MODEL DYX-A 7"×5"(4½")

HYDRAULIC LINER HANGER

USER MANUAL

SHANDONG SAIGAO GROUP CORPORATION

CONTENTS

Structure

Model DYX-A 7"×5"(4½") Hydraulic Liner Hanger is hydraulic-set and features dual-cylinder and dual-row cone. It is comprised of the following parts:

Liner hanger body assembly (comprised of cones, hydraulic cylinder, piston, slips, etc. See Fig. 1)

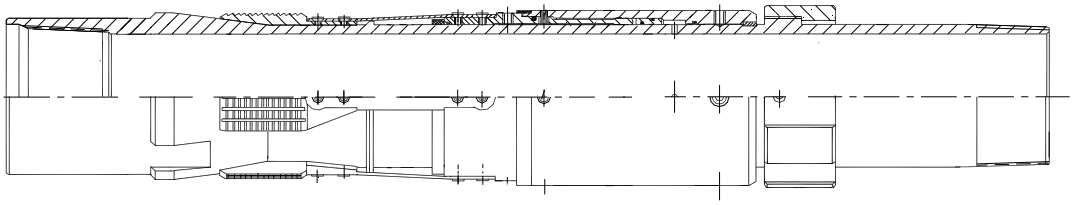

Fig. 1: Liner hanger body assembly

Setting tool (can be used repeatedly and consists of sand cap, short drill pipe, release nut, polished nipple, etc. See Fig. 2)

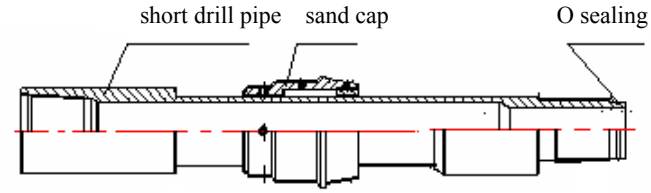

Fig. 2: Setting tool (A)

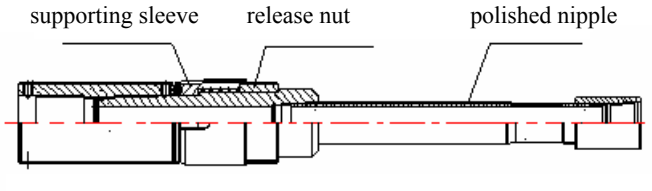

Fig. 3: Setting tool (B)

Seal assembly (consisting of sealing collar, pack-off bushing, etc. See Fig. 4)

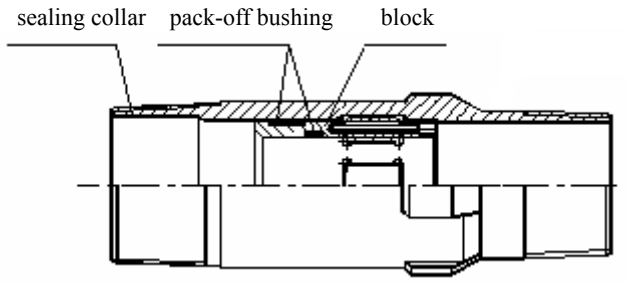

Fig. 4: Seal assembly

Polished bore receptacle (See Fig. 5)

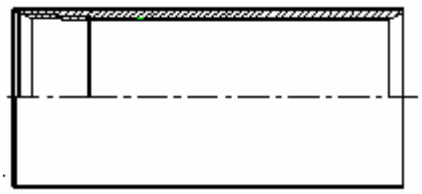

Fig. 5: Polished bore receptacle

Plugs (pump-down plug and liner wiper plug. See Fig. 6 and Fig. 7)

Fig. 6: Pump-down plug

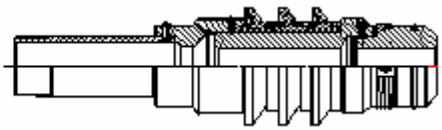

Fig. 7: Liner wiper plug

Landing collar assembly (See Fig. 8 and Fig. 9)

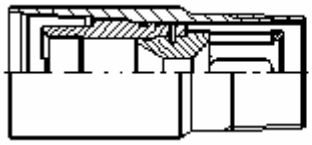

Fig. 8: Landing collar

Fig. 9: Brass ball

Working Principle

Model DYX-A 7"×5"(4½") Hydraulic Liner Hanger is hydraulic-set. The setting tool is used to run the liner hanger to designed depth. After the brass ball is dropped into the landing collar, the system is pressurized, at which point the piston moves upward, shearing the pins in the hydraulic cylinder, driving the slips upwards through the annulus between the cones and the upper casing. Slack-off completes the setting action and transfers the liner weight to the upper casing. Keep applying pressure until the ball seat drops off from the landing collar and circulation is established. After the back-off and cement displacement is finished, pull out the setting tool. Trip out and wait on cement time.

Features

1. The main parts of the line hanger are made of high-strength alloy steel, which ensures high mechanical performance and strong ability to hang heavy liner.
2. The liner hanger is hydraulic-set and applicable to various well conditions.
3. All of the pump-down plug, liner wiper plug and the landing collar have locking systems and are easily drillable.
4. The pack-off bushing can be pulled out with the setting tool and therefore saves time for drilling out.
5. The seal assembly contains a set of “W” packing rings that have perfect two-direction sealing capacity.

6. The gage rings on the liner hanger not only serve as rigid centralizers, but also protect the hydraulic cylinder and slips while running in.
7. To release the setting tool from the liner, simply apply 5 to 10 t load to the drill string and rotate right hand.

Technical Parameters (See Table 1.)

Table1: Technical Parameters of Model DYX-A 7"×5"(4½") Hydraulic Liner Hanger

Specifications		Φ177.8×Φ127（Φ114.3）
Rated load, t		50
Rated packing pressure, MPa		>25
Rated load of supporting sleeve, t		30
Shearing pressure of pins in hydraulic cylinder		7～8 MPa
Shearing pressure of pins in landing collar,		16～17 MPa
Shearing pressure of pins in liner wiper collar,		12 MPa
Max OD of liner hanger body, mm		Φ152
ID of liner hanger body, mm		Φ108.6
Length of polished bore receptacle, mm		1200
ID of polished bore receptacle, mm		Φ133
Length of pump-down plug, mm		303
Diameter of brass ball, mm		SΦ36
Upper casing wall thickness, mm		9.19 10.36 11.51
Upper casing linear weight, kg/m		38.69 43.15 47.62
Connection of the short drill pipe		API 3½"IF（310 NC38）
Liner thread		BTC
Bypass area, cm^2	Casing wall thickness, mm	Before setting/After setting, cm^2
	9.19	20.2/14.1
	10.36	17.1/12.1
	11.51	11.5/9.7

Note: If the liner hanger is to be hung on a casing with different wall thickness from those shown in this table, please inform us of the difference.

Storage, Transportation and Maintenance

1. The product should be stored in a flat and dry warehouse. All components should be carefully maintained and kept away from rain, sunshine and seawater.
2. Do not open the boxes before use unless needed. Do not tear the plastic baggage.
3. Be careful when moving the product, especially do not hurt the slips, hydraulic cylinder and polished nipple.
4. The setting tool should be cleaned as soon as possible after it is pulled out from the well. The release nut, bearings, pack-off bushing, polished nipple and all of the threads should be greased.

Field Examination and Installation

A. Field Examination

1. Check the liner hanger and all accessories according to the packing list. Make sure the following components are contained: the liner hanger body, short drill pipe, polished bore receptacle, landing collar, brass ball (**Note: The diameter of the brass ball for 5"(4½") liner is 36mm.**), pump-down plug and liner wiper plug. (Float collar, float shoe and drift diameter gauge are also contained if they've been ordered.)
2. Check, measure and record all the components according to the Field Checking List. Ensure that:
    a. The appearance of all components is in good condition and has no evidence of collision.
    b. The seal rings are complete.
    c. All of the components match each other and the threads are in good condition.
    d. No debris is inside the components.
    e. The sealing capacity of the float collar and float shoe is good.
    f. The threads and plugs match the liner specifications.
    g. Technical parameters of the product meet the cementing operation.

B. Installation

1. Put the liner hanger on a flat, clean place and put several wooden sticks below it. (Do not place the wooden sticks under the hydraulic cylinder and slips.) Clean and

grease the upper joint of the release assembly.

2. Install the polished bore receptacle on the setting tool (the thread side faces the liner hanger).
3. Loosen the set screws of the sand cap on the short drill pipe and remove the thread protector. Check the seal ring and connect the short drill pipe (**A**) with the upper joint of the setting tool (**B**). The set screw holes should match the hollows on the short drill pipe when completely connected. Then fasten the set screws.
4. Do back-off test and fasten the release nut with a torque of 1500 N·m.
5. Clean the threads of the seal assembly, then grease with casing thread compound. Connect the polished bore receptacle with the seal assembly. It is recommended that 3 people use 48" chain tongs for connecting.
6. Install the sand cap on the polished bore receptacle and fasten the set screws.

Note:

a. Do not get sand and debris into the product during the installation.

b. Do not place tongs on the hydraulic cylinder or on the slips.

Operation Procedures

A. Preparation

1. Check trip and adjust the mud properties before casing, make sure the casing can be run to designed depth.
2. Check the length of the liner, calculate the kelly-up and arrange the drill string. Prepare one or two short drill pipes, which is convenient for arranging drill string and breaking out when dropping the ball. Make sure that the down connection of the short drill pipe is near the rotary table.
3. Measure the casings carefully and clean the threads and drift every casing with standard drift diameter gauge. The diameter of the drift diameter gauge should not be less than 50mm. Shoulder is not allowed when connecting the drill string.
4. When tripping out or checking trip, lift the drill string to the liner hanger setting depth. Measure and record the weight and the friction.
5. Calibrate the setting depth of the liner hanger, keeping the slips away from the upper casing coupling.
6. Check the weight gauge and pump gauge, make sure that they are sensible and

accurate.

B. Casing

Note: Operate smoothly and do not fall anything into the bore hole.

1. Casing string design: the landing collar setting depth depends on the designed height of cement plug. Recommended casing string design: float shoe + casing + float collar +casing + landing collar + casing string + liner hanger + drill string+ cementing head.
2. Run in the casings and accessories in order and use standard torque. Regularly, fill up within 20 casings. After the float shoe and float collar are connected, connect the kelly and start the mud pump (or take other actions) to check flow back.
3. Put centralizers on the two casings below the linger hanger. After the casing running is finished, fill up before connecting the liner hanger.
4. Connect the liner hanger (make sure there is no collision when moving it to the drill floor): hook the liner hanger assembly, remove the coupling from the polished nipple, remove the thread protector on the lower side of the liner hanger, connect the coupling on the polished nipple, connect the liner wiper plug with the coupling, and fasten with tongs. Ensure the release assembly does not back off while connecting the liner wiper plug. Grease the rubber of the liner wiper plug, stab the plug into the liner carefully, and connect the liner hanger with the liner.

   Note:

   a. Do not place tongs on the hydraulic cylinder or on the slips.

   b. Fill up the polished bore receptacle with drill pipe thread compound and fasten the set crews on the sand cap.

   c. Limit the speed when run the liner hanger into the well, especially when passing the top connecting collar and the stripper head. Do not hurt the slips and hydraulic cylinder.

5. Measure and record the liner weight. Lock the rotary table, preventing the liner from rotating.
6. Run in the drill string. Use back-up tongs when connecting the drill pipes. The drill string cannot rotate before the liner hanger is set. All of the drill pipes should be drifted. Regularly, fill up every 10 stands. Try to fill up every stand as possible. Limit the running speed within 1.5 to 2.0 min/stand. If circulation is needed when sticking, the pump pressure should not exceed 5.0MPa.

7. After the liner is run to designed depth, fill up (**Note: Lift and lower the drill string several times to avoid sticking**) connect the kelly (or top drive). Measure and record the weight and the friction.
8. Adjust the kelly-up. Start the mud pump and circulate the drilling fluid with low flow rate. Limit the pump pressure within 5MPa. Increase the flow rate gradually after the mud is circulated out from the hole. Keep the flow resistance within 5.0MPa. Circulate with normal flow rate until the pump pressure is steady.

C. Setting and back-off

1. Try pre-setting. The pins in the hydraulic cylinder may be sheared as a result of the high circulation pressure. In this condition, the drill string cannot be lifted (the drill string cannot be set at previous position after being lifted) and the liner hanger can be set immediately if there is no rotating cementing head or there is no hole in the cementing head to drop the ball.
2. If the liner hanger has not been set, drop the ball (**Note: The diameter of the brass ball for 5"(4½") liner is 45mm**) and start the mud pump with low flow rate (or wait for the free fall without starting the mud pump). Keep a close eye on the pressure changes. After the ball arrives in the landing collar, pressure up. Control the pressure within 11～12MPa for 2 minutes, and then lower the drill string slowly. When the total weight decreases and is equal to the weight of the drill string and the traveling block (meanwhile, the shrinking length of the drill string is equal to or next to the calculated value), the liner hanger is set on the upper casing successfully.
3. Apply a load of 10～20t to tighten the liner hanger with the liner.
4. After the setting is finished, lift the drill string to neutral point. Pressurize to 17 MPa to shear the pins in the ball seat and establish circulation.
5. After circulation is established, unlock the rotary table and use drill pipe clamp. Make sure 5～10t is loaded on the supporting sleeve. To back off, make right hand rotations. At least 20 rounds of effective rotation are needed. (Normally, the rotary table hardly rotates back when backing off. If the rotary table rotates back for several rounds, the load applied on the supporting sleeve may be too heavy or too light. The load should be adjusted. (**Note: Do not back off before shearing the ball seat pins and establishing circulation.**)
6. Slowly lift the drill string to the neutral point, then lift 1.5～1.8m. If the total weight is equal to the weight of the drill string and the traveling block, then the liner hanger

is released.

7. After the back off is finished, lower the drill string to its previous position and apply 5～10t on the liner hanger. Then install the cementing head (the pump-down plug has been preloaded in the cementing head) and circulate according to the cementing requirements.

D. Cementing and pulling out the polished nipple

1. Take pressure test of the cementing pipes.
2. Pump the cement according to the cementing design.
3. Release the pump down plug from the cementing head.
4. Displace the mud. Reduce the flow rate 1.5 m^3 before the pump down plug latches in the liner wiper plug. Note the pressure change from the pressure gauge. If the pressure increases immediately and then decreases to the previous value suddenly, then the plugs have combined. Check and calibrate the amount of displacement. (**Note: The pressure changes cannot be observed in most cases.**)
5. Reduce the flow rate when there is 2m^3 of mud left to be displaced. The plugs latch in the landing collar and the pressure increases immediately.
6. Release the mud pump and check flow back. Uninstall the cementing head and the cementing pipes.
7. Rotate the drill string right hand for 2～4 rounds. Lift the drill string for 5～6m (Note the weight changes). Break out 1～3 stands after the drill string leaves the liner hanger. Circulate with high flow rate for more than one circle to carry out the remaining slurry.

Note:

A. To avoid cement plug on top of the liner hanger, the following procedures may be taken: release the mud pump after the pressure is immediately increased when the plugs land on the landing collar. After the pressure is released, start the mud pump again and pressurize to 5～7MPa. Lift the drill string slowly and observe the changes on pressure and weight. If the pressure drops to 0 MPa, then the pack-off bushing has been pulled out from the liner hanger. Start the mud pump and circulate, until the remaining slurry is carried out.

B. To carry out the remaining slurry completely, rotate, lift and lower the drill string while circulating.

3. Trip out and wait on cement time. (**Note: Do not leave the drill string in the hole**

while waiting on cement time.)

Accessories Drilling-out

The pump-down plug, liner wiper plug and the inner sleeves of the landing collar, float collar and float shoe are all made of drillable material. They have anti-rotation system and can be easily drilled out. The following are the notes and drilling parameters when drilling out the accessories:

1. Use a rock bit, which is for hard formation or a PDC bit, which is for medium-hard formation.
2. Do not use an automatic driller.
3. A reamer or stabilizer can be installed on the drill string. A fishing cup can also be installed when necessary.
4. Recommended drilling parameters (See Table 3).

Table 3: Recommended drilling parameters

Bit size (mm)	WOB (t)	Rotation speed (rpm)	Hydraulic horsepower (hhp)	Flow rate (m^3/min)
104	3～5	40～60	30	>0.5
95	2～4	40～60	30	>0.5

Note: The rotation speed should not exceed 100rpm.

5. If a down-hole motor driller is used, the WOB should not exceed 2t.
6. Rotate the rotary table before the bit is pressed on the accessories.
7. The drill string should be lifted and lowered after drilling every 5cm. Meanwhile, do not stop circulation while moving the drill string in order to carried out the debris.
8. Drilling parameters should be adjusted when the drilling rate slows down. If that still does not work, trip out and check the bit and analyze the reason.

Tieback Procedures

A. Preparation before casing

1. Measure and drift the casings carefully and clean all the threads.
2. Calculate the kelly-up of the casing (the particular part of the last casing which is above the rotary table) and arrange the casing string.
3. Prepare several casings, which are approximately 0.5m shorter than the others and

convenient for kelly-up calibration. (The actual kelly-up is not equal to the calculated value due to measurement error and the remaining threads of the casings.)

B. Polishing the polished bore receptacle

1. Connect the milling shoe and trip in. Polish the inner surface of the polished bore receptacle, make sure there is no debris.
2. Note the depth of the milling shoe when it reaches the top of the seal assembly (judge from the changes on pressure and WOB). Then lift the drill string for 1m.
3. Use a drilling rate of 40～50rpm and a normal flow rate. Slowly lower the drill string. Polish the inner surface of the polished bore receptacle twice or three times. Each time polish 3～4min. During the last polishing, apply an additional load of 2～3t when the torque suddenly increases (the milling shoe reaches the top of the seal assembly) during the last polishing. Polish for another 2~3min and note the depth of the milling shoe, which is an important clue for the casing setting depth.
4. Circulate with high flow rate for 5min.
5. Trip out and check the milling shoe. If there is a circle of polished trace and the diameter is equal to the I.D. of the left thread on the seal assembly, then the milling shoe have reached the bottom of the polished bore receptacle.

C. Casing and cementing

1. Run in the tieback casing string. Casing string order: tieback stinger + casing + float collar + casing string
2. Control the running speed and fill up timely and regularly.
3. When the stinger is near the polished bore receptacle, lower the casing string slowly, with a flow rate of 10 l/s. Note the pressure changes. Close the mud pump when the pressure increases suddenly. Then lower the casing string slowly until the total weight decreases suddenly. The stinger has stabbed into the polished bore receptacle completely. Record the kelly-up.
4. Start the mud pump and pressurize to 5.0MPa, then check the sealing capacity of the stinger. Release the pressure and lift the casing string for 1m. Make sure the circulation ports of the stinger are above the polished bore receptacle and the nose is in the polished bore receptacle.
5. Circulate. Pump the slurry, release the plug, displace the cement and pressurize according to cementing design.
6. Increase another 3~5MPa after the pressure is bumped. Slack off the casing string slowly. Apply a load of 20～30t on the casing string when the stinger reaches the top of the polished bore receptacle.

7. Release the pressure and check flow back. If there is no flow back, the sealing capacity of the stinger is good. If the sealing capacity of the stinger is not good, then close the well and wait on cement time.
8. Wait on cement time.

Calculations

1. Falling speed of the brass ball in drilling fluid

$$V_t = \frac{2GD_1^2(\rho_0 - \rho_m)}{36\mu_\rho} \qquad (m/s)$$

G: Gravity Acceleration Speed, 9.8m/s^2;

D_1: Diameter of brass ball: For Φ139.7mm liner, D_1=3.6cm;

ρ_0: Density of the brass ball, 8.9g/cm^3;

ρ_m: Density of the drilling fluid, g/cm^3;

μ_ρ: PV of the drilling fluid, cp.

2. Shrinking length of the drill string after the liner hanger is set

$$\Delta l = \frac{KWL}{100EF} \qquad (m)$$

K: Coefficient of the connection influence, normally K=0.85~0.95;

L: Length of the drill string, m;

E: Elasticity coefficient of steel, 2.059×10^{5}Mpa;

F: Section area of the drill string, cm^2;

W: Load on the drill pipe, N;

$W = W_1 + W_2$

W_1: Liner weight in drilling fluid, N;

W_2: Additional weight on the drill string when pressure build-up for setting the liner hanger, N;

$$W_2 = \frac{100\pi D^2 P}{4} \qquad (N)$$

D: I.D. of drill string, cm;

P: Pressure built up when setting the liner hanger, MPa.

3. Kelly-up

$\Delta L=\Delta l+\Delta l'+l_1+l_2$ (m)

$\Delta l'$: Shrinking length of the drill string when lowering the liner hanger after the setting;

$$\Delta l' = \frac{KW'L}{100EF} \quad (m)$$

K: Coefficient of the connection influence, normally K=0.85~0.95;

W': The weight applied, N;

l_1: Height of the elevator(s), m;

l_2: Length of the drill pipe's coupling (or length of the kelly's pin connection), m.

Note: **If the kelly is not used when backing off, the kelly-up mentioned above refers to the length of the last single's particular part, which is above the rotary table.**