Model: PAH-275HP

PAH Triplex Single Acting Mud Pump

Instruction Manual

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Preface

In order to help the users to get familiar with the design features and performance of the slush pumps of our make, this manual gives a detailed description of the technical specifications, construction, installation, operation, maintenance, storage, etc. of the PAH triplex slush pumps for the guidance of the operators and repairmen in their work.

Reading this manual carefully and abiding by the requirements specified herein are of importance to ensuring a normal operation of the pumps and extending their service life.

The front and rear sides, the right and left sides of the pump are determined by viewing the pump from the back of the power end, looking toward the fluid end.

1. Technical specifications

Type Parameter	PAH
Input power rating (KW)	205 (275HP)
Rated pump speed (SPM)	175
Stroke (mm)	203.2(8”)
Gear ratio	4.7
Rated speed of transmission shaft (RPM)	823
Max. working pressure (MPa)	21.9 (3118PSI)
Valve size (API)	4#
Max. liner diameter (mm)	Φ127 (5”)
Max. displacement (GPM)	357(1351L)
Max. liner pressure (MPa)	7.9(1122PSI)
Diameter of suction pipe (mm)	158 ($6^{1}/_{4}$”)
Diameter of discharge pipe (mm)	58 ($2\ ^{9}/_{32}$”)
Overall dimensions（with steel skid,LXWXH）	3120x1695x1280mm($122^{3}/_{4}$”x$66^{3}/_{4}$”x$50^{3}/_{8}$”)
Weight （ton）(with skid)	5.0T(11028LB)

PAH Pump Performance Data

Dia. of Liner	IN	5”	4-1/2”	4”	3-!/2”	3-1/4”	3”
Displacement	Gallon/Minute	357	289	228	175	151	128
	Liter/Minute	1351	1094	863	662	572	485
Discharge	PSI	1122	1386	1753	2290	2657	3118
Pressure	MPa	7.9	9.7	12.3	16.1	18.7	21.9

2. Design features

2.1 The power end

2.1.1 The pump frame is of welded whole body ductile cast iron construction. They are stress–relieved through heat aging after welded.

2.1.2 The crankshaft is alloy ductile cast iron and of symmetrical construction.

2.1.3 The pinion shaft is helical gears in pair respectively. The surface of the bull gear and pinion shaft are hard.

2.1.4 The crosshead is a one–piece casting and runs directly in the guides.

2.1.5 All the bearings, crossheads and guides are double lubricated with splash and force.

2.1.6 Gear lubrication pump may be equipped aside the pump body depending on the oil pressure of lubrication line (never lower than 2.0kg during working).

2.1.7 The jackshaft is equipped with double–row radial spherical–roller bearings.

2.1.8 The main bearings are double–row radial spherical–roller bearings.

2.1.9 The crosshead is equipped with copper bushing bearings.

2.1.10 The big end of the connecting rod runs in copper bush bearing.

2.2 The fluid end

2.2.1 The fluid end is composed of three fluid modules (cylinders), each of which is a sectional and communicating construction. The suction and discharge are accomplished by suction and discharge pipes. The suction and discharge valves are vertically aligned with each other to minimize the volumetric clearance.

2.2.2 There is clamp connection between the piston rod and the intermediate rod, which facilitates the services of these parts.

2.2.3 The piston liner is pressed by the liner seat, which is attached to valve box with bolts.

2.2.4 The threaded cover of the valve box is of acme thread connection, which facilitates the services of them. Suction valve is supplied with valve retainer and valve guide, which facilitate its service.

2.2.5 The taper of the valve seat is 1:6. The bottom of the seat is provided with a shoulder to be suitable for high pressure. Conform to API Spec 7K.

2.2.6 The piston rod conforms to APE Spec 7K. The piston is fastened with 1-1/2” locknut and is lubricated and cooled by the water or the water with inhibitor supplied by a centrifugal spray pump.

2.2.7 There are six sizes of liners in I.D. All these liners are the same in O.D.

2.2.8 There are two types of liners: high-grade liner and plain liner. The high–grade liner is made of carbon steel as a base metal, which is casted or inserted with high–chrome alloy–steel to ensure wearability. The plain liner is made of low–carbon steel which is carburized and quenched inside to enhance the surface hardness.

2.2.9 There are suction inlets in front of and on both sides of the pump, which are connected to the suction manifold. The suction flanges are of 6.25" ASAB16.5-150PSI.

2.2.10 The discharge pipe and discharge flange are of $2^{9}/_{32}$" 5000PSI.

2.2.11 The discharge pulsation dampener is spherical and pre–pressured. Its Max. working pressure is 5000PSI, and volume is 18 litres (5 gallons). The pulsation dampener can make discharging more smooth.

2.2.12 It is advisable to equip a charging pump during operation to improve the suction performance and raise the efficiency of the slush pump.

2.2.13 It is advisable to equip a spray pump during operation to cool the pistons and liners so as to extend their service life.

3. Installation

Prior to installation, a proper layout plan shall be prepared to indicate the position of the slush pump, charging pump and spray pump as well as the disposition of the suction and discharge manifolds.

The slush pump shall be provided with a centrifugal charging pump to enhance the pump efficiency. There shall be a metallic slush sump above the ground, and the suction manifold shall be as short as possible to improve the suction condition.

3.1 Foundation

The slush pump shall be set on a level concrete foundation and the same oil level shall be kept in the left and right oil troughs of the power end so as to assure satisfactory distribution of oil to all parts to be lubricated. Especially in drilling vessels, the slush pump shall be properly leveled over the whole length. With the slush pump leveled, all the anchor bolts shall be tightened uniformly around the main base to secure the pump base against deformation, especially in case of belt or chain transmission, and some plates or bars may be used to fix the pump and prevent the pump from displacement.

3.2 Transmissions

A belt or chain transmission can be used for the slush pump. According to the actual

conditions the driven sheave or sprocket can be located on the left or right side, and the sheave to drive the spray and charging pumps will be mounted on the other side. The rotation direction of running centrifugal spray pump or charging pump shall be the same as the designated directions for both spray and charging pumps otherwise it cannot be normally operated. The slush pump should be operated at a low speed to improve the suction condition, realize a smooth operation and prolong the service life of the expendable parts.

The spray pump or charging pump can be driven directly by an electric motor in proper direction.

3.3 The suction manifold

The ID of suction piping shall be at least as large as the inlet ID of the pump. Prior to installation, the suction manifold shall be thoroughly cleaned from inside. After installation, no leakage should be allowed at any connections. It is advisable to use as few valves or bends as possible. Always use full-opening valves, such as butterfly valves, and never use flow-limiting valve which may reduce the efficiency of the pump.

The slush pump should be provided with a charging pump to realize a smooth operation of the pump and extend the service life of expendable parts.The suction manifold shall be designed to be suitable for “dual” operation, permitting either “natural” suction or “charged” suction. The piping used for “natural” suction shall be as short as possible and preferably without bends. A suction pulsation dampener (desurger) should be connected with suction piping at either type of suction and shall be mounted as close as possible to the pump inlet.

There shall be a safety valve between the pump inlet and the outlet of the charging pump. The safety valve shall be adjusted to 5kg/cm^2 (70psi). It protects the charging pump from damage in the event of overpressure occurring in the suction manifold.

3.4 The discharge manifold

According to the field conditions, the discharge manifold can be installed on either the left or the right side of the pump. The inside diameter of the manifold is 65mm ($2^9/_{16}$"). A pressure relief valve shall be mounted near the discharge port of the pump to protect the pump against damage from overpressure. The valve shall be located ahead of any valve on the discharge manifold. In such a case, any unexpected starting of the pump in the event of closed valve will not damage to the pump. The discharge piping of relief valve shall be fastened securely and extended safely into the slush sump to avoid any accident resulting from high-pressure slush with the relief valve opened.

A pulsation dampener is mounted on the discharge manifold to reduce the fluctuation of the pressure of discharged fluid.

4. Operation

4.1 Preparations prior to starting

4.1.1 The Crankcase Oil Requirements attached .PAH pump with 110 litres (30gallon). The lubricant shall be inspected and changed at regular intervals to keep it clean. Be sure to keep the oil level up to upper limit when adding oil.

4.1.2 Prior to starting a new slush pump or restarting a pump stored for a long time, open the inspection hole on the pump and fill the pinion and gear oil–trough and the crosshead oil reservoir with lubricant. Then run the pump by hand for several revolutions to ensure prompt lubrication of parts with the lubrication spots full of oil. **Warning:** Prior to starting the pump, ensure that rotation direction of gear of transmission shaft is identical to the tag arrow on the frame.

4.1.3 Water or water–based rust–preventing cooling fluid shall be used to spray–cool the piston liners. The spray pump shall be started earlier than or simultaneously with the slush pump to avoid overheating of the pistons and liners.

4.1.4 The spray pump can be driven by the transmission (pinion) shaft with belts or directly by an electric motor.

4.1.5 If gear lubrication pum is used at power end, it can be driven by the transmission (pinion) shaft with belts or directly by an electric motor.

4.1.6 Inspect the pistons, liners and valves to see that they are assembled properly. Inspect also the discharge manifold to see that the valve thereon is open.

4.1.7 Open the valve on the suction manifold and start the centrifugal charging pump earlier than or simultaneously with the slush pump. The charging pump shall run in a condition without cavitations.

4.1.8 Prior to starting of the slush pump, it is advisable to fully fill the fluid modules with drilling fluid or water to prevent cavitations. No air cavity can be eliminated under pressure. For this purpose, open the valve towards the slush pump and run the pump in a condition of “small circulation” until air is removed so as to ensure smooth operation of the slush pump and to extend the service life of the valves and pistons.

4.1.9 Inspect that the safety pin of relief valve is inserted into the pin hole which has the relevant pressure with the liner.

4.2 Some points for attention after starting

4.2.1 Increase RPM of the pump gradually so that the fluid speed in the suction manifold may keep pace with the piston speed to prevent cavitations.

4.2.2 In the case of “natural suction”, the top speed of the slush pump is determined by an abundant suction of the pump in its suction stroke and is different from condition to condition, depending upon the design of the suction manifold and upon the effective head and upon the conditions of the drilling fluid such as its specific gravity, viscosity and air content. The operator can judge from the pump noise whether cavitations or poor suction occurs and can take action promptly.

4.2.3 For the charged suction, with the slush pump started, adjust the discharge valve of the charging pump to ensure adequate charging.

4.2.4 If the slush pump is equipped with a suction desurger, the latter shall be filled with air prior to starting of the slush pump (some 0.7kg/cm2 or 10psi). In the case of a horizontal pre-pressing desurger, with the slush pump running, the diaphragm position can be observed through the window of the desurger. The diaphragm can be positioned between the middle and button lines to undulate by increasing or reducing the internal pressure of the desurger.

4.2.5 As the spray pump is set horizontally, if no water flows from the pump, only need to remove the hose top at pump water-out end, and drain out air inside the pump, and water will flows.

4.2.6 Inspect the bearings, crossheads, guides, etc. for overheating or other abnormalities. Generally, the oil temperature shall not exceed 70℃. **Warnning: If oil temperature is too high, it is necessory to add heat exchanger on the external side of the pump body, and decrease oil temperature below 70℃.**

4.2.7 Operation Instructions for heat exchanger：the heat exchanger is Oil Cooler with Water-cooling Type.Use purified water as cooling water to avoid scale formation. Keep water temperature as low as possible and remain flow a little larger.Assure oil lateral pressure is larger than water lateral pressure.Keep eye on the outlet oil temperature and adjust water into the valve to secure oil cooling needs.When start the cooler, never to open quickly the water sunction valve, as large volume of cooling water going through the cooler will form a layer of “too-cool layer” on the surface of cooling tubes. “Too-cool layer” features bad thermal conductivity, and

will make the cooler function bad even if large water enters into the cooler. When water temperature rises up to 5℃-10℃, turn on the discharge valve for cooling water, and then gradually open the water suction valve to make water flow. At the same time turn on the oil discharge valve and gradually open the oil suction valve to ensure oil flows. Then adjust flow of water to keep oil temperature at working status.In winter, release out remaining water and oil in cooler to avoid frost cracking. Clean the cooler half-yearly. Use trichloroethylene to wash or immerse in carbon tetrachloride, untill the water flowing from the cooler becomes clean. Be careful to prevent poisoning during washing.

4.2.8 **Observe the pressure gauge reading for lubrication line at anytime and keep pressure over** 2.0KG/CM². If pressure decreases suddenly or always below 2.0KG/CM², it is possible that two ends seals of main bearing inside the crankshaft are damaged needs changing ,another filter element jammed and needs cleaning or changing,or oil circulating pump are damaged needs changing. By reducing the diameter of V sheave on the external gear pump, and increasing the pump flow, the oil line pressure can be increased.

5. Maintenance

5.1 Daily maintenance

5.1.1 The oil level at the power end shall be inspected once a shift with the slush pump stopped. In the case of chain transmission, the oil level in the chain box shall be inspected.

5.1.2 The operating conditions of the pistons and liners shall be frequently observed. A slight leakage due to by–passing is normal and is unlikely to indicate any wear of the pistons or liners. However, no leakage in excess is permissible.

5.1.3 The cooling fluid for the pistons and liners shall be frequently inspected, refilled and, if necessary, changed if it’s dirty. Dirty coolant will increase the wear of the pump, and shorten its service life.

5.1.4 The spray pipes for the liners shall be inspected once a day and, if necessary, dredged to ensure adequate cooling and lubrication of the pistons and liners.

5.1.5 When the slush pump is equipped with a suction desurger, it is advisable to check its internal pressure once a day to ensure that its air filling meets the specified requirement.

5.1.6 Check the pressure of the discharge pulsation dampener to ensure that its air filling meets the specified requirement.

5.2 Weekly maintenance

5.2.1 Remove the threaded cover of the valve and clear away any sludges or dirts from the threads of the threaded over and ring, and then coat them with thread lubricant to prevent its wear, scratch or jam. (Lead–base lubricant for thread is recommended).

5.2.2 Check the valve stem guide bush for wear and, if worn evidently, change it. Any guide bush out of round or oval bush will badly guide the valve stem and speed up the valve wear.

5.2.3 Check the valve and its seat for wear. Any worn or damaged valve seat shall be changed. Retighten the loosened valve nut.

5.2.4 Check the pistons and liners and change the worn or damaged piston or liner.

5.2.5 Change worn or damaged lock nut of the piston. The lock nut shall be changed if its locking fibre does not function.

5.2.6 If attached the five-way joint ,clean the filter screen in the five-way joint, and replace it when necessary.

5.3 Monthly maintenance

5.3.1 The oil sink at the power end shall be emptied of dirty oil every six months and refilled with new clean oil. Clean or replace the filter element.

5.3.2 Inspect the gaskets and seal rings at the power end and change damaged ones. Retighten the loose screws, especially the screws which fasten the sheaves or sprockets.

5.3.3 Check the clearance between the crosshead and guides every six months and change the crosshead if it is too large clearance.

5.3.4 Check all the studs and nuts at the fluid end for rightness, including those between gland flange and valve box, between valve box and frame and between liner seat and valve box.

5.4 Yearly maintenance

Check once a year or every two years all the bearings of the crankshaft, connecting rods, transmission shaft, and crossheads, for looseness. If necessary, carefully and thoroughly inspect the slush pump and take corrective action.

6. Assembling & dismantling

6.1 Assembling of the power end

6.1.1 Mount the transmission shaft assembly into the frame from the right or left side with the pinion and gear located to the two sides of the frame’s centerline. When mounting the oil

seals of the bearing's retainers of the transmission shaft, care shall be taken not to damage their sealing lips.

6.1.2 Mount the bushing on the big end of connection rod, and the copper sleeve on the small end.

6.1.3 Fasten the ring gear to the crankshaft with screws. Mount the bearing and bearing guard from two sides after main shaft installed into the crankshaft hole.

6.1.4 Configure lubrication system.

6.1.5 Combine crossheads, crosshead pins with con rods, and hang the assembly into the frame. Make sure the crosshead is sliding free on the guide. Hang the larger end of the con rod to upper central side. The three connecting rods centerlines of the crankshaft shall be aligned with those of the holes for the guides on the frame respectively.

6.1.6 Hang the crankshaft assembly into the frame and set the main shaft inside the main bearing seat. Fasten the connection rod cap with connection rod through bolts. Then adjust right the crankshaft gear along the transmission shaft. After adjustment, fasten the bearing cover with two nuts.

6.1.7 Adjust gear oil pump according to gear-driven, and fasten it.

6.1.8 Connect well lubrication system, and tighten bolts.

6.1.9 Mount the intermediate rods and their seal rings successively.

6.2 Dismantling of the power end

6.2.1 Remove the intermediate rod and its seals.

6.2.2 Remove the crosshead pin retainers. Pull out the right and left crosshead pins with the help of the threaded holes on the pins. The right and left crossheads can be taken out of the liner chamber. The middle crosshead can be either taken out of the liner chamber with its pin pulled out, or taken along with the crankshaft and connecting rod without pulling its pin out. Pull out the con rod bolts and remove press cover of con rod, and hang the larger end of con rod.

6.2.3 Unscrew the retainers of the bearing supports. Take out the upper cap of the bearing supports.

6.2.4 Remove the lubrication manifolds, oil filter, and gear oil pump.

6.2.5 Take out the crankshaft with the main shfat.

6.3 Assembling of the fluid end

6.3.1 Fluid modules (cylinders)

a) Mount the three assembled fluid modules on the frame and tighten the nuts connecting the fluid modules and the frame.
b) Prior to mounting the discharge manifold, clean out the locations concerned of three modules and mount the seal rings thereon. Clean out the three planes of the discharge manifold and screw them onto the modules.
c) Mount the suction manifold onto the fluid modules.

6.3.2 Pistons and liners

a) Mount the piston onto the piston rod. There is a seal ring between the piston body and the rod shoulder. The seal ring shall be properly mounted onto the piston body before mounting the piston onto the piston rod. Then tighten the lock nut. Change the lock nut timely with damaged threads or malfunctioning fibre, otherwise it will result in damage to the piston, its rod and liner.
b) Coat the inner surface of the liner and the outer surface of the piston with grease. Then mount the piston rod assembly into the liner with the end equipped with a seal ring of the liner and the end of the piston rod equipped with a nut both looking toward the fluid module.
c) Coat the wear plate of the fluid module and the inner surface of the liner bush with grease, and then operate the pump by hand so that the intermediate rod goes to the rear dead–point. Mount the piston rod assembly into the liner which will touch the wear plate.
d) Clean the joint surface of the liner’s retainer, coat it with thread lubricant and tighten it.
e) Align the piston rod with the intermediate rod and connect them by means of the piston rod clamp.
f) Mount the spray hose and support.

6.3.3 Valves and valve seats

a) Press the valve rubber securely against the valve body with the nut. The cone surface of the valve rubber shall project about 0.25-0.5mm over the valve body. Any loose body or rubber will be quickly damaged by the drilling fluid.
b) The bottom of the valve pot is equipped with a shoulder sealed by the outer cone surface of the valve seat to prevent the valve seat from sinking. The valve pot and the outer cone of the valve seat shall be cleaned and free of scratches or burrs. Put the valve seat into the taper bore and hammer it with copper striker to ensure a preliminary sealing.
c) Mount the valve onto the valve seat with the centerline of the valve spring aligned with that of the valve body.

d) Fasten the guide bush located at the upper section of the valve stem to the valve cover. In the event of excessively worn bore of the bush or increased clearance between the valve stem and the guide bush, such a bush shall be changed, otherwise the valve and its seat will easily be worn.

e) Coat the gasket of the valve cover with grease and mount it onto the cleaned shoulder of the fluid module. The gasket shall be changed if it is scratched or damaged.

f) Assembly of the suction valves

Place the valve spring and valve on the valve seat. Vertically insert the positioning rack and then turn it by 90° and insert vertically the valve fixed frame from side of the fluid module and make it mash with posioning rack surface. Then screw the gland into the fluid module and insert the gland hole with a iron rod of 0.4meters, and force it with a 16lb hammer for 3-4 times.

6.4 Dismantling of the fluid end

6.4.1 Prior to dismantling, stop the pump and unpressurize the fluid modules to avert accidents.

6.4.2 Suction manifold

The suction manifold can be independently removed. However it shall be as seldom removed as possible. The gaskets shall preferably be changed therewith.

6.4.3 Suction valve

Remove the threaded cover and the plug of the fluid end. The worn seal ring shall be removed. Take the positioning plate out of the positioning rack and loosen the latter. Take it up and turn it by 90° before removing it.

6.4.4 Liner spray

Remove the spray hose for piston liner and clean it thoroughly.

6.4.5 Pistons and liners

Removal of the piston along with the liner

Operate the pump by hand until the intermediate rod goes to the rear dead–point. Remove the piston rod clamp. Put a suitable pry bar between the liner bush and liner shoulder to pry out the liner seat, and then remove out the piston with the liner.

6.4.6 Pistons

a) The piston body shall not be removed from the rod if replacement of the piston cup is needed only. Remove the snap ring and retainer in front of the piston body to take out the piston cup.

b) If replacement of the piston as a whole is needed, remove the lock nut for the piston and remove the piston body from the rod. Care must be taken not to damage the seal of the piston body.

7. Storage

7.1 Power end: when the slush pump is to stop working for more than half a month, the fluid end shall be raised to tilt the pump to the power end. Then empty the oil pools and clean them to store the pump for a long time store. With the oil drained off, coat all the bearings, machined surfaces and the whole surface of the power end with anti rust oil.

7.2 Remove the valves, pistons, piston rods and liners, thoroughly clean the inside of the fluid modules and all the parts, coat all the valves, fluid modules and parts with anti – rust oil. Rinse out the spray system and liner chamber and fill the spray system with lubricant.

7.3 Inspect the slush pump once a month. Rotate the pinion and gear. If necessary, recoat them with anti–rust oil.

8. Restarting after storage

When restarting a pump stored for some time, whether a pump used in the field or a new pump received from the manufacturer, it is advisable to carefully inspect it for fitting conditions and for any damage of components. Failure to bide by the following requirements will result in serious consequences.

8.1 Open the covers of the power end and the fluid end. Carefully inspect and thoroughly clean all the components and machined surface. Check all the bearings for cleanness and good conditions. Fill the power end with lubricant to the level required. Fill the oil–distributing grooves with lubricant so that the lubricant may reach all the bearings.

8.2 Inspect all the components of the fluid end, especially valves, pistons, liners, etc. to make sure that they are properly assembled and in good conditions. Tighten the screws, nuts, studs and movable joints securely.

9. Bearings list

Type			PAH
No.	Location	Q'ty	Bearings
1	Transmission shaft	2	22326CA/33KW Double row radial spherical roller bearing ϕ 110x ϕ 240x80
2	Crankshaft	2	22322CA/33KW Double row radial spherical roller bearing ϕ 130x ϕ 280x93.25

10. Tightening moment for the main positions N.m (kgf.m)

Type			PAH
No.	Location	Size	Torque values
1	Valve box and frame	1-1/8"	1085(111)
2	Connection rod and rod cap	7/8"	597(61)
3	Piston rod	1/2"	1505(153)
4	Liner room	1-1/8"	813(83)
5	Retainer for main shaft	2"	4067(415)

Crankcase Oil Requirements

API－GL5 Oil Grade	Ambient Temperature	Crankcase Operating Oil Temperature	Minimum Startup Oil Temperature
75W-90	－20° F to 60° F (－29℃ to 16℃)	60° F to 140° F (16℃ to 60℃)	20° F (－7℃)
80W-140	10° F to 100° F (－12℃ to 38℃)	90° F to 180° F (32℃ to 82℃)	50° F (10℃)
80	－10° F to 45° F (－23℃ to 7℃)	70° F to 125° F (21℃ to 52℃)	30° F (－1℃)
90	20° F to 80° F (－7℃ to 27℃)	100° F to 160° F (38℃ to 71℃)	60° F (16℃)
140	50° F to 115° F (10℃ to 46℃)	130° F to 195° F (54℃ to 90℃)	80° F (27℃)