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Analysis of Performance of Drilling Operation on Steel Plate

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ABSTRACT

Drilling is one of the stages of oil exploration, carried out after the prospecting phase, and involves all the operations done since the beginning of the well to its delivery, The objective of this study is to analyse and characterize exactly the major processes performed during the drilling of a steel plate. These are processes that involve a low investment and financial risk, where safety and efficiency are key words and crucial for an economic viability. It is in this context that the analysis of procedures and the operational issues relating to these processes, become extremely important for the drilling operation. In this work, we have made a hole on the steel plate with the help of tool bit of different diameter on the drilling machine. Through the hole it was found that the smaller the diameter of the bit. The same thickness plate can be holed in less time than the other tool bit.

Keywords: drilling operation, safety, efficiency, viability.

INTRODUCTON

The drilling machine is one of the most important machine tools in a workshop. As regards its importance, it is second only to the lathe. In a drilling machine hole can be drilled quickly and at low cost. The hole is generated by the rotating edges of a cutting tool known as the drill which exerts large force on the work clamped on the table. As the machine tool exerts a vertical pressure to originate a hole it is loosely called a drill press. Drilling machines are made in many types and sizes, each is designed to handle a class of work or specific jobs to the best advantage.

Fig.1 drilling machine[1]

Construction of drilling machine-
The basic parts of a drilling machine are a base, column, drill head and spindle. The base made of cast iron may rest on a bench, pedestal or floor depending upon the design. Larger and heavy-duty machines are grounded on the floor. The column is mounted vertically upon the base. It is accurately machined and the table can be moved up and down on it. The drill spindle, an electric motor and the mechanism meant for driving the spindle at different speeds are mounted on the top of the column. Power is transmitted from the electric motor to the spindle through a flat belt or a 'V' belt.

Base
The base is made of cast iron and so can withstand vibrations. It may be mounted on a bench or on the floor. It supports all the other parts of the machine on it.

Column
The column stands vertically on the base at one end. It supports the work table and the drill head. The drill head has drill spindle and the driving motor on either side of thecolumn.

Table
The table is mounted on the vertical column and can be adjusted up and down on it. The table has 'T'-slots on it for holding the workpieces or to hold any other work holding device. The table can be adjusted vertically to accommodate workpieces of different heights and can be clamped at the required position.

Drill head
Drill head is mounted on the top side of the column. The drill spindle and the driving motor are connected by means of a V-belt and cone pulleys. The motion is transmitted to the spindle from the motor by the belt. The pinion attached to the handle meshes with the rack on the sleeve of the spindle for providing the drill the required down feed. There is no power feed arrangement in this machine. The spindle rotates at a speed ranging from 50 to 2000 RPM.

MACHINING

Machining is a technical and detail-oriented process in which material is cut into a final shape and size to create parts, tools, and instruments. Machining is typically used to shape metals, though it can also be used on a variety of other raw materials. Machine shops utilize equipment and tools like mills, lathes, and drill presses to cut material and 3D printers to add material. Machining is the process used to remove material, typically metal, to create parts for machines, tools, transportation, and more. Machine shops and machinists use equipment like lathes, mills, and drill presses to turn material into useful tools using precise cuts.

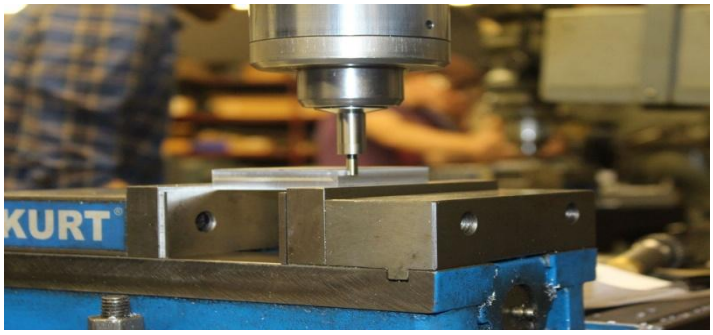


Fig.2 machining (drill on steel plate)[1]

DRILLING

Drilling machines are manufactured in different types and sizes according to the type of operation, amount of feed, depth of cut, spindle speeds, method of spindle movement and the required accuracy. The different types of drilling machines are:

1.Portable drilling machine (Hand drilling machine)
2.Sensitive drilling machine (Bench drilling machine)
3.Upright drilling machine
4.Radial drilling machine
5.Gang drilling machine
6.Multiple spindle drilling machine
7.Deep hole drilling machine

PortableDrilling Machine

Fig.3 portable drilling machine[1]

The portable drilling machines are used in the entire workshop. This type of drilling machine is operated by holding in a hand and the workpiece where the hole is to be drilled is held in a vic

Sensitive Drilling Machine

Fig.4 sensitive drilling machine[2]

It is a small machine designed for drilling small holes at high speeds in light jobs. It may be bench or floor mounted. It consists of a base, a vertical column, horizontal table, a head supporting the motor and driving mechanism and a vertical spindle for driving and rotating the drill. Total drilling operation is manually controlled. The machine is capable of drilling holes from 1.5 to 15mm diameter.

Upright Drilling Machine

Fig.5 upright drilling machine[2]

The upright drilling machine is designed for handling medium sized workpieces. In an upright drilling machine, a large number of spindle speeds and feeds may be available for drilling different types of work. The table of machine also has different types of adjustments. There are two general classes of upright drilling machine:

(1) Round column section or pillar drilling machine
(2) Box column section

Radial Drilling Machine

Fig.6 radial drilling machine[3]

The radial drilling machine is intended for drilling medium to large and heavy workpieces. The machine consists of a heavy, round, vertical column mounted on a large base. The column supports a radial arm which can be raised and lowered to accommodate work pieces of different heights. The arm may be swung around to any position over the work bed. The drill head containing mechanism for rotating and feeding the drill is mounted in a radial arm and can

be moved horizontally on the guide-ways and clamped at any desired position. These three movements in a radial drilling machine when combined together permit the drill to be located at any desired point on a large work piece for drilling the hole.

Gang Drilling Machine

Fig.7 gang drilling machine[3]

When a number of single spindle drilling machine columns are placed side by side on a common base and have a common work-table, the machine is known as the gang drilling machine. In this machine four to six spindles may be mounted side by side. This type of machine is specially adapted for production work. A series of operations may be performed on the work by simply shifting the work from one position to the other on the work-table. Each spindle may be set up properly with different tools for different operations.

Multiple – Spindle Drilling Machine

Fig.8 multiple-spindle drilling machine[3]

The function of a multiple-spindle drilling machine is to drill a number of holes in a piece of work simultaneously and to reproduce the same pattern of holes in a number of identical pieces in a mass production work. Such machines have several spindles driven by a single motor and all the spindles holding drill are fed into the work simultaneously. Feeding motion is usually obtained by raising the work-table. A machine will drill a number of parallel holes simultaneously in a work piece. Multi spindle drilling machines are employed for work of a light character, especially repetition work, such as drilling small components for the Automobile and Aircraft industries.

Deep Hole Drilling Machine

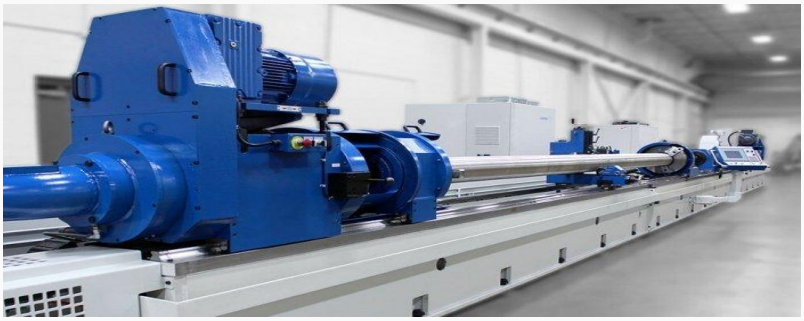


Fig.9 deep hole drilling machine[3]

A deep hole drilling machine is a metal-cutting machine tool, designed to produce very deep, precision holes into virtually any metal. Deep hole drilling machines enable the performance of specific tools such as BTA and gun drills, to optimize the deep hole drilling process for manufacturers. Machines are engineered to integrate the technology used by these tools, and optimize all aspects of the process, to drill deep holes with accuracy, reliability, and efficiency.

Following basic operation on drilling machining: -

Reaming

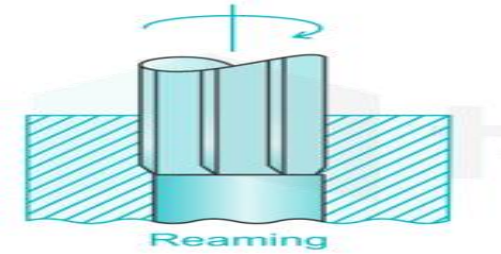


Fig.10 reaming[4]

The tool used for enlarging and finishing a previously drilled hole is known as a reamer. It is a multi-tooth cutter and removes smaller amount of material. It gives a better finish and accurate dimension

Boring

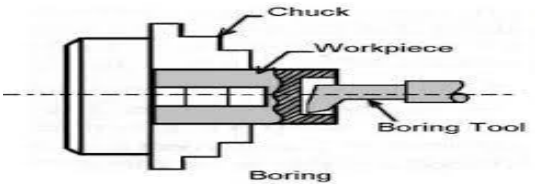


Fig.11 boring[5]

It is the process carried on a drilling machine to increase the size of an already drilled hole. initially a hole is drilled to the nearest size and using a boring tool the size of the hole is increased.

Counter Boring

Fig.12 counterboring[4]

This process involves increasing the size of a hole at only one end. Cutting tool will have a small cylindrical portion called cutting speed is equal two-thirds of the drilling speed for the same hole.

Counter Sinking

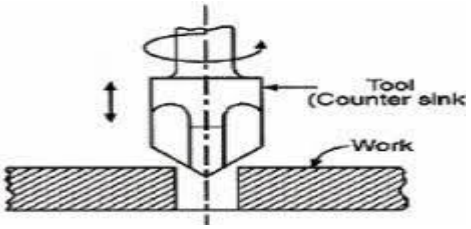


Fig.13 counter sinking[5]

This is an operation of making the end of a hole into a Cutting speed is equal half of the cutting speed of drilling for the same hole.

Spot Facing

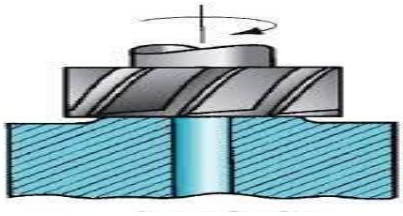


Fig.14 spot facing[4]

It is a finishing operation to produce flat round surface usually around a drilled hole. For proper seating at bolt head or nut. It is done using a special spot facing tool.

Tapping

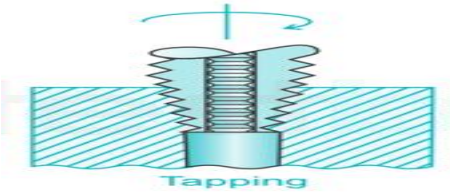


Fig.15 tapping[5]

Procedure

Drilling tools are devices that rotate to create round holes on a workpiece by removing material. A machine shop may have a designated drill press for hole making or specific tools that can be attached to compatible machineries such as a lathe or CNC machine.Process of cutting internal threads wit a thread tool called as tap. Tap is a fluted threaded tool used for cutting internal threads. Cutting speed is very low.

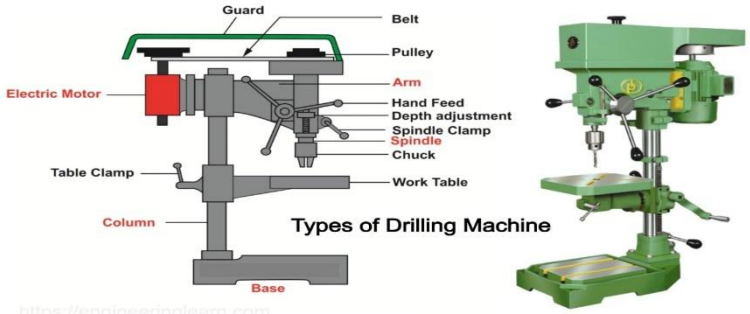


Fig.16 drilling tools

Machine Used: -

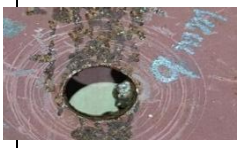
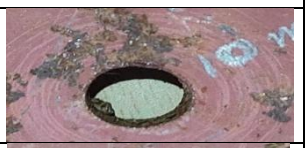
Machine specification are given below. Which is used in operation in our work. We had Select the Spindle speed 260.

Table 1 -Parameter of Machine with Specification	
Parameter	**Specification**
Model No.	19KBR
Brand	K. M. Panchal
Riling Cap. In Steel	20mm
Drilling Cap. in C. I.	23mm
Tapping Cap. in Steel	M13
Spindle Taper	MT2
Spindle Speed (rpm)	86,154,260,460,617,1100,1880,3360
Type of Feed	manual
Dia. of Column/ Length of Column	73.80mm/915mm
Max. Dist. Bet. Spindle Centre to Column Face	125mm

Max. Dist. Bet. Spindle Nose to Table	365mm
Max. Dist. Bet. Spindle Nose to Base Plate	630mm
Up-Right Travel of Working Table	250mm
Size of Base Plate	490×310mm
Size of 'T' Slot in Base Plate	7/16
Working Surface of Base Plate	270×270mm
Electric Motor	1 HP/1440 RPM
V-Belt Size	A43
Weight Of Machine (kg)	99

We have taken a steel plate whose dimension is 15mm*15mm*6mm in which different holes have been made in different bit (with different diameter).

Table 2. Image of 1st plate (thinner)

Sr. no.	Bit diameter (mm)	Dimension hole after operation(mm)	Image
1.	7mm	8mm	
2.	9mm	10mm	
3.	10mm	11mm	
4.	11mm	12mm	

Below table shows that, different bit diameter, thickness of plate size of hole and time taken by tool for operation.

Table 3. dimensions of 1st plate (thinner)

Sno	BIT diameter (mm)	Thickness of plate (cm)	Size of hole after operation(mm)	Time taken (second)
1	7	0.6	8	2
2	9	0.6	10	2.5
3	10	0.6	11	3.5
4	11	0.6	12	5

We saw that (table3) that the steel plate in thinner (0.6cm) and if the tool bit is of less diameter, then it is taking less time, if the bit size is thicker that plate is thinner then it is taking more time because more material is being removed from the plate.

We have taken a steel plate whose dimension is 15mm*15mm*12mm in which different holes have been made in different bit (with different diameter).

Table 4. Image of 1st plate (thicker)			
Sr. no.	**Bit diameter (mm)**	**Dimension hole after operation(mm)**	**Image**
1.	13mm	13.5mm	
2.	16mm	16.5mm	
3.	19mm	19.5mm	
4.	23mm	23.5mm	

Below table shows that, different bit diameter, thickness of plate size of hole and time taken by tool for operation.

Table 5. dimensions of 2nd plate(thicker)				
S no	BIT diameter (mm)	Thickness of plate (cm)	Size of hole after operation(mm)	Time taken (second)
1	13	1.2	13.5	6.5
2	16	1.2	16.5	7
3	19	1.2	19.5	8.5
4	23	1.2	23.5	10

We saw the that (table 5) the hole made in the 1.2 cm plate was drilled with a tool bit. Only 0.5mm extra size hole is being obtained from the size.therefore, we can say that this effect was seen due to the thickness of the plate and its internal structure. Earlier 1mm extra size was obtained in a hole made with different tool bits in a 0.6 cm steel plate.

RESULT and DISCUSSION

The texture of the material gives information about the machining being done on it, through table (4) it can be said that after material removal from the drill done on the thin plate hole of 1 mm more was obtained the effect of the internal structure of the substance was seen in the thin (0.6mm) plate, the atom of the substance is not well connected (due to weak of inter molecular bond). As a result of the change in the structure of the atoms or it was seen that 0.5 mm additional hole size is becoming more or less the same which is according to the properties and size of matter.

Table 4. thickness of plate, hole size after operation and taking time					
S no	**Bit diameter(mm)**	**For plate size 0.6 mm**		**For plate size 1.2cm**	
		Size of hole after operation(mm)	Time taken (second)	Size of hole after operation(mm)	Time taken (second)
1	7	8	2	7.5	3
2	9	10	2.5	9.5	4
3	10	11	3.5	10.5	5
4	11	12	5	11.5	6
5	13	14	5.5	13.5	6.5
6	16	17	6	16.5	7
7	19	20	7.5	19.5	8.5
8	23	24	9	23.5	10

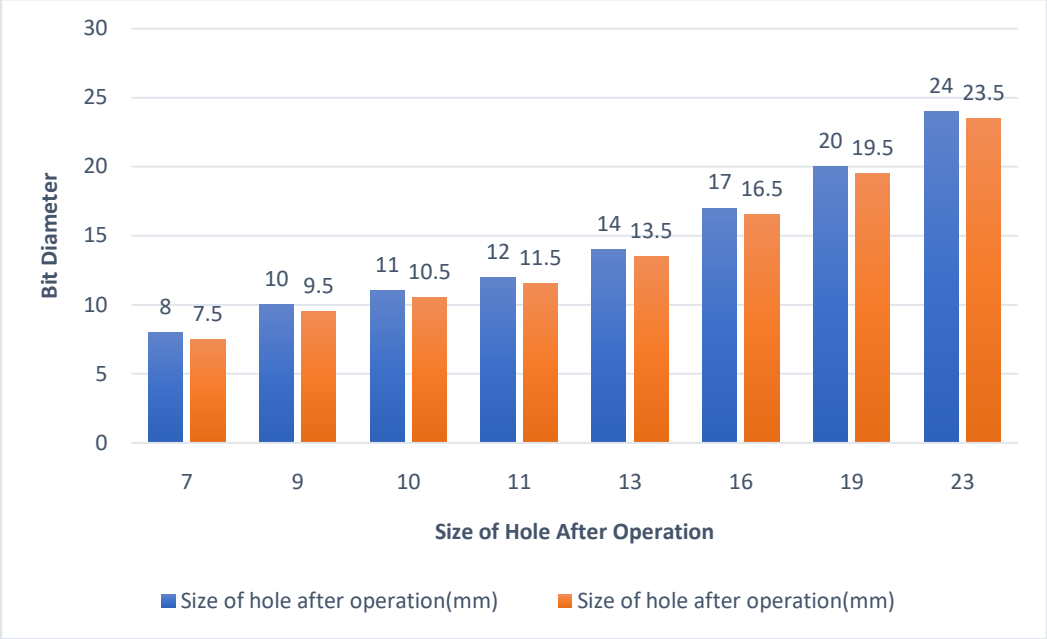


Fig.17 size of hole after operation

CONCLUSIONS

The drilling machine is defined as a machine which is used to make a circular hole, a tool used to drill the hole of different size and other related operations using a drill bit. The drilling machine is the most important machines in a workshop.Drilling is a vital machining process for many industries. Automotive and aerospace industries are among those industries which produce millions of holes where productivity, quality, and precision of drilled holes plays a vital role in their success. Therefore, a proper selection of machine tools and equipment, cutting tools and parameters is detrimental in achieving the required dimensional accuracy and surface roughness. While drilling the steel plate, it is important to keep in mind that the coolant should be circulated from time to time, so that the operation can be done smoothly the stability of the atom in the internal structure and texture of the plate affects the material removal time.

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