# SECTION 6 HYDRAULIC SYSTEM

# **GROUP 1 STRUCTURE AND FUNCTIONS**

#### 1. HYDRAULIC CIRCUIT



1) LIFT ASCENDING, TILTING REAR

When pulling lift and tilt operation lever, spools of first and second blocks move to position of lift ascending tilting backward. Hydraulic oil of hydraulic pump flows into main control valve to push rod check valve of spool to large chamber of lift cylinder and small chamber of tilt cylinder. At the same time, hydraulic oil from small chamber of lift cylinder and large chamber of tilt cylinder returns to hydraulic oil tank. This hydraulic oil flow forms lift ascending and tile backward.

2) LIFT DESCENDING, TILTING FORWARD

When pushing lift and tilt operation lever, spools of first and second blocks move to position of lift descending tilting forward. Hydraulic oil of hydraulic pump flows into main control valve to push rod check valve of spool to move to large chamber of tilt cylinder.

Large and small chambers of lift cylinder are connected to return path to let return of hydraulic oil, and mast descends with weight of forks.

Hydraulic oil from small chamber of tilt cylinder is returned to hydraulic oil tank. This hydraulic oil flow forms tilting forward.

## 2. HYDRAULIC GEAR PUMP

1) 25BE-X



\* Seal kit: 7,8,9,11



- 1 Cover-Front
- 2 Cover-Rear
- 3 Body-Middle
- 4 Main Gear
- 5 Slave Gear
- \* Seal kit: 7,8,9,11

- 6 Plate
- 7 Ring-Retain
- 8 Oil Seal
- 9 Ring-Seal

- 10 Bush
- 11 3 Type Seal
- 12 Washer
- 13 Bolt

# 3. MAIN CONTROL VALVE



Port	Port name	Dimonsions	Fastening torque	
		Dimensions	kgf∙m	
A1	Lift	M20*1.5	5	
A2, B2	Tilting	M20*1.5	5	
A-, B-	Aux.	M20*1.5	5	
Р	Inlet	M22*1.5	7	
Т	Outlet	M22*1.5	7	
PT	Gauge, pilot	PT1/8	1.5	
PF	PF	M16*1.5	3	
LS	LS	M12 <sup>*</sup> 1.5	1.5	

#### 2) FUNCTIONS

Emergency mast lowering.

In case that the mast can't be lowered due to a problem in the controller, activate the emergency lowering valve on the MCV assy by rotating the valve (a).

- A Manual override features are intended for emergency use, not for continuous-duty operation.
- Loosen and remove the MCV cover connecting bolts.

Tightening torque :1.5 - 1.8 kgf • m

- ② Use the L-wrench (5 mm) to loosen the bolts counterclockwise until lowering of the mast begins.
- ※ Do not undo the bolts more than 1.5 turns.
- If lowering still does not begin, there is a mechanical block. Do not under any circumstances continue to unscrew the emergency lowering feature.
- ③ After lowering is complete, the valve must be screwed back in again.
- \* Do not exceed a tightening torque of maximum 1.8 kgf-m.
- A When operating the emergency lowering valve in order to lower the mast inevitably, always make certain that any person should not stand or pass under the mast, the fork and platform so as to avoid from unexpected accident such severe personal injury or death.





Cutoff solenoid for blocking hydraulic pressure

This equipment is a mast interlock that preventing activation of hydraulic functions of main control valve until operator sits on the seat. The system is also a key-lowering interlock system that prevents fork descending while start key is kept on OFF position. This safety function is defined in ISO 3691-1, and should not discretionally be deactivated on main control valve.

#### Relief valve

① Primary relief valve (DV1)

Primary relief valve limits max. pressure of lifting and tilting function. When lifting or tilting function operates simultaneously with aux. function, max. pressure of lifting or tilting function is limited by pressure setup of secondary relief valve. Primary relief valve does, typically, not require field adjustment. Refer to testing and adjustment of relief valve for further information of adjustment.

② Secondary relief valve (DV2)

Secondary relief valve limits max. pressure of aux. (attachment) function, and pressure setting of the valve is lower than primary relief valve. Secondary relief valve may require pressure adjustment dependent upon types of attachments. If it is required to adjust pressure, adjustment within 90% of primary relief valve pressure is recommended (e.g.,  $200 \times 0.9=180$  bar). If pressure of secondary relief valve is too close to pressure of primary relief valve, interference

between circuits may take place. Refer to testing and adjustment of relief valve for further information of adjustment. Up to 2 optional functions are provided.

#### 3) RELIEF VALVE PRESSURE TESTING AND ADJUSTMENT

Test specifications

- Hydraulic motor speed: High rpm
- Oil temperature:  $50\pm5^{\circ}$ C (122 $\pm9^{\circ}$ F)
- Relief valve pressure setting
  - > Primary : 195+5bar
  - Secondary :160+5 bar
  - Tools : lock nut 17mm, internal hex 5mm
- A Primary relief valve (DV1) should not be used for pressure boosting at field. When boosting pressure of primary relief valve higher than specified setting, system may be damaged.
- A Check relief valves in safe and clean environment.
- A Make sure there is no bystanders or other workers in the vicinity of system during operation and testing.
- A Pressurized hydraulic oil may remain in hydraulic system after turning off. Fully lower folks onto the ground to prevent personal safety accident. Loosened mast chain indicates fully lowering of forks.
- ▲ Turn engine off before disassembling, fastening, removing or adjusting piping parts (e.g., fitting, plug and hose), and fully move main control valve lever forward and backward two or three times to fully discharge hydraulic oil from circuits. Open tank oiling cap to relieve pressure. When air breather filter inside hydraulic oil tank is clogged, pressure may reside inside tank.
- A Hot hydraulic oil may cause severe burn. Never touch components or hydraulic oil during testing. Make sure that hydraulic oil is cooled down to safe temperature before installing or removing testing systems.
- A Your skin may contact with pressurized hydraulic oil. Fully lower forks onto the ground before removing test plug from valve, and then relieve pressure from all of circuits.
  - ① Operate hydraulic system until oil temperature reaches specified value in test specifications.
  - ② Lower forks onto the ground, stop engine, and then apply parking brake.
  - ③ Open cover of main control valve.
  - ④ Connect pressure gauge to pressure check port (G) of main control valve.
  - (5) Operate pump motor in accordance with test specifications.
  - 6 Pull lift lever to raise forks to the top, and keep the conditions as they are.
  - O Read pressure gauge. Compare value on the gauge with specifications.
  - ⑧ Loosen lock nuts of main control valve and relief valve, and turn adjustment screw to adjust pressure.
    - Fastening torque :3.8 kgf m
    - If pressure is lower than specification, turn relief valve adjustment screw clockwise.
    - If pressure is higher than specifications, turn relief valve counterclockwise.
  - Adjustment screw of MCV relief valve is very sensitive. Rotate the screw by a quarter turn to prevent overpressure.

4) PREFERENTIAL VALVE



The priority valve is integrated into the main valve. The valve is affected by the LS signal on the steering device to ensure that sufficient oil is supplied to the steering circuit. The valve maintains a constant steering force and speed to resist changes in the pump hydraulic oil supply flow, and first supplies hydraulic oil to the steering circuit.

# 4. LIFT CYLINDER

1) V MAST



2) VF MAST





5. TILT CYLINDER



## 6. PRE-LIFT CYLINDER

1) VF AND TF MASTS (30/35BE-X)



2) TF MAST (25BE-X)



# **GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING**

#### 1. OPERATIONAL CHECK

- 1) INSPECTION ITEMS
  - Visually check rod for deformation, crack or destruction.
  - Place mast in horizontal direction, and lift it from the ground by 1 m. Measure hydraulic drift (distance for fork lowering, and mast tilting forward) 10 minutes later.
     Inspection conditions
    - Hydraulic oil temperature:  $45\pm5^{\circ}$ C
    - Rated load
    - Mast kept vertical
    - · Hydraulic drift
    - Lowering: Within 100 mm
    - Tilting forward: Within 5° or 40 mm
  - ③ If hydraulic drift is greater than specified value, replace control valve or cylinder packing.





- 2) HYDRAULIC OIL
  - Make use of dipstick to measure oil level, and make it up, if required.
  - ② Clean suction strainer fixed on outlet port pipe with screw when exchanging hydraulic oil.



3) MAIN CONTROL VALVE

Raise forks to the highest position, and measure hydraulic pressure. Make sure that pressure of hydraulic oil is 210 bar.

## 2. FAILURE DIAGNOSIS AND TROUBLESHOOTING

## 1) HYDRAULIC SYSTEM

Trouble	Possible cause	Troubleshooting	
Sudden drop of forks	· Defective seal inside control valve	· Replacing spool or valve body.	
	· Oil leak from joint or hose.	· Replacing	
	· Defective seal inside cylinder.	· Packing exchange.	
Large tilting angle by	· Leaning backward: Defective check valve.	· Cleaning or replacing.	
tare weight of mast	· Leaning forward: Defective tilting lock valve.	· Cleaning or replacing.	
	· Oil leak from joint or hose.	· Replacing.	
	· Defective seal inside cylinder.	· Seal replacing.	
Slow speed of fork	· Insufficient hydraulic oil.	· Oil making up.	
lifting or mast tilting	· Intrusion of air in hydraulic oil.	· Air bleeding	
	· Oil leak from joint or hose.	· Replacing.	
	· Excessive restriction on oil flow on pump	· Filter cleaning.	
	suction.		
	$\cdot$ Relief valve failed in keeping at specified	· Relief valve adjusting.	
	pressure.		
	· Defective seal inside cylinder.	· Packing exchange.	
	· High viscosity of hydraulic oil	· Replacing with ISO VG46.	
	· Mast not moving smoothly.	· Adjusting rolls in rail interval	
	· Oil leak on lift control valve spool.	· Replacing spool or valve body.	
	· Oil leak on tilting control valve spool.	· Replacing spool or valve body.	
Abnormal noise from	· Excessive restriction on oil flow on pump	· Filter cleaning.	
hydraulic system	suction.		
	· Defective hydraulic pump gear or	· Gear or bearing replacing.	
	bearing.		
Control valve lever	· Foreign substance between spool and valve	· Cleaning.	
locked	body.		
	· Defective valve body.	$\cdot$ Evenly tightening body mounting	
		bolt.	
Rise of oil temperature	· Insufficient hydraulic oil.	· Oil making up.	
	· High viscosity of hydraulic oil.	· Replacing with ISO VG46.	
	· Oil filter clogged.	· Filter cleaning.	

## 2) HYDRAULIC GEAR PUMP

Trouble	Possible cause	Troubleshooting	
Oil leak from oil	· Backlashing	· Rotating pump in correct direction	
seal	· Abnormally high pressure on suction port	· Keeping pressure proper	
	· Seal damaged by foreign substance	· Replacing oil seal with new part	
	· Damage or abrasion of seal of shaft	· Centering adjustment.	
	· Defective centering of shaft	· Pump replacing.	
Oil leak on	· Bolt loosened or damaged on cover and body	· Bolt fastening or keeping pressure	
cover or body		proper.	
interface	· Deterioration or damage of oil seal by	· Replacing gasket with new part	
	thermosetting of gasket		
Oil leak on port	· Port fitting damaged or loosened	· Port tightening and keeping design	
		pressure intact	
	· Port seal damaged	· Port seal replacing	
	· Port damaged	· Pump replacing	
Discharge flow	· Insufficient oil in tank	· Suppling oil of proper type and capacity	
insufficient, or		into tank, and cooling system replacing.	
pressure not	$\cdot$ Internal oil leak by abnormally high pressure,	· Exchanging contaminated oil.	
established	or improper oil viscosity		
	· Capability degraded by oil contamination	$\cdot$ Using suction pipe of proper length and	
		width, and replacing filter to prevent	
		negative pressure.	
	· Cavitation by negative pressure	· Suction valve opening	
	<ul> <li>Internal part destructed</li> </ul>	· Pump replacing	
	· Backlashing	· Rotating pump in correct direction, and	
		preventing abnormally high temperature	
		on suction side.	
Rise of tank or	· Abnormal heat generated by frequent	· Setting to proper pressure.	
oil temperature	operation of pressure control valve		
	· Internal part destructed	· Pump replacing.	
Noise and	· Poor mounting	· Centering adjustment	
vibration	· Cavitation	$\cdot$ Using suction pipe of proper length and	
		width, and replacing filter to prevent	
		negative pressure.	
	· Air induced	$\cdot$ Filling tank with oil, and preventing air	
		inducing with suction pipe.	
	$\cdot$ Vibration of piping or mounted flange	$\cdot$ Reinforcing pipe and mounting flange,	
		and preventing resonance.	
	· Chattering of relief valve	· Replacing relieve valve.	
	<ul> <li>Internal part destructed</li> </ul>	· Pump replacing.	

\* Capability of disassembled pump may not be restored after reassembling.

\* If pump is destructed, replace the assembly.

\* If it is inevitable to disassemble pump, consult with the authorized shop or dealer of HD HYUNDAI.

## 3) LIFT CYLINDER

Trouble	Possible cause	Troubleshooting	
Oil leak on rod cover through rod	· Foreign substance on packing.	· Packing replacing.	
	· Severe flaw on rod.	· Grinding rod surface with oil stone.	
	$\cdot$ Abnormal distortion of dust seal.	· Dust seal replacing.	
	· Chromium plating damaged	· Rod replacing.	
Oil leak on cylinder rod cover	· O-ring damaged.	· O-ring replacing.	
thread			
Rod shrunken	$\cdot$ Flaw on internal surface of tube.	$\cdot$ Grinding rod surface with oil stone.	
	$\cdot$ Very serious flaw on internal	· Cylinder tube replacing.	
	surface of tube.		
	· Foreign substance into piston seal.	· Piston seal replacing.	
Abrasion (play between cylinder	· Serious play between cylinder	· Abrasion ring replacing.	
tube and abrasion ring)	tube and abrasion ring.		
Abnormal noise when tilting	· Insufficient lubricant on anchor pin	· Applying lubricant or replacing.	
operation	or bushing or pin abraded.		
	· Tilt cylinder rod bent.	· Replacing.	

# **GROUP 3 DISASSEMBLY AND ASSEMBLY**

Always work in clean environment, and comply with the followings:

- Make sure that there is no damage of parts immediately after accepting them.
- All of components should be cleaned with solvent, and dried with compressed air before reassembling.
- Care should be exercised for protecting rubber seal from damage.
- Care should be exercised for protecting precise-machined surface from damage.
- Components should be inserted into housing not exercising large force. If large force is required, dimensional tolerances of parts are not complied with or misaligned.
- If force of hands is not sufficient, use press or rubber mallet.
- Never strike part with iron hammer.
- Proper press should be used for metal bushing.
- Do not use mallet for mounting bearings.
- Always pay attention to rotation direction when assembling parts.

#### 1. MAIN CONTROL VALVE



- 1 Main relief valve
- 3 Steering relief valve
- 5 To steering unit LS port

- 2 2 nd relief valve
- 4 To steering unit P port

#### 2) DISASSEMBLING AND ASSEMBLING



- ① Hydraulic oil model: N32 hydraulic oil
- ② During handling, installation and storage, avoid collision and damage to the processing oil port.
- ③ It is not allowed to disassemble and assemble in dusty places before installation to prevent dirt from entering.
- ④ Before use, check whether the rated pressure, spool valve function, oil circuit type and function meet the system requirements.
- ⑤ The mounting plate and bracket shall be flat, and the tightening force of the mounting screws shall be uniform, and the valve shall not be twisted.
- (6) The working fluid should be clean, and the cleanliness of the fluid should reach NAS 1638 level 10 or above.
- ⑦ Allowable oil temperature: 20 ℃~80 ℃.
- ⑧ Connect the oil ports correctly, and the pipeline should not be too thin or too long.
- ③ On the premise that the user complies with the rules of storage, use, installation and transportation, the factory implements "three guarantees" in case of failure due to manufacturing quality problems within one year from the date of delivery.

## 2. LIFT CYLINDER



Model	Inner diameter	Outer diameter	Stroke	Rod (outer diameter)
25BE-X	50 mm	58 mm	1630 mm	40 mm
30/35BE-X	55 mm	63 mm	1630 mm	45 mm

#### 2) DISASSEMBLING

Hold cylinder tube in vice, and loosen and remove cylinder head.

Remove space from cylinder tube, and pull bushing out. Connect wrench to the hole of retainer at the end of piston, and turn the wrench. Lift the edge of guide and turn guide to move guide.



#### 3) CHECKING AND INSPECTION

Inspection items	Standard dimensions	Limit on repair	Troubleshooting
Gap between cylinder rod and bushing	0.072 - 0.288mm	0.5mm	Bushing Replacing
Gap between piston ring and tube	0.05 - 0.030mm	0.5mm	Piston ring Replacing

#### 4) ASSEMBLING

Put piston ring in hydraulic oil of 40-50°C, and expand inner diameter of the ring, and assemble it on piston. Install piston seal. Bend and turn the edge of guide install guide.



## 3. TILT CYLINDER



Model	Inner diameter	Outer diameter	Stroke	Rod (outer diameter)
All of models	75mm	87mm	129mm	35mm

### 2) DISASSEMBLING

Hold flat area on the bottom of cylinder tube in vice, mark fastening torque on the end of rod head, and then separate rod head. Hook wrench on the notch of cylinder head, and then separate cylinder head from cylinder tube.

Wind valleys of thread of rod with adhesive tape to protect dust seal and rod seal inside cylinder head from damage.



#### 3) CHECKING AND INSPECTION

Inspection items	Standard dimensions	Limit on repair	Troubleshooting
Gap between cylinder rod and bushing	0.072 - 0.288mm	0.5mm	Replacing bushing
Gapbetweenrodhead bushing and pin	0.10 - 0.35mm	0.6mm	Replacing bushing