Common maintenance procedures for hydraulic and pneumatics control system

Objectives: At the end of this lesson you will be able to
- **plan hydraulics and pneumatic maintenance practices**
- **select proper practices of hydraulics and pneumatics maintenance.**

Key concepts

- Trouble shooting, done in a logical manner, can solve most hydraulic and pneumatic system problems.
- Safety should be the first consideration when trouble shooting.
- Inspect the equipment and question the operator to help solve problems in hydraulic and pneumatic systems.

Safety Precautions

Hydraulic systems operate under very high pressures. Shut the system down and relieve system pressure before opening any part of the system that is under pressure. Do not allow spray from any high pressure leak to contact any part of the body, as serious injection injuries may result. Pumps, valves and motor may beocme hot; be cautious of incidental contact between bare skin and hot surfaces. Keep hands and clothing away from moving parts of the system.

Basic hydraulics system maintenance

Weekly

- Check the systems performance and general condition.
- Check that the oil level in the reservoir is correct on the sight glass. (Hydraulic cylinder should be fully retracted when doing this) Check the oil color as compared to the sample of new oil.
- Check reservoir cover, solenoids and pipe connections for leaks and tighten as required.
- Check the indicator on filters and replace elements if required. When replacing elements, inspect for tell tale signs of impending unit failure, e.g., metal particles.
- Inspect relief valve locks, checking for unauthorized tampering.
- Check accumulator pre-charge (where fitted).

Annually and or every 3000 operation hours

- Check all mounting bolts for tightness. Remove coupling guards from pump / motor and check flexible couplings for wear. Replace the rubber sleeve if necessary.
- Check all the valve, pump and actuator for oil leak. Remove and replace the seals if necessary.
- Check filler breather, suction flter and systen filters element for cleanliness and replace if necessary.
- Check the cooler and clean the element. If necessary replace the seals.
- Have a sample of oil in the reserrvoir checked by a specialized laboratory for size end type of particle contamination. Drain the reservoir if recommended, clean the tank interior and refill with fresh oil of correct type if necessary.

Hydraulic system maintenance

Hydraulic system is recommended to be serviced at every 3000 operational hours or at least once a year.Continuous operation exceeding the mentioned period may cause increased contamination that may ruin components such hydraulic pump, valves, actuator, etc.,

More than 90% of all hydraulic systems failure are caused by contaminated hydraulic fluid. In order to reduce the contamination level, regular or schedule maintenance are essential.

Basic pneumatic system maintenance

Once in a Week

- Drain compressor, tank, filter, bowl, and any air lines that have drain cocks.
- Check compressor crankcase oil level
- Check compressor safety - relief valve

Once in a Month

- Inspect discharge air filter.
- Check pressure - reducing valve setting

Once in Every 3 Months

- Change crankcase oil
- Oil the compressor motors.
- Check compressor pressure switches.

Once in Every 6 Months

- Check for moisture, oil , and dirt in air lines.
- Clean the intake air filter, felt and screen types
- Check the compressor belt
- Check the pressure relief valves
- Check calibration, operation, nozzles, and and restrictors of transimt - temperature controllers, pressure controllers, thermostats and humidistats
- Check piping of pressure transmitters and controllers
- Clean elements and humidistats

Once in Year

- Replace cartridge - type intake air filters
- Check calibration of receiver controllers
- Check valves for tight close - off

Importance of technical English terms used in industries

Objectives : At the end of this lesson you shall be able to
- **state importance of english for employability skills**
- **state importance of english for soft skills.**

English as a language is important for professional courses It enhances:

- Employability skills: Trainees who possess the ability to understand,read,write and speak the language get better opportunity to get a job and retain in to scale heights in their career not only in the corporate,but also in the public sector.
- Soft skills: Apart from the hard skills that is the ability to acquire technical skills it has beocme very much necessary to master the art of soft skills equally in the under graduation level to develop the art of articulation in the world of competitive environment when the world has become very small with the access of internet and electronic media at our doorsteps.Being articulate it would be easier to build interpersonal relationship for smooth flow of communication to ensure productivity. The openness of the environement would ensure the confidence in decision making capability. Openness of the ambiance would lead to smart work which steer one to be multitasking.
- English as a language gained popularity not until 14 th century. Today it is a language of survival and sustenance
- Dominance of the British in every part of the world during the 19th and early 20th century by setting up colonies due to industiral revolution made the language richer and richest.

Different types of documentation as per industrial needs

Objectives : At the end of this lesson you shall be able to
- **state the purpose of documentation**
- **list the different types of documentation**
- **explain the documents format - batch processing, BOM, cycle time, productivity report, manufacturing inspection report.**

Documentation

Documentation and records are used throughout the manufacturing process as well as supporting processes (quality control) must meet the basic requirements. Documentation is a set of documents provided on paper, or online, or on digital or analog media, such as audio tape or CDs. Examples are user guides, white papers, online help, quick reference guides.

The stages of recording the documents is to

- prepare, review, update and approve documents.
- identify changes and current revision status of documents.
- use of applicable documents available at points of use with the control documents of external origin
- identify and distribute relevant versions to be identifiable and remain legible.
- prevent unintended use of obsolete documents and archiving.

The different types of documentation as per industrial needs includes

- Processing charts
- Bill of materials (BOM)
- Production cycle time format
- Productivity reports
- Manufacturing stage inspection report
- Job cards format
- Work activity log
- Batch production record format
- Estimation of work
- Maintenance log format

Process chart

A process chart is a graphical representation of the activities performed during manufacturing or servicing jobs. Graphical representation of the sequence of operations (workflow) constituting a process, from raw materials to finished product.

Process charts are used for examining the process in detail to identify areas of possible improvements.

The different types of process charts are

- Operation process chart
- Flow process chart (man/ material/ equipment type)

- Operator chart (also called two handed process chart)
- Multiple activity chart
- Simo chart

The following symbol set derived from Gilbreth's original work as the standard for process charts.

Symbol	Letter	Description	Examples
O	O	Operation	Saw cut, paint, solder, package
→	M	Transport	Conveyor / Fork lift / OTR truck
□	I	Inspection	Visual/dimension
D	D	Delay	WIP/Hold/ Queue
∇	S	Storage	Warehouse/tracked storage location

The application of symbols on a flow process chart is shown in the figure

Flow process chart(Machines)

Industry : _____

Product : _____

Summary

Function	Present		Proposed	
	*	Time	*	Time
Operation				
Inspection				
Transport				
Delays				
Storage				

Details	O→□ D∇	Qty	Time (in mins)	Analysis	Actions recommended
Raw material from stores	O→□ D∇				
To cutting machine	O→□ D∇				
Cutting of material to size	O→□ D∇				
Filling, Finishing	O→□ D∇				
To inspection for finished size	O→□ D∇				
To stores (Finished job)	O→□ D∇				

Batch record forms

The documents used and prepared by the manufacturing department provide step-by-step instructions for production-related tasks and activities, besides including areas on the batch record itself for documenting such tasks.

Batch production record is prepared for each batch should include information on the production and control of each batch. The batch production record should confirm that it is correct with standard operating procedure.

These records should be numbered with a unique batch or identification number and dated and signed when issued.

The batch number should be immediately recorded in data processing system. The record should include date of allocation, product identity and size of batch.

Documentation of completion of each significant step in the batch production records (batch produciton and control records) should include :

- Dates and, then appropriate time
- Major equipment used machinery and specific batch numbers of raw materials, reprocessed materials used during manufacturing.

- Critical process parameters records.
- Trial product or sample (if required).
- Signatures of staff for sequence of operation.
- Laboratory test results and line inspection notes.
- Achieved production against target.
- Packaging and label (if any) details.

Batch processing record : (Sample format - 1)

The format 1 used in documentation of batch processing record has the description of the job, necessarily mentioned with part number and name of the part.

A predetermined batch quantity with batch number alloted and identified with batch record number for documentation.

The product reference is made with purchase order number.

The production process is descriptively written about the sequence of operation to be carried out on the product.The batch processing record is signed with date mentioning name of person responsible and their designation.

The manufacturer organization name, period of manufacture preferably the year with starting date of manufacture and end date of manufacturer and number of pages of document according to batch quantity processed, and total number of pages of document, inclusive of inserted pages and manufacturing facilities is provided with.

The remarks if any on the process should be also mentioned then and there.

BATCH PROCESSING RECORD - FORMAT - 1

Batch Processing Record		
Description of job	Batch no. :	
Part no. : Name of part :	Batch quantity : Batch record no. : Purchase order no. :	
Description of process :		
Manufacturing Organisation :		
Period of manufacture (Year - Qtr):	Start date of manufacture:	End date of manufacture:
Number of pages according to batch:	Inserted pages:	Manufacturing facilities:
Total number of pages		
1. Operator / Technician	Date	Name and signature
2. Production in-charge:	Date	Name and signature
3. Section manager	Date	Name and signature
4. Plant in-charge:	Date	Name and signature
5. Production in-charge:	Date	Name and signature
Remarks (if any)		

Bill of materials (BOM) format - 2

The list of parts involved in manufacturing of an assembly hierarchially is given in this format.

The format shown is as per bureau of Indian Standards IS:11666-1985 as example for Engineering Component drawings.

The BOM in the form of tabular columns has the component marked with item number, and its name is given under description and number of is mentioned under quantity, with reference drawing ie., sub assembly/part drawing number.

The material designation as per code of practice or standards is mentioned, and any other specific notes are given under remarks column.

The BOM is placed on the manufacturing drawing containing with assembly and parts in standard sheet sizes of engineering drawing.

BILL OF MATERIAL (BOM) - FORMAT - 2
as per IS: 11666-1985

S.No	Item No.	Description	Quantity	Reference dwg no.	Material as per standard	Remark

Cycle time

Cycle time is the total time from the beginning to the end of the process. Cycle time includes process time, during which a raw material worked with to bring it closer required form output, and delay time, during which the to workpiece waiting for next operation.

The time taken to perform one operation repeatedly measured from “Start to Start” the starting point of one product’s processing in a specified machine or operation until the start of another similar product’s processing in the same machine or process. Cycle time is commonly categorized into same machine/process.

Machine cycle time

The processing time of the machine working on a part.

Auto cycle time

The time a machine runs un-aided (automatically) without manual intervention.

Overall cycle time

The complete time it takes to produce a single unit. This term is generally used when speaking of a single machine or process.

Total cycle time

This includes all machines, processes, and classes of cycle time through which a product must pass to become a finished product. This is not lead time, but it does help in determining it.

Production cycle time (Format - 3)

This format 3 should contain mentioning the organization name department / section name. The process which is being observed for analysing the cycle time is mentioned with line in charge name and the date/time of the operations, with operator name is indicated.

The time observation on each operation, sequence noted in the column, and lowest repeatable is also mentioned for each operation. The times observation for machine cycle time is also noted, with any notes be recorded in respective operations in sequence.

PRODUCTION CYCLE TIME - FORMAT - 3

Organisation Name: **Department / Section :**	**Process:**	**Line Incharge:**	**Date/Time:**

Operator :										**Machine Cycle Time**	**Notes**
Operator Sequence	**Observed Times**								**Lowest Repeatable**		

Productivity report

Productivity report to measure and review the efficiency of a person, machine, factory, system, etc., in converting inputs into useful outputs. Productivity report is computed by dividing average output per period by the total costs incurred or resources (capital, energy, material, personnel) consumed in that period.

The base document daily production report which reveals the actual output against the target plan and on investment cost incurred as mentioned above decides the cost efficiency.

Daily production report (Format 4)

The output of production is shown in the format, referring the job order no quantity, material and size, every process involved, to produce a component, quality control, packing should contain the details of planned quantity and produced quantity is recorded in the document. This is the base details for arriving the productivity report.The incurred cost is worked out considering infrastructure, raw materials and facilities.

DAILY PRODUCTION REPORT - FORMAT - 4

			Daily Production Report										
Date:			**Department:** **Section:**					**Organisation Name:**					
	Process - I		Process-II		Process-III		Process-IV		Quality Control		Packing	
	Planned	Completed	Planned	Completed	Planned	Completed	Planned	Completed	Planned	Completed	Planned	Completed
Job Order No. Quantity Material & Size												
Job Order No. Quantity Material & Size												
Job Order No. Quantity Material & Size												
Job Order No. Quantity Material & Size												
Job Order No. Quantity Material & Size												

Signature of section Incharge

Manufacturing stage inspection report (Format 5)

The format 5 is to monitor the production in various stages for which manufacturing stage inspection conducted for documentation to review the productivity. The format gives the details of product being inspected showing the details of customer reference by purchase order (PO) number and date, job order number and date, process involved in manufacture of product, the quality submitted for inspection. The accepted and rejected quality recorded with inspection record review date and the inspection person signature who conducted the stage inspection is recorded date wise for mentioned /specified period with start and end dates.

MANUFACTURING STAGE INSPECTION REPORT - FORMAT - 5

Status: From Date ..../..../..... To Date .../.../.....

Organisation Name :

Date	Product ID/ Code	Customer	P.O No. & Date	Job Order No.	J.O Date	Process	Qty	Accepted	Rejected	Inspection Record No.	Inspection conducted by

Documentations - 2

Objectives : At the end of this lesson you shall be able to
- **state the purpose of job card and its format details**
- **explain work activity log format details**
- **state the details of batch production format.**

Job card

A job card is a document showing the details of a job to be performed in a production shop. It is used to authorize and instruct the work team to take up the production work.

Job card format - 1

Job card has the details of commencing the job, customer name, work order no, document number, reference number and date.

The details which have to be recorded about the product line description showing the operations each into recording of start time and total time of operation. The location time recorded is to track if any delay/ reasons and necessary actions if taken with remarks.

If the product has to be completed with any of the further operations in sequence, this card will travel along with job for next workstations for further operations if any to complete the requirement of job, and recorded till finishing of the job.

JOB CARD - FORMAT-1

Job Card		Doc No.	
		Rev No.	
		Date	
Order Starting Date			
Customer			
Work Order No.			

Details

S.No.	Date	Production Line Description	Time (Minutes)			Location Time	Remarks
			Start Time	End Time	Total Time		

Lubrication methods

Objective: At the end of this lesson you shall be able to
- **state the systems of lubrication and their application.**

There are 3 systems of lubrication.

- Gravity feed system
- Force feed system
- Splash feed system

Gravity feed

The gravity feed principle is employed in oil holes, oil cups and wick feed lubricators provided on the machines. (Figs 1 & 2)

Fig 1

OIL CUP

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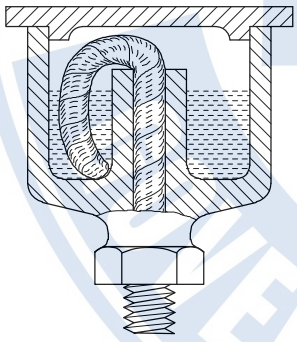
Fig 2



WICK FEED

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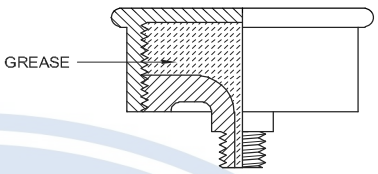
Force feed/Pressure feed

Oil, grease gun and grease cups

The oil hole or grease point leading to each bearing is fitted with a nipple, and by pressing the nose of the gun against this, the lubricant is forced to the bearing. Greases are also force fed using grease cup. (Fig 3)

Oil is also pressure fed by hand pump and a charge of oil is delivered to each bearing at intervals once or twice a day by operating a lever provided with some machines. (Fig 4) This is also known as shot lubricator.

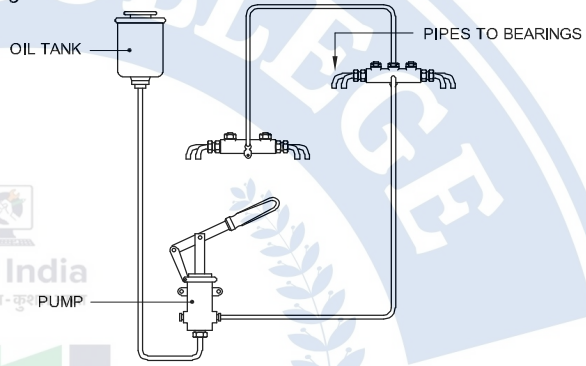
Fig 3



MANUAL SCREW DOWN GREASER

FI20N2718813

Fig 4



HAND PRESSURE FEED (SHOT LUBRICATED)

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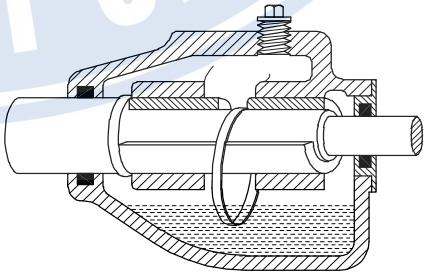
Oil pump method

In this method an oil pump driven by the machine delivers oil to the bearings continuously, and the oil afterwards drains from the bearings to a sump from which it is drawn by the pump again for lubrication.

Splash lubrication

In this method a ring oiler is attached to the shaft and it dips into the oil and a stream of lubricant continuously splashes around the parts, as the shaft rotates. The rotation of the shaft causes the ring to turn and the oil adhering to it is brought up and fed into the bearing, and the oil is then led back into the reservoir. (Fig 5) This is also known as ring oiling.

Fig 5



RING OILING

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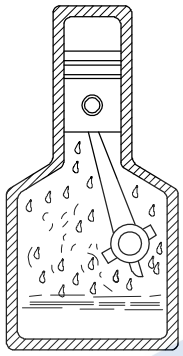
In other systems one of the rotating elements comes in contact with that of the oil level and splash the whole

system with lubricating oil while working. (Fig 6) Such systems can be found in the headstock of a lathe machine and oil engine cylinder.

Fig 6



SPLASH-LUBRICATING SYSTEM

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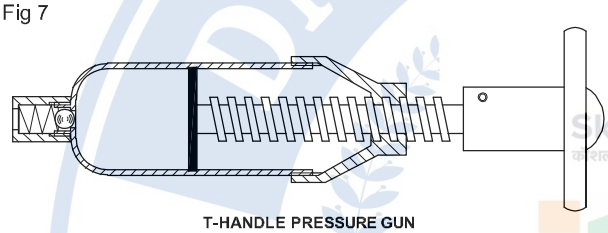
Types of grease guns

The following types of grease guns are used for lubricating machines.

- 'T' handle pressure gun (Fig 7)

Fig 7

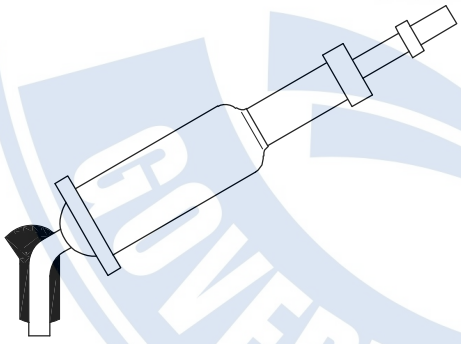


T-HANDLE PRESSURE GUN

FI20N27188I7

- Automatic and hydraulic type pressure gun (Fig 8)

Fig 8



AUTOMATIC HYDRAULIC-TYPE PRESSURE GUN

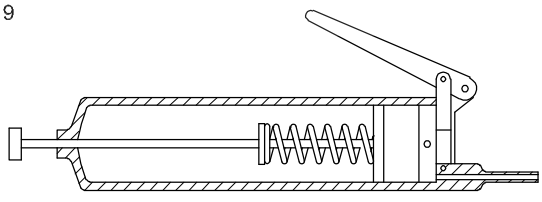
FI20N27188I8

- Lever-type pressure gun (Fig 9)

Lubrication to exposed slideways

The moving parts experience some kind of resistance even when the surface of the parts seems to be very smooth.

Fig 9



PRESSURE GREASE GUN

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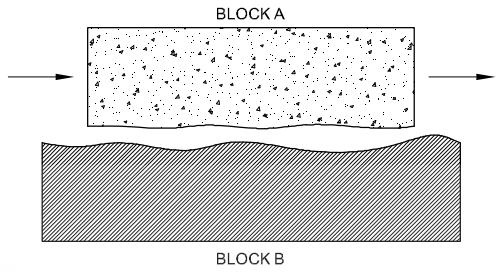
The resistance is caused by irregularities which cannot be detected by the naked eyes.

Without a lubricant the irregularities grip each other as shown in the diagram. (Fig 10)

Fig 10



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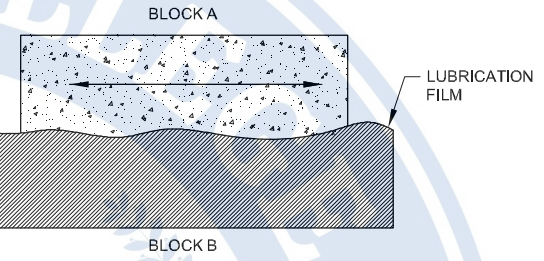
With a lubricant the gap between the irregularities fills up and a film of lubricant is formed in between the mating components which eases the movement. (Fig 11)

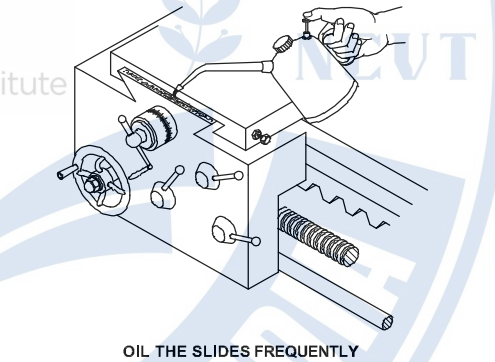
Fig 11



FI20N271881B

The slideways are lubricated frequently by an oilcan. (Fig 12)

Fig 12

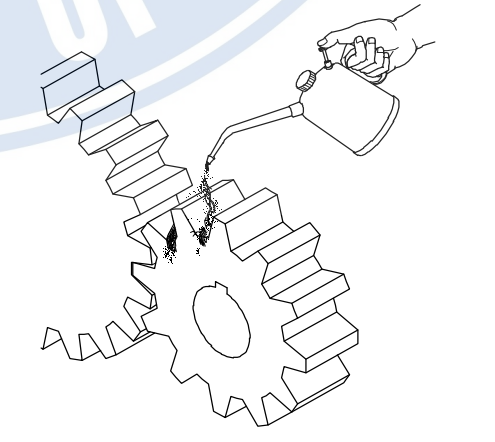


OIL THE SLIDES FREQUENTLY

FI20N271881C

After cleaning the open gears, oil them and repeat lubrication regularly. (Fig 13)

Fig 13



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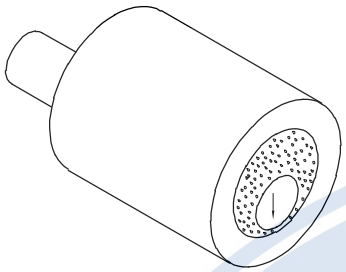
Lubricate bearings

A shaft moving in a bearing is also subjected to frictional resistance. The shaft rotates in a bush bearing or in ball/ roller bearing, experiencing friction.

When the shaft is at rest on the bottom of the bush bearing, there is hardly any lubricant between the shaft and the bush. (Fig 14)

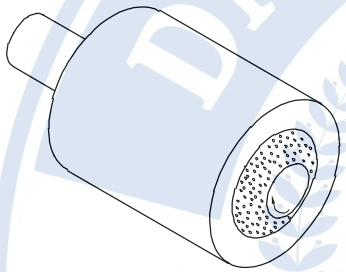
Fig 14



FI20N271881E

When the shaft starts rotating the lubricant maintains a film between the shaft and the bush and an uneven ring of lubricant builds up. (Fig 15)

Fig 15



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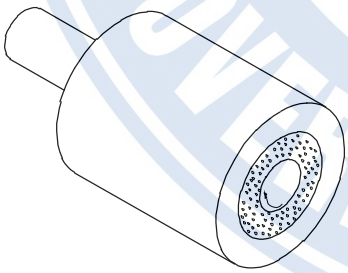
When the shaft is rotating at full speed a full ring of lubricating film surrounds the shaft (Fig 16) which is known as hydro dynamic lubrication.

This lubrication ring decreases the frictional resistance very much and at the same time protects the mating members against wear and changes.

Fig 16



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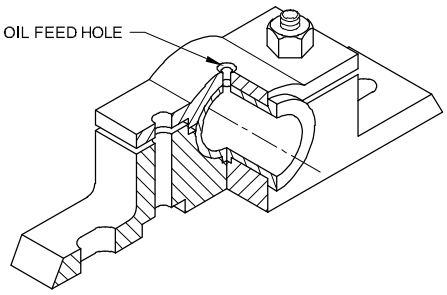
Some bush bearings have oil feeding holes over which the oil or grease cup is mounted and the lubricant is fed through the holes into the bearing by gravity feed system.(Fig 17)

Fig 17



FI20N271881H

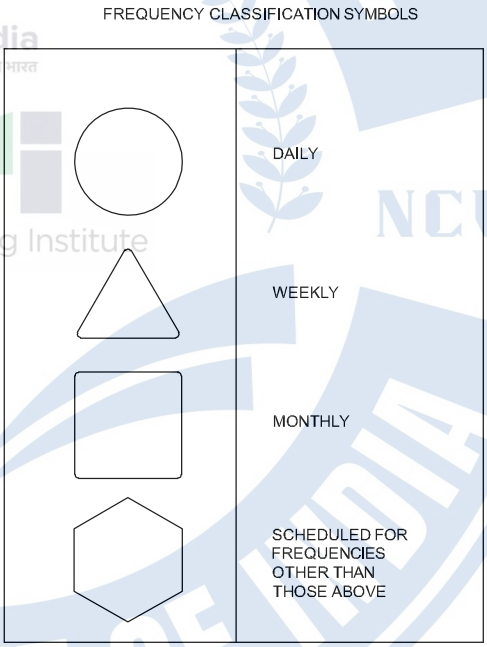
Hints for lurbicating machines:

- identify the oiling and greasing points
- select the right lubricants and lubricating devices
- apply the lubricants.

The manufacturer's manual contains all the necessary details for lubrication of parts in machine tools. Lubricants are to be applied daily, weekly, monthly or at regular intervals at different points or parts as stipulated in the manufacturer's manual.

These places are indicated in the maintenance manuals with symbols as shown in Fig 18.

Fig 18



FI20N271881I

Cutting fluids

Objectives: At the end of this lesson you shall be able to
- **state what is cutting fluid**
- **state the function of cutting fluids & their advantages**
- **state the properties of a good cutting fluid**
- **identify different types of cutting fluids**
- **select appropriate cutting fluids for different materials.**

Cutting fluids and compounds are the substances used for efficient cutting while cutting operations take place.

Functions

The functions of cutting fluids are:

- to cool the tool as well as the workpiece
- to reduce the friction between the chip and the tool face by lubricating
- to prevent the chip from getting welded to the tool cutting edge
- to flush away the chips
- to prevent corrosion of the work and the machine.

Advantages

As the cutting fluid cools the tool, the tool will retain its hardness for a longer period; so the tool life is more.

Because of the lubricating function, the friction is reduced and the heat generated is less. A higher cutting speed can be selected.

As the coolant avoids the welding action of the chip to the tool-cutting edge, the built up edge is not formed. The tool is kept sharp and a good surface finish is obtained.

As the chips are flushed away, the cutting zone will be neat.

The machine or job will not get rusted because the coolant prevents corrosion.

Properties of a good cutting fluid

A good cutting fluid should be sufficiently viscous.

At cutting temperature, the coolant should not catch fire.

It should have a low evaporation rate.

It should not corrode the workpiece or machine.

It must be stable and should not foam or fume.

It should not create any skin problems to the operator.

Should not give off bad smell or cause itching etc. which are likely to irritate the operator, thus reducing his efficiency.

Should be transparent.

Types of cutting fluids

The following are the common cutting fluids.

- Straight mineral oil
- Chemical solution (synthetic fluids)
- Compounded or blended oil
- Fatty oils
- Soluble oil (Emulsified oil-suds)

Straight mineral oil

Straight mineral oils are the coolants which can be used undiluted. Use of straight mineral oil as a coolant has the following disadvantages.

It gives off a cloud of smoke.

It has little effect as a cutting fluid.

Hence straight mineral oils are poor coolants. But kerosene which is a straight mineral oil is widely used as a coolant for machining aluminium and its alloys.

Chemical solution (Synthetic oil)

These consist of carefully chosen chemicals in dilute solution with water. They possess a good flushing and a good cooling action, and are non-corrosive and non-clogging. Hence they are widely used for grinding and sawing. They do not cause infection and skin trouble. They are artificially coloured.

Compounded or blended oil

These oils are used in automatic lathes. These oils are much cheaper and have more fluidity than fatty oil.

Fatty oil

Lard oil and vegetable oil are fatty oils. They are used on heavy duty machines with less cutting speed. They are also used on bench-works for cutting threads by taps and dies.

Soluble oil (Emulsified oil)

Water is the cheapest coolant but it is not suitable because it causes rust to ferrous metals. An oil called soluble oil is added to water which gets a non-corrosive effect with water in the ratio of about 1: 20. It dissolves in water giving a white milky solution. Soluble oil is an oil blend mixed with an emulsifier.

Other ingredients are mixed with the oil to give better protection against corrosion, and help in the prevention of skin irritations.

Soluble oil is generally used as a cutting fluid for centre lathes, drilling, milling and sawing.

Soft soap and caustic soda serve as emulsifying agents.

A chart showing coolants for different metals is given below.

Recommended cutting fluids for various metals and different operations

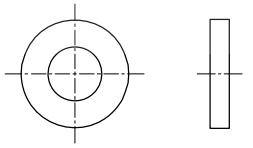
Material	Drilling	Reaming	Threading	Turning	Milling
Aluminium	Soluble oil Kerosene Kerosene and lard oil	Soluble oil Kerosene Mineral oil	Soluble oil Kerosene Lard oil	Soluble oil	Soluble oil Lard oil Mineral oil Dry
Brass	Dry soluble oil Mineral oil Lard oil	Dry soluble oil	Soluble oil Lard oil	Soluble oil	Dry soluble oil
Bronze	Dry soluble oil Mineral oil Lard oil	Dry soluble oil Mineral oil Lard oil	Soluble oil Lard oil	Soluble oil	Dry soluble oil Mineral oil Lard oil
Cast iron	Dry Air jet Soluble oil	Dry soluble oil Mineral lard oil	Dry sulphurized oil Mineral lard oil	Dry soluble oil	Dry soluble oil
Copper	Dry soluble oil Mineral lard oil Kerosene	Soluble oil Lard oil	Soluble oil Lard oil	Soluble oil	Dry soluble oil
Steel alloys	Soluble oil Sulphurized oil Mineral lard oil	Soluble oil Sulphurized oil Mineral lard oil	Sulphurized oil Lard oil	Soluble oil	Soluble oil Mineral
General purpose steel	Soluble oil Sulphurized oil Lard oil Mineral lard oil	Soluble oil Sulphurized oil Lard oil	Sulphurized oil Lard oil	Soluble oil	Soluble oil Lard oil

Washer types and calculation of sizes

Objectives : At the end of this lesson you shall be able to
- **state the various types of washers**
- **determine the sizes of washers**
- **state the uses of washerWashers**

Washers are used to distribute the clamping pressure over a larger area, and prevent the surface damaged (marking). they are also provide an increased bearing surface for bolt heads and nuts. Washers are manufactured in light, medium, heavy and extra heavy series. (Fig 1)

Fig 1



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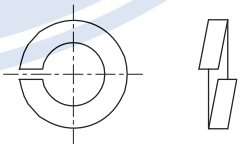
Lock washers

A lock washer is used to prevent a bolt or nut from loosening under vibration.

The split ring lock washer is being rapidly replaced by lock washers designed for specific applications. (Fig 2)

Fig 2



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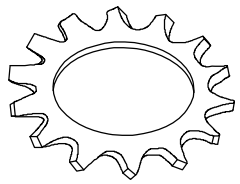
Tooth type lock washers

These washers have teeth that bite deep into both screw head and work surface. Their design is such that they actually lock lighter as vibrations increase.

External type

Should be used where possible as it provides the greatest resistance. (Fig 3)

Fig 3



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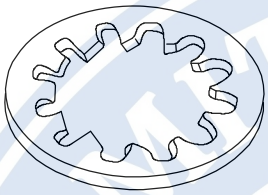
Internal type

Used with small head screws and where it is desirable to hide the teeth either for appearance or to prevent snagging. (Fig 4)

Fig 4



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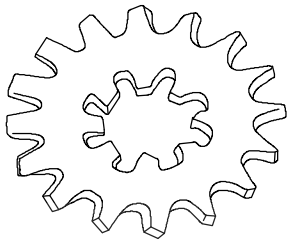
Internal and external type

Used when the mounting holes are over size. (Fig 5)

Fig 5



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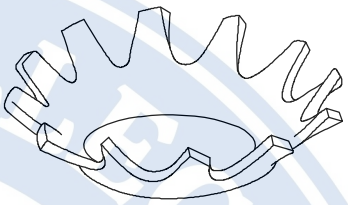
Countersunk type

For use with flat or oval type head screws. (Fig 6)

Fig 6



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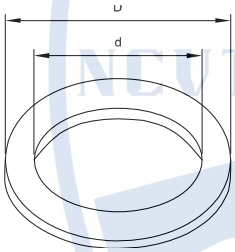
Calculation of washer



Specific bearing load (N/mm^2)

$$P = \frac{4W_t}{\Pi(D^2 - d^2)}$$

Sliding speed (m/s) rotation

$$V = \frac{\Pi \times D \times N}{60 \times 10^3}$$

Sliding speed (m/s)

$$V = \frac{\pi x D}{60 x 10^3} x \frac{2 a x Nos}{360}$$

p	Specific bearing load	N/mm^2
d	inside diameter	mm
D	outside diameter	mm
W_t	load on thrust washer	N
N	Speed of rotation	rpm
∂	angle of oscillations	degrees
Nos	frequency of oscillations	cycles /min
V	sliding speed	m/s

Type A is a series of steel whashers at broad tolerances.

Type B is a series of steel washer s chamfered at one end is shown in Fig 8.

Washer sizes are listed in Table 1.

Fig 8

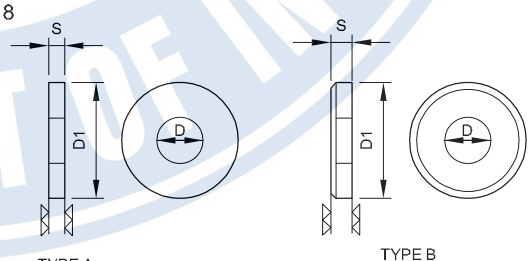


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TABLE 1

Washer sizes

Nominal diameter	D	D1	S	Weight kg/1000 pcs
M3	3.2	7	0.5	0.12
M4	4.3	9	0.8	0.3
M5	5.3	10	1	0.44
M6	6.4	12.5	1.6	1.14
M7	7.4	14	1.6	1.39
M8	8.4	17	1.6	2.14
M10	10.5	21	2	4.08
M12	13	24	2.5	6.27
M14	15	28	2.5	8.6
M16	17	30	3	11.3
M18	19	34	3	14.7
M20	21	37	3	17.2
M22	23	39	3	18.4
M24	25	44	4	32.3
M27	28	50	4	42.8
M30	31	56	4	53.6
M33	34	60	5	75.4
M36	37	66	5	92

Lubricants and lubrication

Objectives : At the end of this lesson you shall be able to
- **state the purpose of using lubricants**
- **state the properties of lubricants**
- **state the qualities of a good lubricant.**

With the movement of two mating parts of the machine, heat is generated. If it is not controlled the temperature may rise resulting in total damage of the mating parts. Therefore a film of cooling medium with high viscocity is applied between the mating parts which is known as a 'lubricant'.

A 'lubricant' is a substance having an oily property available in the form of fluid, semi-fluid, or solid state. It is the lifeblood of the machine, keeping the vital parts in perfect condition and prolonging the life of the machine. It saves the machine and its parts from corrosion, wear and tear, and it minimizes friction.

Purposes of using lubricants

- Reduces friction.
- Prevents wear.
- Prevents adhesion.
- Aids in distributing the load.
- Cools the moving elements.
- Prevents corrosion.
- Improves machine efficiency.

Properties of lubricants

Viscosity

It is the fluidity of an oil by which it can withstand high pressure or load without squeezing out from the bearing surface.

Oiliness

Oiliness refers to a combination of wettability, surface tension and slipperiness. (The capacity of the oil to leave an oily skin on the metal.)

Flash point

It is the temperature at which the vapour is given off from the oil (it decomposes under pressure soon).

Fire point

It is the temperature at which the oil catches fire and continues to be in flame.

Pour point

The temperature at which the lubricant is able to flow when poured.

Emulsification and de-emulsibility

Emulsification indicates the tendency of an oil to mix intimately with water to form a more or less stable emulsion. De-emulsibility indicates the readiness with which subsequent separation will occur.

Film of oil formed in journal bearing

In a sliding contact bearing, the journal is directly inserted into the bearing. This results in direct metal to metal contact between them. As a consequence the friction is higher between the inner surface of the bearing and the outer surface of journal, if there is no lubricating film present in between them. Bearings can be lubricated with three kinds of lubricants, viz. Liquids like mineral oil or vegetable oils, semi - solids like grease, and solids like graphite or molybdenum di-sulfide. These lubricants are used to reduce friction and wear, dissipate the frictional heat and to protect against corrosion. There are two basic modes of lubrication: (a) thick film and (b) thin film lubrication.

Thick film lubrication

In thick film lubrication, two surfaces of bearing in relative motion, (Viz., the journal and the bearing inner surface) are completely separated by a fluid film. The resistance to relative motion arises from the viscous resistance of the fluid. This does not depend on the structure of jurnal surface and bearing inner surface as they are not in contact with each other. Thick film lubrication is classified into: hydrodynamic and hydrostatic lubrication.

Hydrodynamic lubrication

Hydrodynamic lubrication is defined as a system of lubrication in which the load supporting fluid film is created by the shape and relative motion of the slideing elements. The principle of hydrodynamic lubrication in journal bearing is shown in Fig 1

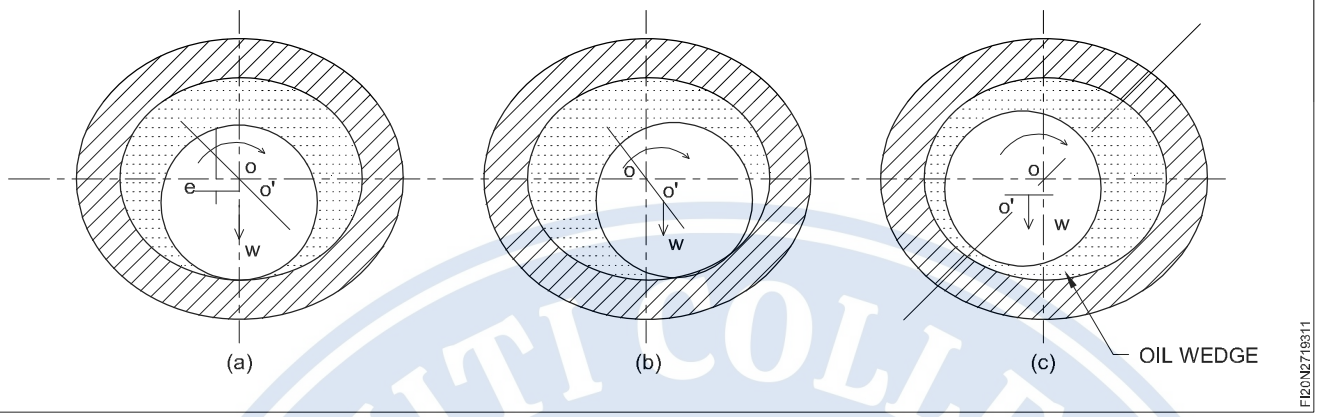
Hydrodynamic lubrication (a) Journal at rest (b) journal starts to rotate (c) journal at full speed

When the shaft (Centered at o') is at rest, it goes to the bottom of bearing (centered at O) under the action of load W. This load is due to the weights of shaft and various elements (gears, pulleys) supported by the shaft. The outer surface of journal and inner surface of bearing touch each other during rest, with no clearance at the bottom. The letter 'e' denotes the eccentricity, the offset between the axes of the journal and the bearing.

As the journal starts to rotate, it will climb bearing surface. When the speed is increased further, it forces the fluid into the wedge-shaped region between the journal and bearing. As more and more fluid is forced into the wedge shaped

region, pressure is generated within the fluid as shown in Fig.1 This fluid pressure generated in the clearance space supports the external load (W). It can be seen that the pressure distribution around journal varies greatly. Hydrodynamic lubrication does not need a supply of lubricants at high pressure from external soruce (pumps), as enough fluid pressure is, generated within the system. Bearings that use 'hydrodynamic lubrication' are called 'Hydrodynamic bearings'.

Fig 1



INDUSTRIAL LUBRICATING OILS **Annexure I**

Product	Kinematic viscosity Cst at 40°C.	VI	Flash point COC°C	Description/Application
General Purpose Machinery Oils				
Lubrex 57	54.60	..	160	Lubrex oils are low viscosity index straight mineral
Lubrex 68	64.72	..	160	lubricants having good inherent oxidation stability; they protect machine elements from excessive wear and provide economical lubrication. These oils are recommended for lubrication of bearings, open gears, lightly loaded slides and guideways of machine tools.
Flushing Oil				
Lubrex Flush 22	19.22	..	150	Lubrex Flush 22 is a light coloured, low viscosity, straight mineral oil specially developed for slushing of automotive and industrial equipment. The characteristics of Lubrex Flush 22 make it possible to easily clean all inacessible internal surfaces of various equipments.
Circulating and Hydraulics Oils (Anti-wear Type)				
Servosystem 32	29.33	95	196	Servosystem oils are blended from highly refined
Servosystem 57	55.60	95	210	base stocks and carefully selected anti-oxidant,
Servosystem 68	64.72	95	210	anti-wear,anti-rust and anti-foam additives.These
Servosystem 81	78-86	90	210	oils have long service life, and are recommended
Servosystem 100	95-105	90	210	for hydraulic systems and a wid of circulation
Servosystem 150	145-155	90	230	systems of industrial and automotive equipment. These oils are also used for compressor crank case lubrication, but are not recommended for lubrication of turbines and equipment having silver coated components.
Spindle Oils				
Servospin 2	2.0-2.4	..	70	Servospin oils are low viscosity lubricants contain-
Servospin 5	4.5-5.0	..	70	ing anti-wear, anti-oxidant, anti-rust and anti-foam
Servospin 12	11-14	90	144	additives. These oils are recommended for lubrication

				of textile and machine tool spindle bearings, timing gears, positive displacement blowers, and for tracer mechanism and hydraulic systems of certain high precision machine tools.
Machinery Oils				
Servoline 32	29.33	..	152	Servoline oils provide good oiliness for general lubrication even under boundary lubrication conditions, protect parts against rust and corrosion and maintain thin film strength and anti-rust additives. Servoline oils are general purpose lubricants for all loss lubrication systems of textile mills, paper mills, machine tools.
Servoline 46	42.50	..	164	
Servoline 68	64-72	..	176	
Gear Oils				
Servomesh 68	64-72	90	204	Servomesh oils are industrial gear oils blended with lead and sulphur compounds. These oils provide resistance to deposit formation, protect metal components against rust and corrosion, separate easily from water and are non-corrosive to ferrous and non-ferrous metals. Servomesh oils are recommended for lubrication of industrial gears, plain and anti-friction bearings subjected to shock and heavy loads and should be used in systems were operating tem
Servomesh 150	145-155	90	204	
Servomesh 257	250-280	90	232	