

Lubrication System Design

Method for determining amount of lubricant required -

A useful guide is to calculate the frictional surface area (cm²) of the bearing and multiply by 0.0025 cm, this will give approximate volume of oil required to adequately lubricate over a one hour period for 'Total Loss Systems' and a one minute period for 'Continuous Systems'. Where high speeds, loads, temperature, contamination etc. are encountered, allowance should be made by adding to the calculation as conditions demand.

Where more frequent operation is required, as for automatic 'Total Loss' systems, these quantities are inversely proportional to the operational frequency e.g.,

If 1cc is required for 1 hour then 0.5 cc is required for 30 minutes, and so on.

Having determined the cc. of oil required per operation for each lubrication point, choose the nearest size of metering device (preferably above the calculated figure).

Add the individual requirements to give a total amount of oil to be dispensed by the pump.

Thickness and life of the Film of Lubricant

| Total Loss | Oil | Grease |
|-----------------------|---------------|---------------|
| Manual | 0,0050cc/2-4h | 0.0050cc/4-8h |
| Automatic | 0,0025cc/1h | 0,0025cc/4h |
| Recirculating Systems | | |
| Continuous Flow | 0,025cc/min. | |

To Calculate Requirements (cc)

Symbol Used - Unit of measurement cm.

V = Required Volume - cc.

A = Equivalent contact area - cm²

S = Thickness of lubricant film - cm

Dp₁ = Pitch circle diameter (PCD) of gear - cm.

Dp₂ = Pitch circle diameter (PCD) of worm screw - cm.

F = Width of pinion/band - cm.

D = Shaft diameter - cm.

L₁ = L. of support/guide - cm.

L₂ = Width of guide - cm.

C = No. of crowns on bearings

General Formula

$$V = A \times S \quad (\text{equivalent area} \times \text{thickness of film})$$

To Calculate Equivalent Area

| | | | |
|-----------------|--------------------|------------------------|-----------------------------|
| Roller Bearings | $A = D^2 C$ | Large Dimension Gears | $A = 2\pi D_p F$ |
| Plain Bearings | $A = \pi D L_1$ | Screw/Wheel-mesh gears | $A = \pi(D_{p1} + D_{p2})F$ |
| Slideways | $A = L_1 L_2$ | Labyrinth rings | $A = \pi D L_1 30^*$ |
| Gears | $A = \pi D_{p1} F$ | | |

* L₁ should take into account the width of the gasket.

Pumps and Reservoirs

The selection of a pump for a system is governed by the total capacity of the metering units to be used. When using a piston type pump (volumetric system) the total capacity should not exceed 70% of the output of the pump stroke to ensure that the system operates efficiently. Allowances should also be made for expansion losses when using nylon tubing e.g., approximately 1cc per metre run of main lubrication line.

Reservoir capacity should be calculated by multiplying the total oil dispensed per cycle by the number of operations per working period according to Planned Maintenance Schedules.

A Comparison of the Viscosity of Lubricating Oils

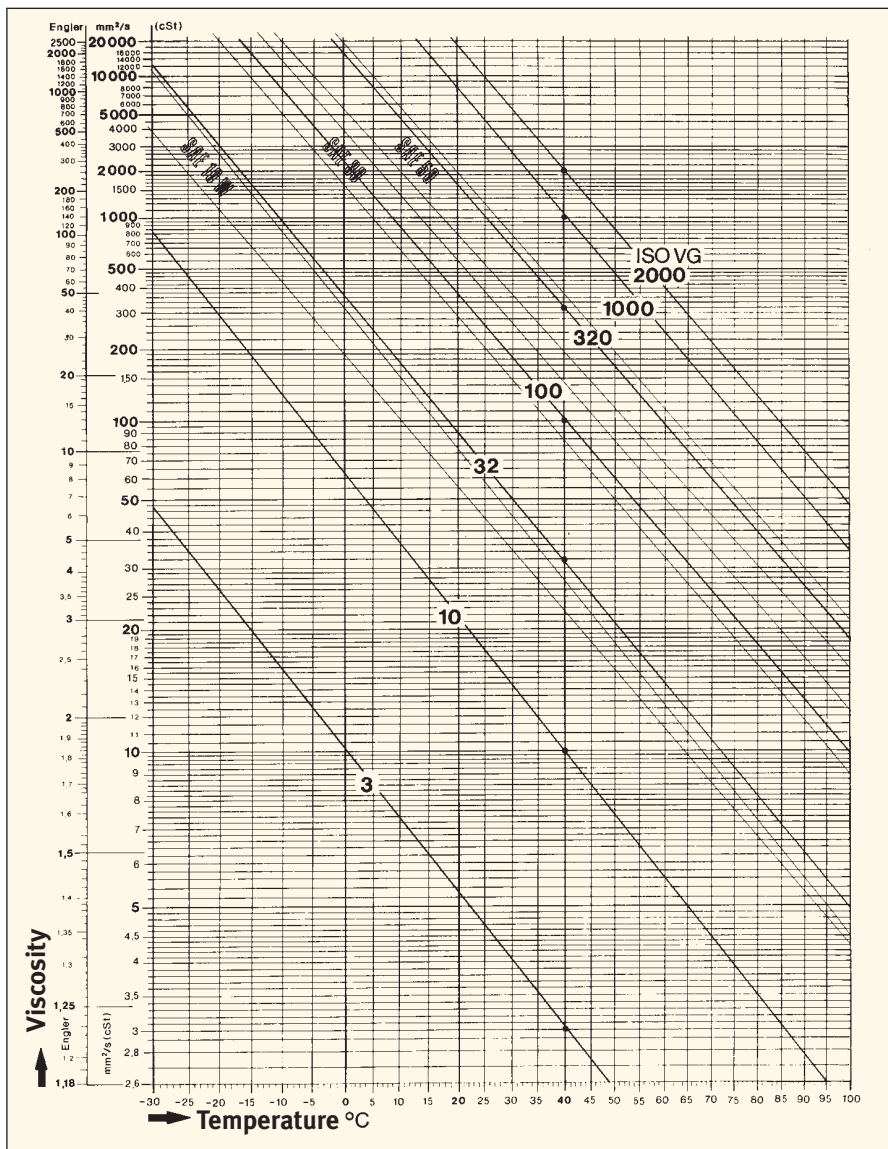
Engler "Diagram" - mm²/S

The diagram shows variations in the figures for viscosity on two different scales (Engler values and mm²/S cSt values) plotted against temperature for some lubricating oils in common use.

Comparative curves are shown corresponding to many ISO VG grades of viscosity, as follows:

| ISO GRADE | CORRESPONDING TO |
|-----------|---------------------|
| 3-10 | light oil |
| 32-100 | average machine oil |
| 320 | semi-thick oil |
| 1000 | thick oil |

It will be seen that the viscosity of ISO VG grade is equivalent to that of the lubricant expressed in cSt at a temperature of 40°C.



The diagram shows that oil viscosity is more affected by low temperature than high temperature. The decision as to which type of lubricant to use also involves various considerations with regard to the structure of the machine, the parts which specifically requires lubricating and their characteristics which are not always mutually compatible. This often leads to a compromise solution representing the lowest common denominator of a whole range of requirements.

Pressure Loss For Lubricating Oils

Estimated pressure loss in piping when using lubricating mineral oils with viscosity: 34-175-490 cSt at 40°C.

| Ext. Pipe Ø x thickness | Working Viscosity of oil mm ² /S (cSt) | Pressure loss per metre piping, in bars, for 3 different viscosities | | | | | | | | |
|----------------------------|--|---|------|------|------|------|------|------|------|------|
| | | Flow Q (L/min) | | | | | | | | |
| | | 0.01 | 0.05 | 0.2 | 0.5 | 1.0 | 2.5 | 4.0 | 6.0 | 9.05 |
| 2.5 x 0.5 | 34 | 0.41 | 2.05 | 8.20 | | | | | | |
| | 175 | 2.11 | | | | | | | | |
| | 490 | 5.91 | | | | | | | | |
| 4 x 1 | 34 | 0.13 | 0.65 | 2.59 | 6.45 | | | | | |
| | 175 | 0.67 | 3.33 | | | | | | | |
| | 490 | 1.87 | | | | | | | | |
| 4 x 0.7 | 34 | 0.05 | 0.23 | 0.91 | 2.27 | | | | | |
| | 175 | 0.23 | 1.17 | 4.68 | | | | | | |
| | 490 | 0.66 | 3.28 | | | | | | | |
| 6 x 0.7 | 34 | | 0.02 | 0.09 | 0.24 | 0.47 | 1.19 | 1.90 | 2.78 | 4.17 |
| | 175 | | 0.12 | 0.48 | 1.19 | 2.38 | 5.96 | | | |
| | 490 | | 0.34 | 1.34 | 3.35 | 6.67 | | | | |
| 8 x 0.7 | 34 | | | 0.02 | 0.05 | 0.11 | 0.27 | 0.44 | 0.66 | 0.98 |
| | 175 | | | 0.11 | 0.26 | 0.56 | 1.41 | 2.25 | 3.37 | 5.06 |
| | 490 | | | 0.32 | 0.79 | 1.67 | 3.91 | 6.29 | | |
| 10 x 0.7 | 34 | | | 0.01 | 0.02 | 0.04 | 0.09 | 0.15 | 0.23 | 0.34 |
| | 175 | | | 0.04 | 0.10 | 0.20 | 0.50 | 0.78 | 1.17 | 1.75 |
| | 490 | | | 0.11 | 0.27 | 0.55 | 1.37 | 2.19 | 3.28 | 4.92 |
| 12 x 1 | 34 | | | | 0.01 | 0.02 | 0.05 | 0.08 | 0.12 | 0.19 |
| | 175 | | | | 0.02 | 0.05 | 0.11 | 0.27 | 0.41 | 0.61 |
| | 490 | | | | 0.06 | 0.15 | 0.30 | 0.75 | 1.20 | 1.79 |

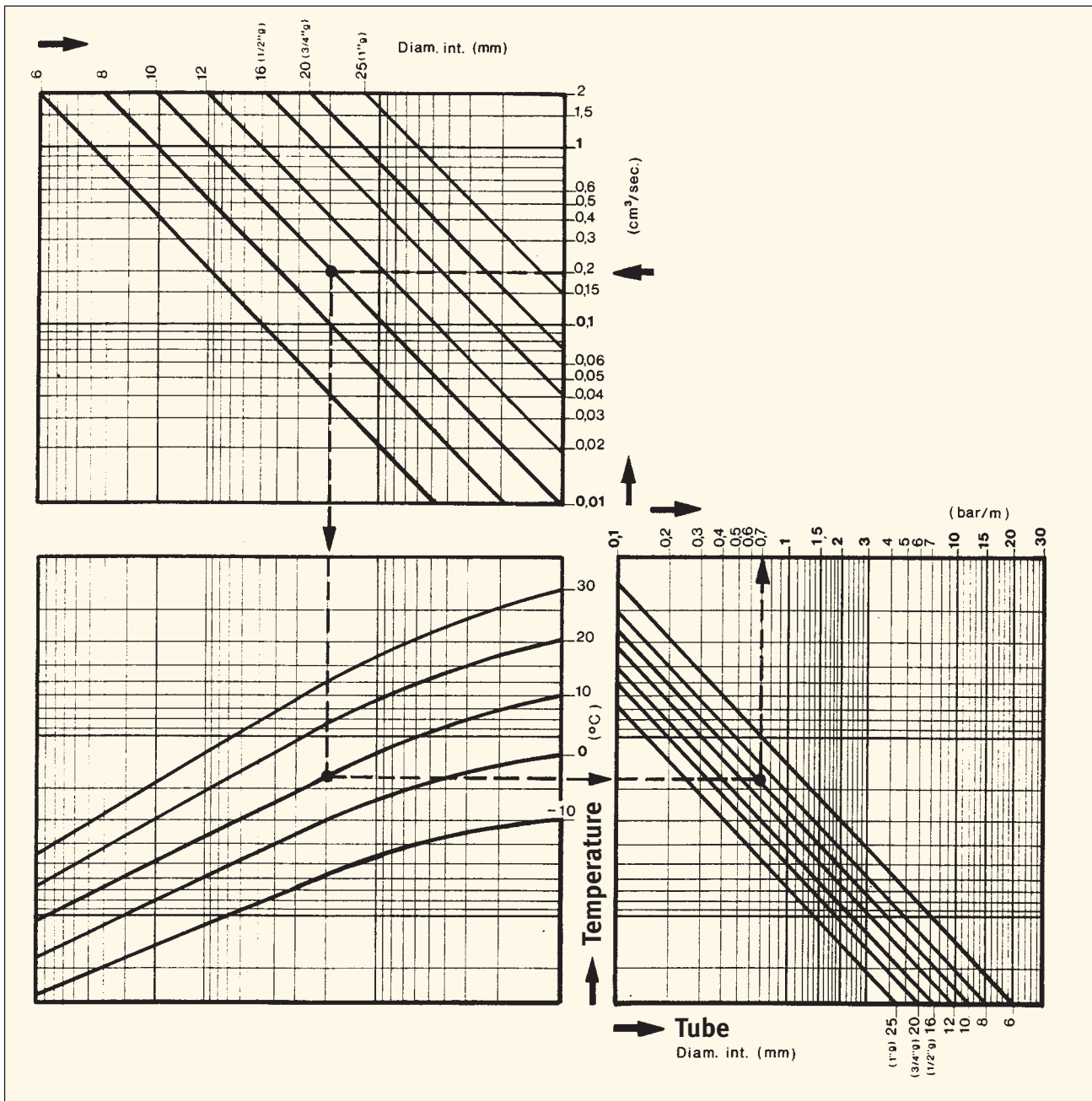
Pressure Loss in Pipework for Grease Systems

ESTIMATED LOSS USING NLGI 1 GRADE GREASE

Example

| | |
|-----------------|---------------|
| Volume | 0.2 cc/sec. |
| Tube Bore | 10 mm |
| Temperature | 10°C |
| Grade of Grease | 1 ASTM (NLGI) |

Pressure Loss = 0.7 bar/m



Note - Above Example is based on Grease Grade NLGI 1.

For NLGI 0 Multiply by Factor 0.6

For NLGI 2 Multiply by Factor 1.6