Manufacturing Processes 1 (MDP 114)

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Machining Operations & Machine Tools

- Turning
- Milling
- Drilling
- Shaper
- Broacher
- Saw
- Screw Thread
- Planner
- Gears
Drilling Machine
Definition

- Drilling is the operation of **producing circular hole** in the workpiece by using a **rotating cutter** called DRILL.

- The machine used for drilling is called **drilling machine**.

- The drilling operation can also be accomplished in **lathe**, in which the drill is held in tailstock and the work is held by the chuck.

- The most common drill used is the **twist drill**.

- It is the **simplest** and **accurate** machine used in production shop.
Drilling Machine Types

Drilling Machine

Construction
- Portable,
- Sensitive,
- Radial,
- up-right,
- Gang,
- Multi-spindle

Feed
- Hand driven,
- Power driven
Drilling Machine Types

- **Twist Drill**: Holes with different diameters.
- **Step Drill**: Holes with different diameters.
- **Core Drill**: Enlarge diameters of exiting holes.
Drilling Machine

Sensitive Drilling Machine

- Drill holes from 1.5 to 15mm
- Operator senses the cutting action so sensitive drilling machine
Drilling Machine

Up Right Drilling Machine

- Drill holes up to 50mm
- Table can move vertically and radially
Drilling Machine

Radial Drilling Machine

- It the largest and most versatile used for drilling medium to large and heavy work pieces.
Drill Material

The two most common types are:

1. HSS drill
   - Low cost
2. Carbide- tipped drills
   - high production and in CNC machines

Other types are:

Solid Carbide drill, TiN coated drills, carbide coated masonry drills, parabolic drills, split point drill
Twist Drills

• **End-cutting** tools.
• Used to produce **holes** in most types of materials.

• Two **helical grooves**, or **flutes**, are cut lengthwise around body of drill.
  – Provide cutting edges and space for chip to escape during drilling process.

• Most made of high-speed steel (H.S. or H.S.S.)
  – Replaced carbon-steel drills due to
    • It can be operated at double the cutting speed

• Carbide-tipped drills
  – Speeds for production have increased up to 300% over high-speed drills
Tool Nomenclature

- Shank
- Margin
- Body
- Flute
- Web
- Point
- Cutting Edge
- Body clearance
- Margin
- Chisel edge
- Lip
- Heal
Drill Main Parts

- Shank
- Body
- Point
Shank

• Straight-shank drills
  – Held in drill chuck
  – Up to ½ in. in diameter

• Tapered-shank drills
  – Fit into internal taper of drill press spindle
  – Tang provided on end to prevent drill from slipping
Body

• Portion of drill between shank and point
• Consists of number of parts for cutting

• Flutes
  – Two helical grooves cut around body of drill
  – Form cutting edges, admit cutting fluid, allow chips to escape hole

• Body Clearance
  – Undercut portion of body between margin and flutes
• Margin
  – Narrow, raised section on body of drill
  – Next to flutes and extends entire length of flutes
  – Provides full size to drill body and cutting edges

• Web
  – Thin partition in center of drill, extends full length of flutes
  – Forms chisel edge at cutting end of drill
Point

BODY CLEARANCE

CUTTING EDGE OR LIP

CUTTING EDGE OR LIP

HEEL

CHISEL EDGE
Lip Clearance

- Is the relief ground on point of drill extending from cutting lips back to the heel
Drill Point Characteristics

The use of various point angles and lip clearances, in conjunction with thinning of the drill web, will allow:

1. Control size, quality and straightness of drilled hole
2. Control size, shape and formation of chip
3. Control chip flow up flutes
4. Increase strength of drill's cutting edges
5. Reduce rate of wear at cutting edges
6. Reduce amount of drilling pressure required
7. Control amount of burr produced
8. Reduce amount of heat generated
9. Permit use of various speeds and feeds for more efficient drilling
Conventional Point (118°)

• Most **commonly** used drill point

• Gives **satisfactory results** for most general-purpose drilling

• Lip clearance of **8° to 12°** for best results
  – Too much weakens cutting edge and causes drill to chip
  – Too little results in use of heavy drilling pressure
Long Angle Point (60º to 90º)

- Used on low helix drills for drilling of nonferrous metals, soft cast irons, plastics, fibers, and wood
- Lip clearance generally from 12º to 15º
- Flat may be ground on face of lips to prevent drill from drawing itself into the soft material
Flat Angle Point (135° to 150°)

- Used to drill **hard** and **tough** materials
- Lip clearance on flat angle point drills **6° to 8°** to provide as much support as possible for cutting edges
- Shorter cutting edge tends to **reduce friction** and **heat** during drilling
Drill Sizes Systems

• **Fractional**
  – Range from $1/64$ to $4$ in. (steps of $1/64^{th}$)

• **Number**
  – Range from #1 (.228 in.) to #97 (.0059 in.)

• **Letter**
  – Range from A to Z (A = .234 in., Z = .413 in.)

• **Millimeter (Metric)**
  – Miniature (0.04 to 0.09 mm, steps of 0.01 mm)
  – Straight-shank standard (0.5 to 20 mm)
  – Taper-shank (8 up to 80 mm)
Tool Holding devices

- The different methods used for holding drill in a drill spindle are:
  - By directly fitting in the spindle hole.
  - By using drill sleeve
  - By using drill socket
  - By using drill chuck
Drilling Operations

• Operations that can be performed in a drilling machine are:
  - Drilling
  - Reaming
  - Boring
  - Counter boring
  - Countersinking
  - Tapping
Drilling Operations

Counter Boring

Drilling

Tapping

Boring

Reaming

Countersinking
Drilling Operations
Types of cutters

Reamers :-
   Multi tooth cutting tool.
   Accurate way of sizing and finishing the preexisting hole.
   Accuracy of ±0.005 mm can be achieved.

Boring Tool:-
   Single point cutting tool.
   Boring tool is held in the boring bar which has the shank.
   Accuracy of ±0.005 mm can be achieved.

Counter Bore Tool:-
   Special cutters uses a pilot to guide the cutting action.
   Accommodates the heads of bolts.
Types of cutters

Countersinks :-
  Special angled cone shaped enlargement at the end of the hole
  Cutting edges at the end of conical surface.

Combined Countersinks and central drill :-
  Special drilling tool to start the hole accurately.
  At the end it makes countersinks in the work piece.

Gun drill :-
  Machining of lengthy holes with less feed rates.
  To overcome the heating and short life of the normal drill tool
Types of cutters

Tapping:-
For cutting internal thread
Multi cutting edge tool.

Tapping is performed either by hand or by machine.

Minor diameter of the thread is drilled and then tapping is done.
Through Hole vs. Blind Hole

*Through holes* - drill exits the opposite side of work

*Blind holes* – drill does not exit work on opposite side

Two hole types: (a) through hole, and (b) blind hole
Work Holding Devices

Machine Table Vice

Standard machine table vice

Swivel vice
Machining Calculations

• Cutting Speed (v):-
  It’s the peripheral speed of the drill (m/min)
  \[ v = \pi DN \]
  \( D = \text{diameter of the drill in (m)}, \ N = \text{Speed of rotation in (rpm)} \)

• Material Removal Rate (MRR):-
  It’s the volume of material removed by the drill per unit time (mm\(^3\)/min)
  \[ MRR = \frac{\pi}{4} D^2 f N \]
Machining Calculations

• Feed Rate \((f_r)\) mm/min:-

\[
f_r = f N
\]

• Machining Time \((T)\) :-

It depends upon \(L = \) the length of the hole to be drilled , \(N = \) speed, \(f = \) feed, \(A= \) allowance account for drill point angle, \(D = \) tool diameter, and \(\theta = \) drill point angle.

\[
T = \frac{L + A}{f N}
\]

\[
A = 0.5 D \tan \left(90 - \frac{\theta}{2}\right)
\]
Precautions for Drilling machine

- **Lubrication** is important to remove heat and friction.
- Machines should be **cleaned** after use.
- Chips should be **removed** using brush.
- T-slots, grooves, spindles sleeves, belts, pulley should be **cleaned**.
- Machines should be lightly **oiled** to prevent from rusting.
Safety Precautions

• Do not support the work piece by hand – use work holding device.
• Use brush to clean the chip
• No adjustments while the machine is operating
• Ensure for the cutting tools running straight before starting the operation.
• Never place tools on the drilling table
• Avoid loose clothing and protect the eyes.
• Ease the feed if drill breaks inside the work piece.
How can you perform a hole in large heavy workpiece?
Boring

Figure 22.12 - A vertical boring mill – for large, heavy workparts