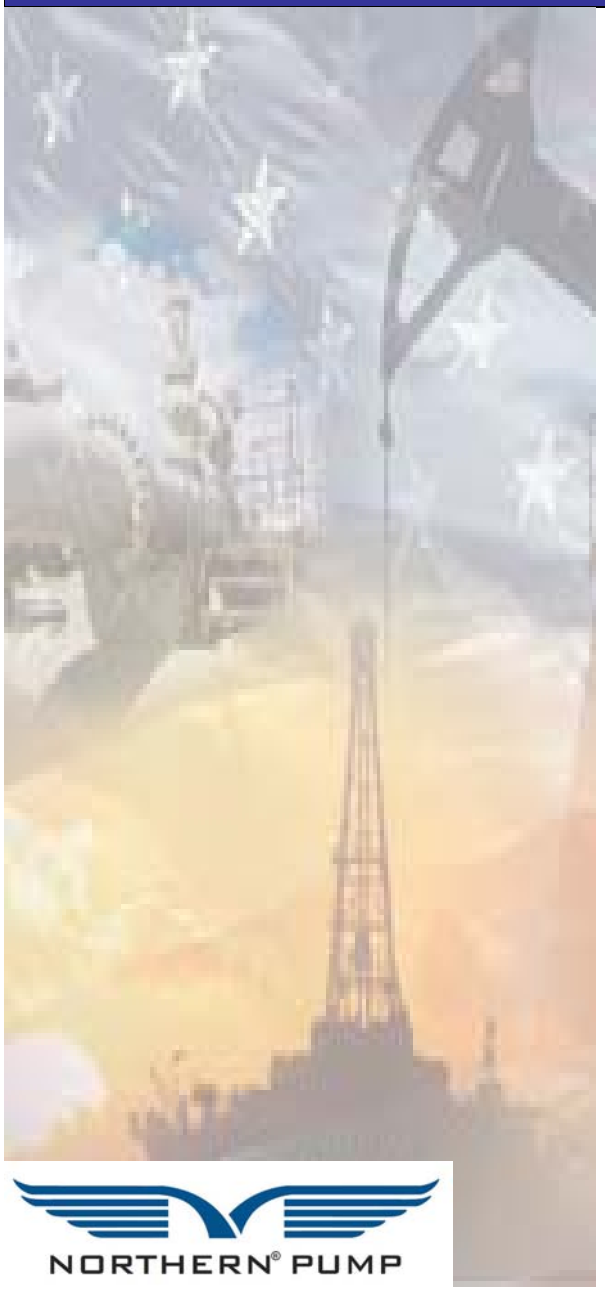
NORTHERN® PUMP

Gear Pump 101

Lesson 2: Gear Pump Terminology

When your reputation depends on it!

Northern® Lesson 2 Gear Pump Terminology



Symbols

Symbol	Term	Metric Unit	Abbreviation	US Customary Unit	Abbreviation	Conversion factor[a]
A	Area	square millimeter	mm2	square inches	in^2	645.2
D	Displacement	milliliters/revolution	mL/rev	cubic inches/revolution	in^3/rev	16.39
d	Diameter	millimeter	mm2	inches	in	25.4
Δ? (delta)	Difference	dimensionless	-	dimensionless	-	1
η (eta)	Efficiency	percent	%	percent	%	1
F	Force	Newton	N	pound-force	lbf	4.448
g	Gravitational acceleration	meter/second squared	m/s2	feet/second squared	ft/sec^2	0.3048
γ (gamma)	Specific weight			pounds/cubic foot	lb/ft^3	
h	Head	meter	m	feet	ft/sec2	0.3048
n	Speed	revolutions/minute	rpm	revolutions/minute	rpm	1
NPIPA	Net positive inlet pressure avail.	kilopascal	kPa	pounds/square inch	psi	6.895
NPIPR	Net positive inlet pressure required	kilopascal	kPa	pounds/square inch	psi	6.895
ν (nu)	Kinematic viscosity	millimeter squared/sec	mm2/s	centistoke	CST	1
π	pi = 3.1416	dimensionless	-	dimensionless	-	1
p	Pressure	kilopascal	kPa	pounds/square inch	psi	6.895
P	Power	kilowatt	kW	horsepower	hp	0.7457
Q	Rate of Flow (capacity)	cubic meter/hour	m3/h	US Gallons/minute	gpm	0.2271
s	Specific gravity	dimensionless	-	dimensionless	-	1
S	Slip	cubic meter/hour	m3/h	US Gallons/minute	gpm	0.2271
t	Temperature	degrees Celsius	ºC	degrees Fahrenheit	ºF	(ºF-32) x $^5/_9$
τ (tau)	Torque	Newton - meter	N·m	pounds-feet	lb-ft	1.356
v	Velocity	meter/second	m/s	feet/second	ft/sec	0.3048
x	Exponent	none	none	none	none	1
Z	Elevation guage distance above or below datum	meter	m	feet	ft	0.3048

[a] Conversion factor x US units = metric units

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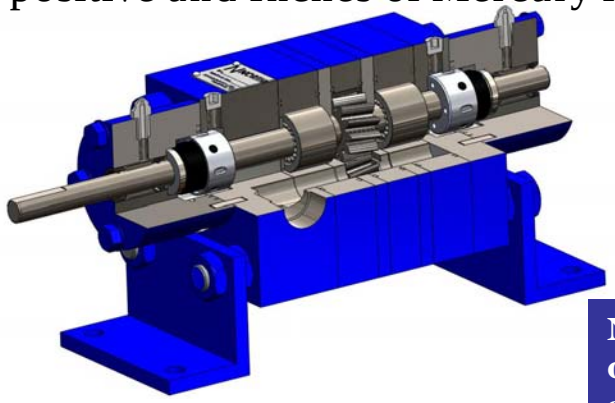
Inlet pressure (p_s) –

• Inlet Pressure = Gauge Pressure + Velocity Pressure + Elevation Pressure (measured at the pump inlet):

$$p_s = p_{gs} + 9.8s\left[Z_s + \frac{v^2 s}{2g}\right] \qquad \text{(Metric)}$$

$$p_s = p_{gs} + .0433s\left[Z_s + \frac{v^2 s}{2g}\right] \qquad \text{(US Units)}$$

The symbol (p_s) may be positive or negative with reference to atmospheric pressure and may have positive or negative values. The symbol is called inlet pressure when positive and inlet vacuum when negative. It is typically measured in Pounds per Inch^2 for positive and Inches of Mercury for negative values.



Cut away view of a typical 4000 Series Hydraulic Balanced Pump

Northern® Fast Fact....

Northern 4000 series can comfortably operate with suction pressures as high as 1200 PSI. See our custom pump page for a diagram of our hydraulic balanced pump option for suction pressures at or above 25 PSI.

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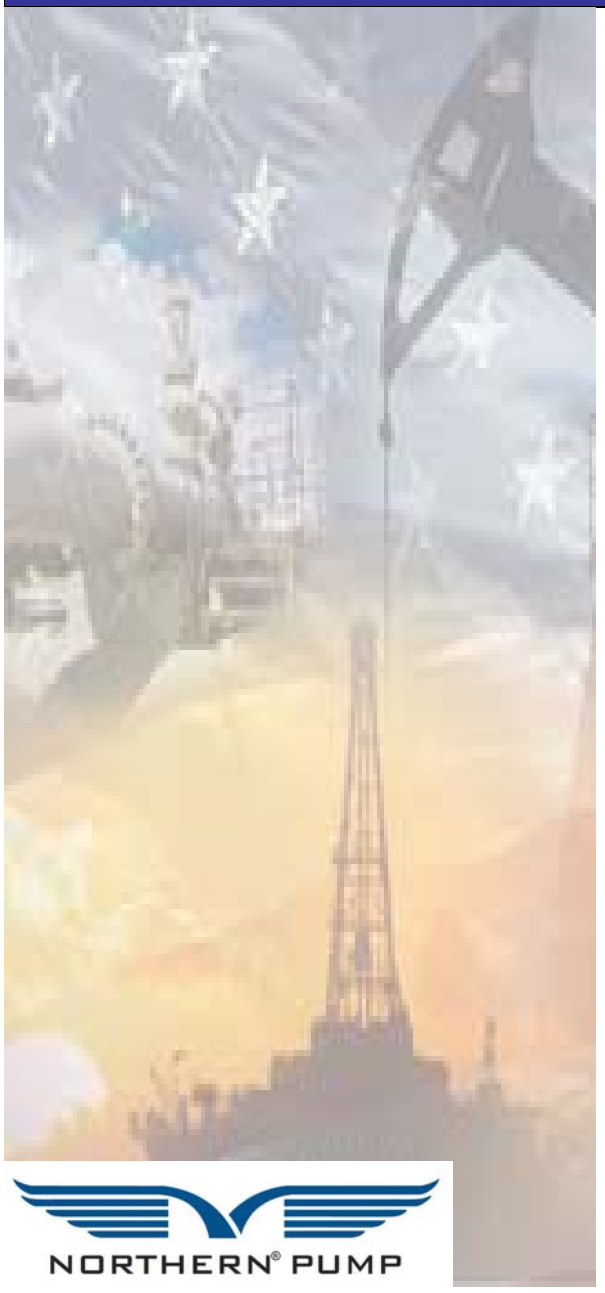

Discharge Pressure

Discharge pressure = Gauge pressure the pump must produce to force the liquid out of the pump and into the system piping, and overcome the potential combination of:

- All pressure loss in pipe from elbows, valves, filters, connections etc.
- Elevation of system piping
- Any system design requiring hydraulic force to operate

Speed (n)

Speed = Number of revolutions per minute of the drive shaft and gear, and as a result, the driven shaft and gear.

- Common motor speeds = 1150, 1750, and 3600 RPM
- Very Compatible with VFD or Gear Reducers For Exact Flows
- Flow and delivery at as low as 5 RPM!

Northern® Fast Fact.....

Nearly all standard Northern 4000 series pumps can comfortably operate with discharge pressures up to 2000 PSI.

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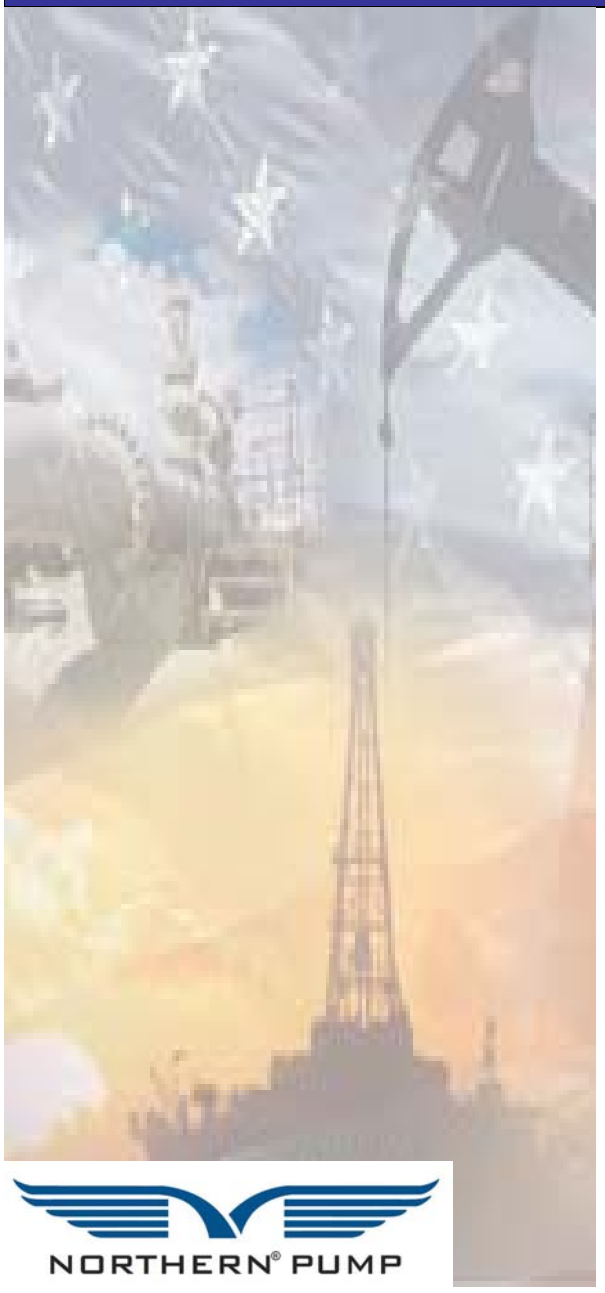

Differential pressure (Δp)

Differential Pressure = Discharge Pressure - Inlet Pressure

$$\Delta p = p_d - p_s$$

Maximum differential pressure (Δp_{max})

Maximum Differential Pressure = Maximum allowable difference between the absolute pressure of the fluid at the discharge port and the absolute pressure of the fluid at the suction port.

Northern® Fast Fact.....

Most 4000 series pumps are designed to operate with a (Δp_{max}) of 2000 PSI.

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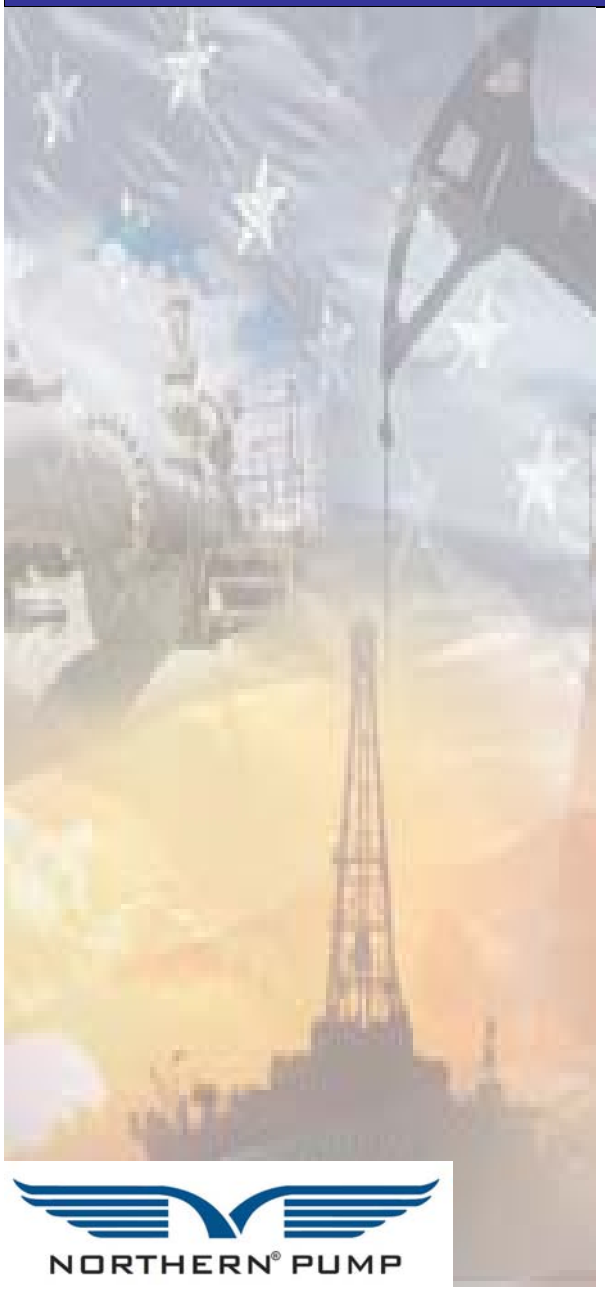

Rate of flow (Q)

- Measurement of Fluid Delivered per Unit of Time
- Q = Volume Displaced per Unit of Time, Less Slip.
- Q Expressed in Gallons Per Minute (GPM)

Pump volumetric efficiency (η_v)

- Volumetric Efficiency = Ratio of Flow Rate to the Volume Displaced per Unit of Time.

$$\eta_v = \frac{16.7x10^3 Q}{Dn} \times 100$$

(Metric)

$$\eta_v = \frac{231Q}{Dn} \times 100$$

(US Units)

Northern® Fast Fact.....

Most 4000 series pumps are volumetrically efficient to at least 80%. The benefit is an energy savings that contributes to a green environment.

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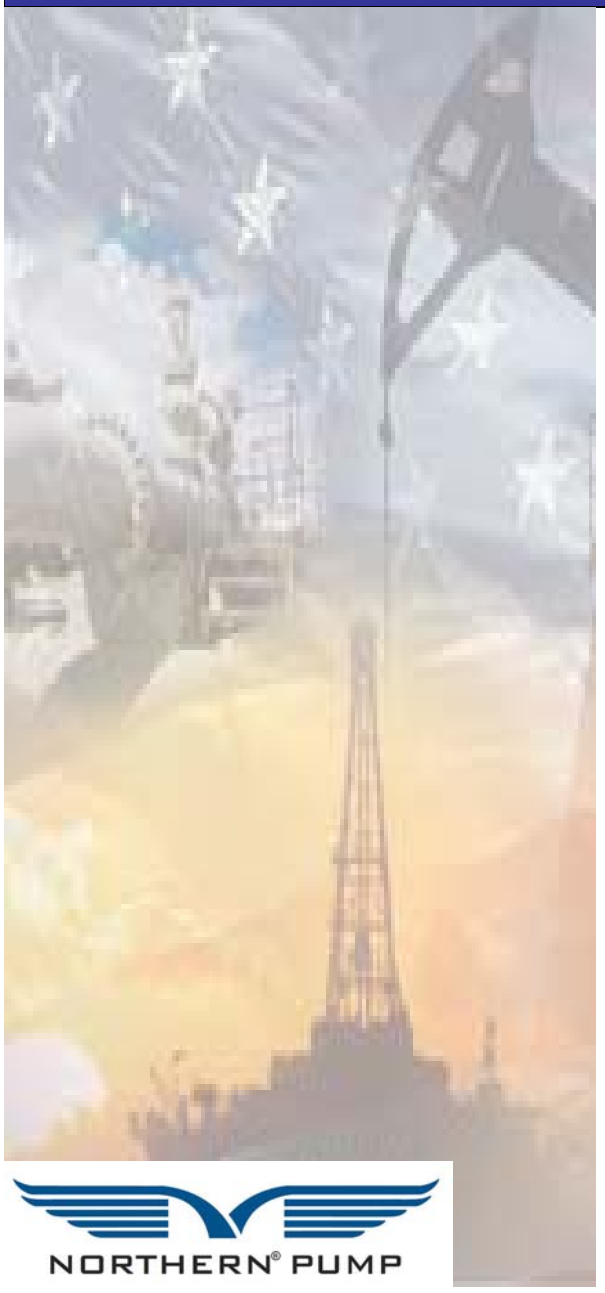


Displacement (D)

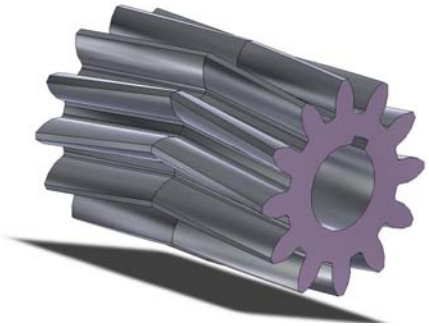
- Displacement = Volume Displaced During One Complete Gear Revolution (cubic inches, cubic gallons or cubic cm/rev)

  ✓ Calculation Based on Dimensions of the Gears, or

  ✓ Volume Pumped per Revolution at Zero Differential Pressure.

Variables Allowing for Easy Match up to the Displacement Needs of Your Application:

- Gear Length…Longer gears = More displacement
- Number of teeth…More teeth = Less displacement
- Gear Diameter…Larger diameter gears = More displacement



Northern® Fast Fact……

Northern 4000 Series pumps are capable of producing a range of .3 to over 200 Gallons per Minute at 1750 RPM!

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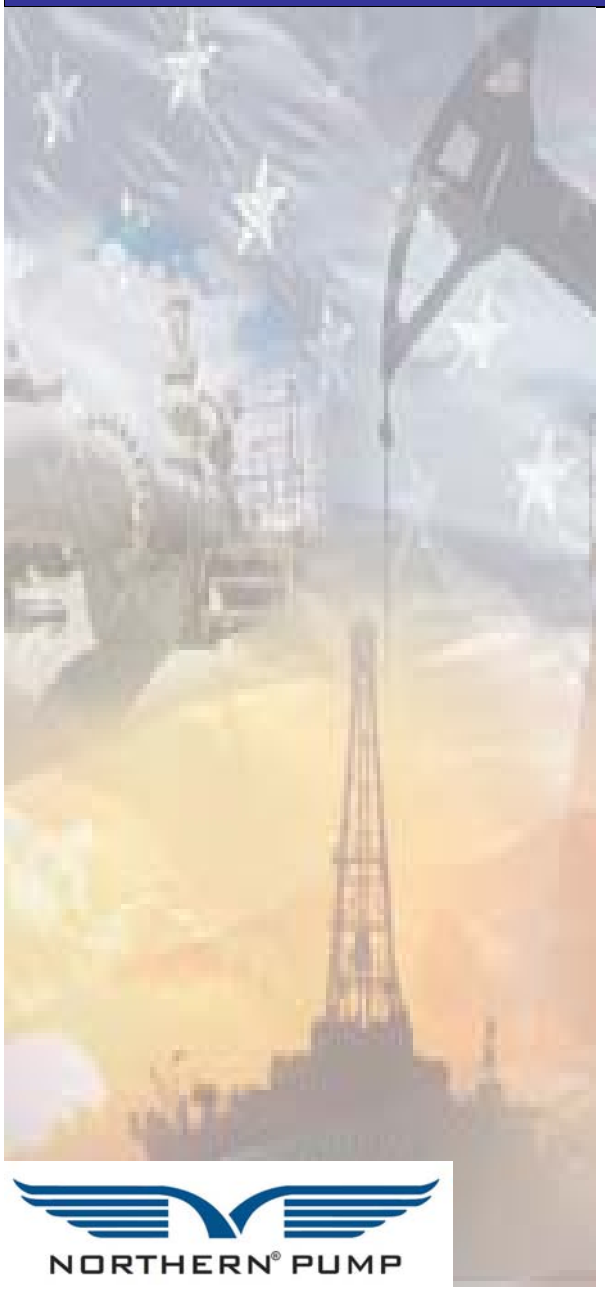

Slip (S)

Slip = Quantity of Fluid Leaking Through Internal Clearances

- Internal clearances
- Differential pressure
- Fluid Characteristics
- Speed

$$S = \left(\frac{Dn}{231}\right) - Q$$

The main factors for predicting the amount of slip are:

- Bore clearance*- Greater clearance around the outside diameter of the gear = more slip
- Side Clearance*- Greater clearance between the gear and bearing or liner plate = more slip

  **See the next slide for a diagram of bore & side clearance*
- Liquid viscosity – Lower viscosity *(thinner liquid)* = *more* slip
- Differential Pressure – Higher differential pressure = more slip
- The Northern® Pump performance calculator takes in all of these factors to predict pump performance, using the following formula:

$$((1.493 \times 10^5)\frac{\Delta P}{V^C})(2(\frac{C^B}{2})^3)((\frac{G^L}{V^1})+((C^S)^3((C^S)((\frac{V^2}{V^3})+(\frac{V^4}{V^5}))))$$

Northern® Fast Fact.....

Slip is not affected by pump RPM. Slip is a result of viscosity, pressure, and available space to pass through.

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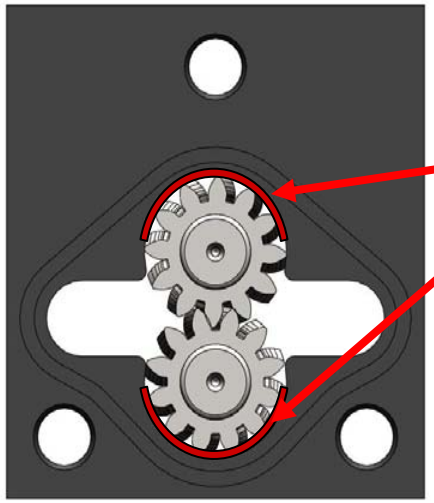
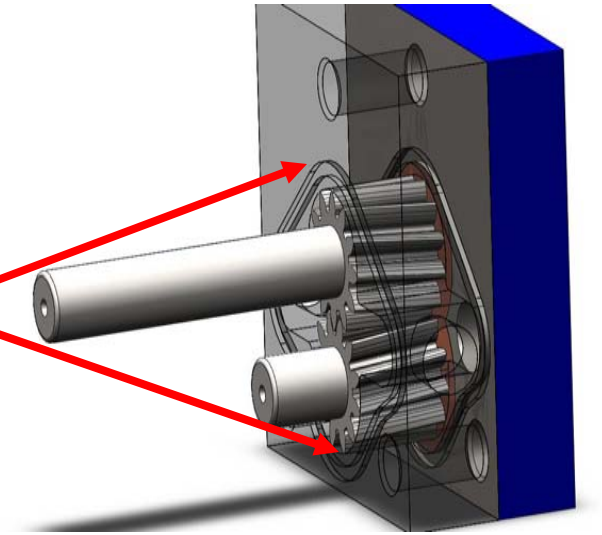


Bore Clearance

The bore clearance in the gap between the outside diameter of the gear and the inside diameter of the cylinder

Side Clearance

The side clearance is in the gap between the side of the gear and the wear surface of the bearing plate.



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