

## ISO-SYSTEM

ISO-Viscosity Grade (VG) is a system for industrial lubricating oils produced by the International Standards Organisation. The system has been divided up into 18 viscosity classes, indicated in mm<sup>2</sup>/s (cSt) at 40°C. The average value in the respective viscosity range, besides the first four numbers (see table) indicates its ISO-VG number.

The ISO classes can be applied to hydraulic oils for motor vehicles. Engine oil and transmission oil are designated by SAE classes.

Viscosities for industrial lubricating oils according to ISO-VG

ISO VG no.	mm <sup>2</sup> /s (cSt) at 40°C			ISO VG no.	mm <sup>2</sup> /s (cSt) at 40°C		
	average value	min.	max.		average value	min.	max.
2	2.2	1.98	2.42	68	68	61.2	74.8
3	3.2	2.88	3.52	100	100	90.0	110
5	4.6	4.14	5.06	150	150	135	165
7	6.8	6.12	7.48	220	220	198	242
10	10	9.0	11.0	320	320	288	352
15	15	13.5	16.5	460	460	414	506
22	22	19.8	24.2	680	680	612	748
32	32	28.8	35.2	1000	1000	900	1100
46	46	41.4	50.6	1500	1500	1350	1650

## Viscosity index

The viscosity of all oils varies with temperature. It decreases as the temperature rises and increases as the temperature falls. Mineral oils can have widely differing properties concerning temperature sensitivity. The property is indicated by the viscosity index (VI) which is acquired by practical experience obtained by determining the viscosity of the oil at two temperatures, and then by making a comparison with reference tables. The lower the change

in viscosity, the higher the viscosity index.

In the temperature-viscosity diagram below, an oil with a high VI has a flatter line than an oil with a low VI. In other words, engine oil SAE 15W/40 has a higher VI than both SAE 15W and SAE 40.

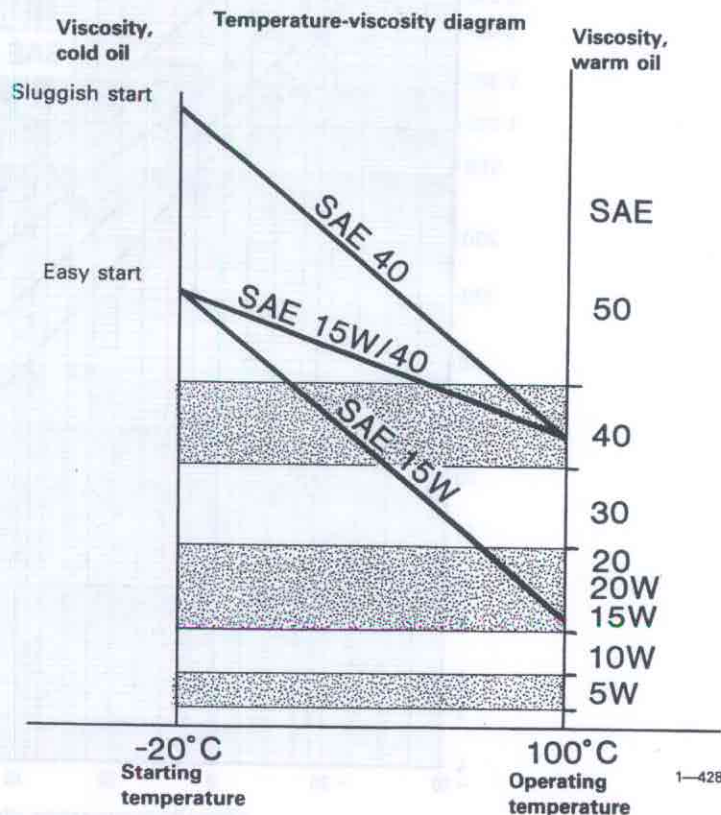
## DESIGNATIONS

Generally accepted technical designations with regard to viscosity are:

**Mono or single grade oil**, for example SAE 10W, SAE 40 and SAE 20W/20. These oils cover only one SAE rating.

**Double grade oil**, for example SAE 20W/30 and SAE 80W/90. These oils cover two adjacent SAE ratings.

**Multigrade oil**, for example SAE 10W/30, 10W/40 and 15W/40. These oils cover three or more SAE ratings.



# STANDARDS

## Engine oil – Volvo Drain Specification

All engine oils with designation CD+, super or long-life, must meet special demands. Where such oils are used in Volvo's turbo engines, they must be in accordance with the demands specified in standard **Volvo Drain Specification (VDS)**.

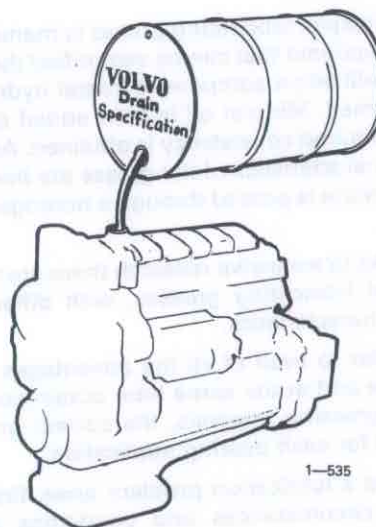
### Volvo Drain Specification (VDS)

The quality demand embraces:

- Cylinder bore polish
- Piston ring wear
- Camshaft/tappet wear
- Cylinder wear
- Oil consumption
- Oxidation stability
- TBN (Total Base Number)  
Alkalinity
- Viscosity variations

It is the responsibility of every oil manufacturer to state in their specifications that the oil meets the demand according to Volvo Drain Specification (VDS).

**NOTE!** The head offices of the additive manufacturers and of the well-known oil companies have been advised concerning Volvo's demands.



## Extra additives

The additives selected by the oil companies are the result of long term tests. The additives are blended with the oil under careful control.

**Volvo Truck Corporation will therefore in the strongest possible terms, point out that extra additives of type STP**

**or molybdenum disulphide must not under any circumstances be added to any lube oil used in Volvo products.** The addition of these additives do not increase the quality of the lubricant and can in certain circumstances cause more harm than good.

## MAKES

Like other automotive manufacturers, AB Volvo has clearly defined quality requirements with regard to lube oil for its products.

The requirements are given on the respective lubricating chart and their importance is stressed under the heading "Quality". Where it concerns engine oils, they must meet the demands according to **Volvo Drain Specification**. In other respects, the demands are in accordance with the general, standardized specifications. AB Volvo does not recommend any particular brand.

**We would like to point out that it is the responsibility of the oil producers themselves to ensure that their various products correspond to the respective standards. AB Volvo disclaims any liability in each and every respect concerning this, likewise the consequences that can be caused by any changes in the product designation.**

# Lubricating grease

## General

Lubricating grease consists of a mixture of oil and one or more soaps. The character of the grease and its range of application depend partly on the component mineral oil, partly on the type of metal included in the soap and also on the additives. The many types of lubricating grease available can be classified partly according to the method of production (metal base) and partly according to the range of use.

In principle, lubricating grease is manufactured by mixing a component that can be saponified during heating with a saponification component (metal hydroxide) until a soap is formed. Mineral oil is then added during stirring until the required consistency is obtained. Additives to improve the characteristics of the grease are then mixed in. Finally the grease is passed through a homogenizing and filtering plant.

Thanks to extensive research there are today a large number of lubricating greases, with different compositions and characteristics.

In order to avail of all the advantages of the lubricating grease and at the same time obtain good protection and long greasing intervals, the correct grease must be selected for each bearing application.

Should a lubrication problem arise, first establish under what circumstances and conditions the grease is to operate.

The most important factors are:

The working temperature of the bearing.

Bearing revolutions.

Pressure, shock loading etc.

Method of lubrication (lubricator or other type of lubricating).

Contamination (water, steam, chemicals, solvents, dirt and dust).

Lubricating intervals (desired).

With the help of these details, it is as a rule possible to find a suitable standard grease. In certain circumstances it can happen that there is no suitable grease available to meet the requirements, in such cases a special grease must be formulated. This is achieved by long-term research work in the laboratory, and intimate cooperation between the grease manufacturer and the user.

## TYPE CLASSIFICATION ACCORDING TO MANUFACTURING METHOD

### Aluminium grease

This grease is transparent and has a smooth, butterlike structure. Fibre length is very short and the grease is therefore designated as being "short". The grease is free from water and insoluble in water. Its resistance to cold is good and the grease can be used at temperatures down to  $-60^{\circ}\text{C}$ . The melting point is about  $80^{\circ}\text{C}$  and the upper limit for operating temperature about  $40^{\circ}\text{C}$ . Its corrosion-protective characteristics are not the very best.

### Graphite grease

Graphite is a designation of a form of pure carbon, characterized by the fact that microcrystals separate out to form determined cleavage surfaces under the effect of slight friction. This is used as an additive in lubricants. A grease with a high percentage of graphite is called graphite grease.

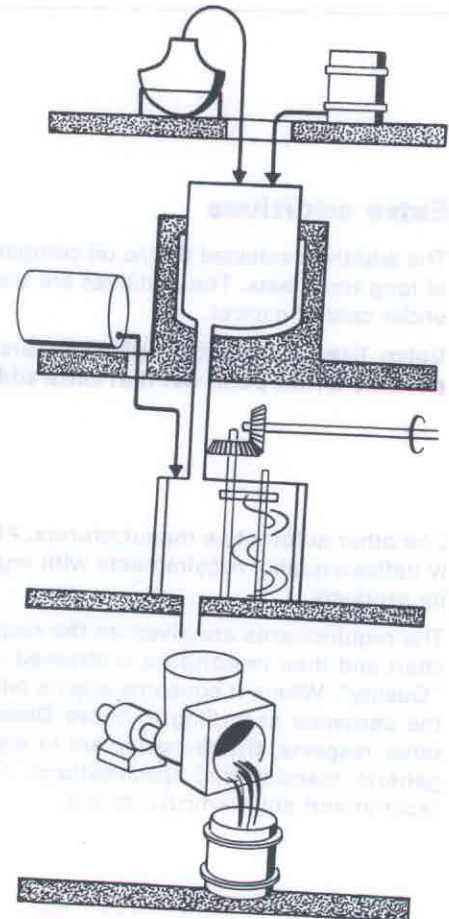
### Calcium grease

Calcium grease is semi-transparent and has a smooth butterlike structure and limited ductility. The grease contains about 2% water and is water resistant. The melting point is about  $95^{\circ}\text{C}$  and normal range of use is between  $-20^{\circ}\text{C}$  and  $+50^{\circ}\text{C}$ .

### Lithium grease

This grease is transparent and has a smooth structure. It is often yellow-brown to violet in colour. Its ductility is limited and the grease is therefore described as being short.

Lithium grease is resistant to both water and heat. It has good cold resistance and can be used in temperatures down to about  $-60^{\circ}\text{C}$ . Its melting point is about  $180^{\circ}\text{C}$  and the upper limit for its operating temperature about  $100^{\circ}\text{C}$ .



## Molybdenum disulphide grease and paste

Molybdenum disulphide is an additive and its structure is similar to graphite. Greases containing additives of this type are called molybdenum disulphide greases and are very practical under such conditions as high temperature. Pure finely powdered molybdenum disulphide together with a thickening agent is called molybdenum disulphide paste. This paste is used for special purposes, for example, as assembly paste.

## Sodium grease

Sodium grease is not transparent and has a fibrous structure. Its ductility is great and fibre length is about 1 mm. This grease is therefore described as being long. It is free from water but relatively soluble in water. The most outstanding characteristic of sodium grease is its resistance to heat. Its melting point is about 180°C and the normal range of use is between -20°C and +100°C.

## Type classification according to range of use

### Long-duration grease for wheel bearings

Long-duration grease is primarily intended for the lubrication of wheel bearings. One of the reasons why such high demands are made on this grease is that it is desirable to have as long a period as possible between repacking operations. Preferably the grease should last for the entire life of the bearing.

### Lubricating grease on lithium base EP additive and consistency NLGI no. 2

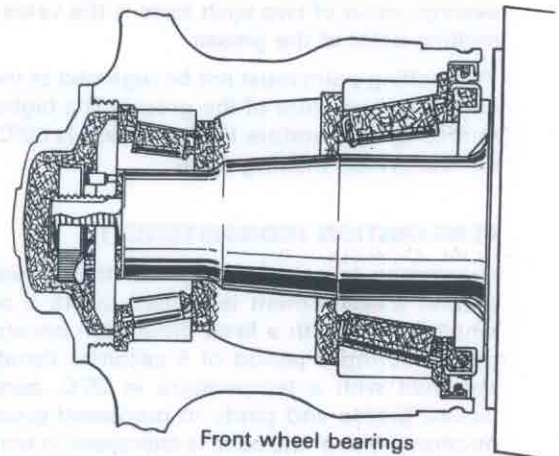
This is a grease we recommend for chassis lubrication. Greases which correspond to this recommendation are those which meet the AB Volvo standards for "Durable grease for wheel bearings" or "Molybdenum disulphide grease".

### Universal grease

In universal grease or multi-purpose grease, an attempt has been made by the careful choice of the components and through the use of high class additives to satisfy as far as possible the various demands made on a motor vehicle lubricating grease. This means that universal grease can to a great extent replace various types of special grease. In general, however, special grease is of an even higher quality within its respective range of application.

## Complex greases

Complex greases contain a so-called complex thickener, which normally consists of a metallic soap combined with metallic salt. This type of grease has a high melting point and can therefore be used with very high temperatures. The most usual types of greases in this category are lithium complex and calcium complex.



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Symbol on lubricating chart

### Other greases

**Chassis grease** for lubricating certain parts of the chassis used for, e.g., trucks and older cars. Distinguishing properties are durability and a high degree of adhesion.

**Heat-resistant ball bearing grease** is intended for lubricating ball bearings and roller bearings, e.g., clutch bearings and king pin bearings, also in coolant pumps. The grease must have a high melting point and be resistant to oxidation. In our lubrication recommendations, this grease has been replaced by universal grease.

## TESTING

The characteristics of lubricating grease are determined through carefully standardized procedures.

These can be divided into laboratory tests and also rig tests.

### Laboratory tests

#### WATER CONTENT

Water content refers to the relative amount of water contained by the grease. A normal type of calcium grease contains approx. 2% water, while aluminium, lithium and sodium greases should not contain any water.

#### MELTING POINT

Melting point is the temperature when the grease changes from its semi-solid consistency to a fluid consistency, and is carried out under stringent testing conditions.

Determination of the melting point is carried out in a special test apparatus, a test instrument is filled with a grease sample and is then heated up. The heating temperature rises approx. 1°C per minute and when the first oil drop falls from the instrument, the temperature is read off. The average value of two such tests is the value given as the melting point of the grease.

The melting point must not be regarded as the highest operating temperature of the grease. The highest permitted operating temperature for the grease is 50°C or more under the grease melting point.

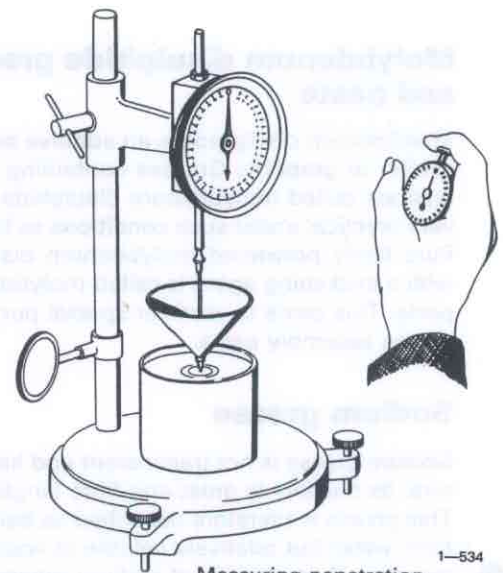
#### PENETRATION (CONSISTENCY)

Penetration is an expression for the consistency of the grease. Measurement is carried out in a penetrometer, where a cone with a fixed dimension penetrates into the grease during a period of 5 seconds. Penetration is determined with a temperature at 25°C, partly in unprocessed grease and partly in processed grease. The penetration depth of the cone is expressed in tenths of a millimetre and the grease is classified according to its consistency, in accordance with the 9 classes on the NLGI scale.

Class 000 indicates a very soft consistency and class 6 is a block grease.

NLGI-value	Penetration
000	445-475
00	400-430
0	355-385
1	310-340
2	265-295
3	220-250
4	175-205
5	130-160
6	85-115

It is always the penetration of the processed grease that is given. As a rule, the penetration should alter as little as possible between processed and unprocessed grease.



Measuring penetration

### LUBRICATION

This characteristic can be determined, for example, in a SKF test rig R2F where, in test operation 2, the grease is tested at room temperature for 667 hours at 2500 r/min and with a constant radial bearing loading of 850 kg. On completion of the test, the bearings are examined for wear and the grease is examined concerning consistency, oxidation and deposits. Test no. 4A is carried out at a temperature of 120–125°C for 600 hours at 500 r/min and 850 kg loading. This test is used for the rejection of grease with insufficient lubricating characteristics, shearing stability and oxidation stability.

#### HEAT STABILITY (BLEEDING TEST)

This test is intended to determine the tendency of a component oil in a lubricating grease to separate out during storage. A certain amount of grease (10 g) is placed in a wire mesh cone. The cone is then placed in a beaker which in turn is put in a heating cabinet for 50 hours. The temperature for high melting point bearing grease is held at 100°C and for other greases at 50°C.

The oil which has run down into the beaker is then weighed and calculated as a % by weight. Any evaporation is also calculated at the same time.

#### CORROSION

The determination of corrosion concerns the appraisal of the tendency of a lubricating grease to cause chemical attack on a metal. This test is carried out by the examination of a strip of copper which has been maintained in the grease for a period of 24 hours at a temperature of 100°C.

Corrosion of a bearing is determined with the so-called Emcor method.

#### Rig testing

In order to determine the operating characteristics of grease, there are many rig test methods which, as far as possible, are identical with practical conditions. Methods of this type have been worked out, for example, by ASTM (the American Society for Testing Materials) and SKF (the Swedish Ball Bearing Factory). The following characteristics of a grease are normally registered.

## PUMPABILITY

The degree to which a grease can be pumped is of interest since it is often necessary to force grease through constricted channels, for example when using a grease gun. This characteristic can be stated with the help, for example, of the Carter method by which a standardized grease gun is used to measure the rate of flow of the grease at constant pressure and at different temperatures.

## MECHANICAL STRENGTH

This refers to the capacity of the grease to retain its consistency and structure during long periods of operations, for example, in bearings. There are many forms of test apparatus to determine this characteristic, for example, ASTM D 217 and SKF WBG (Wheel Bearing Grease Testing Rig). On completion of the test, an examination is made concerning grease leakage and also the condition of the grease.

## CORROSION PROTECTION

Many test methods have been developed in order to examine the corrosion-protection characteristics of lubricating grease. One factor common to all these methods is that the bearings packed with grease are run for certain periods together with water. Testing makes possible an evaluation of the capacity of the grease to prevent corrosion in the presence of water both during operating conditions and when stationary. The most well-known method of testing is called the Emcor method.

## EXTREME PRESSURE LUBRICATION

Testing of the EP characteristics of grease is to find out whether the grease maintains its lubricating properties even under high loading. Tests of this type can be carried out in the Timken test machines where a hardened steel ring rotates against a test block of steel. The degree of wear on the test block is then measured.

## STANDARDS

The following are the demands made on the various types of grease recommended by AB Volvo for the various ranges of use. They are taken from the AB Volvo, concern standards and constitute our minimum demands for production. Naturally, they do not prevent grease of even higher standard being used.

### Long-duration grease for wheel bearings (lubricating grease on a lithium base with EP additive)

Example of standard according to Volvo demands			
Soap	Lithium	Operating temperature, °C	max +110
Melting point °C, processed <sup>2)</sup>	180		min. - 30
Penetration at 25°C, processed <sup>2)</sup>	280	Consistency	Short fibres, smooth, adhesive
Penetration deviation, max.	±15		
NLGI no. <sup>2)</sup>	2	Homogeneous characteristics	The grease must not contain lumps of hard particles and no significant amount of oil must separate out during the time the grease is stored.
Base oil, viscosity at 40°C, min. <sup>3)</sup>	175 cSt		
Water content, max.	0.1%		
Oil separation (static) 100 h/80°C <sup>4)</sup>	max. 5%		

<sup>1)</sup>Test method ASTM D 566

<sup>2)</sup>Test method ASTM D 217

<sup>3)</sup>Test method ASTM D 445

<sup>4)</sup>Test method STD 1027, 2662

### Special demands

The grease is to satisfy the demands made on testing in the "SKF Wheel Bearing Grease Testing Rig" and according to SIS 155130 (Emcor method) and also in accordance with the long duration tests in the "SKF Grease Testing Machine, R2F". This means that the grease must be able to provide dependable lubrication during both vibrations and extremely heavy loading, i.e. it must not be thrown out of the bearing, with poor lubrication or no lubrication at all as a result. Neither must it weaken to cause risk of leakage or cause corrosion on the various parts of the bearing.

## Molybdenum disulphide grease (lubricating grease on a lithium base with EP additive)

Example of standard according to Volvo demands			
Soap	Litium/MoS <sub>2</sub>	Operating temperature, °C	max +100
Molybdenum disulphide, min. volume	3%		min. -25
Melting point °C, min. <sup>1)</sup>	180	Consistency	Short fibres, smooth, adhesive
Penetration at 25°C, processed	280		
Penetration deviation, max.	±15	Homogeneous characteristics	The grease must not contain lumps of hard particles and no significant amount of oil must separate out during the time the grease is stored.
NLGI- no. <sup>2)</sup>	2		
Water content, max.	Trace		
Oil separation (static) max. 100 h/80°C <sup>3)</sup>	5%		

<sup>1)</sup>Test method ASTM D 566

<sup>2)</sup>Test method ASTM D 217

<sup>3)</sup>Test method STD 1027, 2661

### Special demands

The grease must satisfy the demands made on testing in the "SKF Wheel Bearing Grease Testing Rig" and according to SIS 155130 (Emcor method) and also in accordance with the long duration tests in the "SKF Grease Testing Machine, R2F". This means that the grease must be able to provide dependable lubrication during both vibrations and extremely heavy loading, i.e., it must not be thrown out of the bearing, with poor lubrication or no lubrication at all as a result. Neither must it weaken to cause risk of leakage or cause corrosion on the various parts of the bearing.

## MAKES

Like other automotive manufacturers, AB Volvo has clearly defined quality requirements with regard to lubricating grease for its products. Which grease type that should be used is stated on the lubricating chart. The significance of the different types of grease and the standards for these are outlined on the previous pages. In other respects, the demands are in accordance with the general, standardized specifications. AB Volvo does not recommend any particular brand.

**We would point out that it is the responsibility of the grease producers themselves to ensure that their various products correspond to the respective standards. AB Volvo disclaims any liability in each and every respect concerning this, likewise the consequences that can be caused by any changes in the product designation.**

# Service fluids

## Brake fluids

Originally brake fluid consisted of a solvent and castor oil. The disadvantages with this simpler form of brake fluid were that it had a very low boiling point and a setting point already at approx.  $-15^{\circ}\text{C}$ . Development soon presented considerably greater demands on brake fluid and certain standards were drawn up. The best known of these standards are those worked out by the Society of Automotive Engineers (SAE). These standards are continuously being reviewed and are published in the SAE Handbook. SAE 70 R1 was published for the first time in 1946. SAE 70 R3 which was issued in 1958 contained more severe demands. J 1703 was published in 1968 with somewhat altered standards. The American standards DOT3 and DOT4 (US Federal Motor Vehicle Safety Standard 116) were issued in 1971.

DOT = Department of Transportation.

The brake fluid of today consists of a mixture of different glycol esters, the lubricative qualities of which are improved by additives of castor oil derivatives or synthetic lubricants. The various additives also improve the protection against corrosion and oxidation. The particular composition presents the manufacturer with a wide range of possibilities to choose from and to adapt the properties to satisfy the standard in question. This is the responsibility of the brake fluid makers. They usually state on the attached label the standard which the fluid meets. For its products, AB Volvo prescribes a brake fluid which meets the requirements according to SAE J 1703 or DOT4.

## Fluids for cooling systems

### Anti-freeze

Anti-freeze generally consists of ethylene glycol together with anti-corrosive and anti-foam additives. AB Volvo prescribes for its products anti-freeze **type C** (blue green) art. no. 112 9700-9 (1 kg). Anti-freeze of type C provides even better protection against corrosion and is in addition nitrite and amine free, which is a definite advantage from an environmental point of view. Anti-freeze should protect the cooling system against freezing and at the same time prevent corrosion. The glycol content of a ready mixed coolant should not therefore be less than 40%. Coolant with a 40% glycol content provides protection down to  $-35^{\circ}\text{C}$ .

**NOTE! Never use the same container for oil and anti-freeze. Glycol, even in small quantities, will rapidly break down the oil and this will result in damage to the engine.**

### Rustproofing

In those instances where it is not necessary to use anti-freeze, a rustproofing additive should be added to the coolant. Volvo's rustproofing additive, art.no. 112 9709-0 is available in half litre packaging and is added to the coolant in varying amounts (0.5–1.5 litres) depending on the size of the engine. The engine should then be warmed up as soon as possible afterwards if the additive is to provide the best results.

**NOTE! Glycol or any other type of anti-freeze must not be mixed with this rustproofing additive.**

