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भारतीय मानक मसौदा

संयंत्र और मशीनरी पर प्रयुक्त केंद्रीकृत स्नेहक के लिए अनुसंशाएँ

भाग 1 तेल स्नेहन

(दूसरा पुनरीक्षण)

Draft Indian Standard

Recommendations for Centralised Lubrication as Applied to Plant and Machinery

Part 1 Oil Lubrication

(*Second Revision*)

ICS 21.260

Lubrication Equipment Sectional Committee, PGD 19

FOREWORD

Formal Clause will be added later.

This standard was first published in 1977 by taking assistance from BS 4807 : 1972 ‘Recommendation for centralized lubrication as applied to plant and machinery’, issued by the British Standards Institute and revised in 2017 based on inputs from the stakeholders. This revision has been undertaken to incorporate experience gained in the implementation of this standard. This standard is only a general guide and does not lay down the specific design requirements. It is, therefore, recommended that while designing the new system consultation shall take place between the user, equipment designer and lubricant supplier.

The major changes in this revision are as follows:

a) **5.1.1** has been modified and **5.1.2** has been added to include centrifugal pumps and their specific application.

b) **5.1.7** has been added to include standby pump/pumps and/or emergency oil pumps.

c) Figure 1 has been included to show the connection between the reservoir and the oil purification unit (*see* **6.2**).

d) **6.4.1** has been modified to recommend the material requirements.

e) **6.8** has been further elaborated and **6.15** has been introduced to include the return chamber/dirty chamber in the design of the oil reservoir.

f) **6.12** has been introduced to include Stiffeners that provide support to oil reservoirs.

g) **6.14** has been introduced that classifies Oil levels and their importance for the designing requirements.

h) **6.16** has been introduced to include features regarding air entrapment in Oil and the features/principles which need to be followed.

j) **6.17, 6.18** and **6.19** have been introduced to further elaborate on oil reservoir design.

k) **8.2** has been introduced to recommend elements of line filter.

m) **9** has been added to include the Oil Vapour Exhaust System.

n) **11.2** and **11.3** have been introduced to elaborate on oil purification units and oil cleanliness respectively.

p) **12** has been introduced that categorises the type of moisture present in oil circuits.

This standard has been published in three parts. The other parts in this series are:

Part 2 Grease lubrication

Part 3 Aerosol lubrication

Draft Indian Standard

Recommendations for Centralised Lubrication as Applied to Plant and Machinery

(*First Revision*)

1 SCOPE

This standard lays down the recommendations for a centralized oil lubrication system for plant and machinery with respect to installation practice, system pipework and ancillary equipment for light and heavy industries.

2 REFERENCES

The below-mentioned standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
2062 : 2011	Hot rolled medium and high tensile structural steel — Specification (*seventh revision*)
6392 : 1971	Specification for steel pipe flanges
6630 : l 985	Seamless ferritic alloy steel pipes for high temperature steam services (*first revision*)
9466 : 1980	Viscosity classification for industrial liquid lubricants
11428	Specification for wrought carbon steel butt-welding pipe fittings
(Part 1) : 1985	General
(Part 2) : 1985	Shapes and dimensions
(Part 3) : 1985	Tolerances
IS 13542 : 2023	Hydraulic fluid power Fluids Method for coding the level of contamination by solid particles

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply:

3.1 Centralized Lubrication System — A system in which two or more lubrication points on a machine or group of machines are served with the same lubricant from a common source.

3.2 Total Equivalent Length of Pipe —The total lengths of straight pipe plus the total of the pipe length equivalent of associated fittings in the relevant part of the system. This term is used in the calculation of pressure drop.

3.3 Pressure Drop — The difference in pressure of a medium before and after an event, that is, the medium having flowed through a length of pipe.

3.4 Laminar Flow (Streamline, Viscous of Straight Line Flow) — A type of flow in which there is a continuous steady motion of the particles, the motion at a fixed point always remaining constant.

3.5 Turbulent Flow — A type of fluid flow in which there is unsteady motion of the particles, the motion at a fixed point varying in no definite manner.

3.6 Rheological Properties — Properties relating to rheology, the science of the deformation and flow of matter.

3.6.1 *Newtonian Behaviour*— The property of simple liquids by which the rate of shear is proportional to the shearing stress. This constant of proportion is called the viscosity of the liquid.

3.6.2 *Non-Newtonian Behaviour*

The property is assessed by some fluids having a variable relationship between shear stress and rate of shear.

3.7 Strainer — A device for removing coarse and impure particles from a lubricant.

3.8 Filter — A device for fine filtration of a lubricant to obtain the required degree of cleanliness in the system.

3.9 Total Oil Charge in the System — It is the total oil inside the system, including piping, accumulators, coolers, bearings etc. which shall be collected inside the oil reservoir during system shutdown.

4 CLASSIFICATION OF OIL LUBRICATION SYSTEMS

4.1 Circulating Oil System

System in which lubricant medium, after use is collected and returned to the reservoir.

4.1.1 Circulating oil system is a continuous type of system and can be either volumetric or proportionate. The volumetric systems are applicable to only small-capacity systems.

4.2 Total Loss Oil System

System in which the lubricant once fed to lubrication point is not returned to the system.

4.2.1 Total loss oil systems can be sub-classified into intermittent and continuous type of systems. Intermittent type of system can be either volumetric or proportionate while continuous type of system can be proportionate only.

SECTION 1 CIRCULATING OIL SYSTEM

5 PUMPS

5.1 Types and Selection of Pumps

5.1.1 Lubricating oil is generally supplied to plants and machinery by centrifugal pump or positive displacement pump. The selection of the pump is based on the inherent advantages of one type over the other.

5.1.2 Centrifugal Pumps are used where the delivery rate is higher. Its delivery rate varies with pressure as per the pump’s Characteristic Curve.

5.1.3 Positive displacement rotary pumps have a delivery rate less sensitive to discharge pressure. Among positive displacement pumps, spur gear, helical gear and screw-type pumps find the widest use.

5.1.4 The positive displacement rotary pumps shall have an in-built safety valve or relief valve which shall be a part of the system.

5.1.5 *Capacity of Pumps* – The capacity of lubricating oil pumps shall be selected to meet overall pressure and flow requirements for all bearings, gears and machine elements in the system.

5.1.6 In centralized oil circulating systems, the system is operated at 0.4 MPa to 1 MPa finally delivering the oil at 0.07 MPa to 0.15 MPa. For this purpose, the discharge pressure of the pump shall be as agreed between the purchaser and the manufacturer.

5.1.7 In case the system requires a critical supply of oil under all operating conditions, system redundancy is ensured by giving standby pump/pumps and/or emergency oil pumps which come into operation when the running pump fails to deliver oil. The interlock for this is generally taken from the pressure instrument in the common header downstream of the pumps. In case, the standby pump also fails to deliver pressure, an emergency oil pump presses into operation to supply oil.

5.1.8 Some pumps require priming before being put into operation. The requirement of priming is defined by the pump manufacturer. The designer of the lubrication oil system shall decide on the ways to ensure the priming of a pump.

5.2 Mounting of Pumps

5.2.1 Pumps shall be mounted either inside or outside the reservoir and in both cases shall be readily accessible for maintenance.

5.2.2 Pumps and drive mechanisms shall be mounted at a place where they are adequately protected from damage whilst allowing for adequate operation, maintenance, and safety requirements.

5.2.3 Direct coupled pumps shall be securely mounted in a manner to ensure alignment under normal operating conditions.

5.2.4 The coupling, rigid or flexible, shall have adequate capacity to transmit the power required and shall be so fitted that it is easy to replace it.

5.2.5 The mounting surface provided for the pump and motor shall be rigid and able to prevent coupling misalignment due to workload and temperature variations.

5.2.6 All the moving parts shall be adequately guarded.

5.3 Name Plates of Pumps

5.3.1 The following information shall be indicated on each lubricating pump:

a) Manufacturer’s name and address;

b) Manufacturer’s part, model and serial number;

c) Capacity in terms of litres/min;

d) Nominal operating, rev/min;

e) Rated maximum pressure;

f) Power; and

g) Direction of rotation of the pump.

5.3.2 The direction of rotation of the pump shall be indicated on the pump for installation and maintenance purposes. In the case of integral pump and motor units, the marking may be done on the motor.

6 OIL RESERVOIRS

6.1 Reservoir Capacity

6.1.1 Reservoir size shall be large enough to allow oil to dwell long enough to separate air entrained as foam and for water and solid impurities to settle by gravity.

6.1.1.1 Dwell time for various equipment are as follows:

Equipment	*Dwell Time min*
Steam turbine	5 to 10
Gas turbine	5
Electric motors	5 to 10
Gear oil systems in steel rolling mills motors equipment	15 to 40
Morgoil oil film systems in steel rolling mills	50
Paper mill and other industrial machinery	40 to 60

6.1.2 For the design of the reservoir, the following typical proportions are recommended and shall normally be adopted:

$$\text{Width} = \text{Height, Length} = 2 \times \text{width}$$

6.1.2.1 A reservoir of a special shape, such as a circular reservoir may have different proportions.

6.1.2.2 Low oil depth permits faster escape of entrained air and quicker settlement of water and solids. A long tank desirably places the pump suction farther from the oil return to give the largest possible oil path.

6.1.2.3 The normal oil level in the reservoir shall be kept at 80 percent of the tank capacity.

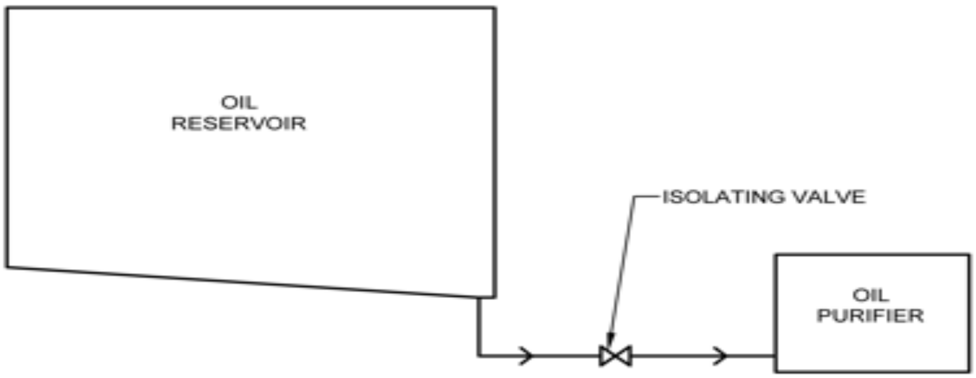
6.1.3 The capacity of the oil reservoir shall be sufficient to dissipate excess heat absorbed by the lubricant during normal operation of the relevant equipment unless heat exchangers are provided.

6.1.4 Having taken all other design parameters into account, the capacity of the fluid reservoir shall be sufficient to contain all of the fluid that might be returned from the system at any time.

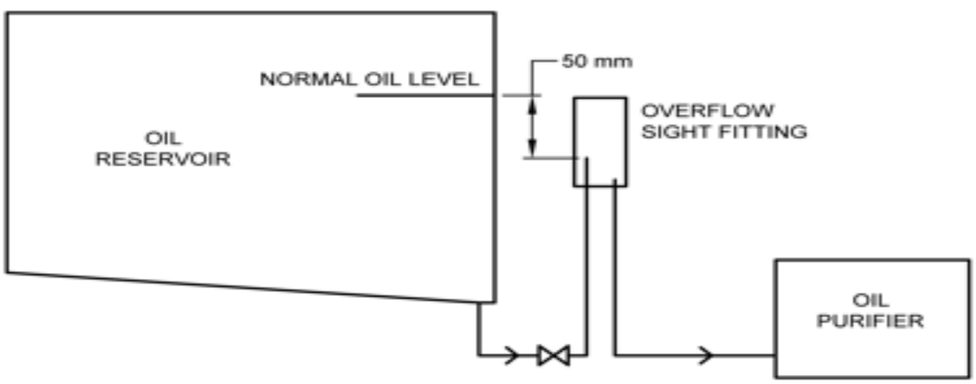
6.1.5 Capacity of the fluid reservoir shall be sufficient to maintain the fluid level within adequate working height during the operating cycle. Working height must provide minimum NPSH required by the pump.

6.2 The reservoir bottom shall slope 1 in 12 from the oil entrance towards the drain at the other end. This will facilitate the removal of solid contaminants and water from the purification system. The connection for the reservoir drain and to the oil purification system should be taken from below the bottom plate at the lowest point. (*see* Fig. 1 for a note on the connection with the oil purification system.)

The reservoir top shall have some slope to ensure no water/fluid stagnates on it.



1A FIGURE SHOWING INCORRECT WAY OF CONNECTION BETWEEN OIL RESERVOIR AND OIL PURIFIER. IN CASE OF LEAKAGE IN ISOLATING VALVE OR INSIDE OIL PURIFIER, THERE MAY BE A POSSIBILITY OF DRAINING OUT OF TOTAL OIL RESERVOIR.



1B FIGURE SHOWING CORRECT WAY OF CONNECTION BETWEEN OIL RESERVOIR AND OIL PURIFIER. IN CASE OF LEAKAGE IN ISOLATING VALVE OR INSIDE OIL PURIFIER, POSSIBILITY OF LEAKAGE VASTLY REDUCED.

FIG.1 CONNECTION BETWEEN THE RESERVOIR AND OIL PURIFICATION UNIT

6.3 To facilitate the return of oil by gravity, the reservoir shall generally be located at a level below the equipment for which oil is fed. In large systems, oil cellar depth may be to the extent of 5 to 8 m below ground level. The location of the reservoir in cellars isolates it from heat and dirt.

6.4 Material

6.4.1 The oil reservoirs shall be fabricated by welding steel plates preferably conforming to IS 2062. Reservoirs may be fabricated from a suitable grade of stainless steel. The material of the reservoir is usually specified by the purchaser in the specification. If not, then the designer shall select the material based on considerations such as corrosion, compatibility with oil etc. Stainless Steel offers better protection against corrosion as compared to Carbon Steel; however, is much more expensive in terms of initial cost.

6.4.2 The thickness of plates is governed by various factors, such as size, oil depth stiffener adequacy and internal pressure or vacuum and shall have the following values:

Capacity of Reservoir litre	*Thickness of Plates, Min* mm
Up to 100	3
Over 100 and up to 2 000	5
Over 2 000 and up to 4 500	3 to 6
Over 4 500 and up to 125 000	6 to 10

6.5 Baffling

Internal baffles shall be provided in large tanks to lengthen the path of the oil to the pump. Baffles promote better separation of impurities between return and suction.

6.5.1 A simple baffle plate shall consist of a vertical plate dividing the reservoir into two compartments. Its height shall be about two-thirds the normal oil level. A small opening in the bottom of the baffle plate may be kept to equalize oil levels and to provide compartment drainage.

6.6 Pump suction opening shall be placed above tank bottom to prevent dirt or water pick-up. The lowest level of the oil level shall be well above the suction opening to prevent sucking of air. In systems which are subjected to gross contamination from outside sources, floating suction shall be incorporated. This shall be arranged to draw oil from approximately 300 mm below the oil level in the tank.

6.7 The reservoir shall be designed and constructed to prevent entry of foreign matters including water and shall be adequately protected against internal corrosion. Such protection shall be impervious to the action of lubricant.

6.8 The reservoir shall have a strainer of adequate size to permit the flow of viscous fluid/lubricant. Precautions shall be taken to ensure that the strainer always remains in use. Strainers shall be removable for cleaning. Return oil shall enter the return chamber or dirty chamber of the oil reservoir and from the return chamber enter the clean chamber of the oil tank after passing through the oil strainer. In this way, major impurities shall be separated from oil. The pump suction chamber shall be as much away from the return oil entry to reduce the chances of impurities reaching the pump suction chamber.

6.9 All the reservoirs shall have means of eliminating pressure build-up with filling, if a vent is provided, it shall be protected by an air cleaner (air breather) of sufficient capacity to always maintain approximate atmospheric pressure.

6.10 The reservoirs shall be equipped with a protected sight glass or other fluid level indicator.

6.11 A well-protected and accessible means shall be provided to drain off water and sludge and to empty the reservoir without spillage. The reservoir interior shall be designed to facilitate emptying and cleaning with adequate means of access.

6.12 Stiffeners may be provided on the side walls of oil reservoir for strength purpose. Preferably, these stiffeners may be welded on outside. Internal stiffeners may cause dirt accumulation in the corners. An alternate way to provide strength to side walls is to use corrugated plate for side walls, wherein the curves of the corrugation prevent dirt accumulation.

Stiffeners, if provided in bottom plate, may also be provided outside.

6.14 Oil Levels

6.14.1 Oil level inside oil reservoir is an important parameter not only for the system designer but also for the plant operator. Different oil levels are defined as follows:

a) Rundown level – Rundown level is the level of oil inside the reservoir when the system is shut down. This includes oil inside piping, bearing pedestals, accumulators, storage tanks etc.
b) Maximum operating level – Maximum level at which system alarm shall be activated and the system may be tripped/shut down.
c) Minimum operating level – Minimum level at which system alarm shall be activated and the system may be tripped/shut down.
d) Normal operating level – The level at which the system operates.
e) Suction loss level – Minimum level below which the pump cannot operate.

6.14.2 Oil levels shall be marked on the side wall of the reservoir alongside the sight glass or fluid level indicator. This aids the working staff to check system leakage, if any. The sight glass or level indicator shall extend 50 mm above the rundown level and 50 mm below the suction loss level. If the oil level increases beyond the maximum level, it may be due to leakage of external fluid inside the oil circuit for example leakage of cooling water inside oil circuit due to damage in Oil Cooler. If the oil level decreases below the minimum level, it may be due to leakage in the oil circuit. Both these occurrences need to be investigated seriously to prevent damage and/or fire. Periodically checking the oil levels is highly recommended. The plant operator needs to formulate a periodic schedule for the same.

6.14.2 The oil levels can be marked by painting or by a level scale fixed on the tank side wall.

6.14.3 The system designer may also use level transmitters.

6.14.4 Switching on/off position of pumps shall be interlocked with oil levels.

6.15 In case the oil reservoir is envisaged with a separate dirty chamber and clean chamber, it shall be ensured that the welding between the dirty chamber and clean chamber reservoir shall be continuous so as not to allow oil seepage from the dirty chamber to the clean chamber. In no way shall these two chambers be connected to allow oil to pass through. An opening at the top of the chambers may be provided to allow for air pressure equivalence.

6.16 Features Regarding Air Entrapment in Oil

Overall design of the reservoir, piping etc. should be done to aid air release or to avoid air entrapment. Air entrapped in oil can negatively affect oil properties. It reduces the load-bearing capacity of oil. For this, some features/principles which need to be incorporated are given below:

6.16.1 Proper dwell time needs to be given to oil inside the tank. This is achieved by giving a long path to oil through a long tank and baffle plates. Baffle plates also need to be designed to avoid air entrapment.

6.16.2 The return oil line is designed to be half full, to aid in air release. The piping layout of the return oil line should be done so that there is no vertical drop of ≥ 2 m. Sharp bends are to be avoided. Otherwise, oil splashing may cause air entrapment.

6.16.3 The discharge end of the return pipe shall be placed below the normal oil level of the reservoir to minimize aeration and shall be sited as far away as possible from the suction point of the pump to minimize the risk of drawing aerated oil into the system. The return line may be terminated over decanting plates if provided to release entrapped air in the oil returning from the equipment lubricated.

6.16.4 The flow *of oil inside the reservoir should be smooth*.

6.17 Reservoir design should ensure that no water seepage takes place inside it. Flanges or pump base plates which are on top of the oil tank should have a minimum height of 25mm above the reservoir top plate to avoid water ingress inside the tank. Plant operators should also ensure that old, workout gaskets are suitably replaced to avoid moisture seepage.

6.18 During transportation, openings in the reservoir may be hermetically sealed and desiccant bags may be placed inside the tank so that moisture does not cause corrosion.

6.19 Since the reservoir contains oil and/or support pumps, filters etc on its top, its Seismic calculation may be done by the designer.

7 HEATERS AND COOLERS

7.1 Heaters

If necessary heaters shall be provided in the tank for heating the oil to designed temperature conditions to maintain proper flow conditions in the system and to aid initial circulation under cold start-up conditions.

7.1.1 If necessary heaters shall be provided in the tank for heating the oil either by steam heating or by electric heating. Depending on the requirement and available facilities, a particular heating method shall be chosen.

7.1.1.1 While selecting the method of heating, the following points shall be taken into consideration:

a. Heat transfer is relatively low with viscous oils.

b. Although the oil layer immediately around the heater coils will quickly reach the steam temperature, it will not attain a temperature higher than the steam temperature.

c. As the oil begins to rise in temperature, it becomes less viscous convection currents become faster and heat dissipation will proceed at a faster rate until equilibrium conditions are reached.

d. When electric heaters are used, excessive heating shall be avoided for additive oils.

NOTE — During the equipment breakdown period, as the convection currents are hampered, it is possible for higher temperature to be built up around the heaters than that indicated at the thermostat. This high localized heating of oil gives rise to the cracking of oil.

7.1.2 The oil temperature in the reservoir shall be limited to 70 °C. In any case the oil temperature shall be maintained at least 20 °C below the flash point of the oil.

7.1.3 lf electric heating is adopted heating intensity shall be limited to the values specified below depending on the viscosity and the type of the oils:

ISO Viscosity Grade	Maximum Rating of Heating Surface	
	Mineral Oils without E.P. Additives kW/m^2	Mineral Oils with E.P. Additives kW/m^2
Up to ISO VG 150	15	11
ISO VG 200 to 680	11	8
Over ISO VG 680	8	5

7.2 Coolers

7.2.1 Bearing performance, oil life, rate of oil flow, ease of purification and desertions are several factors which are directly depending on oil temperature. In order to maintain correct temperature, coolers are arranged in the oil circulation system to remove heat from the oil. Heat is picked up from bearings, pumps, scales, gears, etc.

7.2.2 While plate, fin and tube cooling arrangements are recommended, circulating systems, plate plate-type heat exchangers offer more flexibility.

8 FILTRATIONS

8.1 Three basic forms of removing 'foreign bodies' shall be generally used in lubrication systems are:

a) *Coarse strainers* — Coarse strainers are used to prevent large pieces of debris from getting into the system. In the larger oil storage tanks, coarse strainers shall usually be positioned below the filler connection. Strainers are provided on the suction side to protect the pumps.

b) *Magnetic flow strainers* — The use of these strainers is independent of system design. Strainers shall be fitted in the return line to the tank and in some cases in the supply line, in order to remove ferrous particles. These are especially used in systems feeding large gearboxes.

c) *Line filters* — In oil circulation systems a filter comprises a major component. Following three basic types of filters are recommended.

   1) *Manually operated self-cleaning filters* — This type of filter is recommended for use on smaller systems. The pipework shall normally be fitted with a bypass, so that the filter can be removed for maintenance.

   2) *Duplex filters* — This type of filter allows each element to be manually cleaned in turn. No bypass is necessary.

   3) *Automatic self-cleaning filters* — This type will clean themselves when the pressure drop across the element reaches a predesigned value. For maintenance purposes, a full-flow bypass arrangement shall be provided

8.2 The material of elements of line filter may be organic or stainless steel. Organic elements are throw-away type and are disposed after use. Stainless steel elements are cleanable type and are re-used after cleaning.

8.3 The choking of oil filter is indicative of dirt and impurities collected in the filter and is identified through differential pressure across filter. The differential pressure across the filter in clean and dirty condition shall be marked by filter manufacturer on the filter housing.

9 OIL VAPOR EXHAUST SYSTEM

Vapours emanating out of oil necessitate the use of oil vapor exhausters (OVE). OVE consists of a fan, motor, oil separator and associated piping. OVE fans are designed to create a minor vacuum inside the oil reservoir and return oil piping. They suck the oil vapour from the reservoir and return the oil pipe; and after the separation of oil from oil vapour, the air is passed to the atmosphere while the oil is collected.

OVE are interlocked to run before oil pumps are switched on. Hence OVE motors are flame-proof motors.

10 PRESSURE TANKS

Pressure tanks shall be designed and manufactured in accordance with the codes applicable. The material of construction shall be suitable grade of carbon steel or stainless steel. Pressure tanks may be incorporated into the systems to take care of the following events:

a) pressure surges in the system, and

b) to protect the equipment by supplying oil for a certain period, for example, 3 to 4 min in the case of power failures or sudden pressure drops.

11 OIL CLEANLINESS AND OIL PURIFIERS

11.1 Purification of oil is needed as it picks up contaminants while in circulation. Contaminants that commonly arise in industrial oil circulation systems are as follows:

a) Water which may ingress into the system from the equipment being lubricated or occur due to condensation, etc.

b) Dirt, dust and solid contaminants which find their way from the surrounding atmosphere into the system as well as rust and wear products from bearings and gears.

c) Oxidation products which form sludge especially if oil is operating at higher temperatures.

11.2 For the purification of oil contaminants, oil purification units are employed in the system. These oil purification units are of many types depending on the principle of operation.

a) Centrifuge-type oil purification units separate moisture and mechanical impurities from oil based on the centrifugal operation.

b) Coalescer-type units separate moisture from oil based on the coalescing principle.

The system designer shall select the type of oil purification units based on system requirements.

11.3 The cleanliness level of oil is an important parameter to be periodically monitored by the system operator or plant operator because mechanical impurities in dirty oil may cause failure of system components such as pumps/bearings or may clog small-sized oil passages, say, for example, in valve actuators.

Oil cleanliness is a measure of mechanical impurities in oil and is measured in terms of cleanliness class. (*see* IS 13542). The basic principle is to count the number of impurities above a particular size and use any of the standards to see in which cleanliness class that count lies.

11.4 An oil circuit has many equipment such as pumps, bearings, valve actuators, gearboxes etc through which the oil passes. Normally, the designer of these equipment needs to specify the oil cleanliness levels for which their equipment is designed.

Oil cleanliness levels which need to be maintained in the system should be better than the most stringent requirement of any equipment in the circuit.

The plant operator should take due diligence and be fully aware of the desired oil cleanliness levels to be maintained.

Maintaining oil cleanliness within the cleanliness class specified by the designer ensures reduced system outages or component failures.

11.5 One or more sampling points in the system may be provided from where oil can be extracted for checking oil cleanliness. The sample must be taken in a clean container/bottle which can be air-tightly closed. The sample is then sent to a lab for checking contaminants. Particle contaminants may be checked through the automatic particle counter method.

11.6 The capacity of oil purifiers may be taken as 20 percent of the total oil charge in the system per hour.

12 MOISTURE IN THE OIL CIRCUIT

The presence of moisture in oil can have a detrimental impact on the components of the oil circuit as well as the oil itself. It can be categorised into the following types:

a) Dissolved moisture: This is the lowest level of moisture in oil.
b) Emulsified moisture: As the moisture level increases beyond the dissolved level, it causes emulsified moisture in oil.
c) Free moisture: This is free water in oil.

Moisture can cause rust or corrosion. It can also react chemically with system components. Oil purification units may have a sub-unit for moisture removal like vacuum dehydrators. Oil centrifuge removes moisture through centrifugal action. Oil purification unit manufacturers can give information about the level of moisture that can be removed by their machine.

13 PIPES AND FITTINGS

13.1 Pipes used in the system shall comply with required pressure ranges and conform to IS 6630 or a suitable grade of stainless steel.

13.2 Fittings

Care shall be taken in the selection of the fittings to be used with pipes specified in **13.1** and shall conform to IS 11428 (Parts 1 to 3). Butt welding fittings of stainless steel to be used with stainless steel pipes. Flanges shall be according to IS 6392.

13.3 Suction Pipe Work

Suction pipes shall be so designed that the summation of the frictional and static suction lift losses is kept within the guaranteed lift capability of the selected pump. Once the total losses have been established and a pipe size elected, the oil velocity shall be checked to ensure a laminar flow condition.

13.3.1 In order to keep pressure losses low, the pipe run shall be as short and direct as possible, with tight and right-angle bends and T-pieces being kept to a minimum. The use of plain branch T-pieces directly before the pump inlet shall, when possible, be avoided, The suction pipe bore shall generally be larger than the pump inlet connection.

13.4 Pressure Pipe Work

Size selection shall have a compromise between economy (size and cost) and pressure losses demanding adequate bores. The velocity of oil in the feed pipeline shall be in the range of 1.2 m/s to 3.5 m/s.

13.5 Return Pipe Work

The overall available head between the machinery drain connections and the oil reservoir is the deciding factor in designing gravity-return oil pipelines.

13.5.1 It is recommended that the return pipes are sized to run not more than half full to encourage the escape of entrained air, provide space for any foam and give a margin of safety. Flow rate, slope and the greatest viscosity envisaged govern their size. A slope of 1 in 40 is a good starting point for design. However, where practicable, use shall be made of the maximum slope which can be obtained.

13.5.2 In return pipelines the velocity of oil shall be maintained in the range of 0.2 m/s to 0.65 m/s.

13.5.3 During the layout of piping, the system designer shall ensure that the vertical drop in oil return lines is not more than 2m. This is done because the excessive vertical drop in the return oil line results in oil foaming.

13.6 Metering Elements

Metering elements shall be provided in oil pipes to control the feed rate to individual bearings and other lubrication points and shall be located at inlets to the bearings.

13.6.1 Selection of metering elements depends on upstream and downstream pressure and required flow. Orifices are usually circular but other shapes may also be adopted depending on advantages that can be utilized.

14 COMPATIBILITY OF EQUIPMENT

14.1 With Lubricants

Due to the ever-increasing use of lubrication dispensing equipment, the suitability of lubricant for use in such equipment shall also be taken into consideration. Further, the temperature conditions under which the lubrication system will be operating shall also be taken into account and oil viscosities shall always be related to working temperature.

14.2 Materials

The material used in the manufacture lubrication system shall be compatible with the lubricant to be used. In this respect following precautions shall be taken:

a) Galvanized components shall be avoided in case of lubricants which react with zinc when heated.
b) Metal combinations giving size to galvanic currents shall be avoided.
c) Special paint shall be used for reservoirs in case of certain synthetic lubricants.
d) Special rubber seals, sealing compounds and gaskets shall be used when synthetic lubricants are to be dispersed. The appropriate manufacturer shall be constituted for guidance in this respect.

14.3 Environment

14.3.1 Piping shall not be run in places where local high temperatures are likely to be encountered, as this may cause the lubricant to deteriorate and result eventually in the pipe work becoming blocked.

14.3.2 Where pipe work comes into contact with other lubricants or with process material, care shall be taken to ensure that no adverse interaction can occur. For example, piping on machine tool lubrication system frequently comes into contact with cutting oils and where these are likely to contain ‘active ‘or uncombined sulphur, copper pipe shall not be used.

15 INSTRUMENTATION AND CONTROL

15.1 lf agreed to between the user and the manufacturer instruments as required by **15.2, 15.3** and **15.4** shall be installed on the system.

15.2 Different instruments, such as thermometers, pressure gauges, level indicators, thermostats, contact gauges, pressure switches, flow switches, upstream pressure control valves, downstream pressure control valves, pressure transmitters, temperature transmitters, level, etc, shall be used for indicating the system conditions and for controlling the conditions within the required limits.

15.3 Methods of Warning of System Failure

Lights and audible alarms shall be installed on the system to indicate the failure of the lubrication system.

15.3.1 *Initiation of Warning* – Flow switches, level switches, pressure switches, etc, shall be used to initiate the warning of the system failure.

15.3.2 The use of audible alarms is recommended to indicate the following:

a) Lubricant levels in reservoir and tanks;
b) High and low pressures in the system;
c) Low flow rate;
d) High and low temperature; and
e) Special warning requirements, such as the pressure drop across the filter.

15.4 Interlocks shall be provided in systems so that any variation in the system condition will bring the running equipment to a standstill in order to save the equipment from severe damage.

16 INSTALLATION METHODS AND SAFETY

16.1 Equipment

16.1.1 All items of functional equipment shall be positioned to give adequate and safe access for inspection and maintenance.

16.1.2 Serious consideration shall be given to the fire hazard involved with the storage of lubricants.

16.1.3 Lubrication equipment shall be sited so that to lubricate a component, personnel are not required to reach past control equipment or moving parts of machinery, such as revolving spindles, moving tools, etc.

16.1.4 Identification numbers and name pates likely to be use in obtaining spares and carrying out servicing shall not be removed. Alternatively, identification numbers or the information contained punched or embossed on the equipment.

16.2 Pipe Work

16.2.1 Large bore main pipe work shall be securely clamped at suitable intervals and small-bore feeder pipe or tube work shall be clipped.

16.2.2 Suction pipe work connections shall be airtight. Pipelines shall be run in protected positions or if this is not possible, they shall be adequately guarded.

16.2.3 Pipes shall not be buried in concrete or cemented into position when passing through walls. Trenches shall be provided with lifting covers or proper openings to facilitate inspection and, if with lifting covers or proper openings to facilitate inspection and, if necessary, replacement of pipe runs.

16.2.4 Pipework for oil circulation systems shall be designed so as to effect drainage to a given point for maintenance purposes. Means shall be provided to present inadvertent drainage of supply or feed lines between operations.

16.3 Recommendations for Containment of Oil

16.3.1 The inflammability of oil necessitates the use of civil enclosure of the zone where items such as oil tanks, oil coolers, filters, exhausters, piping etc are kept. It is recommended to install all these items inside a closed room, hereinafter referred to as oil room.

16.3.2 The oil room shall be designed to contain all the oil within itself in case there is leakage in the oil tank. For this, the walls of the oil room may be made of reinforced cement concrete (RCC) and lined with oil-resistant paint which does not allow oil to leak through. Sample calculation for containment height of oil is as follows:

> *Example*: If the total oil charge in the system (rundown tank level) is say, 50 m^3. Then,
> Oil quantity with 10 percent more margin = 50 x 1.10 = 55 m^3………Y
> Let's say, the length (L) and breadth (B) of oil room are 12 m and 10 m respectively.
> Surface area of oil room floor = L x B = 12 x 10 = 120 m^2……… Z
> So, containment height of oil inside oil room = Y / Z = 55/120 = 0.458 m

RCC shall be used till containment height. Above containment height, brickwork may be used for walls of the oil room.

16.3.3 If any openings are provided in the floor of the oil room, they shall be circumscribed by a curb wall whose height shall be equal to the containment height. Also, in this case, the surface area of the opening shall be deducted from the oil room's floor area to calculate containment height.

16.3.4 Grating inside the oil room, above containment height, shall be provided. All equipment shall be kept above containment height over concrete pedestals. This is done so that in the event of total leakage, the oil shall not flood the oil room and all equipment remain accessible.

16.3.5 Oil piping outside the oil room should also be contained inside the civil enclosure as far as possible. Alternatively, pipe-in-pipe may be used.

16.4 Recommendation for Space for Walking Around Equipment in Oil Room

16.4.1 The layout designer of the oil room shall ensure that there is sufficient walking space around equipment kept inside the oil room and sufficient headroom inside the oil room. This shall facilitate the escape of personnel trapped inside the oil room in case of unfortunate events like fire, which may also accompany visibility-inhibiting smoke.

It shall be ensured that there is no piping or supporting or any other kind of hindrance/ obstruction/ protrusion within this walking space and headroom.

17 COMMISSIONING

17.1 To ensure the proper commissioning of the system, the following operations shall be carried out:

a) *Cleaning of pipes* — Pipes and tubes shall be internally cleaned and made free from scale. If conditions like a corrosive atmosphere exist, pipes shall be suitably protected on the exterior. For oil circulation systems where fabricated pipework is to be used, pipes shall be shot-blasted or pickled before fabrication is recommended. After fabrication, the prepared pipes shall be pickled or cleaned again.
b) Checking the main items of equipment and control devices,
c) Flushing as required,
d) Filling of system,
e) Setting of operating conditions,
f) Running tests to prove the system,
g) Checking for leaks,
h) All filter elements shall be finally cleaned or replaced where required before final handing over to the purchaser of the system.

17.2 Flushing of Circulating Oil Systems

Flushing constitutes an important step before the lubrication oil system is commissioned fully. During various stages of the erection of piping, many impurities get inside pipes. There may be weld splatter, dirt or other mechanical impurities inside pipes or inside oil.

The flushing procedure is prepared by the commissioning agency in due consultation with the designer and/or customer. The flushing procedure spells out the various steps used in flushing, various sub-circuits to be installed, system bypasses, thermal shocks as well as flushing completion criteria.

Oil used for flushing may be the same oil that the system uses or it may be some other compatible oil. Flushing oil should have incompatibility neither with any component of the system nor with the main lubrication oil. It should not be a cause of rust/corrosion/acid etc.

The flushing completion criteria are defined as when the desired oil cleanliness class is achieved in samples taken after a period of, say, 5 minutes for a period of, say, 3 hours.

Positive displacement pumps have finer clearances and hence, are not normally used in oil flushing. The time taken for flushing depends on the cleanliness level required.

17.2.1 *Preparing the System for Flushing*

17.2.1.1 During this stage the oil reservoir is cleaned from the inside thoroughly, before pouring the oil. Any rust marks are properly cleaned, and rust is removed. If an anti-rust paint has been agreed between customer and supplier, the same is applied. Components inside the oil tank are properly inspected. While doing this, it must be ensured that national/local safety guidelines are being followed for persons working inside the reservoir and that the inside is properly well-lit. Normally at this stage inspection and approval from the customer may also be taken. The system should be checked for completeness. Once this is done and recorded and necessary approvals taken, Oil is poured into the reservoir. This may be done by pouring oil from a height on top of the reservoir or through temporary pumps.

17.2.2 *Initial Flushing*

Initial flushing is used to remove coarse particles.

17.2.2.1 Throughout this period, all bearings and any other items included in the system or serving equipment that may be damaged shall be temporarily isolated.

17.2.2.2 Where basket-type filters and/or line strainers are fitted, the basket and elements shall be removed.

17.2.2.3 Ferrous pipe work shall be lightly hammered to remove internal scale during this initial flushing period.

17.2.2.4 The piping in the gearings, roller table, etc., shall be disconnected by means of a by-pass piping during the initial flushing baskets period to prevent the coarse dirt coming from the delivery piping from entering the already cleaned pipes.

17.2.3 *Final Flushing*

This stage of flushing shall continue for at least 24 h or until required cleanliness is achieved using only Internal heating and with filter baskets and line strainer replaced. After flushing, the system shall be completely emptied of flushing oil and the reservoir drained and thoroughly cleaned internally, filters and the strainers shall be inspected and cleaned as necessary.

Thermal shocks may be introduced in the flushing circuit by alternate cooling and heating of oil. Alternate expansion and contraction of piping results in better cleaning.

17.2.4 After final flushing, the bearing and any other items previously isolated shall be reconnected. Finally, a check shall be made to ascertain that, with the system fully operational, the discharge of lubricants to the points of applications is as specified.

17.3 The flushing procedure as specified in **17.2** shall not apply to morgoil systems where the procedure recommended by the supplier shall be followed strictly.

SECTION II TOTAL LOSS OIL SYSTEM

18 TYPES

18.1 Two Line (Intermittent Volumetric) System

Consisting of two supply lines connected to a pumping until through which a manually or automatically operated reversing valve pressurizes and relieves each line in turn Piston type metering valves connected across the supply lines are actuated by the difference of pressure in the two lines.

18.2 Single Line Progressive (Intermittent Volumetric) System

Consisting of a single supply line from a pumping unit through which a series of piston type metering valves are pressure actuated consecutively.

18.3 Single Line Spring Reset (Intermittent Volumetric) System

Consisting of a single line from a pumping until connected to injectors which are operated by line pressure whenever the line is pressurized. After each operation, the line is relieved of pressure and a spring in the injector resets the measuring piston ready for the next cycle.

18.4 Single Line Spring Actuated (Intermittent Volumetric) System

Consisting of a single line from the pumping unit supplying lubricant under pressure. When the pressure is relieved from the line the spring pressure injects lubricant into the bearing.

18.5 Single Line Incorporating Restrictors (Continuous or Intermittent Proportionate) System

Consisting of a single line connected to calibrated or adjustable restrictors which become proportionately effective when the line is pressurized by a given volume of lubricant.

18.6 Direct Feed (Intermittent Volumetric)

Consisting of a pumping unit having one or more pumping elements from which a separate line is run to individual bearings. Sequential or semi-continuous feed can be obtained by this system.

19 PIPE SIZING

19.1 System pipe work shall be such that a lubricant is supplied to the lubrication points with sufficient injection pressure after overcoming the pressure drop due to frictional losses in the pipelines.

19.2 In the single line (intermittent volumetric) systems, the size of the pipes shall be such that residual pressure during the relief phase will permit metering elements to reset or inject.

20 BLEEDING OF TOTAL LOSS OIL SYSTEMS

20.1 Normally, total loss systems are bled whereas circulating oil systems are flushed.

20.2 Before the bleeding operation is started, the pipe work shall be cleaned by blowing clean and dry compressed air. The pipework shall then be bled by pumping the lubricant under pressure either with the systems pump unit or with any other suitable pump. During this process, all dead points in the system shall be left open and connections to bearings, gears, etc. shall be disconnected unit clean lubricant comes out. Ensuring the flow of clean lubricant from the systems pipe work, all the dead points shall be sealed and lines feeding the bearings, gears, etc. shall be reconnected.

20.3 After the system is put in operation, the pipe work shall be checked periodically for leaks.