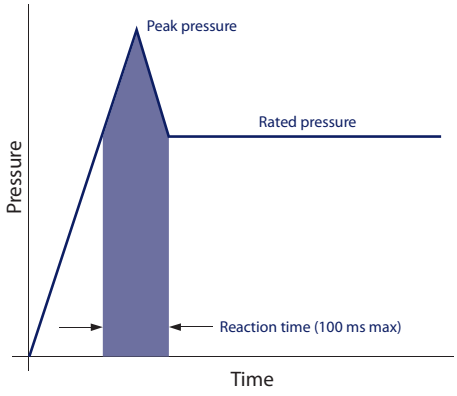
Maximum continuous vacuum	bar absolute [in. Hg]	0.8 [23.6]
Maximum intermittent vacuum		0.6 [17.7]
Maximum pressure		3.0 [88.5]

Peak pressure is the highest intermittent pressure allowed. The relief valve overshoot (reaction time) determines peak pressure. It is assumed to occur for less than 100 ms. The illustration to the right shows peak pressure in relation to rated pressure and reaction time (100 ms maximum).

Rated pressure is the average, regularly occurring, operating pressure that should yield satisfactory product life. The maximum machine load demand determines rated pressure. For all systems, the load should move below this pressure.

System pressure is the differential between the outlet and inlet ports. It is a dominant operating variable affecting hydraulic unit life. High system pressure, resulting from high load, reduces expected life. System pressure must remain at, or below, rated pressure during normal operation to achieve expected life.

Time versus pressure

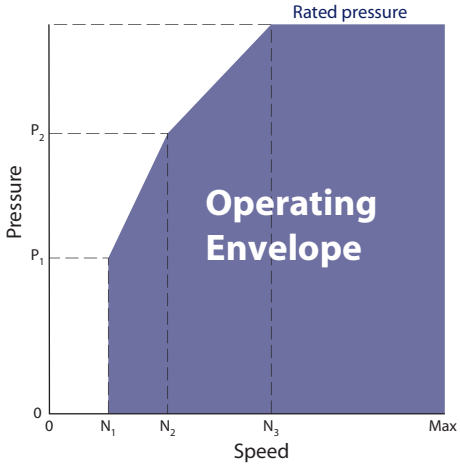


Speed

Maximum speed is the limit recommended by Turolla for a particular gear pump when operating at rated pressure. It is the highest speed at which normal life can be expected.

The lower limit of operating speed is the **minimum speed**. It is the lowest speed at which normal life can be expected. The minimum speed increases as operating pressure increases. When operating under higher pressures, a higher minimum speed must be maintained, as illustrated to the right.

Speed versus pressure



Where:
N_1 = Minimum speed at 100 bar
N_2 = Minimum speed at 180 bar
N_3 = Minimum speed at rated pressure

Hydraulic fluids

Ratings and data for SNP1NN, SEP1NN and SKP1NN gear pumps are based on operating with premium hydraulic fluids containing oxidation, rust, and foam inhibitors. These fluids must possess good thermal and hydrolytic stability to prevent wear, erosion, and corrosion of internal components. They include:

- Hydraulic fluids following DIN 51524, part 2 (HLP) and part 3 (HVLP) specifications
- API CD engine oils conforming to SAE J183
- M2C33F or G automatic transmission fluids
- Certain agricultural tractor fluids

Use only clean fluid in the pump and hydraulic circuit.

Caution

Never mix hydraulic fluids.

Please see Turolla publication Hydraulic Fluids and Lubricants Technical Information, **L1021414** for more information.

Temperature and viscosity

Temperature and viscosity requirements must be concurrently satisfied. Use petroleum / mineral-based fluids.

High temperature limits apply at the inlet port to the pump. The pump should run at or below the maximum continuous temperature. The peak temperature is based on material properties. Don't exceed it.

Cold oil, generally, doesn't affect the durability of pump components. It may affect the ability of oil to flow and transmit power. For this reason, keep the temperature at 16 °C [60 °F] above the pour point of the hydraulic fluid.

Minimum (cold start) temperature relates to the physical properties of component materials.

Minimum viscosity occurs only during brief occasions of maximum ambient temperature and severe duty cycle operation. You will encounter maximum viscosity only at cold start. During this condition, limit speeds until the system warms up. Size heat exchangers to keep the fluid within these limits. Test regularly to verify that these temperatures and viscosity limits aren't exceeded. For maximum unit efficiency and bearing life, keep the fluid viscosity in the recommended viscosity range.

Fluid viscosity

Maximum (cold start)	mm²/s [SUS]	1000 [4600]
Recommended range		12-60 [66-290]
Minimum		10 [60]

Temperature

Minimum (cold start)	°C [°F]	-20 [-4]
Maximum continuous		80 [176]
Peak (intermittent)		90 [194]

Filtration

Filters

Use a filter that conforms to Class 22/18/13 of ISO 4406 (or better). It may be on the pump outlet (pressure filtration), inlet (suction filtration), or reservoir return (return-line filtration).

Selecting a filter

When selecting a filter, please consider:

- contaminant ingression rate (determined by factors such as the number of actuators used in the system)
- generation of contaminants in the system
- required fluid cleanliness
- desired maintenance interval
- filtration requirements of other system components

Measure filter efficiency with a Beta ratio (β_X). For:

- suction filtration, with controlled reservoir ingression, use a $\beta_{35-45} = 75$ filter
- return or pressure filtration, use a pressure filtration with an efficiency of $\beta_{10} = 75$.

βx ratio is a measure of filter efficiency defined by ISO 4572. It is the ratio of the number of particles greater than a given diameter ("$_x$" in microns) upstream of the filter to the number of these particles downstream of the filter.

Fluid cleanliness level and β_x ratio

Fluid cleanliness level (per ISO 4406)	Class 22/18/13 or better
β_x ratio (suction filtration)	$\beta_{35-45} = 75$ and $\beta_{10} = 2$
β_x ratio (pressure or return filtration)	$\beta_{10} = 75$
Recommended inlet screen size	100-125 µm [0.004-0.005 in]

The filtration requirements for each system are unique. Evaluate filtration system capacity by monitoring and testing prototypes.

Reservoir

The **reservoir** provides clean fluid, dissipates heat, removes entrained air, and allows for fluid volume changes associated with fluid expansion and cylinder differential volumes. A correctly sized reservoir accommodates maximum volume changes during all system operating modes. It promotes deaeration of the fluid as it passes through, and accommodates a fluid dwell-time between 60 and 180 seconds, allowing entrained air to escape.

Minimum reservoir capacity depends on the volume required to cool and hold the oil from all retracted cylinders, allowing for expansion due to temperature changes. A fluid volume of 1 to 3 times the pump output flow (per minute) is satisfactory. The minimum reservoir capacity is 125% of the fluid volume.

Install the suction line above the bottom of the reservoir to take advantage of gravity separation and prevent large foreign particles from entering the line. Cover the line with a 100-125 micron screen. The pump should be below the lowest expected fluid level.
Put the return-line below the lowest expected fluid level to allow discharge into the reservoir for maximum dwell and efficient deaeration. A baffle (or baffles) between the return and suction lines promotes deaeration and reduces fluid surges.

Line sizing

Choose pipe sizes that accommodate minimum fluid velocity to reduce system noise, pressure drops, and overheating. This maximizes system life and performance. Design inlet piping that maintains continuous pump inlet pressure above 0.8 bar absolute during normal operation. The line velocity should not exceed the values in this table:

Maximum line velocity

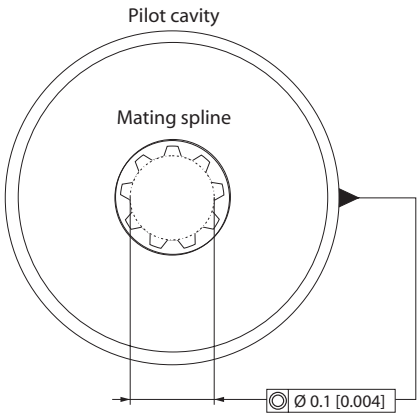
Inlet	m/s [ft/sec]	2.5 [8.2]
Outlet		5.0 [16.4]
Return		3.0 [9.8]

Most systems use hydraulic oil containing 10% dissolved air by volume. Under high inlet vacuum conditions the oil releases bubbles. They collapse when subjected to pressure, resulting in cavitation, causing adjacent metal surfaces to erode. **Over-aeration** is the result of air leaks on the inlet side of the pump, and flow-line restrictions. These include inadequate pipe sizes, sharp bends, or elbow fittings, causing a reduction of flow line cross sectional area. This problem will not occur if inlet vacuum and rated speed requirements are maintained, and reservoir size and location are adequate.

Shaft options for Group 1 gear pumps include tapered, tang, splined, or parallel shafts. They are suitable for a wide range of direct and indirect drive applications for radial and thrust loads.

Pump drive

Plug-in drives, acceptable only with a splined shaft, can impose severe radial loads when the mating spline is rigidly supported. Increasing spline clearance does not alleviate this condition.
Use plug-in drives if the concentricity between the mating spline and pilot diameter is within 0.1 mm [0.004 in]. Lubricate the drive by flooding it with oil. A 3-piece coupling minimizes radial or thrust shaft loads.



Caution

In order to avoid spline shaft damages it is recommended to use carburised and hardened steel couplings with 80-82 HRA surface hardness.

Allowable **radial shaft loads** are a function of the load position, load orientation, and operating pressure of the hydraulic pump. All external shaft loads have an effect on bearing life, and may affect pump performance.

In applications where external shaft loads can't be avoided, minimize the impact on the pump by optimizing the orientation and magnitude of the load. Use a tapered input shaft; don't use splined shafts for belt or gear drive applications. A spring-loaded belt tension-device is recommended for belt drive applications to avoid excessive tension. Avoid thrust loads in either direction. Contact Turolla if continuously applied external radial or thrust loads occur.