



Robit 'H' Series DTH Hammers H4, H5, H6, H8

Operation and Service Manual



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1 Introduction

The Robit H Series of 4", 5", 6" and 8" DTH hammers are designed for use over a wide range of drilling parameters and applications with unique modular and tunable designs providing optimum performance in all drilling conditions.

1.1 Operator's manual

Please study and observe the operator's manual thoroughly in order to maintain the safety and reliability of the machine.

Robit Plc reserves the right to make changes.

For production-related reasons, the figures and technical specifications in this operator's manual may deviate from the actual product.

Robit Plc cannot be held liable for any material damage or injuries caused by using the device incorrectly or in violation of the instructions.

If you do not understand the instructions or some parts of this manual appear to be missing, please contact Robit Plc.

Thank you for choosing Robit Plc as your systems supplier. We are confident that we will fulfil your expectations regarding both usability and the availability of services.

Maintaining the operator's manual

Manual is available in Robit webpage. If printed manual is used it should be kept in good condition and available to the operator and service.

1.1.1 Copyright

This document may not be copied, presented or supplied to a third party or used for any other purposes without Robit Plc's express permission.

Robit Plc reserves the right to change the values, equipment and service instructions provided in the manual without advance notification.

1.2 Warranty

See the warranty information regarding Robit Plc's general warranty terms.

1.3 Customer service

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Address:

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2 Safety

The purpose of the safety information is to reduce the number of accidents and prevent personal injury and property damage. Please read the safety instructions carefully and ensure that you are using the equipment in a safe manner. Use only components and accessories described in this manual.

**Warning:**

- Rock chips and dust which may be discharged from the face of the bit or bore hole at high velocities and can cause severe injury.
- Use eye protection at all times.

**Warning:**

- Percussive hammer emits noise, which can cause hearing damage.
- Use proper hearing protection to safeguard your hearing against damage.

**Warning:**

- Moving parts can cause severe personal injury.
- Beware of getting fingers trapped between the chuck and bit and do not use hands or feet to clear the top of the borehole at any time.
- Wear protective clothing and safety equipment and observe all safety regulations as prescribed by your employer, government, or the site on which you work.
- Do not wear loose clothing that may get caught in rotating parts.

**Warning:**

- Falling heavy loads can cause severe injury.
- Always use proper and approved lifting equipment and take every precaution to safeguard yourself against injury.

3 Technical description

The Robit H Series hammer is available in 4", 5", 6" and 8" size ranges. Version alternatives are Heavy Duty (HD)/Slim Line (SL), Foot valved (FV)/Tubeless (TL) and Low volume (LV)/High Power (HD). Shank and tread connections are size specific.

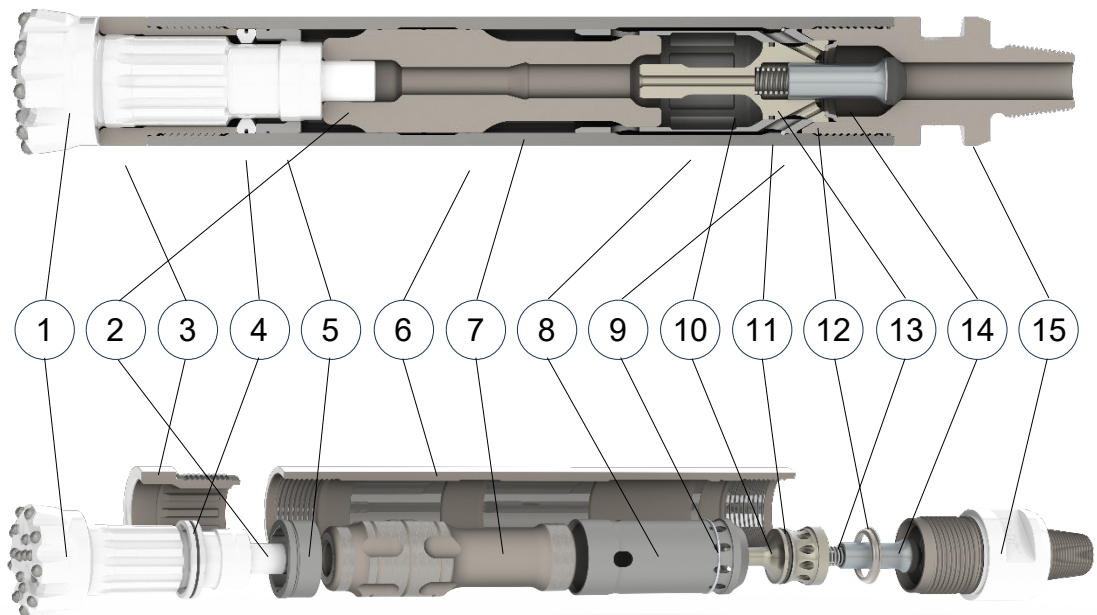


Figure 1. Main components of the DTH hammer

1	DTH bit	6	Wear sleeve	11	Air distributor O-ring
2	Foot valve	7	Piston	12	Make-up ring
3	Chuck	8	Inner cylinder	13	Spring
4	Bit retaining ring	9	Seating ring	14	Check valve
5	Guide bush	10	Air distributor	15	Backhead

3.1 Drill bit

The DTH drill bit is at the working end of drilling and just like the hammer, it will perform extremely well if cared for. Good drill bit care and maintenance helps ensure the longest life and best performance from that bit.

A drill bit is capable of taking considerable punishment in drilling operations. However, care must be taken while handling them to ensure that the bit you are drilling with is in good working condition. Drill bit foot valves or blow tubes are manufactured from hard

plastics and can be easily broken if dropped or something heavy is dropped on them. The Robit H Series hammer are available as Tubeless (TL) designs which eliminate the use of a plastic foot valve or blow tube.

Dropping the bits onto hard surfaces (such as metal) can cause the tungsten carbide buttons to crack and break.

In drilling conditions that are very abrasive such as granite, sandstone or quartzite the chuck should be indexed more than one spline. The DTH hammer chucks are multiple lead threads so it may also be necessary to turn the chucks starting position so that any grooves that have progressed into the wear sleeve are also separated into new locations as demonstrated below.

4 Operating instructions



Note: Familiarise yourself with the controls of the machine and work in accordance with the manufacturers recommendations.

The percussive mechanism begins to operate as the air supply is turned on and when the drill bit is pushed firmly into the hammer. Excessive thrust pressures are not needed to make it work.

The thrust controls on the drill should be adjusted to the correct pressure and readjusted to take into account the weight of any extra tubes added so that the thrust pressure remains constant. Insufficient thrust pressure will make the hammer drill erratically and less efficiently and cause premature wear to the bit and chuck splines with likely damage to the hammer components and threads.

When the hammer is lifted from the rock face, the drill bit extends from the chuck and the percussive action ceases. Extra air will pass through the hammer, which can be used to flush the hole clean.

Whenever possible, the pressurized air in the hammer should be drilled out to avoid situations where back hammering can occur. This is not always possible in conditions where the rock is quite fractured and broken.

When changing drill rods, ensure that the drill string has been depressurized before breaking the tool joint. Rapid depressurization of the drill string can cause a sudden pressure drop in the hammer forcing debris from the bottom of the hole into the hammer.

Before adding drill tubes make sure that the threads are clean and well greased and that there are no contaminants likely to enter the hammer to cause damage and early wear.

4.1 DTH hammer set-up

It is important to remember that although the injection of water into the hammer will increase the pressure in the hammer, the water is a restriction in the hammer that will cause a drop in the drilling performance.

Both temperature and altitude have an effect on air and consequently on compressed air. Higher temperatures and higher altitudes result in air becoming thinner, less dense, and the effect of this is a reduction in a compressor's delivery pressure. For example, if we take a compressor which will deliver 28.3 m³/min (1000 cfm) at sea level and a temperature of 20° C (68° F), this same compressor will only deliver 21.1 m³/min (745 cfm) at 2744m (9,000ft), given a temperature of 4.4° C (40° F).

Additional information on the effect of temperature and altitude on compressed air can be found in the compressor documentation.

4.2 Commissioning a DTH hammer

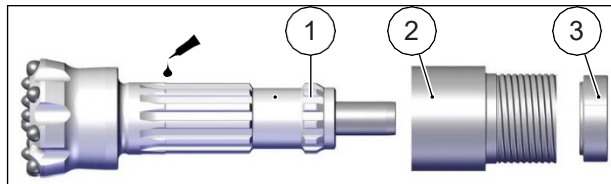
Coat the drill bit shank and the hammer threads with rock drill oil for protection and easier break-out. Prior to use, lubricate the hammer with ¼ liter (½ pint) of rock drill oil. The oil should be poured through the backhead and by using a long screwdriver inserted into the

backhead; the check valve can be depressed to allow the oil to run down into the piston chamber.

Alternatively, install the hammer onto the drill machine's rotary head, place a piece of cardboard on the table, locate the hammer's drill bit just over the cardboard and turn the air on low. When the cardboard becomes wet with rock drill oil all internal components should be sufficiently coated with oil.

Fit the hammer to the drilling rig ensuring no debris or dirt enters the hammer from the site, dirty tubes or from unclean air lines. Make sure that the coupling threads from the drill are of the same specification to that of the hammer and they are in good condition. Run the hammer at half the air flow for a few minutes to allow the oil to flow through and for internal components to settle in.

4.3 Drill bit installation



When installing a new drill bit (1) into a new hammer lubricate the splines on the bit with rock drill oil. Place the chuck (2) over the bit and install the bit retaining ring (3).

When using the drill machine's rotary head to screw the chuck into the hammer, take care not to cross thread the chuck. With the head of the bit in the bit basket, torque up the bit in the hammer.

When installing a new bit on a used hammer it is important to inspect the chuck for wear to the body and splines. In soft and broken drilling conditions there is often excessive bit travel that results in uneven wear to the splines. Where this wear is excessive the chuck should be replaced as failure to do this will result in premature wear to the splines of the new drill bit, and possible damage to other components in the hammer due to lateral movement of the drill bit in the hammer.

The body of the chuck should also be inspected for any gouging or grooving that is caused by erosive wear. Where this has occurred index the chuck so that the grooves or gouges do not line up with the drill bits exhaust grooves. In the case when a used or newly sharpened drill bit is installed on a used hammer, the same indexing principles occur. If the bit is to be removed, sharpened and replaced back on the hammer, mark the location of the current bit alignment on the chuck and drill bit prior to removal. After sharpening, index the chuck by one spline so that the drill bits exhaust grooves are moved to a new location on the chuck.

Prior to using a new or used drill bit it should be inspected for the following and lubricated with rock drill oil:

- Check the condition of all the carbides and ensure that no damage has occurred and that the carbides are sharp.
- Inspect the face and head of the bit for any cracking or damage that could be detrimental to the drill bit.
- Make sure the gauge row carbides have sufficient clearance from the head of the bit.
- Inspect the foot valve (blow tube) for damage or cracking.

- Check that the foot valve is not loose, and check the length of the foot valve from the strike face of the bit to the top of the foot valve.
- Inspect the splines of the drill bit and chuck. Remove any burrs that have formed.
- Excessive wear to the splines of the bit and/or chuck will cause the hammer to run loose and can cause broken foot valve, shanking of the bit, or damage to the strike face of the piston and/or drill bit.

4.4 Torquing up a DTH hammer

Robit DTH hammers use a compression ring to ensure that the hammers top end components are held firmly in place. This is extremely important as any movement of these components will result in premature wear and loss of performance.

When a hammer's backhead is closed up by hand there is a gap between the wear sleeve and backhead shoulder known as stand-off. All Robit hammers have 0.030" (0.76 mm) stand-off. The stand-off must be completely closed as part of the locking system for the hammer. It is not recommended to use the hammer action of drilling to close up the gap as movement in the top end will occur that will be detrimental to the hammer and ultimately lead to premature wear and loss of performance. Recommended torque for closing the hammer is between 1020 - 1350 Nm (750 - 1000 ft.lb) per inch of hammer diameter.

Fit the hammer to the drilling rig ensuring no debris or dirt enters the hammer from the site, dirty tubes or from unclean air lines. Make sure that the coupling threads from the drill are of the same specification to that of the hammer and they are in good condition. Run the hammer at half the air flow for a few minutes to allow the oil to flow through and for internal components to settle in.

4.5 Hammer storage



Note: Before restarting any hammer after prolonged periods of inactivity, disassemble and inspect all internal parts. Clean and remove any oxidation with an emery cloth. Re-lubricate all internal components with rock drill oil and reassemble the hammer.

Short Term Storage (e.g. 1 -2 weeks)

- Using high pressure air, blow the hammer clear of all water.
- Turn automatic oiler up full and cycle hammer until oil is running out the shank of the drill bit.
- If there is not an automatic oiler, pour 1 litre (2 pints) of rock drill oil in to the backhead.
- Turn the air on and cycle for 10 seconds in order to lubricate the internal parts.
- Seal the hammer at the backhead and chuck end to exclude any dust or foreign particles.
- Store the hammer horizontally in a clean and dry environment.

Long Term storage (e.g. 1 month or longer)

- Using high pressure air, blow the hammer clear of all water.
- Break out the back head and chuck on the rig as it is easier to do it here than back in the workshop.
- Disassemble the hammer.

- Inspect and clean all hammer components.
- Lubricate all the internal components with rock drill oil.
- Reassemble the hammer, and seal the backhead and chuck end.
- Store the hammer horizontally in a clean and dry environment.
- Periodically rotate the hammer as the oil will settle.

5 Maintenance instructions

Dismantling the hammer for servicing or to change the bit can be made easier if the chuck threads are regularly greased and the backhead threads are well greased any time the hammer is opened for servicing. We recommend that a good quality thread grease be used. In acidic conditions, we do not recommend copper based greases as this can trigger a galvanic reaction with corrosive effect to damage the root of the threads and cause failure. Care should be taken when working on the hammer and all safety guidelines should be followed for the equipment being used. Personal protective equipment should also be worn while working.

5.1 Dismantling the hammer

5.2 Checking for wear and damage

About this task

Premature wear to internal parts is a result of either incorrect or insufficient lubrication, the ingress of debris into the hammer, or incorrect service and storage. The maximum wear allowances shown in this section are a guide as to when to replace parts. In certain conditions parts may need to be replaced before they reach the sizes shown.

5.2.1 Wearsleeve

About this task

The wear rate of the wearsleeve can be slowed by replacing the chuck before the wear area reaches the wearsleeve.

If a piston has broken within the wearsleeve it is imperative that the bore is honed to remove any burrs or 'pick-up'. Failure to do so will result in 'pick-up' on the replaced piston and will lead to early failure of this component.

Procedure

1. Measure the outer diameter of the wearsleeve at both ends using either a micrometer or a vernier.



If the outer diameter is below the minimum value specified below the wearsleeve must be replaced.

H4 = 90mm (3.543")

H5 = 114mm (4.488")

H6 = 130mm (5.118")

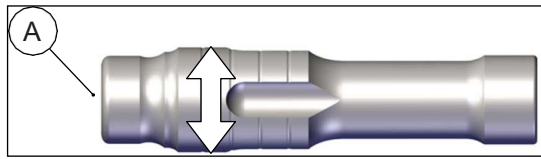
H8 = 174mm (6.850")

2. Check the bore of the wearsleeve periodically for any signs of 'pick-up'

5.2.2 Piston

About this task

There are two main areas to examine on a used piston: striking face (A) and piston body



diameter.

Procedure

1. Check the body diameter for signs of 'pick-up' and burning. Both are signs of poor lubrication.
Any light 'pick-up' marks can be removed by using an emery cloth. However, if there are signs of overheating and cracking, the piston should be replaced and the lubrication system examined.
2. Examine the striking face (A).
Distortion is acceptable providing there are no signs of cracking. Burrs and dents can be removed with an emery stone.

5.2.3

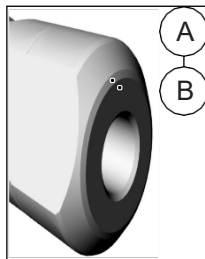
Striking face

About this task

During the working life of the hammer the striking face on the piston may become dented or deformed. To prevent the striking face from cracking or chipping, the piston should be returned to a lathe where the striking face can be re-machined flat and then have the outer radius and inner chamfer reformed. Pistons with wear patterns or indentations deeper than 0.5 mm should be replaced.

Procedure

1. Attach the piston to a lathe.
2. Re-machine the striking face flat and have the outer radius (A) and inner chamfer (B) reformed.

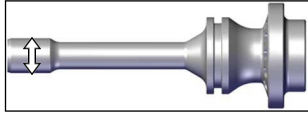


Note: Remove only the minimum amount of material during this re-machining process. At no point should more than 0.5 mm be removed from the face.

5.2.4

Control tube

1. Examine the control tube diameter using a micrometer.



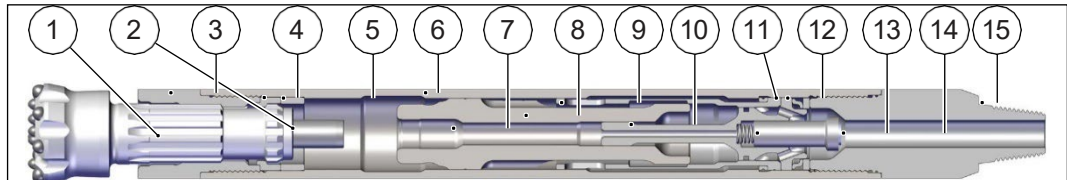
Check that the diameter has not worn under the specified minimum of 26.95 mm / 1.06".

2. Remove any signs of 'pick-up' using an emery cloth.

5.3 Rebuilding the hammer

About this task

The hammer can be reassembled referring to the exploded view of the hammer. Ensure all components are liberally coated with good quality rock drill oil and threads with thread grease. Replace all O Rings.



Procedure

1. Identify which end will be the chuck end and fit the piston retaining ring (5) with open end facing into the hammer perpendicular to the recess it sits in. Use a small hammer to drive the ring down over the threads. When the ring is close, use the handle of the hammer to hit the ring sideways and seat into the recess.
2. If the hammer has an aligner or bit ring spacer, push it in as far as it will go by hand making sure that it is correctly oriented.
3. Using a steel dolly that fits into the wear sleeve (6) and over the aligner, hit the aligner into place with a sledgehammer.
4. Place the bit retaining ring (4) into the hammer.
5. Liberally grease the threads on the chuck (3) and screw in fully. If the chuck does not close up fully, the aligner or bit ring spacer is not in all the way.
6. Place the seating rings on the inner cylinder and secure in place with the seating ring O Ring.
7. Stand the piston (7) upright with the striking face down. Place the inner cylinder over the piston and gently let it slide down as far as it can go. Insert the air distributor into the inner cylinder at the seating ring end and using a soft headed mallet, tap it into place so that it seats up against the top of the inner cylinder. The piston will act as a guide to ensure that the air distributor remains correctly aligned.
8. Turn the wear sleeve (6) over with the chuck (3) on the floor, and drop the piston (7) in with the striking face first. Make sure that your fingers do not get caught between the wear sleeve and the piston!
9. Place the inner cylinder assembly into the wear sleeve, and tap down with a soft headed mallet. Make sure that the cylinder assembly goes in square. Using a steel dolly on top of the air distributor and inside the wear sleeve, drive the assembly into place with a sledgehammer.
10. Drop the lock ring into place and then the steel make up ring on top of this.
11. Insert the spring (13) and check valve (14) in place and finally screw the backhead (15) in place. With the backhead in place, there should be a small gap between the backhead and the wear sleeve. This gap should be between 4 - 7.5mm (0.015" and 0.030"), and can be measured using a feeler gauge. If the gap is less than the minimum, then the lock ring will need to be replaced.
12. Protect the hammer by internal lubrication.

5.4 Lubrication

The hammer pistons oscillate at around 1000 bpm at 10 bar (150 psi). It is therefore extremely important that an adequate supply of the correct type of rock drill oil is constantly fed to the hammer to protect the internal components and to provide a good air seal between the piston and the inner cylinder as well as the piston and the wear sleeve for efficient drilling.

If the oil supply is cut of for any reason, the piston will quickly seize inside the wearsleeve, resulting in irreparable damage to both components.

The correct consumption of oil is dependent upon the air volume and conditions. There should be visual evidence of oil around the drill bit shank and within the tube joints when changing tubes.

The grade of rock drill oil will be determined by the ambient temperature at the drilling site. If the ambient temperature is between 0 and 25 degrees centigrade, then a 30 grade oil should be used. If the ambient temperature is greater than 25 degrees centigrade, use a 50 grade oil.

Table 1: Oil recommendations

Oil manufacturer	Type 30 grade	Type 50 grade
Bulroc	T220	T320
BP	Energol RD-E 100	Energol RD-E 300
Chevron	Aries 100	Aries 320
Shell	Torcula 100	Torcula 320
Esso/Exxon	Arox EP100	Arox EP320

There are two main types of lubricators in use on drill rigs: a plunger oiler and a venturi oiler.

Plunger oilers operate on a timed plunger system that feeds a fixed amount of oil into the air stream at timed intervals. The main benefit with this type of system is that the oil tank does not need to be pressurized.

Venturi lubricators work like a carburettor. A constricted area in the venturi creates a pressure drop which draws oil into the line. The oil is atomized and mixed very efficiently with the air allowing for excellent adherence to the hammer components. The volume of oil used is generally controlled with a needle valve. The rate of lubrication is dependent on oil viscosity which varies with temperature.

When using water injection to flush and clean the hole, the quantity of rock drill oil being used must be increased. When drilling with 3.8 liters (1 gallon) a minute, the quantity of oil used should be increased by 50%.



Important: Insufficient lubrication or incorrect lubrication grades may result in damage being caused to the hammer and it's components. Hydraulic oils, engine oils, gear oils and diesel are not recommended for lubricating DTH hammers.

6 Troubleshooting

PROBLEM	PROBABLE CAUSE	REMEDY
INOPERATIVE DRILL	Drill bit blowholes blocked	Unblock holes
	Dirt inside drill	Strip and clean the drill
	Worn or damaged parts	Replace the damaged parts
	Insufficient lubrication	Check oil level, adjust the lube needle value if necessary
	Excessive lubrication	Adjust the lube needle value
	Hanging piston, piston stuck	Polish out the score marks
	Insufficient air pressure	Check compressor discharge and increase to operational value
SLOW PENETRATION	Insufficient air pressure	Check compressor discharge and increase to operational value
	Dull drill bit	Re-grind or replace the drill bit
	Worn drill parts	Replace worn parts
	Insufficient or excessive lubrication	Check oil level, adjust the lube needle value if necessary
	Dirt inside drill	Strip and clean the drill
LOW RETURN AIR VELOCITY	Insufficient hole flushing air passing through hammer	Drill or increase hole size through the piston
	Drill bit exhaust holes blocked	Clean out the blockage
SPASMODIC OPERATION	Failed or damaged parts	Overhaul the drill
	Lack of oil	Check lubrication
	Drill bit broken	Replace the drill bit
	Dirt inside drill	Strip and clean the drill

7 Appendix

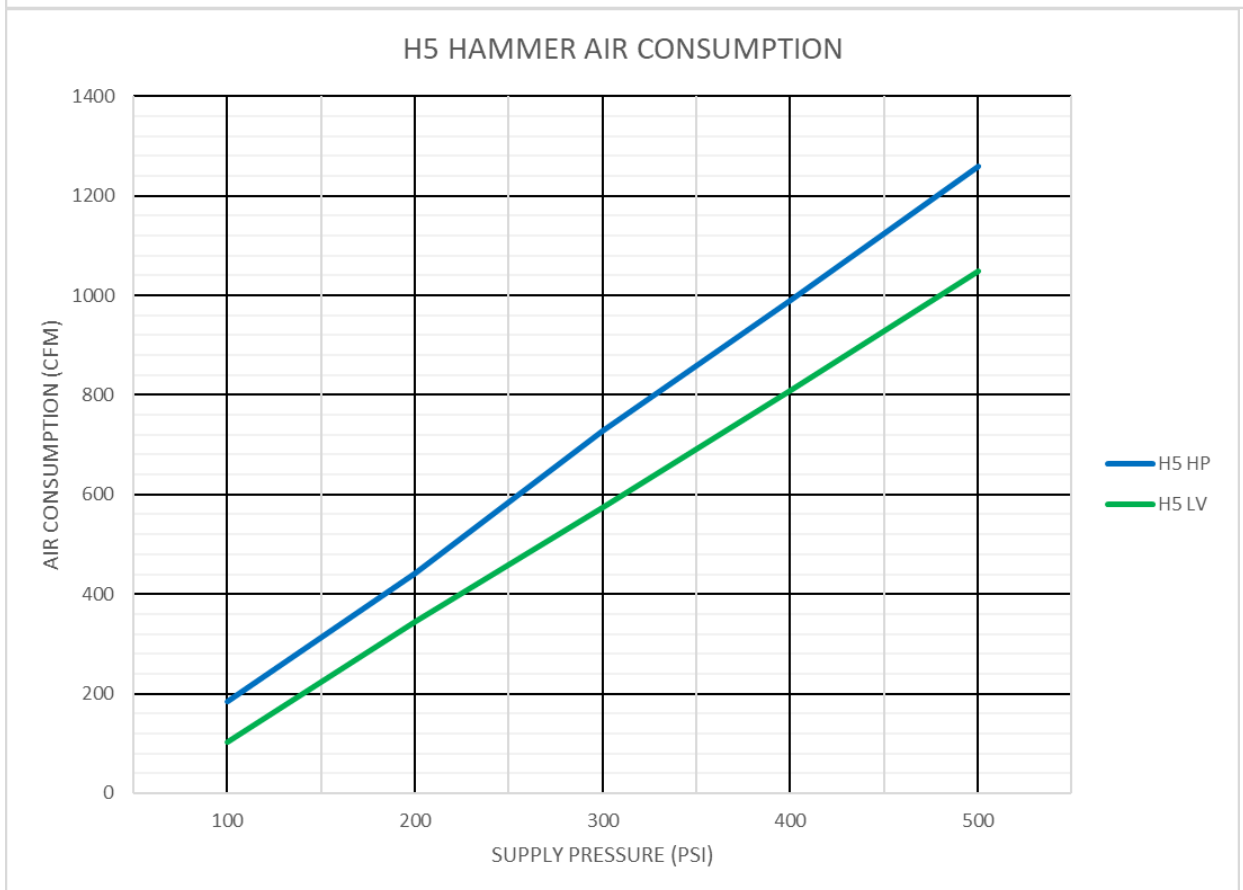
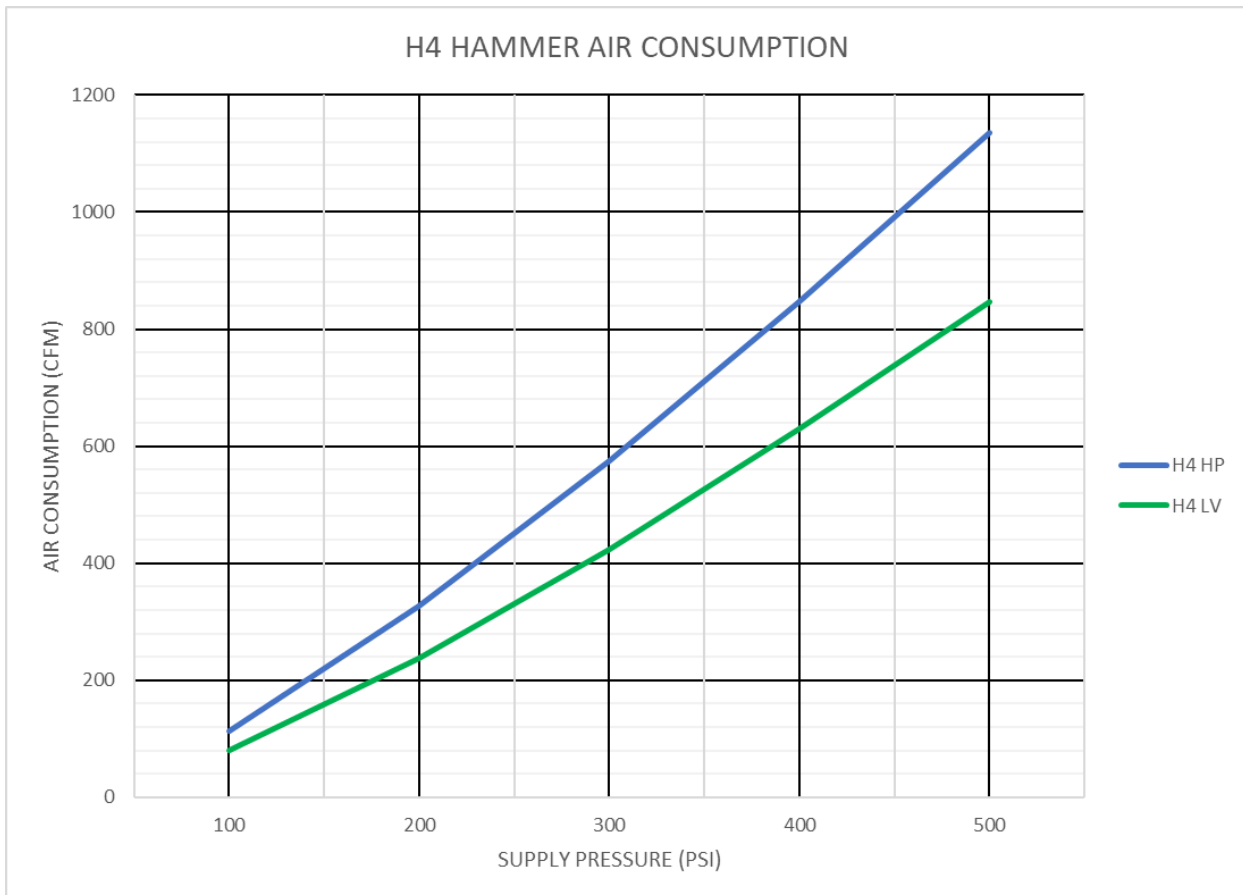
7.1 Technical data

Hammer specifications

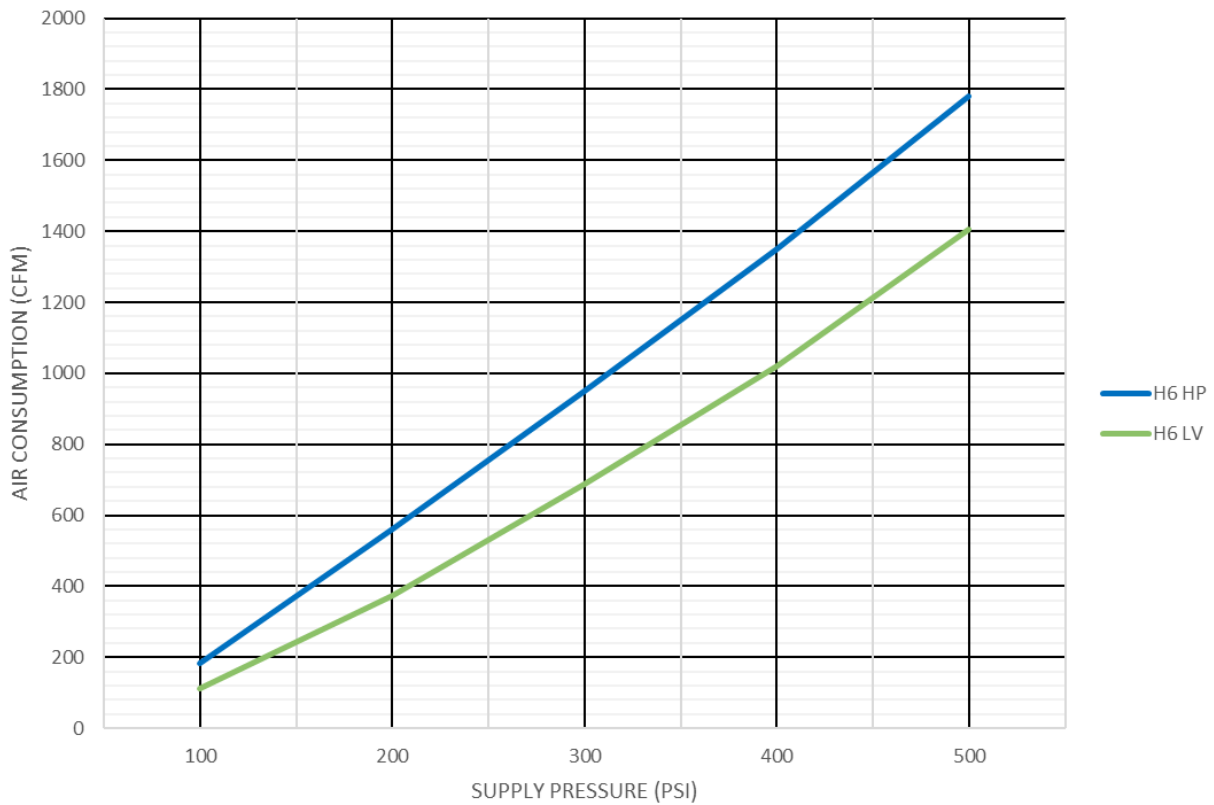
Hammer type	H4 TL	H4 FV	H5 TL	H5 FV
Hammer outside diameter	SL = 98mm (3.858") HD = 102mm (4.018")		SL = 120mm (4.724") HD = 126mm (4.960")	
Hammer length (without bit & thread)	860mm (33.858")		915mm (36.023")	
Thread connection	2 3/8" API REG PIN		3 1/2" API REG PIN	
Backhead spanner flat size	64mm (2.520") Across Flats		94.6mm (3.724") Across Flats	
Drill bit shank type	TD40		QL50	
Minimum bit size	SL = 108mm (4 1/4") HD = 115mm (4 1/2")		SL = 127mm (5") HD = 140mm (5 1/2")	
Hammer weight (without bit)	SL = 34 Kg (75 lb) HD = 38 Kg (83.8 lb)		SL = 54 Kg (119 lb) HD = 61.5 Kg (179.7 lb)	
Piston weight	8.1 Kg (17.9 lb)	8.4 Kg (18.5 lb)	11.8 Kg (26.0 lb)	13.9 Kg (30.6 lb)
Make up torque	4080 - 5400 Nm (3000 - 4000 ft.lb)		5100 - 6750 Nm (3750 - 5000 ft.lb)	
Wear sleeve discard limit	90mm (3.543")		114mm (4.488")	

Hammer type	H6 TL	H6 FV	H8 TL	H8 FV
Hammer outside diameter	SL = 140mm (5.512") HD = 146mm (5.748")		SL = 184mm (7.244") HD = 194mm (7.638")	
Hammer length (without bit & thread)	1014mm (39.921")		1245mm (49.016")	
Thread connection	3 1/2" API REG PIN		4 1/2" API REG PIN	
Backhead spanner flat size	101mm (3.976") Across Flats		127mm (5.000") Across Flats	
Drill bit shank type	QL60		QL80	
Minimum bit size	SL = 152mm (6") HD = 158mm (6 1/4")		SL = 203mm (8") HD = 216mm (8 1/2")	
Hammer weight (without bit)	SL = 65 Kg (143.3 lb) HD = 74.5 Kg (164.2 lb)		SL = 172 Kg (379.2 lb) HD = 200 Kg (441 lb)	
Piston weight	17.5 Kg (38.6 lb)	20.5 Kg (45.2 lb)	41.6 Kg (91.7 lb)	46.8 Kg (103.2 lb)
Make up torque	6120 - 8100 Nm (4500 - 6000 ft.lb)		8160 - 10800 Nm (6000 - 8000 ft.lb)	
Wear sleeve discard limit	130mm (5.118")		174mm (6.850")	

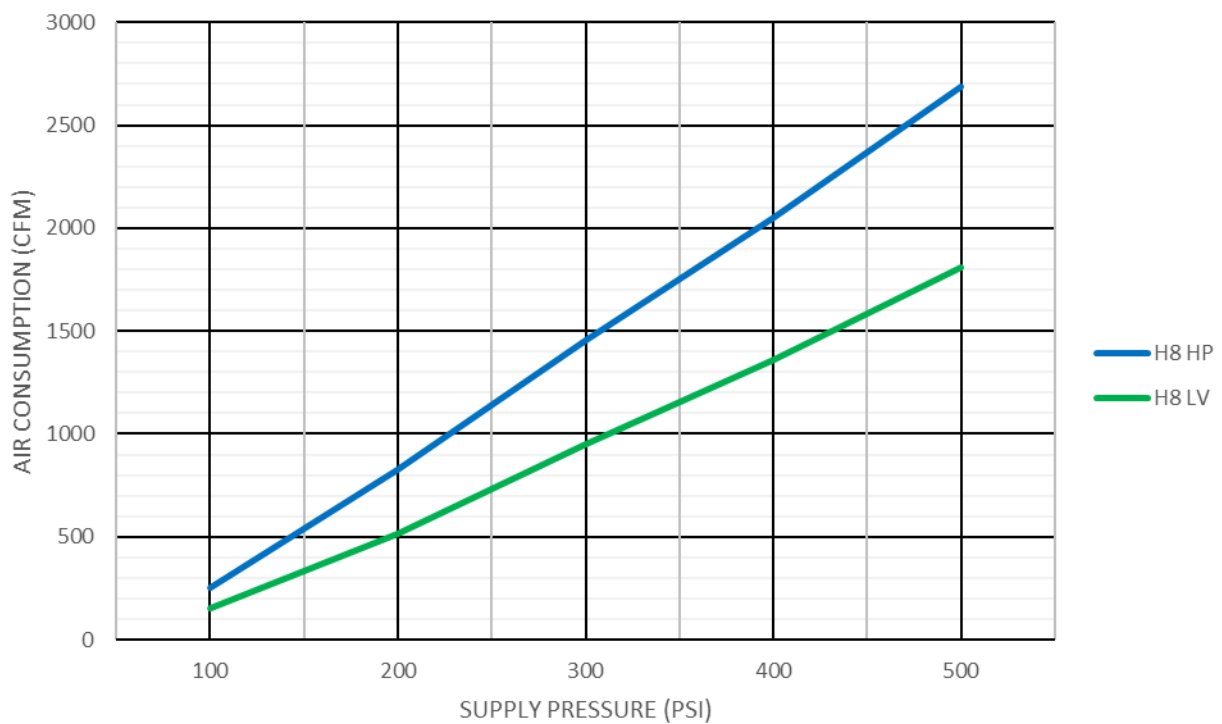
Air consumptions



H6 HAMMER AIR CONSUMPTION

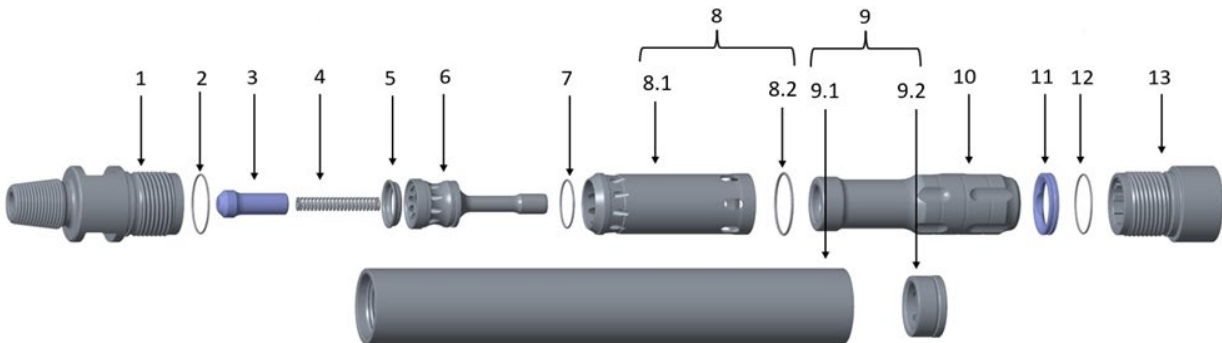


H8 HAMMER AIR CONSUMPTION

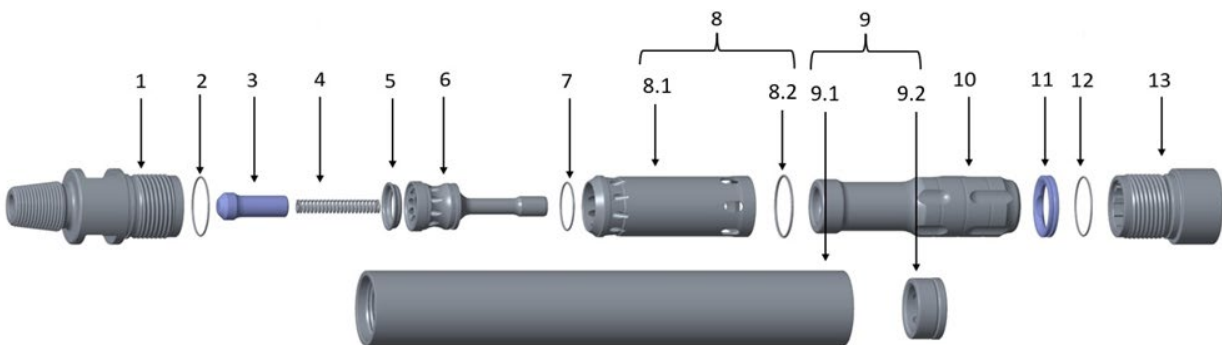


7.2 Part lists

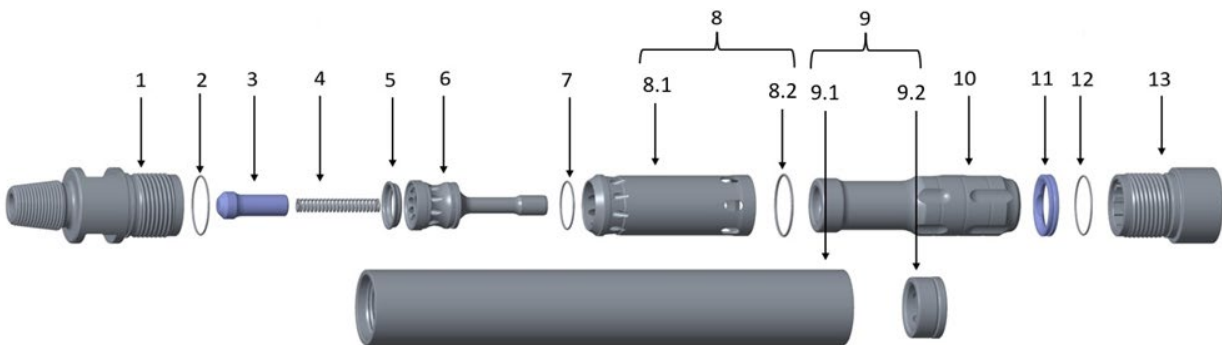
DTH HAMMER H4 TD40					
HAMMER MODEL		FV HP API 2 3/8" Pin	FV LV API 2 3/8" Pin	TL HP API 2 3/8" Pin	TL LV API 2 3/8" Pin
ITEM NUMBER (SL)		2002967	2002972	2002974	2002975
ITEM NUMBER (HD)		2002352	2002813	2002353	2002814
ITEM	DESCRIPTION	PART NUMBER	PART NUMBER	PART NUMBER	PART NUMBER
1	BACKHEAD	2002968 (SL) 2002340 (HD)			
2	O' RING	06M-00-0542			
3	CHECK VALVE	2002351			
4	CHECK VALVE SPRING	06J-25-0544			
5	MAKE UP RING	2002341			
6	AIR DISTRIBUTOR	2002342			
7	O' RING	06M-00-0541			
8	INNER CYLINDER ASSEMBLY	2002854 (HP)	2002853 (LV)	2002854 (HP)	2002853 (LV)
8.1	INNER CYLINDER	2002344 (HP)	2002616 (LV)	2002344 (HP)	2002616 (LV)
8.2	SNAP RING	2002343			
9	WEAR SLEEVE ASSEMBLY	2002971 (SL FV) 2002965 (HD FV)		2002973 (SL TL) 2002966 (HD TL)	
9.1	WEAR SLEEVE	2002969 (SL) 2002347 (HD)			
9.2	GUIDE BUSH	2002348 (FV)		2002349 (TL)	
10	PISTON	2002345 (FV)		2002346 (TL)	
	BIT RETAINING RING ASSY (INCL. PARTS 11+12)	2002350			
11	BIT RETAINING RING				
12	O' RING	06M-00-0543			
13	CHUCK	2002970 (SL) 2002518 (HD)			



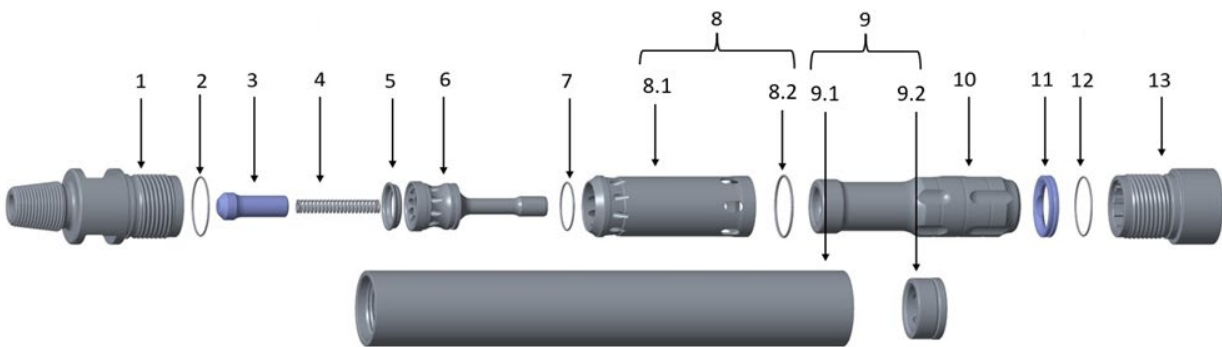
DTH HAMMER H4 DHD340			
HAMMER MODEL		FV HP API 2 3/8" Pin	FV LV API 2 3/8" Pin
ITEM NUMBER (SL)		2002981	2003342
ITEM NUMBER (HD)		2002706	2003354
ITEM	DESCRIPTION	PART NUMBER	PART NUMBER
1	BACKHEAD	2002968 (SL) 2002340 (HD)	
2	O' RING	06M-00-0542	
3	CHECK VALVE	2002351	
4	CHECK VALVE SPRING	06J-25-0544	
5	MAKE UP RING	2002341	
6	AIR DISTRIBUTOR	2002342	
7	O' RING	06M-00-0541	
8	INNER CYLINDER ASSEMBLY	2002854 (HP)	2002853 (LV)
8.1	INNER CYLINDER	2002344 (HP)	2002616 (LV)
8.2	SNAP RING	2002343	
9	WEAR SLEEVE ASSEMBLY	2002979 (SL FV) 2002980 (HD FV)	
9.1	WEAR SLEEVE	2002969 (SL) 2002347 (HD)	
9.2	GUIDE BUSH	2002698 (FV)	
10	PISTON	2002702 (FV)	
	BIT RETAINING RING ASSY (INCL. PART 11+12)	2002700	
11	BIT RETAINING RING		
12	O' RING	06M-00-0543	
13	CHUCK	2002978 (SL) 2002701 (HD)	



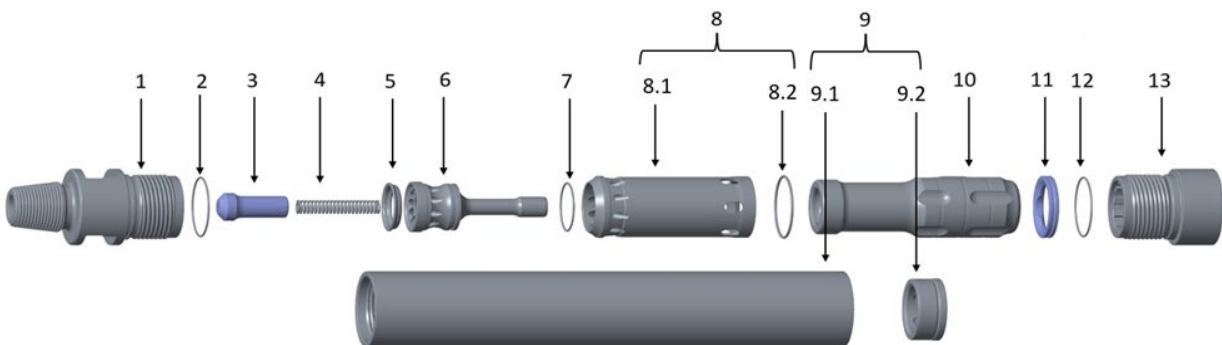
DTH HAMMER H5 QL50					
HAMMER MODEL		FV HP API 3 1/2" Pin	FV LV API 3 1/2" Pin	TL HP API 3 1/2" Pin	TL LV API 3 1/2" Pin
ITEM NUMBER (SL)		1281305	1281307	1281304	1281306
ITEM NUMBER (HD)		1281126	1281128	1281125	1281127
ITEM	DESCRIPTION	PART NUMBER	PART NUMBER	PART NUMBER	PART NUMBER
1	BACKHEAD	1281300 (SL) 1281142 (HD)			
2	O' RING	9003608			
3	CHECK VALVE	9003556			
4	CHECK VALVE SPRING	9003555			
5	MAKE UP RING	1281144			
6	AIR DISTRIBUTOR	1281143			
7	O' RING	9003609			
8	INNER CYLINDER ASSEMBLY	1281131 (HP)	1281132 (LV)	1281131 (HP)	1281132 (LV)
8.1	INNER CYLINDER	1281136 (HP)	1281137 (LV)	1281136 (HP)	1281137 (LV)
8.2	SNAP RING	9003554			
9	WEAR SLEEVE ASSEMBLY	1281303 (SL FV) 1281130 (HD FV)		1281302 (SL TL) 1281129 (HD TL)	
9.1	WEAR SLEEVE	1281309 (SL) 1281133 (HD)			
9.2	GUIDE BUSH	1281135 (FV)		1281134 (TL)	
10	PISTON	1281139 (FV)		1281138 (TL)	
	BIT RETAINING RING ASSY (INCL. PARTS 11+12)	1281141			
11	BIT RETAINING RING				
12	O' RING	1098824			
13	CHUCK	1281301 (SL) 1281140 (HD)			



DTH HAMMER H6 QL60					
HAMMER MODEL		FV HP API 3 1/2" Pin	FV LV API 3 1/2" Pin	TL HP API 3 1/2" Pin	TL LV API 3 1/2" Pin
ITEM NUMBER (SL)		1281297	1281299	1281296	1281298
ITEM NUMBER (HD)		1281089	1281091	1281088	1281090
ITEM	DESCRIPTION	PART NUMBER	PART NUMBER	PART NUMBER	PART NUMBER
1	BACKHEAD	1281292 (SL) 1281077 (HD)			
2	O' RING	1098881			
3	CHECK VALVE	9003390			
4	CHECK VALVE SPRING	9003388			
5	MAKE UP RING	1281080			
6	AIR DISTRIBUTOR	1281068			
7	O' RING	1242029			
8	INNER CYLINDER ASSEMBLY	1281114 (HP)	1281115 (LV)	1281114 (HP)	1281115 (LV)
8.1	INNER CYLINDER	1281067 (HP)	1281082 (LV)	1281067 (HP)	1281082 (LV)
8.2	SNAP RING	9003389			
9	WEAR SLEEVE ASSEMBLY	1281295 (SL FV) 1281084 (HD FV)		1281294 (SL TL) 1281083 (HD TL)	
9.1	WEAR SLEEVE	1281308 (SL) 1281069 (HD)			
9.2	GUIDE BUSH	1281079 (FV)		1281074 (TL)	
10	PISTON	1281078 (FV)		1281075 (TL)	
	BIT RETAINING RING ASSY (INCL. PARTS 11+12)	1281073			
11	BIT RETAINING RING				
12	O' RING	1098846			
13	CHUCK	1281293 (SL) 1281072 (HD)			



DTH HAMMER H8 QL80					
HAMMER MODEL		FV HP API 4 1/2" Pin	FV LV API 4 1/2" Pin	TL HP API 4 1/2" Pin	TL LV API 4 1/2" Pin
ITEM NUMBER (SL)		2002987	2002988	2002989	2002990
ITEM NUMBER (HD)		1281094	1281096	1281093	1281095
ITEM	DESCRIPTION	PART NUMBER	PART NUMBER	PART NUMBER	PART NUMBER
1	BACKHEAD	2002982 (SL) 1281108 (HD)			
2	O' RING	9003540			
3	CHECK VALVE	9003436			
4	CHECK VALVE SPRING	9003435			
5	MAKE UP RING	1281110			
6	AIR DISTRIBUTOR	1281109			
7	O' RING	9003542			
8	INNER CYLINDER ASSEMBLY	1281116 (HP)	1281117 (LV)	1281116 (HP)	1281117 (LV)
8.1	INNER CYLINDER	1281104 (HP)	1281105 (LV)	1281104 (HP)	1281105 (LV)
8.2	SNAP RING	9003437			
9	WEAR SLEEVE ASSEMBLY	2002984 (SL FV) 1281098 (HD FV)		2002985 (SL TL) 1281097 (HD TL)	
9.1	WEAR SLEEVE	2002983 (SL) 1281099 (HD)			
9.2	GUIDE BUSH	1281101 (FV)		1281100 (TL)	
10	PISTON	1281103 (FV)		1281102 (TL)	
	BIT RETAINING RING ASSY (INCL. PARTS 11+12)	1281107			
11	BIT RETAINING RING				
12	O' RING	1119422			
13	CHUCK	2002986 (SL) 1281106 (HD)			



7.3 Up-hole air bailing velocity requirements

The up-hole air bailing velocity is the velocity of the air as it exhausts from the hole and returns to the surface carrying cuttings. Sufficient volume of compressed air is required to maintain pressure at the hammer and to maintain sufficient bailing energy to clean the hole.

Bailing velocity requirements vary with bailing rates, material hardness, density and depth of hole. The higher the drilling rate and density of the material the higher the bailing velocity must be. Bailing velocity for hammers with operating pressures in the range of 13.8 - 24.2 bar (200 to 350 psi) should be 900m (3000 feet) per minute minimum. Recommended minimum bailing velocity is 1500-2100m (5000-7000 feet) per minute. Velocities in excess of 2100m (7000 feet) per minute are not uncommon but in abrasive material this can cause rapid erosion of the bit body and hammer.

Bailing velocities are calculated by using hole diameter, drill pipe diameter and the actual volume of air delivered down the hole. Make sure to allow for the effect of altitude and temperature when calculating the actual volume.

Metric: $VM = X(m^3) \times 1273406.57 / DM^2 - dm^2$

- VM = Velocity in meters per minute
- $X(m^3)$ = m^3 /min of air passed by hammer
- DM^2 = diameter of hole squared in mm
- dm^2 = diameter of drill tube squared in mm

Imperial: $VF = Y(cfm) \times 183.40 / DL^2 - di^2$

- VF = Velocity in feet per minute
- Y(cfm) = cfm of air passed by hammer
- DL^2 = diameter of hole squared in inches
- di^2 = diameter of drill tube squared in inches

7.4 Effect of temperature and altitude on compressed air

°C	°F	Sea Level	305m / 1000ft	915m / 3000ft	1524m / 5000ft	2134m / 7000ft	2744m / 9000ft	3354m / 11000ft	2963m / 13000ft	4573m / 15000ft
-40	-40	0.805	0.835	0.898	0.968	1.043	1.127	1.217	1.317	1.426
-34.4	-30	0.824	0.855	0.920	0.991	1.068	1.154	1.246	1.349	1.460
-28.9	-20	0.844	0.875	0.941	1.014	1.092	1.180	1.275	1.380	1.494
-23.3	-10	0.863	0.895	0.962	1.037	1.117	1.207	1.304	1.411	1.528
-17.8	0	0.882	0.915	0.984	1.060	1.142	1.234	1.333	1.443	1.562
-12.2	10	0.901	0.935	1.005	1.083	1.167	1.261	1.362	1.474	1.596
-6.7	20	0.920	0.954	1.026	1.106	1.192	1.288	1.391	1.506	1.630
-1.1	30	0.939	0.974	1.048	1.129	1.217	1.315	1.420	1.537	1.664
4.4	40	0.959	0.994	1.069	1.152	1.241	1.341	1.449	1.568	1.698
10	50	0.978	1.014	1.091	1.175	1.266	1.368	1.478	1.600	1.732
15.6	60	0.997	1.034	1.112	1.198	1.291	1.395	1.507	1.631	1.766
21.1	70	1.016	1.054	1.133	1.221	1.316	1.422	1.536	1.662	1.800
26.7	80	1.035	1.074	1.155	1.244	1.341	1.449	1.565	1.694	1.834
32.2	90	1.055	1.094	1.176	1.267	1.365	1.475	1.594	1.725	1.868
37.8	100	1.074	1.114	1.198	1.290	1.390	1.502	1.623	1.756	1.902
43.3	110	1.093	1.133	1.219	1.313	1.415	1.529	1.652	1.783	1.936
48.9	120	1.112	1.153	1.240	1.336	1.440	1.556	1.681	1.819	1.970



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