OPTIMIZATION AND MANUFACTURING PROCESS OF DOWN THE HOLE AIR FLESHING BUTTON BIT

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Abstract

The process of DTH (down-the-hole) hammer drilling has been characterized as a very Complex phenomenon due to its high nonlinearity, large deformation and damage behaviors. The impact loads of piston-bit interaction appear to be relatively sensitive to piston impact velocity. The impact between piston-bit interactions occurs at larger forces. The material properties of impact specimen do not affect the first impact process between the piston and bit. However, the period between the two impacts and the magnitudes of the impact forces greatly depend on the specimen material properties. It is found that the penetration depth of specimen is dependent on the impact force magnitude and the macro-mechanical properties of the materials. Another important finding is the local stress concentrations in the component due to insufficiently smooth blending of curvatures at the contacting face. The important finding is that the stresses in the component, in spite of the complicated geometry, approximately follow a simple time history, with some superimposed oscillations. Down-the-hole hammer (DTH) drilling is an air hammer drilling technique designed for drilling through bedrock and features a typical drill string length of 200 m or shorter due to its technical specifications. Generally to manufacture a button bit it takes lot of time and need different machining operations. The button bit manufacturing process contains different stages from material selection to final coating. In the previous manufacturing system we are losing material. But in this paper by changing of machining we can save material, reduce production cost and also can increase production cost. This paper deals with complete manufacturing process of 8 inch DTH button bit With the focus of study on the DTH button bit manufacturing. Generally we are using EN36C for button manufacturing.

1.0 Introduction

Pneumatic down-the-hole (DTH) hammer drilling is a rotary percussive drilling technique widely used in mining, exploration, water-well drilling, road construction, and other drilling operations around the world When the DTH hammer works, it generates percussive force to the bit to impact and shatter the ground and the rotational torque rotates it to tear and cut the fragments whilst the thrust force keeps it in contact with the ground during bit advancement. In the meantime, the drill cuttings and detritus in the form of fine particles and dust are brought from the hole to the ground surface via an air flushing medium as shown in Fig. 1. This drilling technique has a major advantage in that it can rapidly and economically produce holes in hard rocks for various construction and mining purposes. In the pneumatic DTH hammer, a piston moving with speed v0 collides with a drill bit. A stress wave then begins to propagate through the drill bit towards the rock and backwards through the piston from the impact plane. The front end of the stress wave eventually reaches the rock interface, where the tungsten carbide inserts mounted on the drill bit surface generate high point stresses. Depending on the drilling ability of the rock, a certain amount of energy will be dissipated by the rock fragmentation. The remaining energy will be distributed among the piston, drill bit and other DTH hammer components

according to their mass, stiffness and geometric properties. How the wave propagates in the piston, bit, rock and other components is of paramount importance in the impact process of the DTH hammer percussive drilling.

Down the hole (DTH) Drilling:

The use of air as an energy carrier and drilling fluid in down-hole air hammer drilling has been known for many years. Also well known is the fact that down-hole air hammer drilling is by far the fastest method of penetration in hard rock material.

Figure: Down the hole (DTH) Drilling

Down the hole hammer:

Generally, during drilling with down-hole air hammers, the tool is placed in front of the borehole right behind the bit, while energy is transferred through the drill string in the form of compressed air, mechanical torque and mechanical axial force. The mainfunction of the air hammer is to convert energy from the compressed air into pistonkinetic energy which, through the oscillating movement of the piston and eventual mechanical impact with the bit, is transferred to the bit and then to the rock.

There are a variety of down-hole air hammer manufacturers with different proprietary air hammer designs, however there are two basic designs for the down-hole air hammers based on the flow path of the compressed air through the hammer. One design utilizes aflow path of the compressed air through a control tube (or feed tube) down the center ofthe hammer piston (or through passages in the piston) and then through the hammer bit. While the other design utilizes a flow path through a housing annulus passage (around the piston) and then through the hammer bit

Manufacturing process:

Forging:

Forging is a manufacturing process involving the shaping of metal using localized compressive forces. Forging is often classified according to the temperature at which it is performed: "cold", "warm", or "hot" forging. Forged parts can range in weight from less than a kilogram to 580 metric tons. Forged parts usually require further processing to achieve a finished part.

Rough turning:

Turning is a machining process in which a cutting tool, typically a non-rotary tool bit, describes a helical toolpath by moving more or less linearly while the workpiece rotates. The tool's axes of movement may be literally a straight line, or they may be along some set of curves or angles, but they are essentially linear (in the nonmathematical sense). Usually the term "turning" is reserved for the generation of *external* surfaces by this cutting action,

Button whole drilling:

Next, we are going to drill two holes in wood for our button. You could also use a laser engraver or carve a design for this step, but drilling will work well for this example.

For this step, you will need a piece of wood, a power drill, a 1/2" forstner bit, and a 1/16" standard spiral drill bit. Secure the forstner bit into the chuck of your drill, and drill a 1/8" deep hole into

your piece of wood. Be careful not to go past 1/8" deep while drilling because you will have to use more metal powder to fill the hole.

Figure: button whole drilling

button pressing:

Tungsten Carbide buttons has its unique performance and are widely applied to oil filed drilling and snow removal. According to the different oil-field drilling machinery such as roller cone bits,DTHbits,geotechnical drilling tools,. Carbide buttons are used in the coal cutter drilling tools, mine machinery tools and road maintenance tools for snow clearing and road cleaning. Carbide mining button bits are widely applied for rock tools, mining tools for use in quarrying and mining, tunneling, and civil constructions. These are generally made of tungsten carbide, which is imported from West china .These are pressed into the holes of the bit. As this is a interference fit. The buttons once in cannot be removed out.

Figure: button pressing

The fast hammer action breaks hard rock into small flakes and dust is blown clear by the air exhaust from the DTH hammer. Understanding the failure analysis of drill string and its components i.e., drill collar and drilling bit is one of the essential issues in the oil and gas industry for the high cost of oil well drilling. Different ways such as air drilling, percussion drilling and down hole hydraulic ultra-high pressure jet assisted drilling have been often used to improve the rate of penetration, minimize the cost of drilling per foot and diminish well deviation. Nevertheless, these drilling ways aggravate the working conditions of the down hole drilling tools materials and hence their properties cannot meet the demands of these conditions and consequently causing a risk drill string failure.

2.0 literature review

In the industry, the paramount way to get underground minerals is well drilling which is used to create holes in the earth subsurface using a special machine called drilling rig. The term "rig" generally refers to the complex of equipment that is used to penetrate the surface of the Earth's crust. The lower part of drilling rig is hollow column or string called drillstring which is typically made up of three sections: Bottom hole assembly (BHA), transition pipe and drill pipe. The third section is a drill pipe, makes up the majority of the drillstring back up to the surface. Each drill pipe comprises a long tubular diameter portions with an outside diameter called the tool joints which has a male "pin" threaded connection at one end and a female "box" connection at the other end for making segment to the next segment

[1] Karakus M, Perez S (2014)DTH Hammer Bit is a real time industry project. A down-the-hole, usually called DTH is basically mini jackhammer screwed on the

bottom of a drill string. The fast hammer action breaks hard rock into small flakes and dust is blown clear by the air exhaust from the DTH hammer. Understanding the failure analysis of drill string and its components i.e., drill collar and drilling bit is one of the essential issues in the oil and gas industry for the high cost of oil well drilling. Different ways such as air drilling, percussion drilling and down hole hydraulic ultra-high pressure jet assisted drilling have been often used to improve the rate of penetration, minimize the cost of drilling per foot and diminish well deviation.

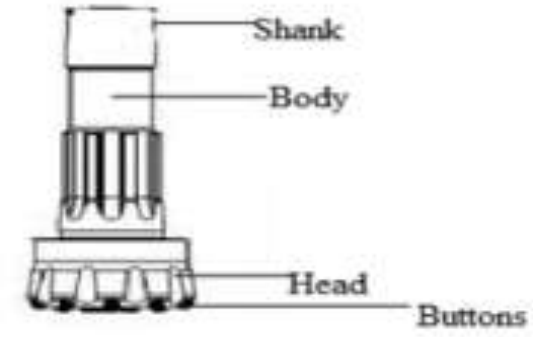
[2] Lundberg, B., Okrouhlik, M., (2001). The term "rig" generally refers to the complex of equipment that is used to penetrate the surface of the Earth's crust. The lower part of drilling rig is hollow column or string called drillstring which is typically made up of three sections: Bottom hole assembly (BHA), transition pipe and drill pipe. The first section, BHA including drill collar that is a rock breaking tool and drill bit where the BHA is heavy with a thick walled hollow tube used for drilling fluid being pumped down through it and circulated back up the annulus (the void between the casing and the drillstring).

[3] Teale, R (2001). This technique is further incorporated with cuttingcleaning mechanisms. On the other side, each of the drilling ways discussed above, has its own drawback that could possibly add a significant threat to the drillstring safety due to the severe working conditions. For instance, in percussion drilling, bit rotation is used to make the bit tooth impacts new positions on the rock each time so that severe drilling tool failures such as tooth loss, tooth fracture and tooth wear occurred where they restricted the further development of the drilling process

[4] P.Makulsawatudum, & D. Meckenzie,(2009) In general, the drill string more frequently vibrates as combinations of all these three basic forms that can result in unwanted vibration modes of the drill string and inefficient drilling. Hence, it is essentially operating the drill string above or below the critical speed as well as carrying out pre-drilling analysis and real time analysis of the drill string dynamics to reduce the vibrations and the probability of a premature failure of the down hole.

3.0 Methodology

The DTH drilling method is growing in popularity, with increases in all application segments, including blast-hole, water well, foundation, oil & gas, cooling systems and drilling for heat exchange pumps. Applications were later found for the DTH method underground, where the direction of drilling is generally upwards instead of downwards. DTH button bit Different types of bits depending on the type of soil and the working conditions. The different types of bits are concave, convex and flat. The holes can be drilled ranging from 4 1/2 inch to 32 inch. The way to choose suitable drilling equipment is complicated and a lot of information is required to reach performance and economy in the operation. The DTH button bit is the multi-point cutting tool that cut the rocks and soil used to make holes or bores in to the hard rock surfaces of the earth and to breaking the rocks and the solid masses of land in its way.



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Influence of tempering temperature on mechanical properties of samples received

The material under consideration is a low alloyed steel, meeting the specifications of BS 970Pt.3 / EN 36C and similar to As per the Steel specifications (Group system) Ministry of Defense, the mechanical properties of this class of steel are the following

Material	Izod test	Chary test
EN36C	31 J	35 J

Test specimens of this steel were subjected to varying cycles of tempering treatment with the objective of verifying whether tempering at a higher temperature is desirable The table below represents the average mechanical response to the changing tempering temperature. A drop in the hardness and impact strength is observed with increasing temperature. This is associated with rather moderate increase in ductility. However, in the range of 250-300C better tensile properties were observed. All things considered impact strength and fatigue life were best in the as-received Condition (tempered at 180C)

Material used for button bit:

EN36C is a case hardening steel or nickel chromium steel. It is low carbon steel[2] or carburizing steel that offers high core strength, high fatigue strength, high temperature resistance and high harden ability. It can achieve carburized case hardness of 60-62 HRC (comparable to conventional gear steels such as 8620, 9310, etc.) but provides ultrahigh core properties for demanding shaft and gear applications. It's high tempering temperature (900°F) offers a 400-600°F increase in thermal stability relative to conventional gear steels

properties of EN36c:

Physical Properties: Density = 7.85 g / cc
Mechanical Properties: Hardness= 40 HRC
Ultimate tensile strength = 1238 Mpa
Yield tensile strength = 993 Mpa
Elongation at break = 200 Gpa
Modulus of elasticity = 200 Gpa
Bulk modulus = 140 Gpa
Machinabilty = 50 % Shear modulus = 80 Gpa
Thermal Properties: CTE = 11.5 mm/m o c
Specific heat = 0.472 J/g - o c
Thermal conduction = 51.9 w/n-k

4.0 Results

The ways to increase bit life without sacrificing (and perhaps increasing) drilling rate are as follows, in order of decreasing importance (i.e., first item most important). We will give specific advice

on these topics in the final report.Reduce stress concentrations. We will propose specific optimized profiles improve the coefficient of restitution and reduce residual vibrations. To do this, you have to balance the masses of the piston and bit; as well as balance aspects of geometry and deformation.Redesign to obtain certain symmetry conditions in the modes, and to achieve proper relative timing between the first and the third mode Understand the role of reduction of mass (higher frequency of hits, possibly higher drilling rate) versus the role of relatively higher or lower diameter in the narrow part of the piston and bit. Some simple approximate formulas can be proposed for these

Manufacturing:

Figure: Forging

Forging is defined as the shaping of a heated metal by hammering or pressing. In forging the metals are made plastic by heating them and then deformed by hammering when they are in red-hot. This process usually carried above recrystallization temperature Therefore, it is called as hot working process. For our raw materials selected, the piece is kept in the furnace and heated to a temperature of 9000 C -12000 C. The different Types of forging are Open die forging Then the piece is forged to steps. The piece will be in red hot even in these conditions. Then the piece in the form of steps is placed in the mould and they drop forged. Then the piece attains the shape of the die finally the piece is kept in air for cooling. Next, the piece will be sent for further machining. After forging, the metal will be of 34.5kg in mass.

Finish and turning:

Figure: Finishing machine

The piece from rough turning comes to C.N.C (Computer Numerical Control) to prepare a semi-finished bit. The bit is placed in the jaws are operated pneumatically and by leg pedals. Then the pneumatically operated tailstock holds the work piece by means of revolving centre. This finishing and turning operation is performed by CNC machine. This cnc machine is already programmed by the cnc programmer. According the given instructions the cnc performs the operations that are required to produced part. This cnc machine consists three cutting tips (or) carbide tool tips. These carbide tool tips posses high thermal and wear resistance and posses high toughness. In this cnc machine three tool bits are used. First tool bit is used to produce the shank. Second tool bit is allotted for performing roughing operation and third one is for finishing. in this cnc machine to reduce the heat of working part , to reduce the temperature of tool and for cleaning purpose quacker coolant is used. Scrap is collected automatically

Figure: surface turning

The surface may also be milled to any combination of shapes. The machine for holding the work piece, rotating the cutter, and feeding it is known as the Milling machine. Splines are made on the center of body of the DTH button bit by the use of multi point cutting tool. During splline milling shank is fixed in head stock of CNC lathe. And the head of button bit is supported with center of tail stock. Three jaw chuck is used to fix the shank of button bit. The main purpose of this cutter is to remove huge amount of material within the quick time. After finishing of Spline rough cutting ,the cutter moves in to the its original place. The speed of the rough milling is 1200 rpm,feed is 380mm/min and depth of cut is 12.2 mm

Figure: after spline milling

After completion of producing of spline rough cutting it has to be finish well For that purpose Splines are cut on the body of the work piece about 12 splines are cut and the tool used for this splines are square milling cutter. Slots are cut at the bottom surface of the bit about 10 slots are cut at regular intervals. The distance between slots in 29mm and size of slot is 24mm from cutter is used here. Speed of the finish cutter is 1400 rpm and feed is 800 mm.

Figure: work piece after milling.

Cutting fluid:

Cutting fluid is a type of coolant and lubricant designed specifically for metalworking and machining processes. There are various kinds of cutting fluids, which include oils, oil-water emulsions, pastes, gels, aerosols (mists), and air or other gases.

Figure: Cutting Fluid

Need of cutting fluids:

- To improving tool life
- To reducing work piece thermal deformation

- To improving surface finish and flushing away chips from the cutting zone
- To keep the work piece at a stable temperature (critical when working to close tolerances) Very warm is OK, but extremely hot or alternating hot-and-cold are avoided.

Conclusion

To with stand vibrations and impact loads generally manufacturing industry apply welding. Due to welding application the hard material become brittle. For the remedy of that problem I preferred instead of welding applying ceramic coating on the periphery of button bit .due to this ceramic coating the periphery of button bit gets hardened, and it improves the wear and tear resistance of button bit. I hope that in future there is chance of implement my suggestion to overcome the above problem i also suggested that by decreasing rough turning about 2mm there is a possibility for saving of materials about 2kgs .instead of rough turning if we can use exact dimensions of bit from the forging .It leads to availability of button bit at lower cost and also profits for the management. In future there is a scope for reducing the weight of button bit and increase the strength by the using of different new trend materials like aluminum alloys and other type of materials.Detecting the precise time of breakage of a button of drill bits in hard rock drilling is vital for the prime performance in mining industry, as the breakage of buttons affect financial losses for the mining companies. However, it is difficult to identify the exact time of breakage with the experience of drill rig operators. Thus, a more reliable method is desired. This research was carried out to find whether it is possible to detect the precise moment of button breakage of bits during the drilling process, by using the sound generated by rock-bit interactions

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