



Hydraulic Motors

INSTALLATION GUIDE

**Hydraulic Motors ▪ Planetary Gearboxes**

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## 1. ABOUT THIS MANUAL

This installation manual summarizes the necessary information concerning the main terminology, precautions for installation, procedures for starting operation, storage, reparations, etc. of SAI Hydraulics products.

All the information from this manual is complementary to the leaflets and catalogue. Always verify and check the technical specification and information from the catalogues.

For any further assistance consult SAI technical department.

## 2. SAFETY INSTRUCTION and INSTALLATION PRECAUTIONS.

### 1) Before installation

(1) Cleaning and painting instructions:

- A. Avoid high pressure cleaning.
- B. Close all ports with flanges or plugs and protect electrical or hydraulic components before cleaning or painting.
- C. Protect the shaft seal before cleaning or painting.
- D. Close all ports with flanges or plugs and protect electrical or hydraulic components if they can be exposed with external fluids

(2) Take all necessary safety precautions and comply with the safety regulations.

(3) Wear proper *personal protective equipment* (PPE)

✘ Such as, Protective clothes, safety footwear, protective gloves, etc.

(4) Establish a safety perimeter, limited to qualified personnel.

(5) Prepare the proper tools and necessary equipment for the correct installation.

(6) Do not start the hydraulic motor until the installation is fully completed.

(7) Confirm that hydraulic specifications are within motor specifications.

- A. Hydraulic motor input power > Hydraulic pump output power.
- B. Hydraulic motor input power > Relief valve setting pressure x Max flow within motor allowance.

2) During installation

- (1) Do not manually lift the hydraulic motor / planetary gearbox.
- (2) Lift components with an adequate lifting device.
- (3) Avoid temperatures which can ignite the hydraulic oil / lubricants.
- (4) Always follow the safety instructions.
- (5) Avoid unnecessary loads on the following components.
  - A. Output shaft.
  - B. Mounting surfaces.
  - C. Installation fixing bolts mounting areas.
  - D. Ports of distributors.
  - E. Metal or plastic plugs

3) After installation

- (1) Connect main ports (A/B), complying with the connection instructions given by the manufacturers.
- (2) Make sure that the fitting connected to the drain port, is securely connected.
- (3) Only for variable displacement motors: After start-up of the application, any handling of the motor or if the controller of a variable displacement motor is replaced with a new one, perform a zero setting of the controller.

### 3. DELIVERY CONDITIONS

1. Hydraulic motors and gearboxes are delivered as follow:

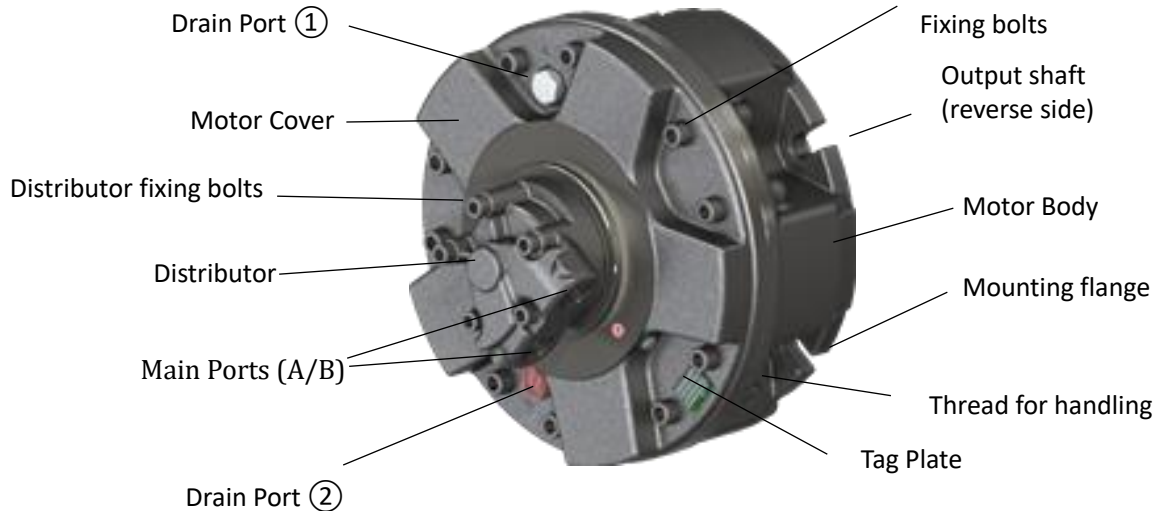
- A. Type of packaging:                   → Wooden box
- B. Hydraulic fluid – Gear oil:       → Without
- C. Primer or topcoat paint:         → No paint
- D. Hydraulic ports:                   → Plastic/metallic plugs

2. Handle and move motors with suitable lifting equipment.

3. If stored, store motors in the original wooden boxes.

## 4. HYDRAULIC MOTOR TERMINOLOGY- GENERAL KNOWLEDGE

### 1) External components terminology



※ Components vary depending on each model. For specific information, refer to the technical documents.

### 2) Tag plate designation



Description

Part number

Serial Number

Description	Product Code
Part number	SAI internal code
Serial number	1-2 Production week
	3-4 Production year
(Digits from left to right)	5-7 Motor number on that week

※ Example: 3219125 – Produced in 2019, week 32, motor number 125 on week 32.

3) Technical specification

Refer to each technical datasheet, as specifications vary on each product.

4) Determining motor direction of rotation

(1) Direction of motor rotation decided before its delivery, in accordance to machine operation.

(2) The method to determine the direction of rotation when is unknown:

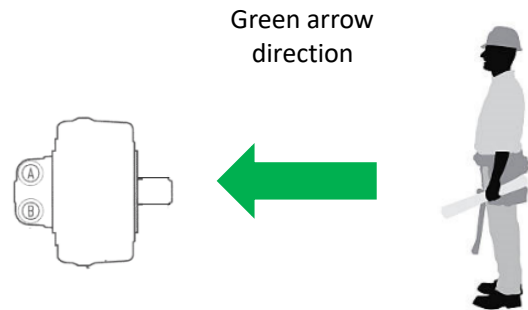
A. Verify whether is (L) indicated on motor description.

Example: GM1 300 9H D40; GM1 300 9H D40L

B. Locate in front of output shaft.

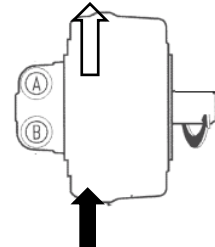
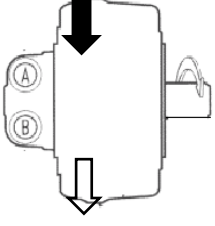
C. Verify where the oil is supplied from port A or B.

D. Direction of rotation can be defined as per following table.



Motor description	A Port	B Port	Hydraulic motor direction of rotation	
Without [L]	Inlet	Outlet	Clockwise	
	Outlet	Inlet	Anti-clockwise	



With [L]	Outlet	Inlet	Clockwise	
	Inlet	Outlet	Anti-clockwise	

5) Hydraulic fluids

- A. SAI recommends filtration on the return line:
- |           |                  |
|-----------|------------------|
| Allowable | 25micron filters |
| Ideal     | 10micron filters |
- B. General hydraulic oil requirements:
- Recommended oil: ISO 6743-4 (ISO 11158 and ISO 15380) hydraulic fluids “H” type.
  - Additives: Anti-wear, Anti-foaming, Anti-oxidation, and extreme pressure.
  - Oil temperature:
 

Allowable	-20°C~+80°C
Ideal	+30°C~+50°C
  - Viscosity range for motors:
 

Allowable	15~150mm <sup>2</sup> /s (cSt)
Ideal	20~100mm <sup>2</sup> /s (cSt)
  - Viscosity range for gearboxes:
 

Allowable	15~1000mm <sup>2</sup> /s (cSt) (cold start)
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  - Cleanliness level: ISO/DIS 4406 BS 5540/4 : 19/17/14 (class 8 NAS 1638 • SAE 749 Grade 5)

C. For hydraulic oils different to mineral oils (ISO 11158), consider the following statements:

Hydraulic Fluids	Cautionary points	Proposed solution
<b>Synthetic fluid</b> Ex: Esters, polyglycols, polyalphaolefin (PAO), ...	Reactions between the polymers used in seals and the chemicals in fluids.	Usage of compatible seal material.
<b>Aqueous fluid</b> Ex: Oil-Water emulsion, water-oil emulsion, water-glycol solutions, ...	<ul style="list-style-type: none"> <li>• Deterioration internal lubrication.</li> <li>• Hydraulic motor performance decreased with higher temperatures</li> </ul>	<ul style="list-style-type: none"> <li>• Maximum continuous working pressure: 150 bar</li> <li>• Allowable speed: 50% of hydraulic motor max speed.</li> <li>• Allowable temperature: +10°C ~+60°C</li> </ul>

※ For any other hydraulic fluid, consult SAI technical department.

#### 6) Back-pressure

A. SAI hydraulic motors are designed to work with following back-pressure.

Motor series	Maximum allowable back-pressure
T series	40bar
B series	40bar
GM/GS series	150bar
P series	150bar
L/S series	150bar

※ For back-pressure values out of the allowable range, contact the technical department.

7) Pilot pressure

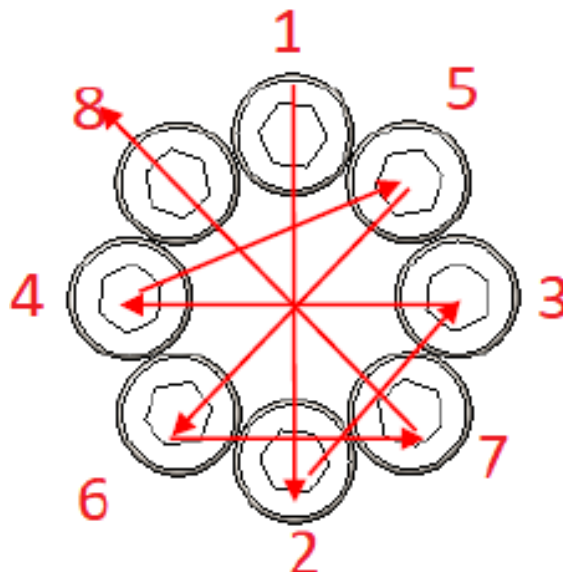
- A. Refer to the catalogue values for the pilot pressure.
- B. When the pilot line is not powered make sure it is connected to the tank and the pressure on the line is below 2 bar.

8) EP line (for double displacement and variable displacement motors)

- A. Refer to the “Distributors” catalogue for the EP line connection.
- B. EP line pressure must be > 50 bar.
- C. EP line must be used to switch displacement when the pressure on the system is lower than 50 bar.

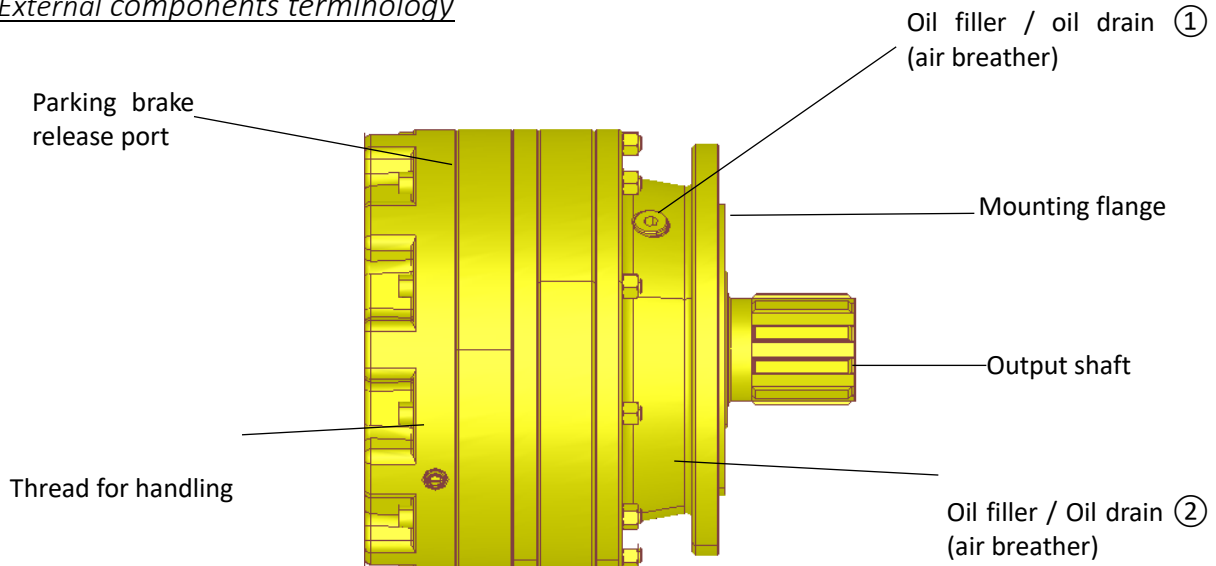
9) Fastening (mounting bolts)

- 1. Mounting bolts – Not supplied except T series motors.
- 2. Usage of new mounting bolts, at the time of install the motor onto the chassis of machine.
- 3. No need to grease the bolts.
- 4. Recommended High Tensile Grade 12.9 bolts and studs.
- 5. Check the correct tightening torque of the mounting bolts (see table 12).
- 6. Screw and tighten the bolts following a criss-cross sequence as in the image below (adapting it to the number of screws).



## 5. PLANETARY GEARBOX TERMINOLOGY – GENERAL KNOWLEDGE

### 1) External components terminology



※ Oil filler / Oil drain ① ② are equal size. Either one can be used for installing an air breather.

### 2) Tag plate designation

Refer to section (4-2)

### 3) Technical specifications

Refer to each product technical documentation

### 4) Direction of gearbox rotation

Refer to section (4-4)

### 5) Recommended lubricant (gear oil)

SAE90-GL4, ISO VG 220 or equivalents.

### 6) Hydraulic piping connection

Refer to section (4-6)

Product	Hydraulic port	:	Connector type
Planetary gearbox	Oil filler / Oil drain	:	Drain fitting not supplied, plug supplied
Air breather	Oil filler / Oil drain	:	Supplied if separated case oil
Parking brake	Releasing brake	:	Refer to section 10
Dynamic brake	Activating brake	:	Not supplied

7) Fastening (mounting bolts): Refer to section (4-7)

8) Pilot pressure

- A. Refer to the catalogue values for the pilot pressure.
- B. When the pilot line is not powered make sure it is connected to the tank and the pressure on the line is below 2 bar.

※ Gearbox oil drain is only used when an extra flushing flow is supplied.

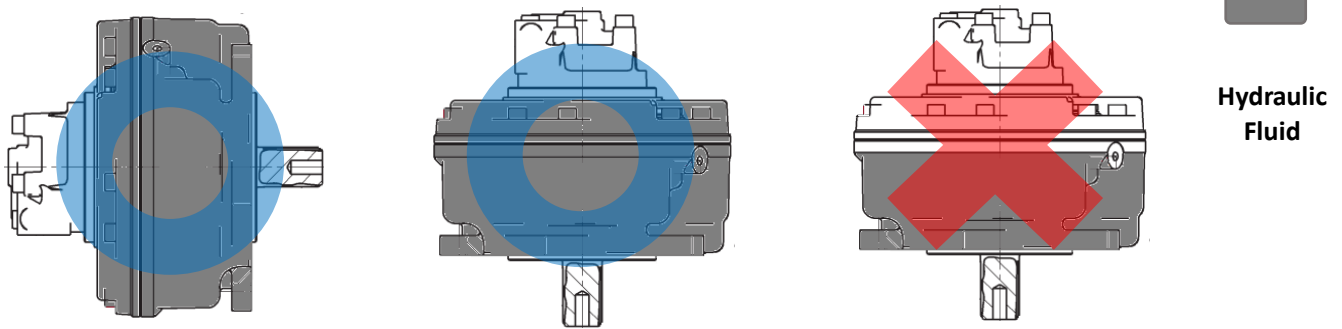
## 6. HYDRAULIC MOTOR DRAIN – PLANETARY GEARBOX AND BRAKE LUBRICATION FILLING

1) Hydraulic fluid filling precautions

- A. Never operate the motor with insufficient hydraulic fluid. Make sure that the rotary components have sufficient lubrication.
- B. When commissioning, make sure that the case interior and the service lines of the radial piston unit are filled with hydraulic fluid and remain filled during operation.
- C. Check the hydraulic fluid level in the case interior regularly; if necessary, recommission. With above-reservoir installation, the case interior may drain via the reservoir line after longer standstill periods, via the service line (gap leakage). The bearings are thus insufficiently lubricated at switch on.
- D. Make sure that suction line is always filled with hydraulic fluid during commissioning and operation.
- E. After the filling procedure is complete, verify that the oil volume used is close to the value from the catalogue, to be sure no trapped air is remaining inside.

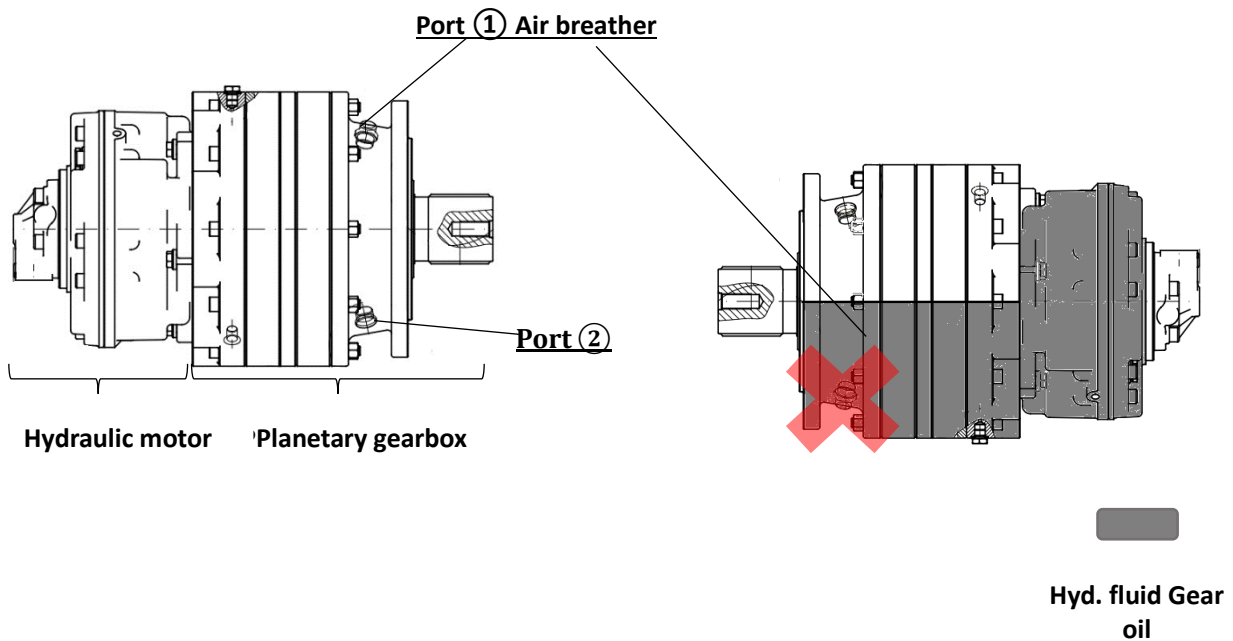
a) *Hydraulic motor*

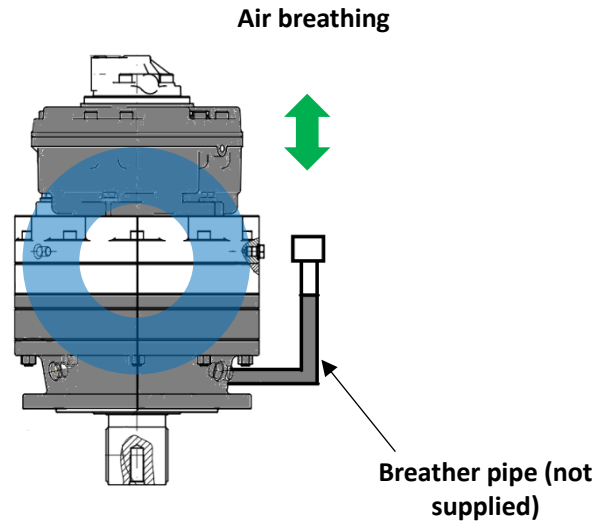
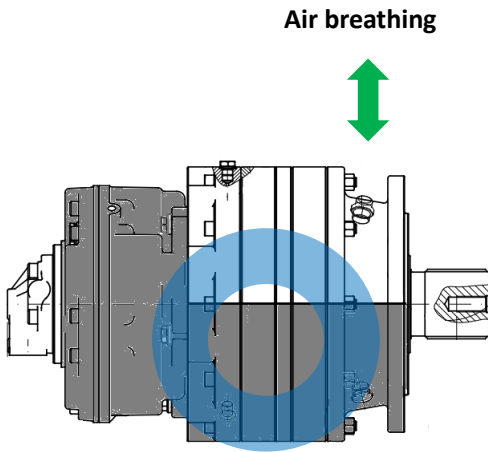
- Hydraulic fluid: Refer to section (4-5) – (2)
- Amount: Hydraulic motor case fulfilled.
- Cautionary points: Ensure casing is fully filled and drain located on upper position.



b) *Planetary gearbox or brake / Hydraulic motor separated case oil.*

- Lubrication (gear oil): Refer to section (5-5)
- Amount: Half case planetary gearbox capacity.
- Cautionary point: Locate air breather in position to permit correct breathing.

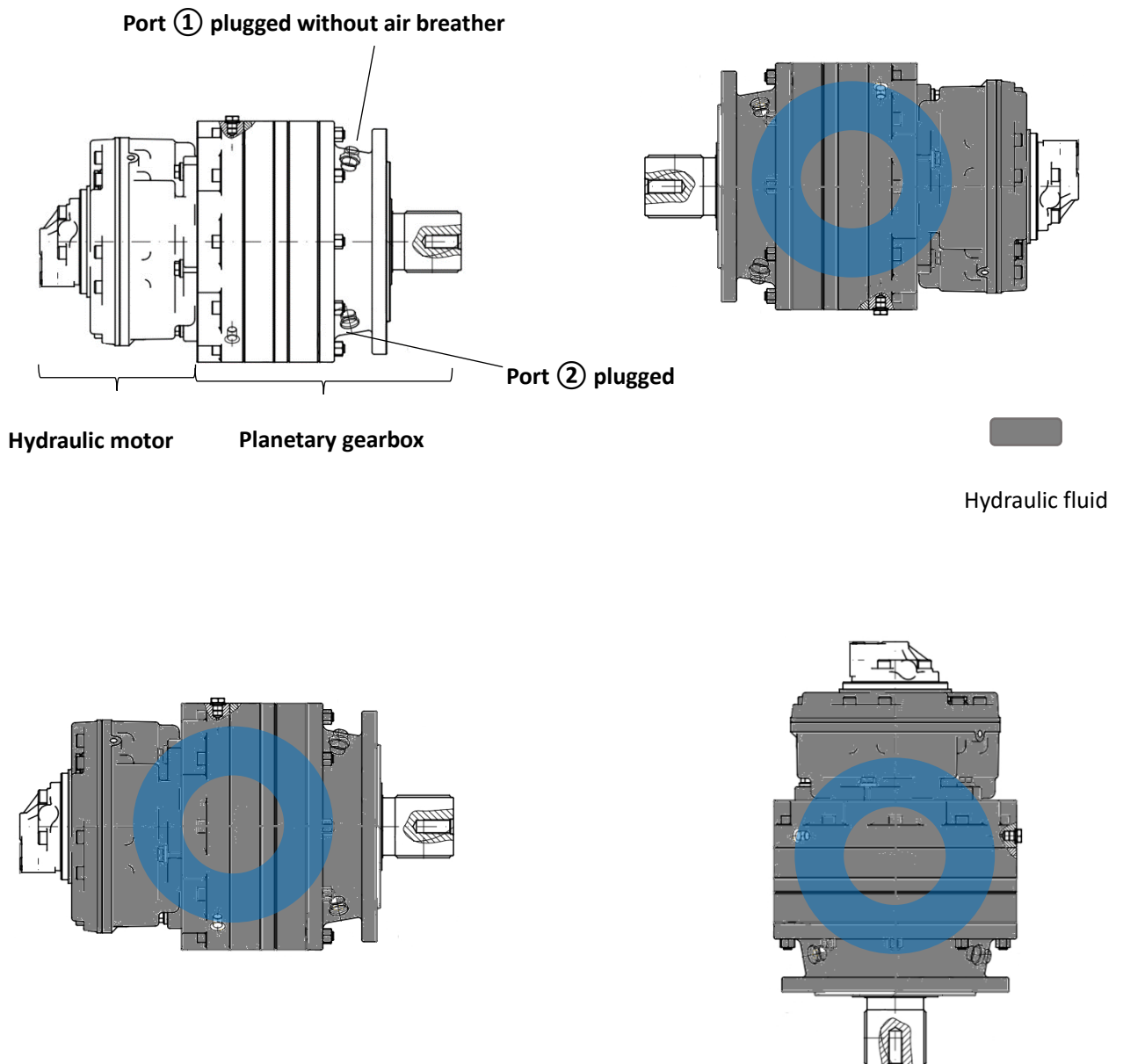




c) Planetary gearbox or brake / Hydraulic motor shared case oil

- Lubrication (gear oil): Refer to section (5-5)
- Amount: Half case planetary gearbox capacity
- Cautionary point: Locate air breather in position to permit correct breathing

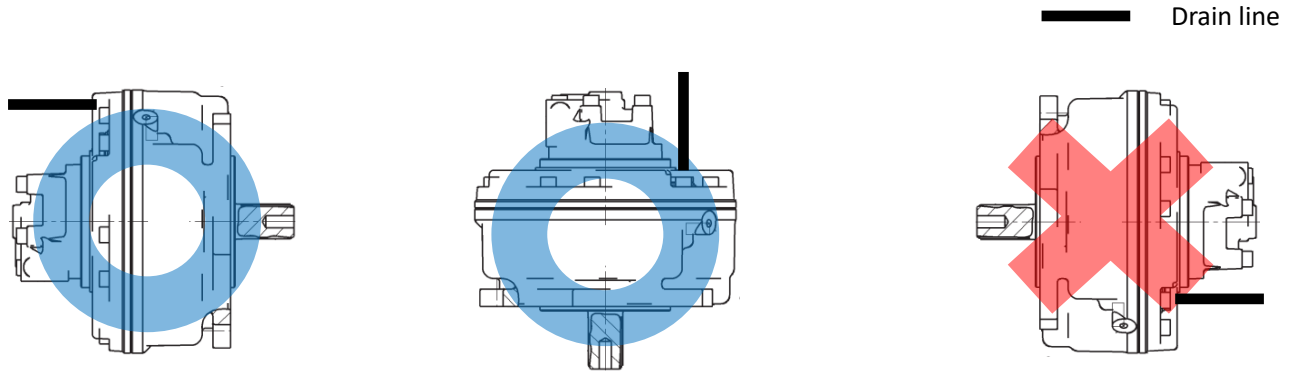
✘ Do not use gear oil for filling the motor and gearbox



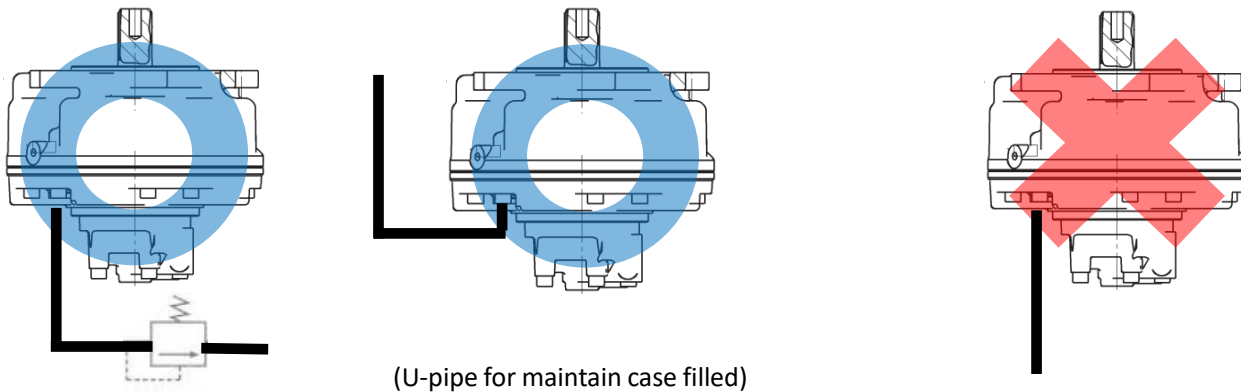


2) Drain line installation

A. After install, the motor onto the chassis of machine, locate drain line on the upper position.



B. If drain line cannot be located on upper position, follow below recommendations.



(Relief valve / Check valve)

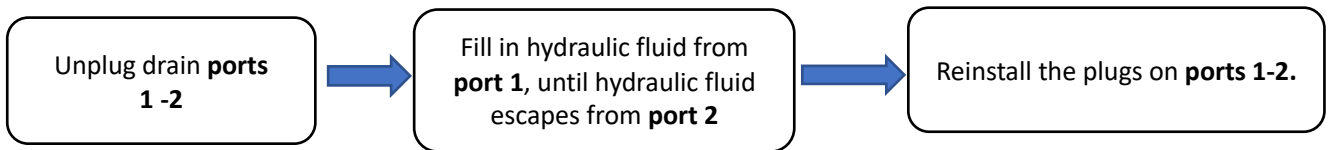
※ Hydraulic motor / planetary gearbox drains ports ① and ② are equal size.

※ Verify piping specifications (nominal diameter, length, pressure, ...) are within allowable limits.

3) Filling in motor case

a) *In case of motor only*

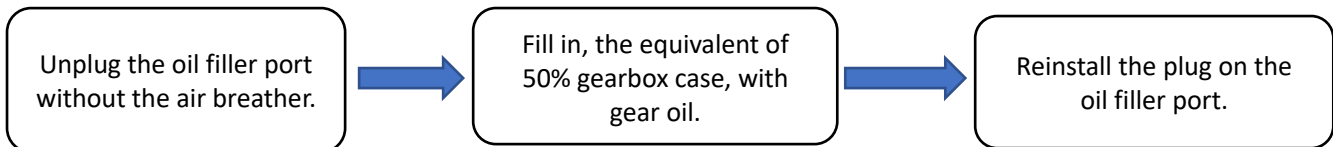
- Locate motor's end shaft vertically from floor.
- Prepare the necessary hydraulic fluid for fill in completely the motor case.
- Procedure to fill in motor is as follows.



✘ Avoid trapped air filling in the motor case intervals.

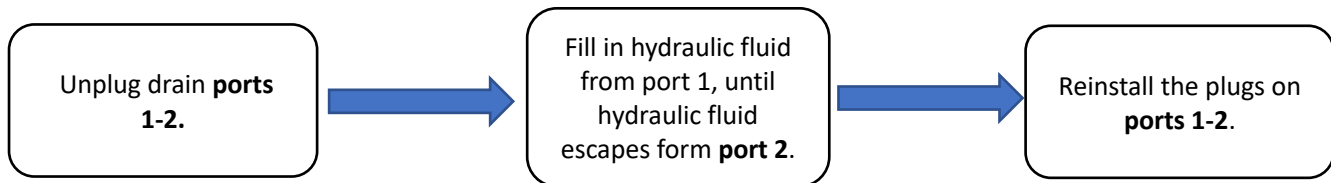
b) *Hydraulic motor with gearbox with separated case oil*

- Locate gearbox's end shaft vertically from floor.
- Prepare the necessary hydraulic oil to fill in 100% of the hydraulic motor, and gear oil to fill in 50% of the gearbox case.
- Refer to (6-3) – (1) to fill in the hydraulic motor case.
- Procedure to fill in gearbox is as follows.



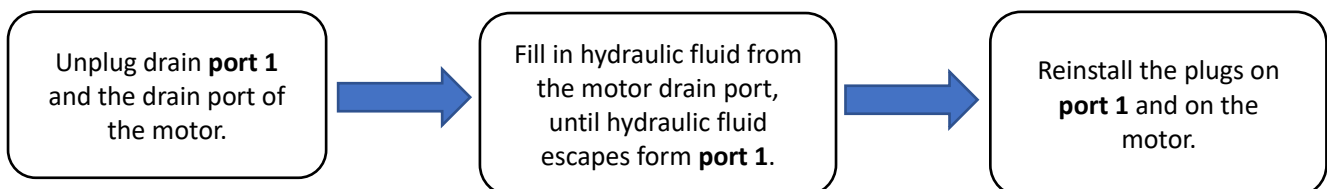
c) *Hydraulic motor with gearbox with shared oil.*

- Locate gearbox's end shaft vertically from floor.
- Prepare the necessary hydraulic oil to fill in 100% of the hydraulic motor gearbox.
- Clean the surfaces of the gearbox mounting flange and the mating surface of the machine.
- Procedure to fill in motor / gearbox is as follows.



An alternative procedure:

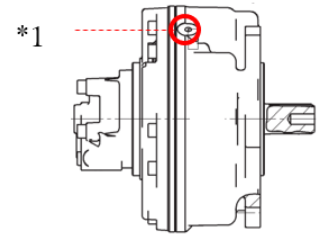
- Locate gearbox's end horizontally, with the drain port on the motor and on the gearbox in the upper part.
- Prepare the necessary hydraulic oil to fill in 100% of the hydraulic motor and gearbox.
- Clean the surfaces of the gearbox mounting flange and the mating surface of the machine.
- Procedure to fill in motor / gearbox is as follows.



- ⊗ Avoid trapped air filling in the motor case in intervals.
- ⊗ Keep plugged both ports of gearbox case during the whole operation.

## 7. HOW TO ASSEMBLY / RUNNING-IN / DISASSEMBLE.

### 1) Shaft end drive units



#### A. Procedure to assembly the motor:

No.	Procedure
1	After filling the motor case, mount an eyebolt on the metric thread *1.
2	Use the eyebolt for lifting the motor with safety measures.
3	If end shaft is spline type, lightly grease or lubricant oil around the splines. ⊗ Recommend molybdenum disulfide grease.
4	Locate the motor shaft perfectly centered to machine shaft.
5	Assembly the motor onto chassis of machine, without applying any load to end shaft.
6	Secure the motor with mounting bolts and nuts. ⊗ Refer section 13) for tightening torques according to DIN 267.
7	Assembly and tighten drain port connector [Straight fitting BSPP (G) or flange SAE J518]
8	Assembly and tighten drain port connector [ Straight fitting BSPP (G)]
9	Ensure hydraulic motor case is fully filled.
10	Connect piping to connectors following manufacturer's instructions.

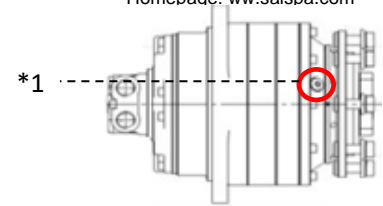
⊗ Gearbox oil drain is only used when an extra flushing flow is supplied.

#### B. Procedure to running-in:

No.	Procedure
1	Start the machine unloaded.
2	Bleed air running the hydraulic motor at minimum load (speed and torque), for at least 20 minutes.
3	Verify external leakages all around hydraulic motor and gearbox.  SAI recommends using an oil leak detection spray.
4	Load the machine at the continuous working conditions.
5	Check if anomalous noise or leakages occurs from hydraulic motor or gearbox.
6	Running- in completed.

C. Procedure to disassemble: Follow section (7 – 1) – (1) on reverse order.

2) Complete wheel drive units



A. Procedure to assembly the motor:

No.	Procedure
1	After filling the motor case, mount an eyebolt on the metric thread *1.
2	Use eyebolt for lifting the motor with safety measures.
3	Clean the surfaces of the motor mounting flange and mating surface of the machine.
4	Locate the motor shaft perfectly centered to machine shaft.
5	Secure the motor with studs and nuts. ✂ Refer section 13) for tightening torques according to DIN 267.
6	Assembly and tighten main ports connectors [Straight fitting BSPP (G) or flange SAE J518].
7	Assembly and tighten drain port connector [Straight fitting BSPP (G)]
8	Ensure hydraulic motor case is fully filled.
9	Connect piping to connectors following manufacturer's instructions.

✂ Gearbox oil drain is only used when an extra flushing flow is supplied.

B. Procedure to running-in:

No.	Procedure
1	Start the machine unloaded.
2	Bleed air running the hydraulic motor at minimum load (speed and torque), for at least 20 minutes.
3	Verify external leakages all around hydraulic motor and gearbox. SAI recommends using an oil leak detection spray.
4	Load the machine at the continuous working conditions.
5	Check if anomalous noise or leakages occurs from the hydraulic motor or gearbox.
6	Running-in completed.

C. Procedure to disassemble: Follow section (7-2) – (1) on reverse order.

## 8. MAINTENANCE

### 1) General

Ensure periodically the proper tightening torque of mounting bolts between motor and machine.

### 2) Hydraulic motor

Hydraulic motor's bearing lifetime is determined based on the working conditions. Consider an overhaul before its failure.

For precise lifetime calculations, consult with SAI technical department.

Only for variable displacement motors: every 2000 hours perform a sensor reset of the controller.

### 3) Planetary gearbox:

- A. Periodic disposal of lubricating fluid (gear oil) and replace them with new gear oil.  
According to operating conditions.
- B. Recommended standard oil replacement timing:
  - First time: during the 500 hours
  - Service interval: Every 2500 hours
- C. Hydraulic motor's bearing lifetime is determined based on the working conditions.  
Consider an overhaul before its failure.  
For precise lifetime calculations, consult with SAI technical department.

## 9. STORAGE METHOD / INTERVAL

Do not store the radial piston motor full of oil without a breath valve (opening pressure max 5 bar). Because the temperature the internal pressure could increase (increase the volume) and damage the body.

### 1) Storage method

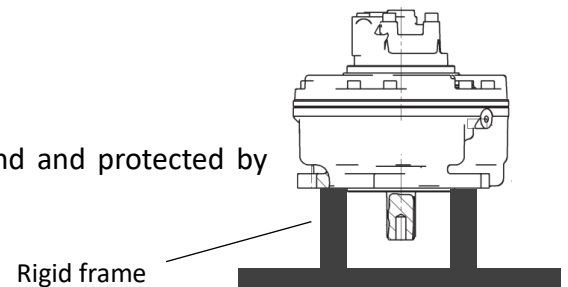
(1) If motor must be stored:

- A. Store them in the original wooden boxes.
- B. Storage indoors with low humidity and controlled environmental temperatures (ideal range +5°/+20° C).
- C. Store wooden boxes on a flat surface and safe from potential shocks.

(2) Motors stored for a short period of time without original wooden boxes:

#### ① SHAFT END DRIVE UNITS

- A. Avoid contact or loading shaft at any time.
- B. Locate unit so the shaft is not touching the ground and protected by shocks.



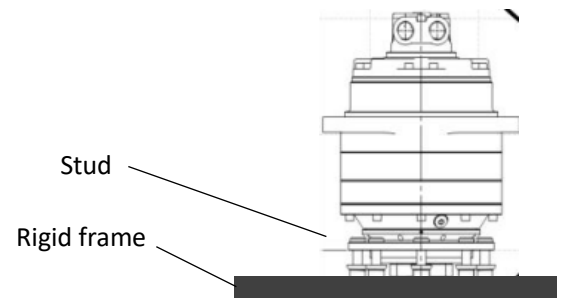
#### ② COMPLETE WHEEL DRIVE UNITS

- A. Locate unit on a flat surface, keep unit weight on studs protected by nuts screwed.

### 2) Storage internal – Recommended storage conditions

Recommended storage conditions

- A. Keep all ports plugged.
- B. Maintain case filled with hydraulic fluid.
- C. Paint the outside of the motor




#### ✘ Cautionary points:

For particularly long storage or aggressive environment (example: marine environment), consider filling the case with hydraulic oil HV 46 with anticorrosive additives.

Before using the unit, remove the storage oil and refill the case with hydraulic fluid.



## 10. TIGHTENING TORQUE (ACCORDING NORMATIVE DIN267)

				Technical Datasheet Tabella Tecnica										Tab.05	
				METRIC SYSTEM BOLT TORQUE SETTINGS COPPIE DI SERRAGGIO PER VITI METRICHE										REV.	2
<b>NORM NORMA</b>  <b>DIN 267</b>				<b>PITCH PASSO</b>		CLASS OF RESISTANCE   CLASSE DI RESISTENZA									
						5.8		6.8		8.8		10.9		12.9	
bolt Ø Ø vite ↓ hexagon esagono mm coarse grosso mm fine fine mm				5S		6S		8G		10K		12K			
				PITCH	PASSO	PITCH	PASSO	PITCH	PASSO	PITCH	PASSO	PITCH	PASSO		
				coarse grosso Nm	fine fine Nm	coarse grosso Nm	fine fine Nm	coarse grosso Nm	fine fine Nm	coarse grosso Nm	fine fine Nm	coarse grosso Nm	fine fine Nm		
M2	4	0.4	-	0.2 0.2	-	0.2 0.3	-	0.3 0.4	-	0.4 0.5	-	0.5 0.6	-		
M2,5	5	0.45	-	0.4 0.5	-	0.5 0.6	-	0.6 0.8	-	0.9 1.1	-	1.1 1.3	-		
M3	5.5	0.5	-	0.7 0.8	-	0.8 1.0	-	1.1 1.3	-	1.5 1.9	-	1.8 2.3	-		
M3,5	6	0.6	-	1.1 1.3	-	1.3 1.5	-	1.7 2.1	-	2.4 2.9	-	2.8 3.5	-		
M4	7	0.7	-	1.6 1.9	-	1.9 2.3	-	2.5 3.1	-	3.5 4.3	-	4.2 5.2	-		
M5	8	0.8	-	3.1 3.8	-	3.7 4.5	-	4.9 6.0	-	6.9 8.5	-	8.3 10.0	-		
M6	10	1.0	-	5.3 6.5	-	6.4 7.8	-	8.5 10.0	-	12.0 15.0	-	14.0 18.0	-		
M7	11	1.0	-	8.7 11.0	-	10.0 13.0	-	14.0 17.0	-	20.0 24.0	-	24.0 29.0	-		
M8	13	1.25	1.0	13.0 16.0	14.0 17.0	15.0 19.0	16.0 20.0	20.0 25.0	22.0 27.0	29.0 35.0	31.0 38.0	34.0 42.0	37.0 46.0		
M10	17	1.5	1.25	25.0 31.0	26.0 33.0	30.0 37.0	32.0 39.0	40.0 50.0	42.0 53.0	57.0 70.0	59.0 74.0	68.0 84.0	71.0 89.0		
M12	19	1.75	1.5	43.0 53.0	45.0 56.0	52.0 64.0	54.0 67.0	69.0 85.0	72.0 89.0	97.0 119.0	101.0 125.0	116.0 143.0	121.0 150.0		
M14	22	2.0	1.5	68.0 84.0	74.0 92.0	82.0 101.0	89.0 111.0	110.0 135.0	118.0 148.0	154.0 190.0	166.0 208.0	185.0 228.0	199.0 250.0		
M16	24	2.0	1.5	106.0 132.0	112.0 141.0	128.0 159.0	135.0 170.0	128.0 212.0	180.0 226.0	240.0 298.0	253.0 318.0	287.0 357.0	303.0 382.0		
M18	27	2.5	2.0	147.0 182.0	155.0 194.0	176.0 218.0	186.0 233.0	235.0 290.0	248.0 310.0	330.0 402.0	349.0 436.0	397.0 490.0	419.0 523.0		
M20	30	2.5	2.0	208.0 258.0	217.0 273.0	249.0 310.0	261.0 327.0	332.0 413.0	347.0 436.0	467.0 580.0	489.0 614.0	561.0 697.0	586.0 736.0		
M22	34	2.5	2.0	284.0 355.0	296.0 373.0	341.0 426.0	355.0 448.0	454.0 568.0	474.0 597.0	639.0 798.0	666.0 840.0	767.0 958.0	799.0 1.008.0		
M24	36	3.0	2.0	359.0 446.0	386.0 488.0	431.0 535.0	463.0 586.0	574.0 714.0	617.0 781.0	808.0 1.004.0	868.0 1.098.0	969.0 1.204.0	1.041.0 1.317.0		
M27	41	3.0	2.0	525.0 656.0	561.0 712.0	630.0 788.0	673.0 855.0	840.0 1.050.0	897.0 1.139.0	1.181.0 1.477.0	1.261.0 1.602.0	1.418.0 1.772.0	1.513.0 1.923.0		
M30	46	3.5	2.0	716.0 893.0	780.0 994.0	859.0 1.072.0	936.0 1.193.0	1.146.0 1.429.0	1.248.0 1.590.0	1.611.0 2.009.0	1.754.0 2.236.0	1.933.0 2.411.0	2.105.0 2.648.0		
M33	50	3.5	2.0	968.0 1.213.0	1.045.0 1.335.0	1.162.0 1.456.0	1.254.0 1.602.0	1.549.0 1.941.0	1.673.0 2.136.0	2.179.0 2.792.0	2.351.0 3.004.0	2.614.0 3.275.0	2.821.0 3.605.0		
M36	55	4.0	3.0	1.248.0 1.561.0	1.310.0 1.658.0	1.498.0 1.873.0	1.572.0 1.989.0	1.997.0 2.497.0	2.096.0 2.652.0	2.809.0 3.511.0	2.948.0 3.730.0	3.370.0 4.213.0	3.537.0 4.476.0		
M39	60	4.0	3.0	1.615.0 2.026.0	1.690.0 2.144.0	1.938.0 2.431.0	2.028.0 2.573.0	2.584.0 3.242.0	2.703.0 3.430.0	3.633.0 4.559.0	3.802.0 4.824.0	4.360.0 5.471.0	4.562.0 5.789.0		

The torque values are to be considered as reference only as they can vary depending on the kind of coupling (rigid, semi-rigid, elastic, etc.), on the material on which the bolts have to be fixed on, on the length of the bolt, on the kind of wrench used (impact wrench, friction wrench, continuous torque wrench, etc.), on the finishing condition of the thread, etc. Therefore it is advised to test the couplings to identify the most correct way to tighten them. In the event that the coupling is done with locknuts or self-locking nuts the value of the torque has to be increased by approximately 15%.

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