GUIDE

to the selection and installation
of air-cooled single and multi cylinder
HATZ Diesel Engines

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This Guide to the Selection and Installation of Engines has been compiled for the users of our engines.

The guide examines the criteria used in selecting an engine, it draws attention to the permissible operating limits, and it provides advice on good installation practice and the proper use of auxiliary equipment.

Whether an engine has been installed successfully is not revealed until the installation is tested. A check-list is included, therefore, as an indispensable part of this guide.

The guide will be able to answer many questions but certainly not all.

Please do not hesitate to contact us, therefore, if you are doubtful about anything.

New results will cause alternations without notice.

Contents

A The engine

B Auxiliary equipment

C Installation test and installation approval

D Dimensions and application limits of major power take-off points

THE ENGINE

1.0 Selecting an engine

To choose the best possible engine for an application the parameters of the engine's environment have to be carefully analyzed and incorporated in the selection process.
In this case the engine's environment is not to be thought of as only the engine's direct area of installation in the machine.
On the contrary, it also covers the machine's mode of operation, the geographical area of use in terms of temperature, altitude and dust, etc., and the intended method of starting.
For general purposes we recommend defining an engine in accordance with the following scheme:

Selection of:	Criteria for the selection process:
Speed	Level of speed in relation to: - operating hours per annum - noise - free inertial forces / torques / vibrations - elastic / rigid mounting - geographical area of use (servicing background) - the machine to be driven
Power setting	Power calculation incl. - temperature - altitude above sea level - efficiency - safety margins for imponderables - geographical area of use (climate) - load profile, standardized power classes - fuel
Engine type	Selection of the engine with due regard to: - standard, power class - speed / power - weight / volume - starting method, starting temperature - power take-off points - load capacity of the power take-off points - flange compatibility - elastic / rigid mounting - speed controller data - fuel - starting method
Auxiliary equipment	- adaptation to the machine and to its environment

This general overview of the engine selection process will now be followed by sections containing detailed information:

1.1 Selecting the speed

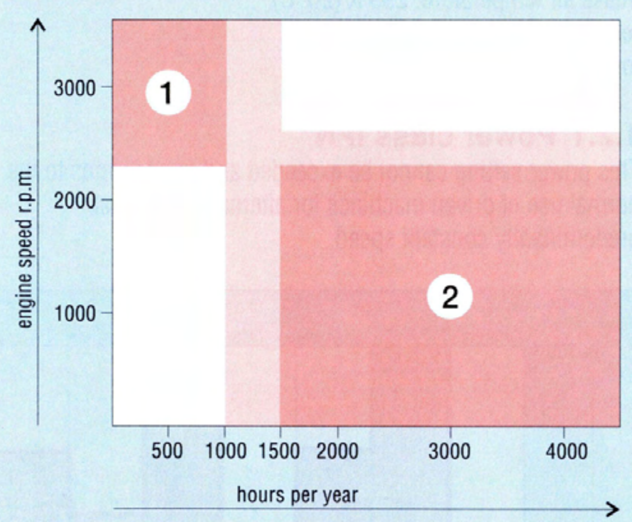
It makes sense to begin the engine selection process by defining the speed range.

It is not always correct to choose the highest engine speed if you want to obtain a specific power or minimum cost per kilowatt. An optimum offer is not just a question of a particularly low price but will also include a recommendation of engine characteristics largely in line with the customer's expectations, e.g.:

- service life
- weight
- noise
- vibrations
- power
- dimensions
- service organization
- availability of spare parts
- price, etc.

Probably the most important factor when choosing an engine is the correctly selected speed because this has the most crucial influence on engine performance.

The decisive factor for determining the speed, on the other hand, is the number of operating hours per annum. Different annual operating hours are assigned to different speed ranges:



1.1.1 Speed range 1

Speed range 1 begins at over 2300 min^{-1} and extends to the engine's maximum speed.

For engines in speed range 1 the number of operating hours is normally less than 1000 h/annum, although the limit is flexible and may sometimes lie at e.g. 1200 h/annum.

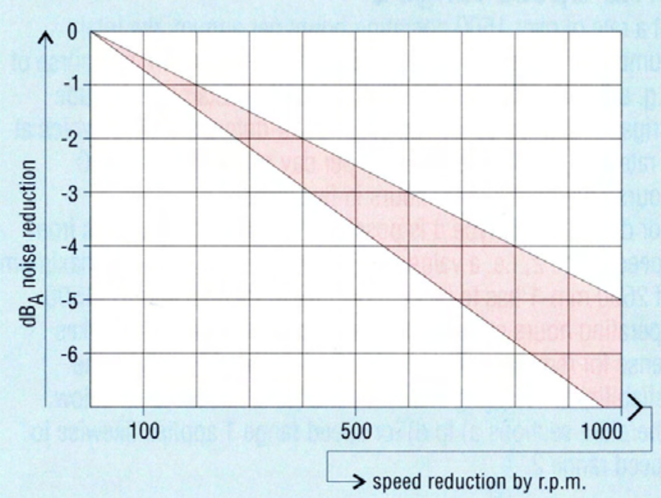
Engines for construction machines and for industrially or commercially used equipment generally fall within speed range 1.

Example: In a year with 240 work days a commercially used machine is used on around 70 % of the days and for approx. 60 % of an 8-hour day. This adds up to around 800 operating hours per annum.

Under these conditions the engines can normally be used up to the maximum permissible speed, although a speed of 3600 min-1 would appear meaningful only in conjunction with 60 Hz generators. It should not necessarily be used for other drives because the engine speed has a major influence on the following characteristics:

a) Noise

The lower the engine's speed, the less noise it produces, i.e. it is quieter. Each reduction of speed by 100 min-1 lowers its noise by approx. 0.5 - 0.6 dB_A, on practically all types of engine.



Reducing the speed e.g. by 500 min^{-1} would result in a noise reduction of approx. 3.0 dB. Which less is equivalent to a noise reduction of 50 %, i.e. the engine would now be only half as loud as before!

b) The equilibrium of the engine and the machine is also improved by a reduction of speed because the inertial forces and the mass moments of inertia are then far smaller (see also Chapter A 3.0). Better equilibrium goes hand in hand with less generation of structure-borne noise, leading once again to a quieter machine.

c) Poor maintenance
At a lower speed the engine becomes less dependent on maintenance. Hence engine damage is not caused so quickly by shortcomings in the maintenance, should they occur.

d) Service life of power transmission elements.
Please remember that the life of power transmission elements such as belts and flexible couplings is extended when the speed is reduced.

Altogether these considerations may well lead to a reduction of speed, which certainly makes sense if a speed of 3000 min-1 or even 3600 min-1 is not absolutely essential for the machine (as is the case e.g. with generators). And if the required power can also be produced at a lower speed, then a lower speed should be preferred for the reasons listed above.

1.1.2 Speed range 2

At a rate of over 1500 operating hours per annum, the total number of operating hours reached by a machine in the course of e.g. a 5-year period of use is considerable. Examples include irrigation pumps as well as continuous-duty generators, which at a rate of just 5 operating hours per day reach approx. 1800 hours/annum and 9000 hours in five years.
For drives of this type it is possible to choose only speeds from speed range 2, i.e. a value of 2300 min-1 to an absolute maximum of 2600 min-1 has to be observed for more than approx. 1500 operating hours per annum. This choice of speed also makes sense for remote regions in developing countries where the reliability of servicing and maintenance is known to be below. Therefore sections a) to d) for speed range 1 applies likewise to speed range 2.

1.2 Selecting the power class

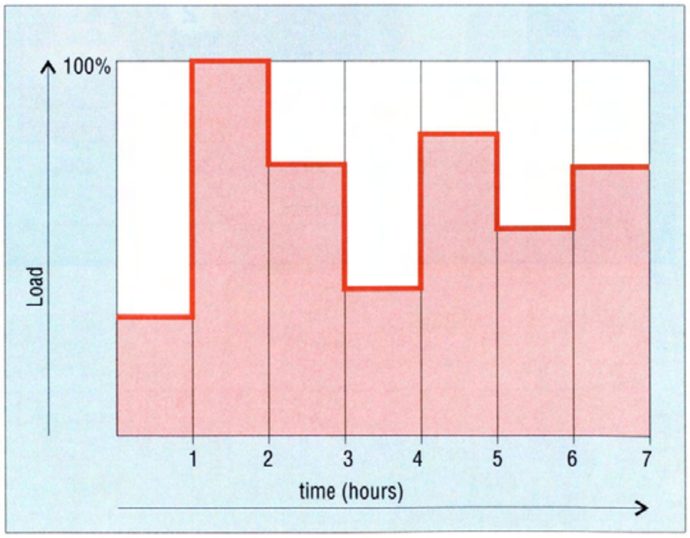
The power setting of HATZ diesel engines conforms with the power classes of DIN-ISO 3046, the international standard governing engines for driven machines:

Power classes DIN-ISO 3046	
1. blocked output for intermittent duty = blocked ISO effective output	IFN
2. blocked output for severely intermittent duty = **blocked ISO effective output**	IFN_{si}
3. continuous output, 10 % overload capability = **ISO standard output** **10% overload capability**	ICXN
4. continuous output, no overload capabillity = **blocked ISO standard output**	ICFN

The standard reference conditions for DIN-ISO 3046 are as follows:
air pressure: 100 kPa (at approx. 100 m altitude above sea level)
intake air temperature: 298 K (25 °C)
relative air humidity: 30 %
Vehicle drives with mechanical transmissions are also governed by DIN 70020. The following standard reference conditions are in force for this standard:
air pressure: 103 kPa (approx. sea level)
intake air temperature: 293 K (20°C)
rel. air humidity: not defined
tolerance: ± 5 %

1.2.1 Power class IFN

This power setting cannot be exceeded and corresponds to the normal use of driven machines for alternating loads at predominantly constant speed.



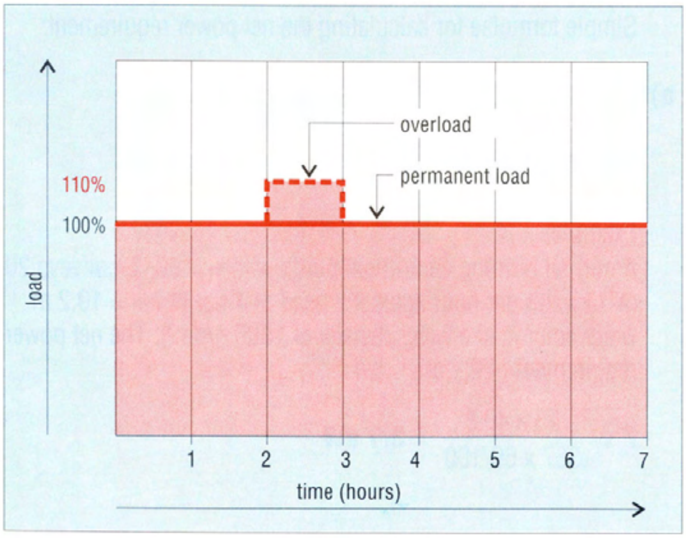
Typical applications are:
Emergency generating sets for providing an emergency power supply to connected consumers or other driven machines such as: compressors, trench cutting machines, earthmovers with hydrostatic systems such as crawlers, loaders, excavators etc., and fire-fighting pumps.

The maximum value of the blocked ISO effective output can be tapped for up to one hour within 6 hours of alternating load.

1.2.2 Blocked ISO effective output IFNsi for severely intermittent duty:

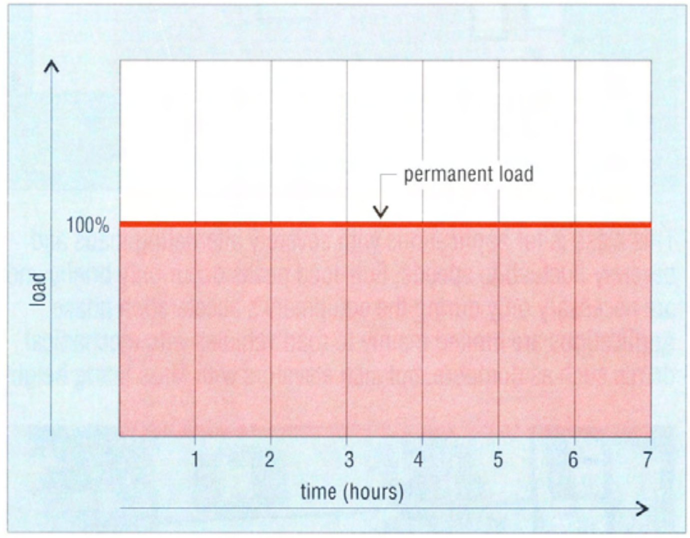
This class is used when full power is required briefly while the speed is largely constant, as is the case e.g. with refrigerating units, vibrating plates and rollers, welding units, lifting stackers, mobile cranes and combine-harvesters.

1.2.3 ISO standard power ICXN, exceedable

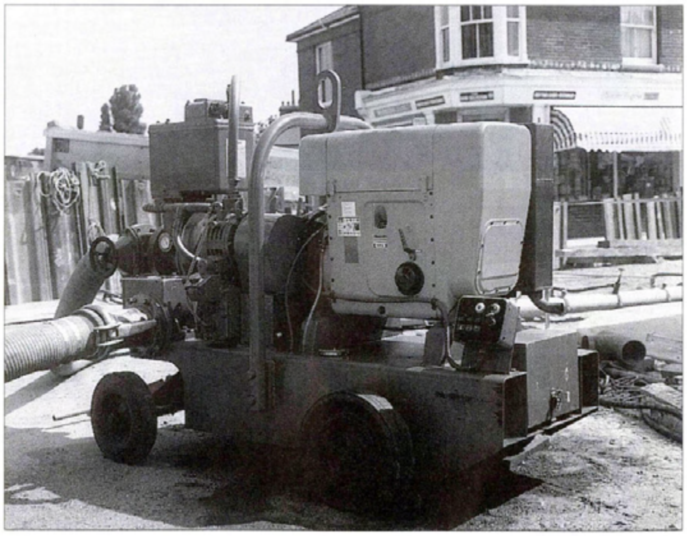


ISXN is used for equipment with constant load consumption at constant speed, e.g. generating sets for a base load or for a ship's drive system. Exceeding the maximum output is possible for a period of one hour within 12 hours. Allowance for the possibility of this additional output is made with the engine setting. Its magnitude is selected according to the engine's use - it is normal to set an additional output of 10 %.

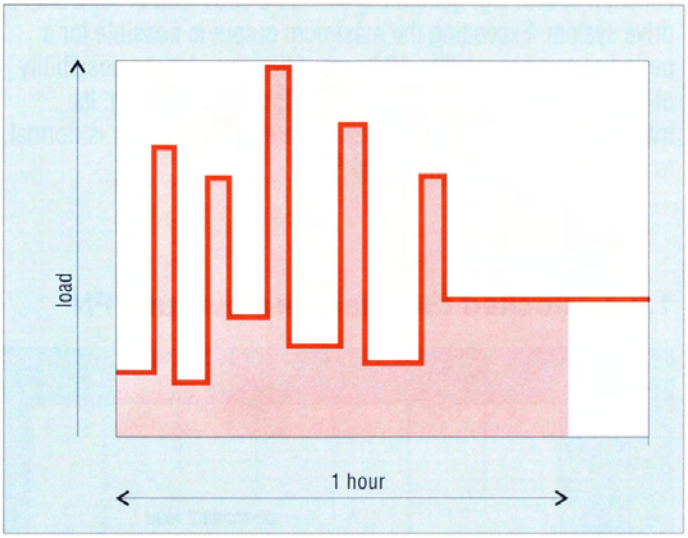
1.2.4 Blocked ISO standard output CFN



ICFN cannot be exceeded - it is the continuous effective output which the engine is able to produce continuously - i.e. interrupted only for maintenance purposes - at constant speed. This power setting is selected e.g. for irrigation pumps, but also for driven machines which can be run for hours on the torque increase curve, e.g. joint cutters at maximum feed rate.



1.2.5 Vehicle power according to DIN 70020



This class is for applications with severely alternating loads and severely fluctuating speeds. Full-load peaks occur only briefly and are necessary only during the equipment's acceleration phase. Applications are limited mainly to road vehicles with mechanical drives such as dumpers, but also elevators with large lifting heights

1.3 Power calculations

Having decided on the power class you must now calculate the necessary engine power:

Too weak an engine will be too highly loaded and will lead to problems within a short period of operation. On the other hand, selecting too large an engine that is rarely made to work to full capacity will not please the user either when he is confronted by coking, high oil consumption and other side-effects.

It is particularly important, therefore, to carry out the power calculation as meticulously as possible.

The power calculation establishes the following:

1. the net power requirement of the driven machine,
2. the size of the safety margins,
3. the load capacity of the engine with regard to the temperature, altitude and relative air humidity at the point of use.

Re 1.

The net power requirement of the driven machine (P_G) is derived from:

A) the machine's power consumption, which either needs to be calculated or is already known.

   When calculating the power consumption you must make allowance for the efficiency of the machine and the power-transmission elements.

   Examples of efficiency values:

   Belt transmissions and gear transmissions approx. 95 % (poorly designed belt transmissions may be as low as approx. 85 %).
   Hydrostatic systems (pump, pipe line, engine) approx. 60-70 %.
   2 kW generators approx. 70 %, 20 kW generators approx. 85 %.
   Normal priming centrifugal pumps approx. 60-65 %, self-priming centrifugal pumps 45-50 %. In the case of centrifugal pumps you must also remember that the pump's power consumption increases by a considerable 33 % when the speed is raised by just 10 %. Similarly, the pump's power consumption drops just as dramatically when the speed is reduced.

   Simple formulae for calculating the net power requirement:

a) For water pumps

$$\mathbf{P\ (kW) =} \frac{Q\ (m^3/h) \times H\ (m)}{367 \times \eta\ (\%/100)}$$

Example:

A normal priming centrifugal pump with $\eta = 60$ % conveys 20 m^3 of water per hour against a head of 4 bar (1 bar = 10.2 m water column at a water density of 1000 g/dm³). The net power requirement of the pump is:

$$P = \frac{20 \times 40.8}{367 \times 60/100} = \mathbf{3.7\ kW}$$

b) For hydraulic pumps

$$P\ (kW) = \frac{Q\ (l/min) \times p\ (bar)}{600 \times \eta\ (\%/100)}$$

Example:
a gear pump conveys 33 litres per minute against a pressure of 160 bar. The efficiency of the overall system is 70 %. The net power requirement is:

$$P = \frac{33 \times 160}{600 \times 70/100} = \mathbf{12.6\ kW}$$

c) For generators

$$P\ (kW) = \frac{kVA \times \cos\varphi}{\eta\ (\%/100)}$$

Example: a 12 kVA generator has an efficiency of 82 % at full load and is

a) connected with inductive consumers at cos φ of 0.8.
b) with ohmic consumers at cos φ of 1.0.
The net power requirement of the generator is:

a) $$P = \frac{12 \times 0.8}{82/100} = \mathbf{11.7\ kW}$$

b) $$P = \frac{12 \times 1.0}{82/100} = \mathbf{14.6\ kW}$$

B) The power calculation must also take account of power-distorting auxiliary outputs such as dynamos. Particularly where small engines are concerned it should not be forgotten that a dynamo's power consumption is equivalent to about twice its electric output.
The power requirement for dynamos in the various engine families is as follows: Approx. power requirement of dynamos

Engine family	Dynamo	
	unloaded	loaded
1 B ..	300 W	600 W (14V/15A)
1 D ..	300 W	600 W (14V/15A)
2 G ..	300 W	600 W (14V/15A)
Z 7 ..	300 W	600 W (14V/15A)
. L ..	500 W	2000 W (14V/52A)
. M ..	500 W	2000 W (14V/52A)

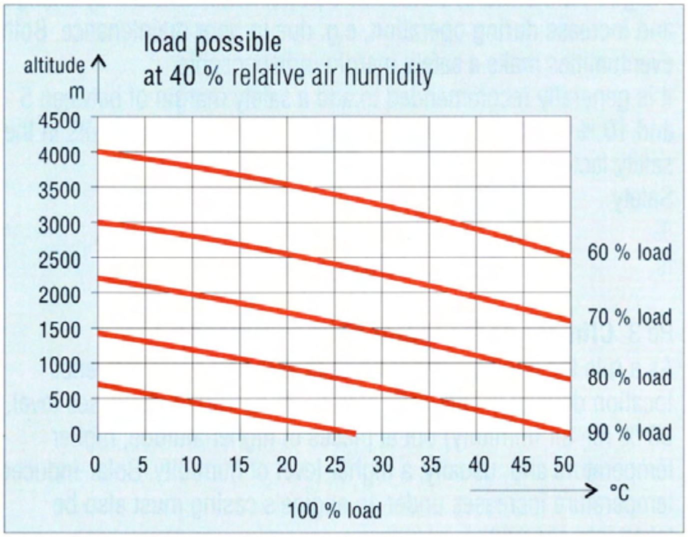
The power calculation has to allow for the power requirement of the above mentioned auxiliary units and similar equipment.

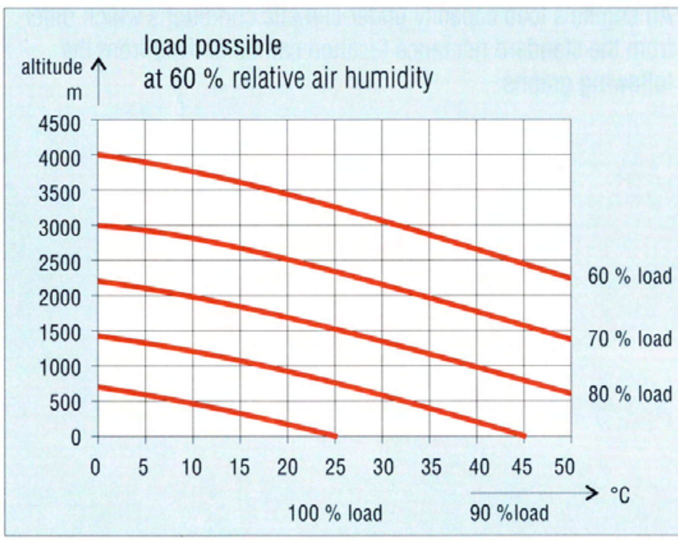
Re 2. **Safety margin** (factor fs)
Most assumptions used to determine the power requirement are of a theoretical nature. It is necessary, therefore, to include a safety margin. Furthermore, a machine's power requirement may change and increase during operation, e.g. due to poor maintenance. Both eventualities make a safety margin indispensable.
It is generally recommended to add a safety margin of between 5 and 10 % for imponderables in the calculation - this results in the safety factor fs:

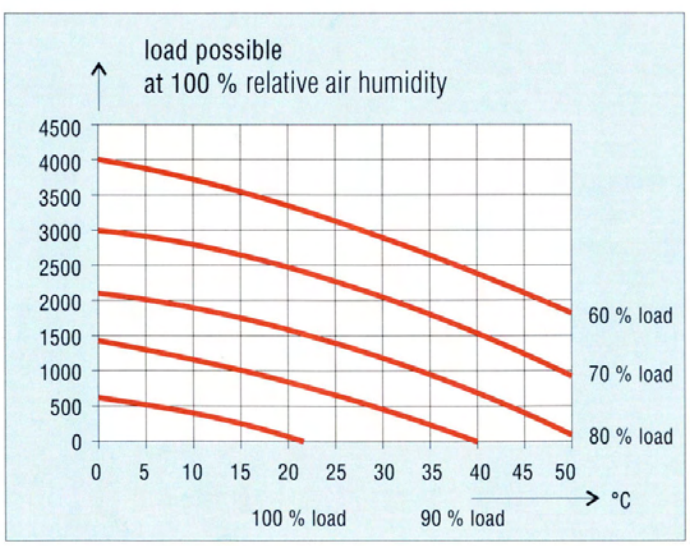
Safety %:	5	10	15
fs:	1.05	1.10	1.15

Re 3. **Climate at the point of use** (divisor K)
As a rule the engine will not be used at the standard reference location defined in DIN-ISO 3046 (+ 25 °C 100 m above sea level, 30 % rel. air humidity) but at places of higher altitude, higher temperature and, usually, a higher level of humidity. Solar-induced temperature increases under an engine's casing must also be taken into account.
An engine's load capacity under climatic conditions which differ from the standard reference location can be derived from the following graphs:

Load capacity limits of Diesel engines without charging ($\eta_{mech.}$ 80 %) according to DIN-ISO 3046-1/A as a function of: temperature, altitude and relative air humidity.







An example: for 60 % relative air humidity at a temperature of + 35 °C and an altitude of 1200 m the engine's load capacity equals 80 %. Hence the climate divisor K is = 0.8.

1.3.1 Necessary engine power P (kW)

With the previously established values for

- the machine's power consumption (P_G)
- the power of any auxiliary outputs (P_N)
- the power allowance for safety (factor fs)
- the power allowance for the climate at the point of use (divisor K)

you can now calculate the necessary amount of power for the engine:

$$\mathbf{P\ (kW)} = \frac{(P_G + P_N) \times fs}{K}$$

As an example of how to calculate the necessary engine power let us assume that the following data apply for the previously mentioned 12 kVA generator under ohmic load:

Power requirement of the generator	P_G	=	14.6 kW
Dynamo output for charging the battery	P_N	=	1.0 kW
Safety margin 5 %	fs	=	1.05

Climate: 60 % rel. humidity + 35 °C,
1200 m above sea level, K = 0.8

$$\mathbf{P} = \frac{(14.6 + 1.0) \times 1.05}{0.8}$$, hence you will need to select a

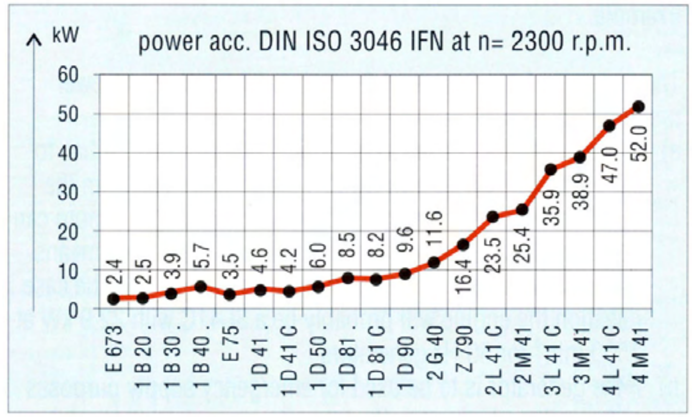
P = 20.5 kW engine able to generate an output of 20.5 kW at the standard reference location.

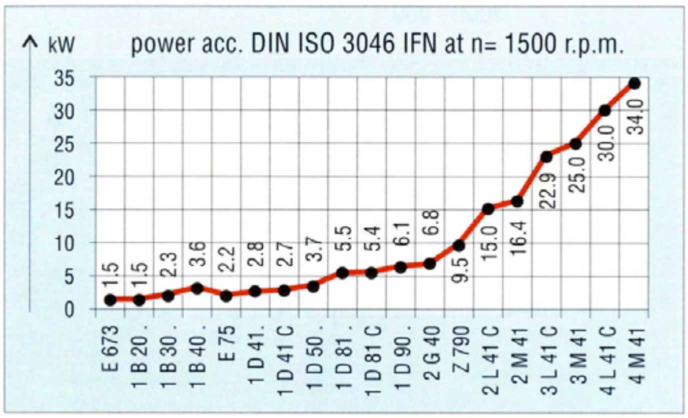
If a series-built machine (e.g. an earth compacting machine) is to be exported and used world-wide we recommend choosing a climate divisor of approx. 0.75. It will then be possible, namely, to serve a not unusual altitude of 2000 m at + 30 °C and 60 % relative humidity or, for example, 40 °C and 100 m altitude at 100 % relative humidity.
When you calculate the climate reserve, don't think only of overseas regions in Africa, South East Asia or South America but also of high-altitude areas in Europe (the Alps), hot zones in Europe and high-altitude zones in North America.

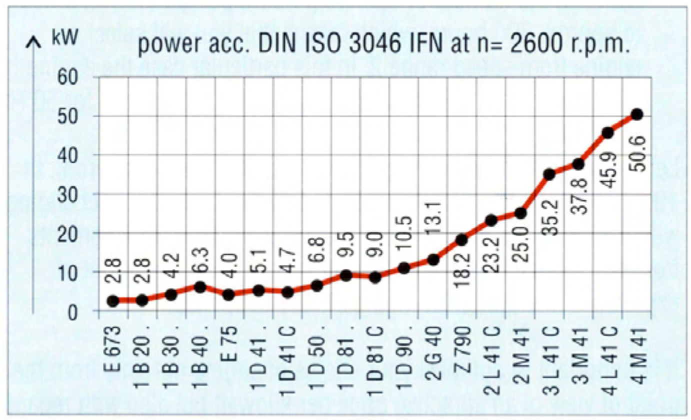
1.4 Selecting the engine type

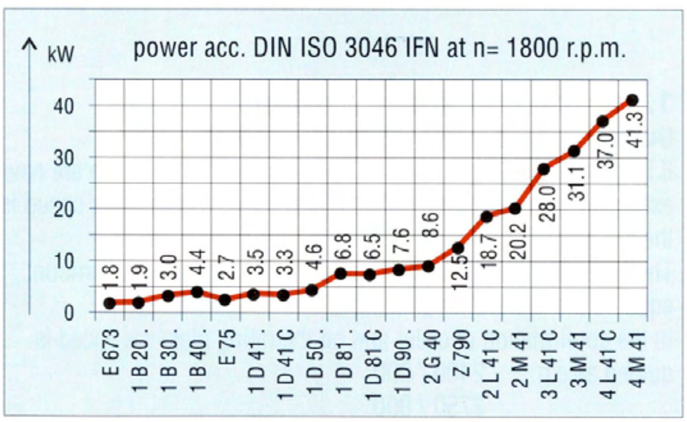
Having completed the power calculation, established the necessary engine power and determined the speed range in accordance with the considerations set out in Chapter 1.1, you can now use the following selection table to find the HATZ Diesel engine to match your application.

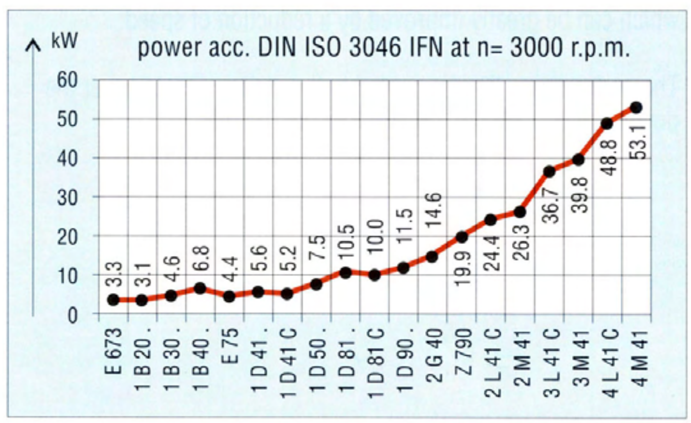
The quoted power figures are guide values. They do not represent the bottom limits but can be adjusted upward if permitted by the type of load, e.g. for welding current generators, vehicles with mechanical transmissions, etc. Similarly, lower power values may make sense for continuous duty at full load.

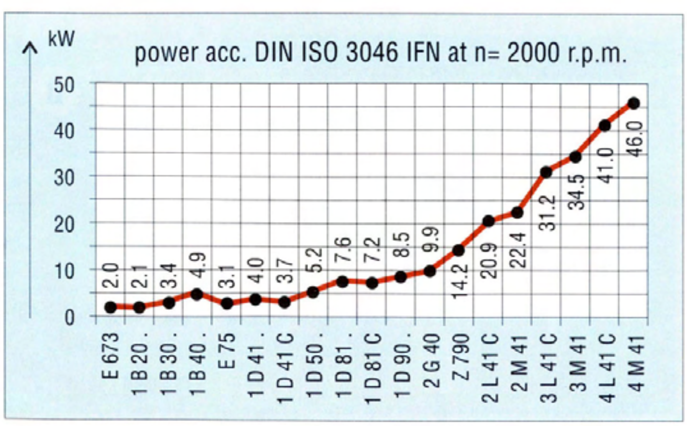


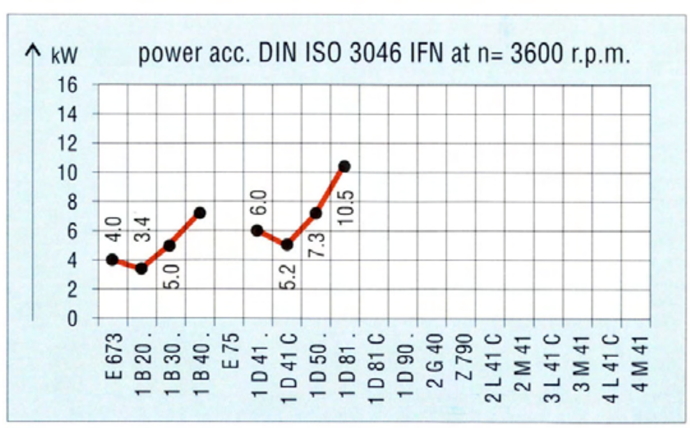












Example:

The generator from Chapter 1.3 requires 20.5 kW drive power under ohmic load.

a) If this generator is used as an island solution, i.e. if it has to supply a plant on its own without drawing on help from the public network, the number of operating hours per annum can be estimated at approx. 2000 hours and more, which means that you will select an engine from speed range 1. In the case in question the engine will probably be a 3L41C with 22.9 kW at 1500 min^{-1} for 50 Hz generators.
b) If the generator is to be used for emergency supply purposes only, i.e. the plant normally draws its power from the public network, the number of operating hours per annum will amount to approx. 300 hours, which means that you will select an engine from speed range 2. In this particular case the engine will probably be a 2L41C with 24.4 kW at 3000 r.p.m. for 50 Hz machines.

Let's recall: HATZ Diesel engines are known to be burst-proof. In 1957 HATZ was the first company to build industrial Diesel engines with a continuous duty speed of 3000 r.p.m.. New developments from HATZ have been founded, therefore, on a vast amount of experience in engines for high continuous speeds.

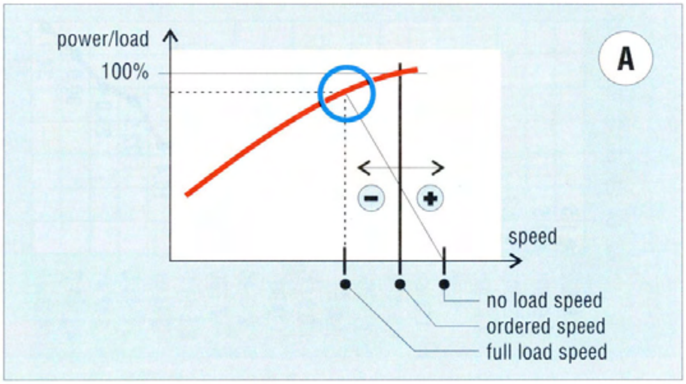
It is important to optimize your choice of engine not only from the point of view of an attractive price per kilowatt but also with regard to noise emission, vibration characteristics and service life, all of which can be greatly improved by a reduction of speed.

The performance figures quoted in the model sheets cover the power classes IFN_{si}, ICXN and F as well as IFN.

1.5 HATZ Diesel engine speed settings and speed controller precision

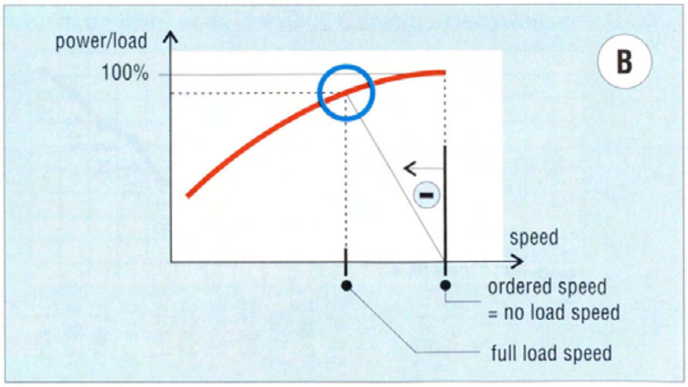
1.5.1 Normal setting

If, when ordering an engine, you stipulate no wishes apart from the speed, the speed setting will be made so that the ordered speed is reached at about half load = Figure A.
The advantage of this type of speed setting is that the speed of the engine is as close as possible to the ordered speed over the entire range between full load and zero load.
In the confirmation of order and on the rating plate the speed is quoted as e.g.: 1500 / 150
2300 / 090
3000 / 060



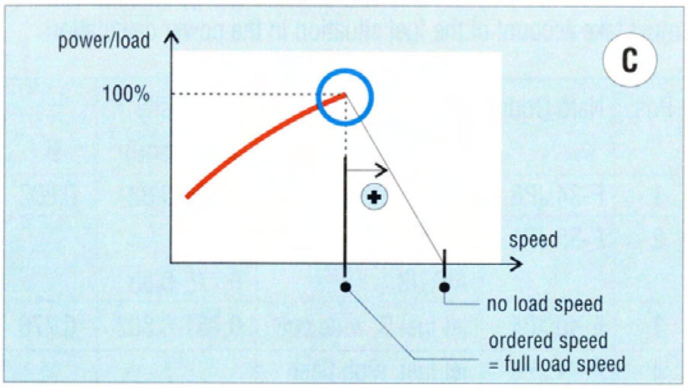
1.5.2 Top idle speed setting

Diagram B shows another speed setting option.
If it is imperative that speeds of rotation or vehicle speeds are never exceeded, you must note on the order sheet that the order speed is the top idle speed.
The full-load speed then lies below the idle speed by an amount equal to the "controller differential".
In the confirmation of order and on the rating plate the speed is quoted as e.g..: 2400 / 000
2750 / 000
3000 / 000



1.5.3 Full-load speed setting

If the ordered speed is to be equivalent to the full-load speed you must note this likewise on the order sheet. The idle speed then lies above the order speed by an amount equal to the "controller differential" = Figure C.
The top idle speed setting can make sense for generators if the generator is to run as close as possible to nominal frequency at nominal load.
In the confirmation of order and on the rating plate the speed is quoted as e.g..: 1500 / - - -
2300 / - - -
3000 / - - -



If the ordered engines are used to drive generators, controller sets which do not exceed a speed differential of approx. 5 % between zero load and full load are installed at the "generator speeds" 1500 r.p.m., 1800 r.p.m. and 3000 r.p.m.. The speed controllers for generator engines comply with the specifications laid down in DIN 6280 Part 3, design class 2, namely:

- static speed change (P-grade) δ_s 5 %
- speed swing width nn for 1- and 2-cylinder engines - 2.5 %,

  for 3- and 4-cylinder engines - 1.5 % or better.

This controller set has to be specified when ordering the engine.

For further information about the subject of speed, see the HATZ ABC of Engines, Chapter 4.

2.1 Ambient temperature
The normal temperature limits for the use of HATZ Diesel engines range from approx. - 25 °C to approx. + 45 °C (hand startingapprox. - 6 °C to approx. + 45 °C).

This does not mean, however, that HATZ Diesel engines cannot be used at lower or higher temperatures. These limits are intended as a guideline for normal applications with normal equipment.

The use of engines at below - 25 °C and above + 45 °C is an extreme requirement with repercussions which we need to discuss with you, e.g. essential starting aids, special seal materials, etc.

2.2 Maintenance
For an engine to work well and properly it must also be serviced reliably.

Maintenance is certainly a less critical factor for engines used at lower speeds, which - depending on the region where the engine is installed - is an advantage that ought to be exploited. It is also recommendable to choose a somewhat lower speed if the service support and spare parts supply are known to be below grade in the region in question.

2.3 Capacity utilization
Engines are designed and built to do work, i.e. to run continually under load. HATZ Diesel engines are designed to be operated under the loads described in Chapter 1.3.

Running an engine at zero or no notable load, on the other hand, is not a normal case of application but an extreme case. No load or an extremely low load may cause leaks at the outlet valve, rust on the nozzle holes, and other problems.

Thus we recommend operating our engines at a load of approx. 15 - 20 % and running a notable load phase prior to switching off any engine used in low-load mode.

2.4 Fuel
2.4.1 Normal fuels
All Diesel fuels which meet the following minimum requirements are suitable:
DIN 51601, BS 2869 A1/A2, ASTM D975 - 1D/2D.

Diesel fluid loses its fluidity at low temperatures. Adding petroleum (including to winter fuel) restores the fuel's filterability. Further details are to be found in the operating manual supplied with each engine.

2.4.2 Special fuels
HATZ Diesel engines can also be run with kerosene fuels. A high-pressure supply pump may be necessary, depending on the particular fuel.

The following table shows a list of such fuels. Please note that items 6, 7 and 13 are only listed for the sake of completeness and are not approved for use with HATZ engines.

With fuels other than Diesel according to DIN 51601, output is lower for the same rate of injection. This is due mainly to the difference in density but also to a different energy content. You must take account of the fuel situation in the power calculation.

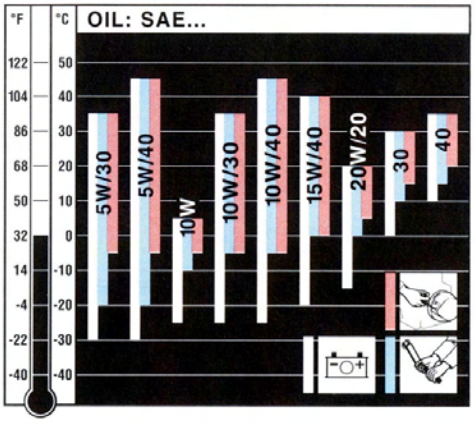
Pos.	Nato Code	Designation	Density (kg/dm³)	Ø
1	F-34:JP8	jet fuel, Kerosene	0,775-0,83	0.802
2	F-35:JP1	jet fuel A1, Kerosene AVTUR	0,775-0,83	
3	F-40:JP4	jet fuel B, wide cut*	0,751-0,802	0.776
4	F-44:JP5	jet fuel, high flash Kerosene AVCAT	0,788-0,845	0.816
5	F 45	wide cut AVTAG*	0,751-0,802	
6	F 46	regular petrol ***	0,720-0,75	
7	F 50	premium petrol ***	0,720-0,75	
8	F-54 DF-2	summer Diesel		
9	F-56 DF-A	arctic diesel		
10	F-58	petroleum	0,760-0,86	
11	F 65	mix F34 : F54 = 1:1		
12	F-75 DF-1	winter Diesel		
13	F 76	marine diesel (S)**		
14		Diesel DIN 51601	0,815-0,855	0.835

* high-pressure presupply pump necessary
** operation impeded by high sulphur content
*** spark-ignition engine fuels

2.5 Oil

Oil viscosity

The following table shows the recommended viscosities in relation to ambient temperature at cold starting, broken down by single-grade and multi-grade oil, hand starting and electric starting.



The following oil grades are approved for use in HATZ Diesel engines:

- **CCMC-D4-D5-PD2**
- **API-CD-CE-CF-CG**
- **SHPD**

If oils of the next lower classes are used

- **API -CC or CCMC-D1**

you must observe shorter oil change intervals.

Detailed information concerning lubricating oil are to be found in the operating manual supplied with each engine.

2.6 Installing the engine in a machine

An engine's generally described characteristics will be obtained if the selection of the engine, the selection of auxiliary units, and the installation of the engine are performed in accordance with our guidelines. Proper installation includes ensuring good accessibility to operating and maintenance sections and preserving the engine prior to lengthy stoppages.

2.7 Machines with a tendency to topple

If the machine topples (= operating error!) you must prevent lubricating oil getting into the intake port of the engine via the crankcase ventilator. Oil in the intake port will lead to uncontrollable combustion, overspeeding and the engine's destruction. Special crankcase ventilators may be necessary for machines with a tendency to topple. Please ask us.

Good performance characteristics do not depend on the engine alone, nor do they depend entirely on the driven machine. Rather it is a question of both components being properly in tune with each other. The following chapters contain advice on

3.1 installing engines on frames with rigid mountings

3.2 installing engines on concrete foundations if an engine is intended for stationary use

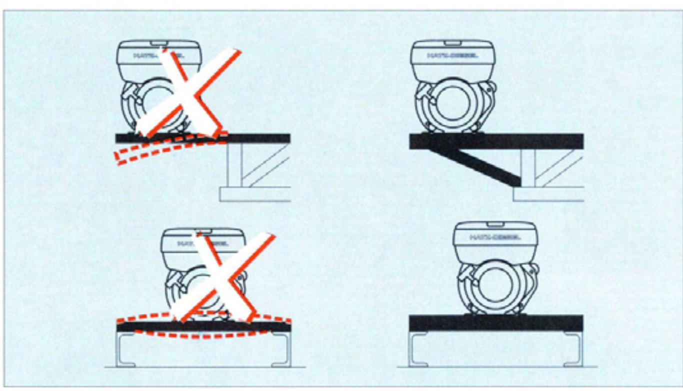
3.3 installing engines with elastic mountings.

3.1 Rigid mounting on a frame:

Rigid mountings are recommendable for an engine of only up to approx. 2300 - 2600 min^{-1}. Above 2600 min^{-1} the free inertial forces are usually so high as to make an elastic mounting the only sensible solution (exceptions prove the rule).

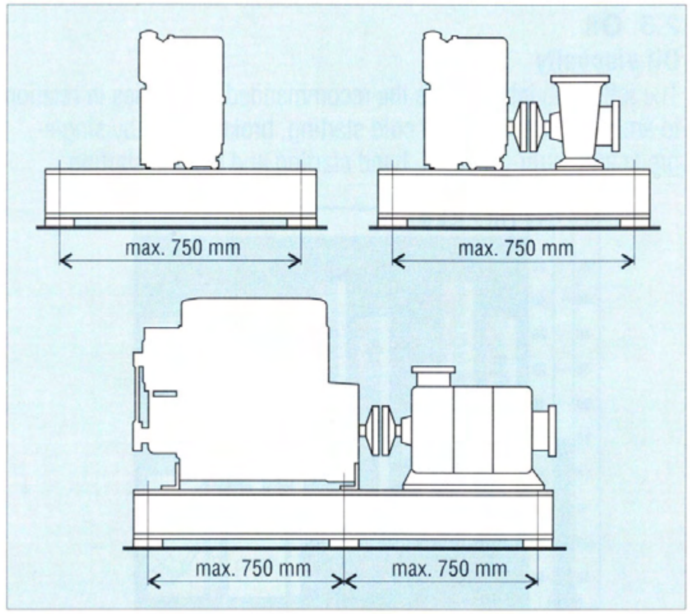
The most important preconditions for every engine mounting is that the frame or stand is rigid in itself and is designed large enough to display the necessary strength.

Non-rigid frame components act like springs and have to be braced with struts.



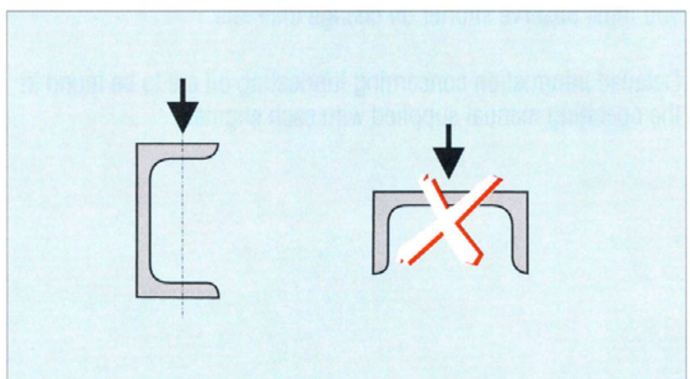
We consider frame components with the following design specifications to be adequate for a rigid engine mounting (up to n max. approx. 2300 - 2600 min^{-1}):

- frame components made of rolled U-sections in accordance with DIN 1026
  a) for 1-cylinder engines U 80
  b) for 2-cylinder engines U 100
  c) for 3- and 4-cylinder engines U 120
- these frame components have to be kept as short as possible to prevent them acting as springs.
  We recommend a max. permissible length of 750 mm.



If, for structural reasons (e.g. a 4-cylinder engine with a multi-stage pump), the frame components are longer than 750 millimetres, then it is necessary for these long frame components to be bolted down again after a distance of max. 750 mm.

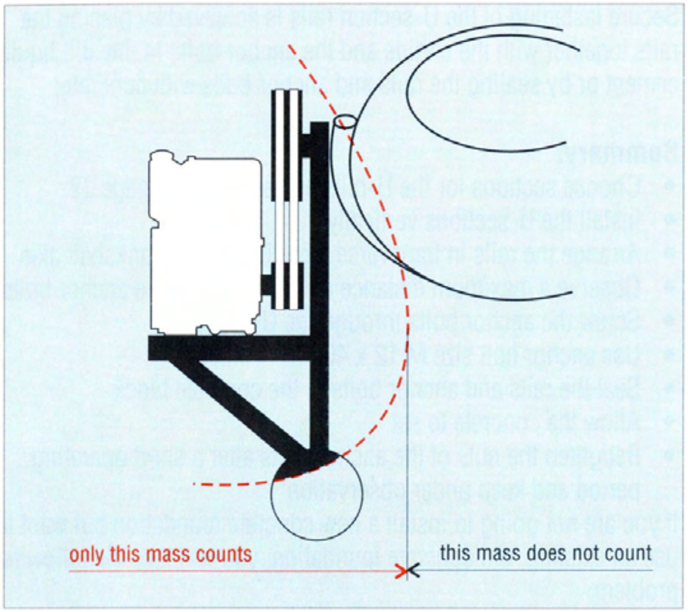
- The dimension recommended above for rolled U-sections applies only when the U-section is installed vertically - only then does it display the necessary rigidity.



A further precondition for a rigid engine mounting is a sufficiently large machine mass / frame mass (in kg), at best directly underneath but at least in the vicinity of the engine.

- For engine speeds from 1500 to 2000 min^{-1} the frame mass should be approximately as heavy as the motor mass (in kg) itself
- And for speeds from 2000 to 2600 min^{-1} the frame mass should be approximately twice as heavy as the motor mass.

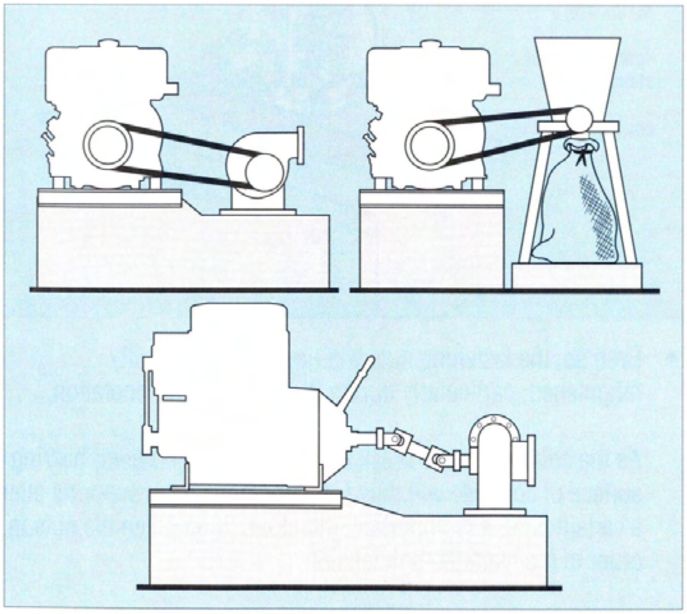
What counts in this connection is only the frame / machine mass in the direct vicinity of the engine and not, for example, any remote lying masses.



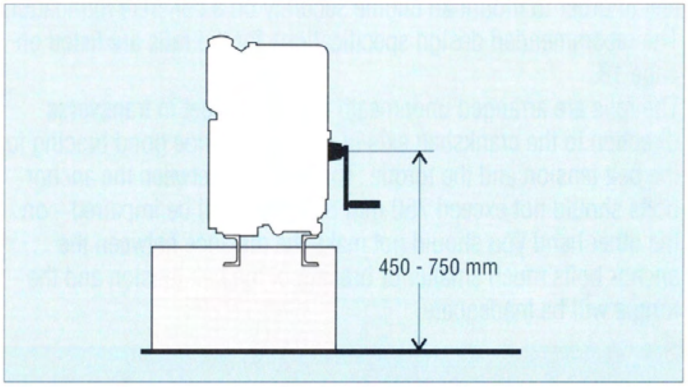
Only sufficiently large masses in the direct vicinity of the engine are able to prevent severe vibrations and possible material fractures.

3.2 Rigid engine mounting on a foundation Speed recommendation:

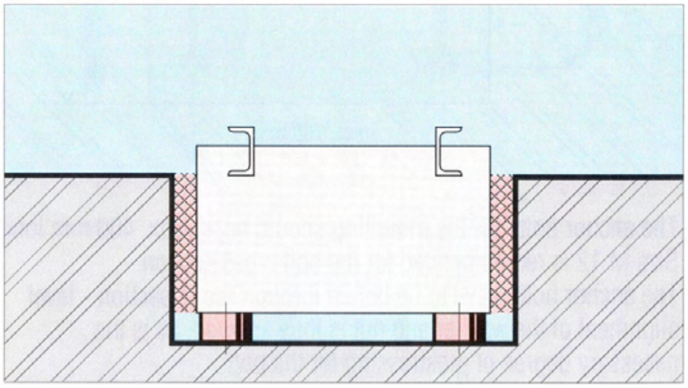
Up to 2300 min^{-1} maximum, but better below.
Engines for stationary use are mounted on a concrete foundation. The machine, e.g. a pump or mill, is driven by flexible drive elements, e.g. belts or articulated shafts.



The height of the concrete foundation above ground level should be such that the pivot for the starting crank lies at a height of between 450 and 750 mm. Higher foundations are to be avoided wherever possible.



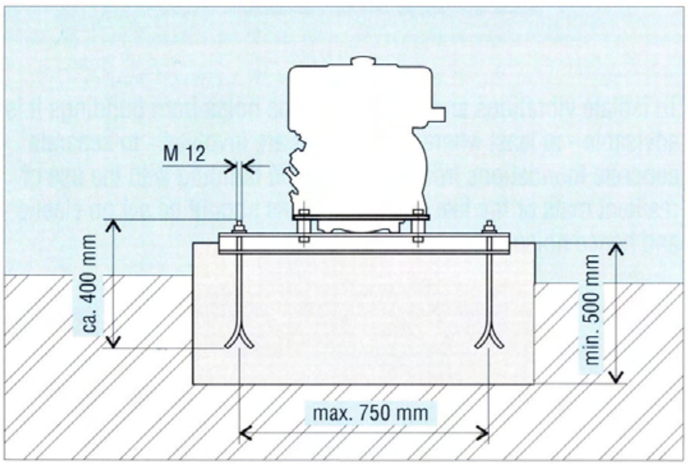
To isolate vibrations and structure-borne noise from buildings it is advisable - at least where high speeds are involved - to separate concrete foundations from the rest of the building with the use of resilient mats or the like, the foundations should be set on elastic and hence noise-insulated bearings.



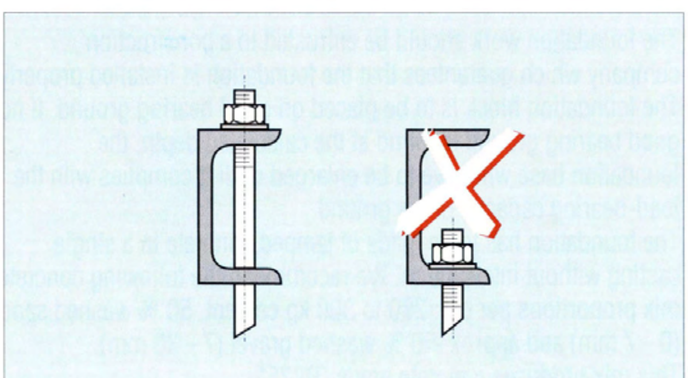
The foundation work should be entrusted to a construction company which guarantees that the foundation is installed properly. The foundation block is to be placed on good bearing ground. If no good bearing ground is found at the calculated depth, the foundation base will have to be enlarged until it complies with the load-bearing capacity of the ground.
The foundation has to be made of tamped concrete in a single casting without interruption. We recommend the following concrete mix proportions per m^3 : 270 to 300 kg cement, 50 % washed sand (0 - 7 mm) and approx. 50 % washed gravel (7 - 30 mm).
This mix produces concrete grade "B225".
The formwork for the anchor holes has to be loosened and removed in good time. Then the engine (suspended from the stand) is moved into the correct position and aligned.
When the alignment is completed, the anchor holes have to be filled with liquid cement mortar (1 part cement - 2 parts sand).

3.0 Installing and mounting the engine

Important: The engine must not be used and the belt must not be tensioned until the concrete has hardened completely (7 - 10 days, according to the temperature.
Rails (rolled U-sections) have to be used underneath the engine feet in order to mount an engine securely on a concrete foundation! The recommended design specifications for the rails are listed on page 18.
The rails are arranged underneath the engine feet in transverse direction to the crankshaft axis in order to provide good bracing for the belt tension and the torque. The distance between the anchor bolts should not exceed 750 mm or rigidity will be impaired - on the other hand you should not make the distance between the anchor bolts much smaller or bracing of the belt tension and the torque will be inadequate.



The anchor bolts for the mounting should be approx. 400 mm long. Size M 12 is recommended for the bolt cross section.
The anchor bolts have to be bolted through the U-section - level alignment of the washer and nut is thus assured, as is the necessary degree of prestressing for the bolt.



The anchor bolts have to be sealed in the concrete block - other fastening methods (e.g. plugs) have not proven successful.

Secure fastening of the U-section rails is achieved by placing the rails together with the engine and the anchor bolts in the still liquid cement or by sealing the rails and anchor bolts with concrete.

Summary:

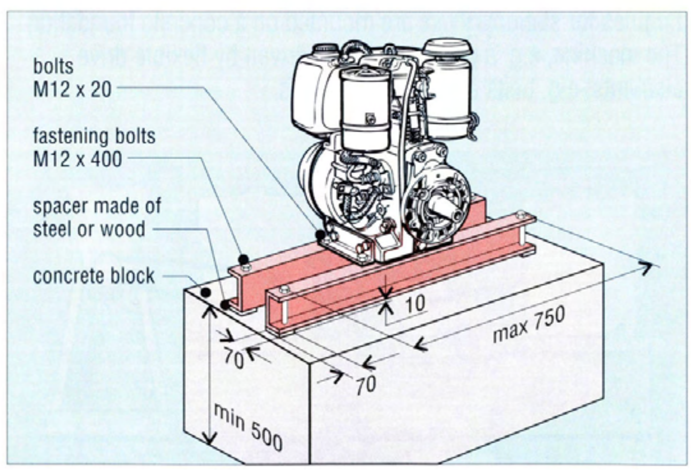
- Choose sections for the U-rails as described on page 12
- Install the U-sections vertically
- Arrange the rails in transverse direction to the crankshaft axis
- Observe a maximum distance of 750 mm between anchor bolts
- Screw the anchor bolts through the U-section
- Use anchor bolt size M 12 x 400
- Seal the rails and anchor bolts in the concrete block
- Allow the concrete to set
- Retighten the nuts of the anchor bolts after a short operating period and keep under observation

If you are not going to install a new concrete foundation but want to use an existing, old concrete foundation, you will face the following problem:
The peaks of the concrete surface underneath the steel rails will break away, causing each bolted connection to lose the tension essential for a secure hold!

- and minutes later the anchor bolt will break!

We recommend the following procedures, therefore, on existing concrete foundations:

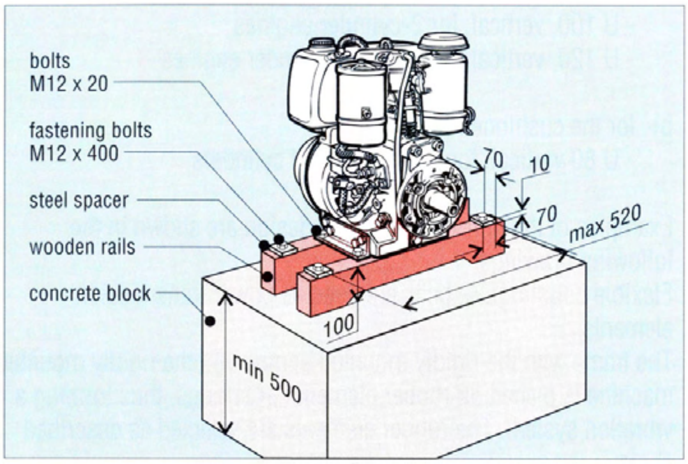
- do not allow the steel rails to lie full-length on the concrete foundation. Instead use steel supports (approx. 70 x 70 x 10 mm) or hardwood supports underneath the fastening points (see drawing).



- Even so, the fastening nuts will have to be frequently retightened, particularly during the first hours of operation.

  As the concrete peaks break away, so a level and good bearing surface of concrete will thus form underneath the supports after a certain time. It is important, therefore, to retighten the nuts in order to maintain the bolt tension.

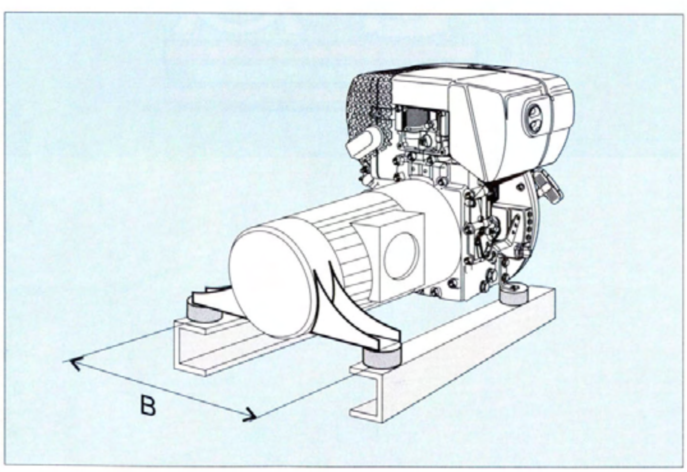
- Alternatively you can use rails made of hardwood with the dimensions and form shown in the following drawing. Wood adapts well to the uneven and rough concrete surface, and the concrete peaks dig into the wood. It is still necessary, however, to keep the bolted connections under constant observation and to retighten the bolts as necessary. Steel supports are used on top of the wooden rails in order to stop the nuts sinking too far into the timber.



3.3 Elastic mountings:

If higher engine speeds (above 2300 min^{-1}) are required, a rigid mounting is no longer recommendable. In such cases the engine needs an elastic mounting.
And because there is practically no transmission of structure-borne noise when using rubber as a mounting element, it may also be an advantage to choose an elastic mounting for noise reasons.

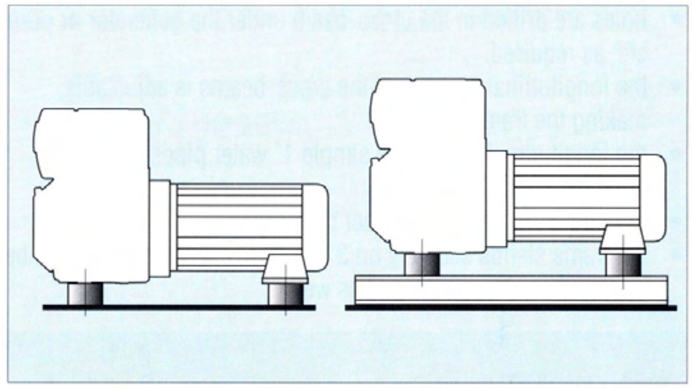
For elastic mounting in general it can be said that the mounting base B has to be as wide as possible because this helps to reduce the amplitudes of vibration and hence the forces at play.



Depending on the machine type a distinction has to be drawn between a) an elastic mounting for flanged units, and b) an elastic mounting for non-flanged units.

a) Elastic mounting for flanged units:

The engine is flanged to the driven machine; hence together with the elastic mounting it represents one vibration system. If there is a suitable base it will not even be necessary to provide a frame because the engine already forms a rigid frame with the flanged machine.



Rubber elements manufactured to the customer's specifications are available on request of course. Please let us know the engine speed, the mass to be cushioned, the position of the centre of gravity, the number of mounting elements required, and the frame weight.

We consider a U 80 section (vertical) to be big enough for the frame components of a flanged unit with elastic mounting since the flanged unit is rigid in itself and the units are cushioned by the rubber buffer. In the case of elastic mounting for flanged machines with 1-cylinder engines, please note:

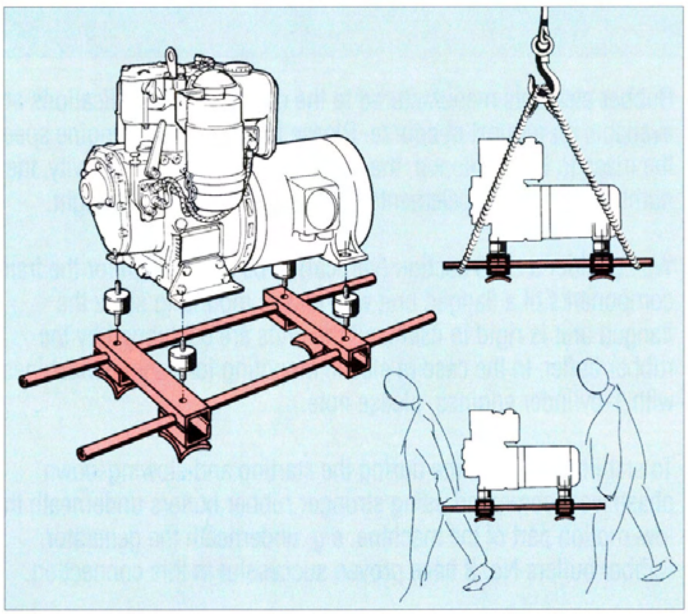
To stabilize the machine during the starting and slowing-down phase we recommend using stronger rubber buffers underneath the low-motion part of the machine, e.g. underneath the generator. Rubber buffers No. 8 have proven successful in this connection.

The HATZ universal frame

A frame under a flanged unit is usually there for transport purposes.

The HATZ universal frame is a practical solution for all flanged and mobile units with single-cylinder engines. The advantages of this universal frame are:

- the frame can be used for all electrical units, pump sets, hydraulic units, etc.
- the engine cross-beam has fixing holes for all HATZ single-cylinder engines.
- holes are drilled in the cross-beam under the generator or pump etc. as required.
- the longitudinal spacing of the cross-beams is adjustable, making the frame universal
- the longitudinal beams are simple 1" water pipes and can be supplied by the user.
- the unit is mounted on rubber buffers.
- the frame stands securely on 3 brackets, enabling the unit to be operated on uneven ground as well.

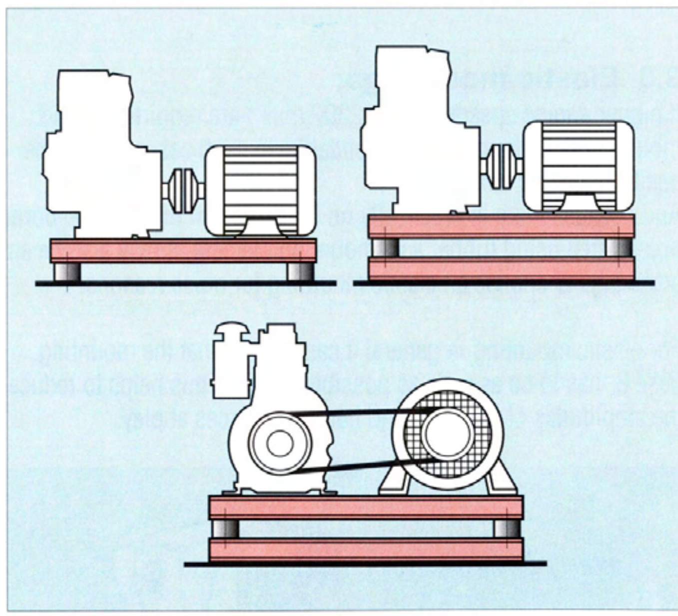


b) Elastic mountings for non-flanged units:
In place of the adapter housing on flanged units we now have a frame on which the engine and the driven machine can be rigidly bolted.
We recommend the following frame specifications for non-flanged units:

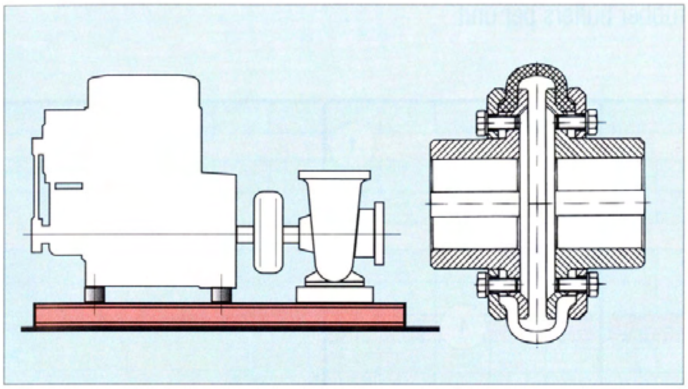
a) for the upper frame on which the engine is mounted
   - U 80, vertical, for 1-cylinder engines
   - U 100, vertical, for 2-cylinder engines
   - U 120, vertical, for 3- and 4-cylinder engines

b) for the cushioned lower frame:
   - U 80 vertical, for all numbers of cylinders.

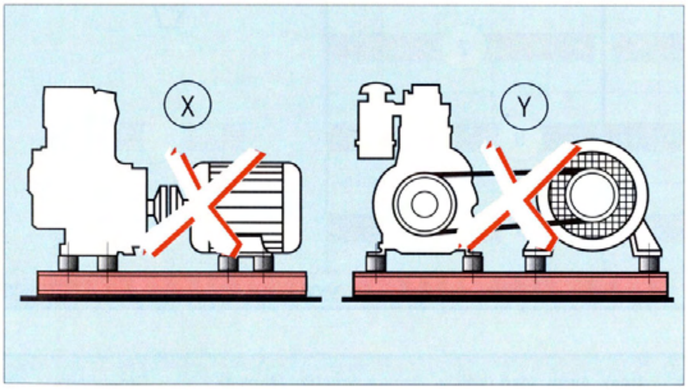
Examples of the non-flanged, open design are shown in the following drawings.
Flexible couplings or belts are used as power transmission elements.
The frame with the rigidly mounted engine and the rigidly mounted machine is placed on rubber elements or springs, thus forming a vibration system. The rubber elements are selected as described above.



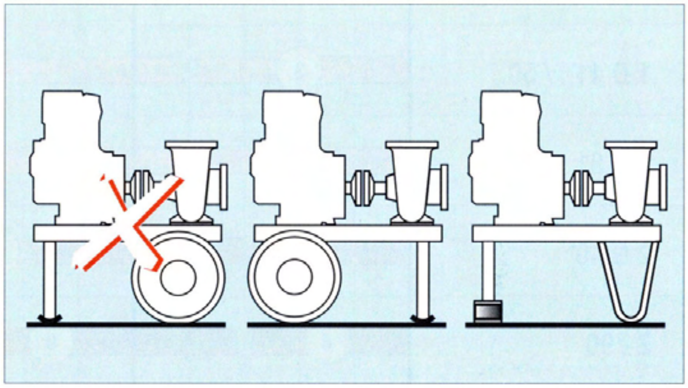
SPECIAL CASE:



At speeds above 2300 min-1 the engine requires an elastic mounting. The open, non-flanged design means that a HIGH-FLEXIBILITY coupling has to be used as shaft connection between the engine on the elastic bearing and the rigidly mounted pump. Example: a STROMAG PN 16 coupling.
The solutions shown in the drawings "X" and "Y" are not acceptable because the engine moves in a different way than the driven machine, a fact that would damage the flexible coupling or the belt.

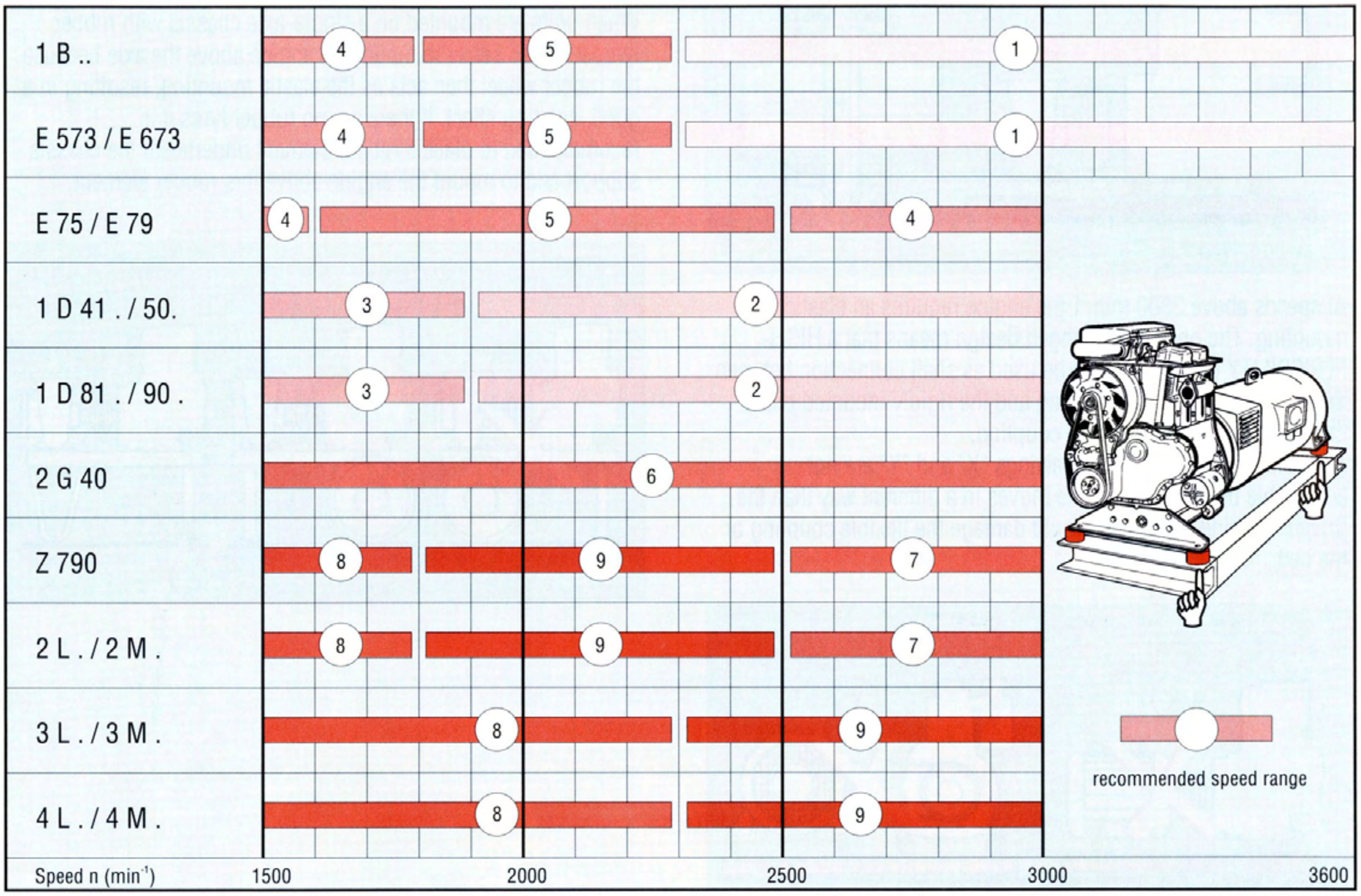


On engines with elastic mountings the pipe connections for fuel, exhaust and waste air have to be designed to absorb any vibrations, i.e. they have to be elastic.
When units are mounted on a single-axle chassis with rubber tyres it makes sense to mount the engine above the axle because the rubber wheel then acts as the elastic mounting, resulting in a good isolating effect. If there are no rubber tyres it is recommended to place a rubber element underneath the chassis support and to mount the engine above this rubber element.

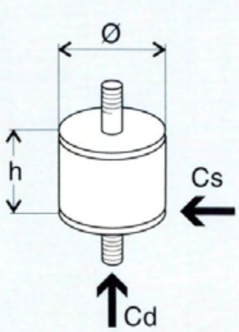


Recommendation for cylindrical rubber buffers

as elastic mountings for stationary units in vertical arrangement, using 4 rubber buffers per unit.



Cylindrical rubber buffer



Dimension	Ø (mm)	h (mm)	Hardness (Shore A)	max. perm. load (kg) per buffer static	Spring constant (N/mm) Pressure = Cd	Spring constant (N/mm) Thrust = Cs	Order code for 4 units
1	40	40	40	60	77	11.5	56 Y 06 A
2	50	45	40	100	118	23	014 311 01
3	50	45	55	100	214	40	014 312 01
4	50	45	40	100	118	19	56 Y 06 B
5	50	45	55	100	208	36	56 Y 06 C
6 *	88	32 / 91	45	75	120	96	011 414 00
7	70	45	40	190	260	43	64 X 06 A
8	70	45	55	190	450	80	64 X 06 B
9	70	45	65	190	660	120	64 X 06 C

On **mobile machines** the rubber buffers have to be secured against transverse forces. Special designs, e.g. cup-type element No. 008 312 00 for engines L and M, are available from the manufacturers of rubber buffers for this purpose.
* = Hydraulic bearing

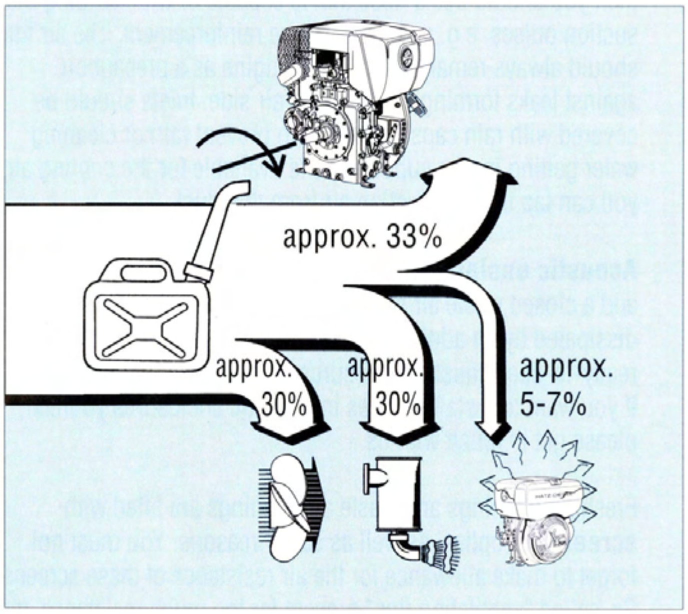
HATZ DIESEL

It is essential:

- for the engine to receive **fresh combustion air** and **fresh cooling air.**
- for the heated **waste cooling air** to be able to escape outdoors without being drawn in again through the air filter or cooling fan.
- for the **radiant heat** to be dissipated.

Energy is fed to the engine in the form of fuel. The energy balance is as follows:

- approx. 1/3 is available at the shaft for useful work.
- approx. 30 % is in the exhaust gas.
- approx. 30 % is in the cooling air.
- the rest (approx. 5 - 7 %) is radiated from the engine surface.



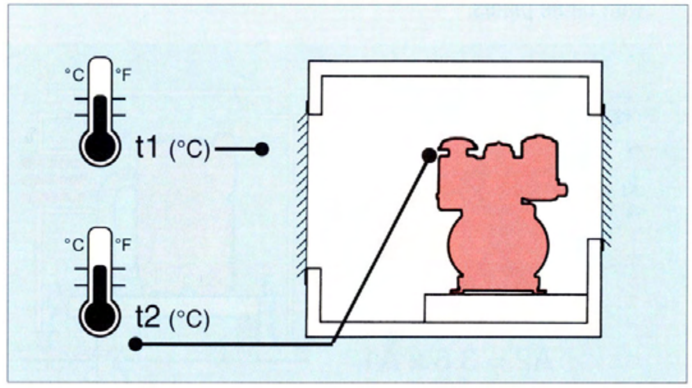
As is clear from this **energy balance**, the greatest attention has to be paid to the large quantities of energy in the **cooling air, in the exhaust gas and in the radiation** when an engine is installed under an enclosure. As a rule the radiation component increases to about 15 % of the energy input because the exhaust gas does not leave the enclosure by the most direct route, i.e. a considerable amount of heat is radiated by the exhaust pipe.

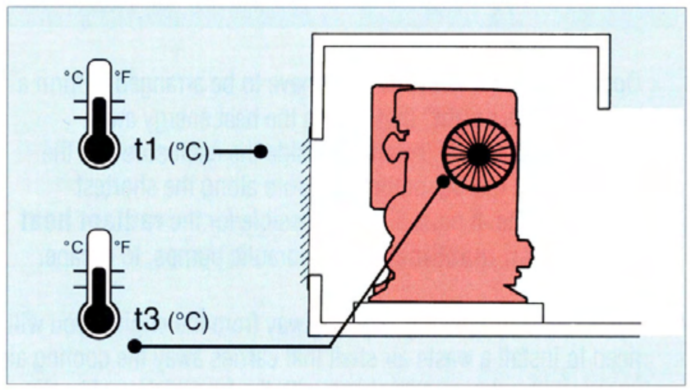
Whenever an engine is **installed under an enclosure** it is important to measure the temperature outside the enclosure and the operating temperature in front of the air filter and in front of the cooling fan inlet.

The temperature difference at the measuring points t2 - t1 and t3 - t1 is a yardstick for the quality of the engine's installation.

If the temperature measurement indicates a rise in temperature, this will be because either the radiant heat is not being dissipated efficiently enough and / or there is short-circuiting of the heated cooling air to the cooling supply air.

A **temperature difference of no more than 8 to 10 °C** is only acceptable if allowance was made for this higher temperature level in the **power calculation** (see Chapter 1.3) or if a forced ventilation system with an additional fan stops the temperature from rising.

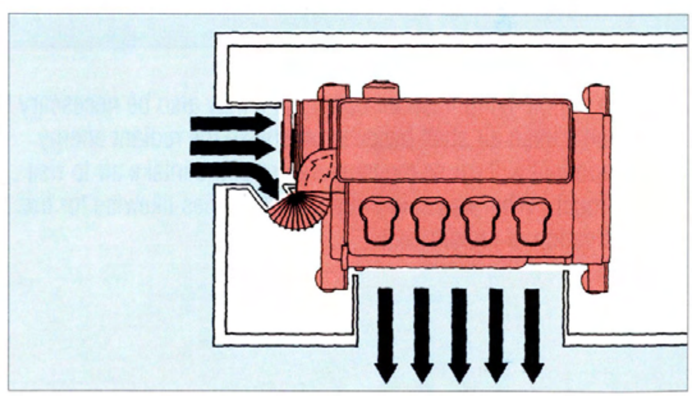




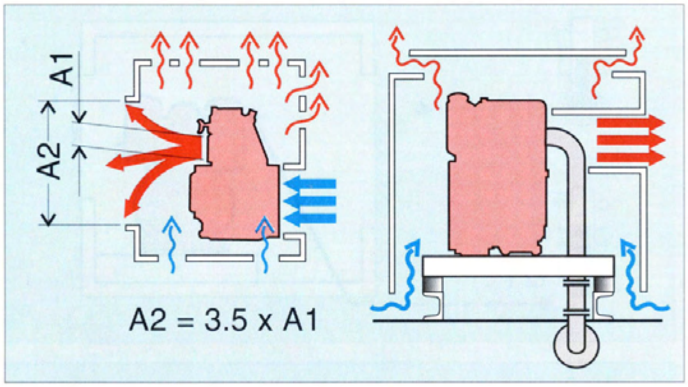
The temperature limits normally in force are invalidated of course by a temperature increase. For example, if the temperature difference between the outside air and the intake air rises by 8 to 10 °C, then it is no longer permitted to operate the engine at ambient temperatures of up to + 45 °C but only to approx. 35 - 40 °C. Hence the engine should be installed in such a way as to enable only a slight temperature increase if at all.

Our proposals in this connection:

1. Place **the combustion air hole and the cooling air intake** hole as close as possible to a large opening in the enclosure.

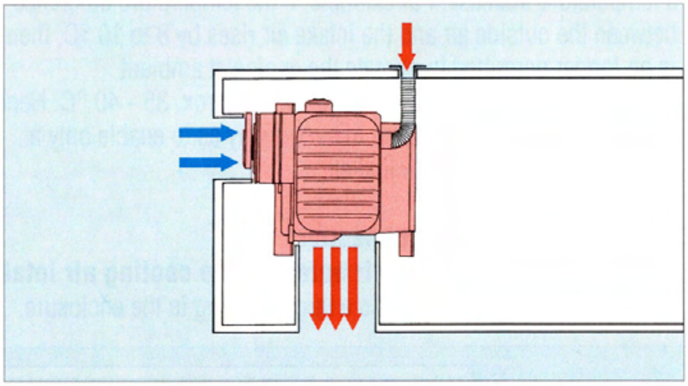


The heated waste cooling air has to be free to flow away along the shortest possible routes over a very large open area. The opening in the enclosure should be approx. three to five times larger in area than the discharge area at the cylinders and cylinder heads. The opening in the enclosure should be fitted with baffle plates.

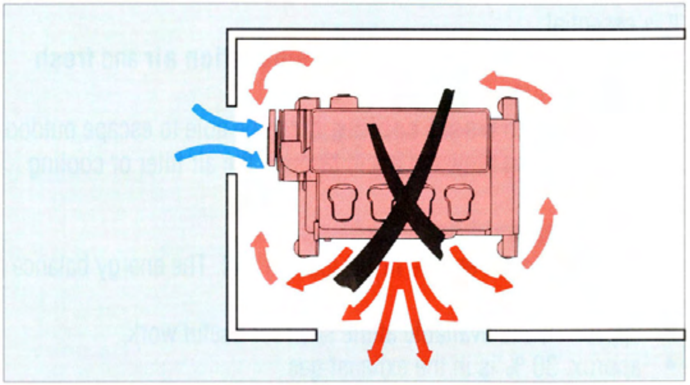


Openings for the **radiant heat** have to be arranged to form a **"chimney draught"** that carries the heat energy away. Silencers should be installed outside the enclosure and the exhaust pipe run out of the enclosure along the shortest possible route. It must also be possible for the **radiant heat from driven machines**, e.g. hydraulic pumps, to escape.

2. If the waste air opening is a long way from the engine, you will need to install a waste air shaft that carries away the cooling air energy without any intermixing with the free intakes of cooling air and combustion air.



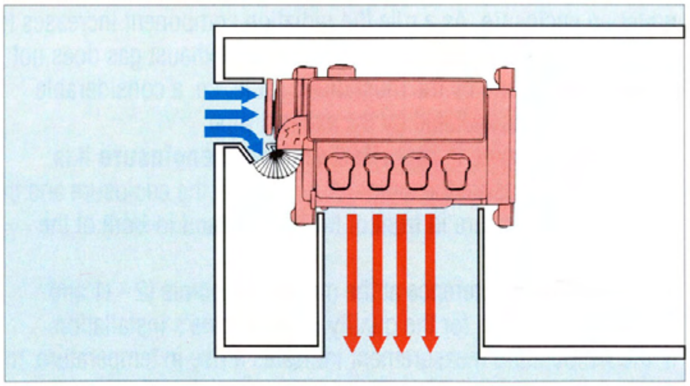
With remote lying fresh air openings it may also be necessary to install a fresh air shaft because otherwise the radiant energy component will cause the temperature of the intake air to rise too much. What was said in Section 1 applies likewise for the dissipation of radiant heat.



If you have to **install fresh air pipes** in front of the air filter, then you should use a hose that is capable of withstanding the suction pulses, e.g. a hose with wire reinforcement. The air filter should always remain fitted to the engine as a precaution against leaks forming on the clean air side. Inlets should be covered with rain caps or the like to prevent rain or cleaning water getting in. If a supply pipe is available for the cooling air, you can tap the combustion air from this duct.

Acoustic enclosures always require a closed fresh air system and a closed waste air system, and the radiant heat has to be dissipated by an additional fan. HATZ **"Silent Packs"** are ready-to-use acoustic enclosures for engines.
If you want to install engines in acoustic enclosures yourself, please get in touch with us.

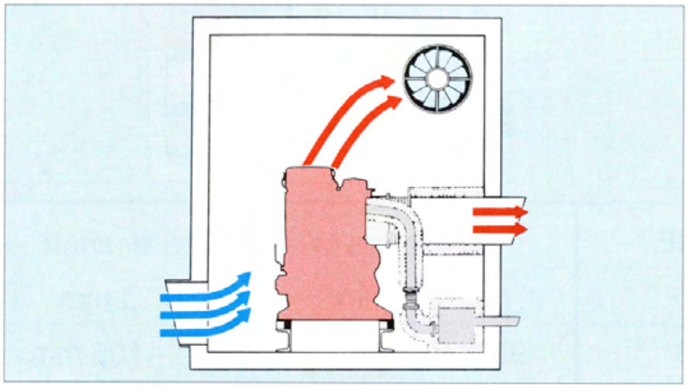
Fresh air openings and waste air openings are fitted with **screens** for optical as well as safety reasons. You must not forget to make allowance for the air resistance of these screens. So-called "ventilation fins" present far too much resistance and are totally unsuitable. While perforated plates are equally inadequate, wire mesh has proven quite successful.



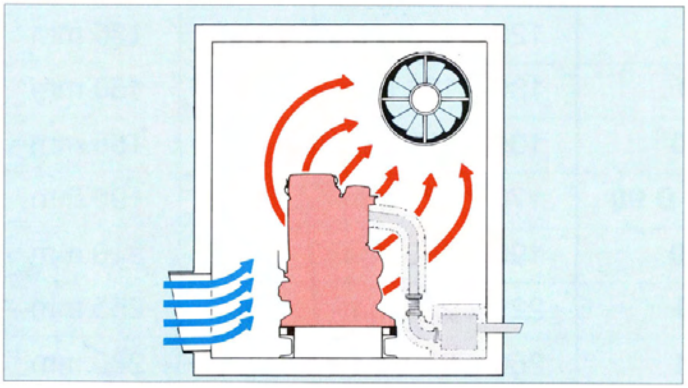
The surface of a room's walls is unable to dissipate to the waste heat from an engine and a driven machine. It is essential, therefore, to equip the room with a ventilator to remove this heat.

Two systems have proven successful:

1. A relatively **small ventilator** for removing the engine's radiant heat and for removing the driven machine's waste heat. The heated waste air from the engine is collected in a waste air shaft and conveyed by the shortest possible, heat-insulated route to the outside.



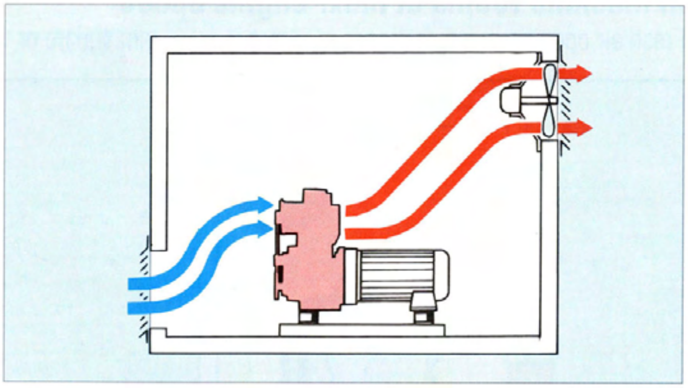
2. A **large ventilator** which not only removes the engine's radiant heat and the driven machine's waste heat but also conveys the engine's heated waste air outdoors.



3. In all cases the arrangement of fresh air and waste air openings should be selected to create a **diagonal air flow through the room**, thus enabling sufficient heat to be removed from the surfaces of the machine system.

   This means that the fresh air opening should always be positioned near the floor and, as far as possible, the opening for the waste air ventilator diagonally opposite and directly underneath the ceiling.

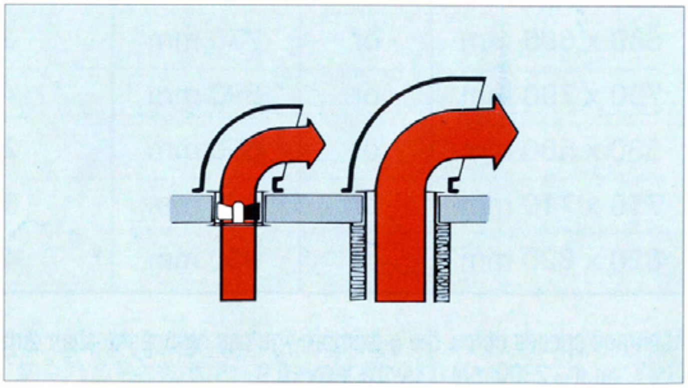
The **exhaust pipe** is laid to the outside along the shortest possible, **heat-insulated** route.



Specifications for room ventilators, fresh air supply cross sections, exhaust pipes and waste air shafts are considered in detail in the HATZ ABC of Engines, Chapter 1. The values quoted there are based on a temperature increase of + 10 oC in the machine room compared with the outside temperature. This **temperature increase has to be taken into account in the power calculation.**

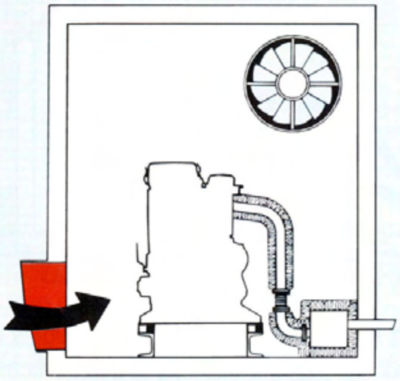
Fresh air openings and waste air openings are fitted with screens for optical as well as safety reasons. You must not forget to make allowance for the air resistance of these screens. So-called "ventilation fins" present far too much resistance and are totally unsuitable. While perforated plates are equally inadequate, expanded metal has proven quite successful.

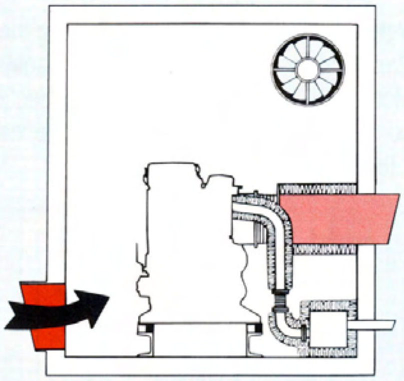
You must always install the blow-out openings for waste air shafts and waste air ventilators on that side of the building facing away from the normal wind direction (the leeward side). If wind blows against these openings, the air current will be obstructed and the temperature inside the machine room will rise to an unacceptable level. Where the openings are exposed to wind you will need to install large air baffles.



Recommended values for the minimum free cross section of fresh air openings in machine rooms at max. engine speed

Fresh air opening cross section: . . . . . mm x . . . . . mm square or . . . . . mm diameter.





for motors ***WITHOUT*** waste air shaft			**ENGINE**	for motors ***WITH*** waste air shaft		
... mm x ... mm		Ø mm		... mm x ... mm		Ø mm
200 x 200 mm	or	225 mm	**E 673**	90 x 90 mm	or	105 mm
205 x 205 mm	or	230 mm	**1 B 20 .**	90 x 90 mm	or	105 mm
240 x 240 mm	or	270 mm	**E 75**	105 x 105 mm	or	120 mm
250 x 250 mm	or	280 mm	**1 B 30 .**	110 x 110 mm	or	125 mm
265 x 265 mm	or	300 mm	**1 D 41 .**	120 x 120 mm	or	135 mm
300 x 300 mm	or	340 mm	**1 B 40 .**	130 x 130 mm	or	150 mm
310 x 310 mm	or	350 mm	**1 D 50**	135 x 135 mm	or	155 mm
380 x 380 mm	or	430 mm	**1 D 81 . / 1 D 90 .**	170 x 170 mm	or	190 mm
430 x 430 mm	or	490 mm	**2 G 40**	190 x 190 mm	or	210 mm
500 x 500 mm	or	570 mm	**Z 790**	225 x 225 mm	or	255 mm
560 x 560 mm	or	630 mm	**2 L 41**	250 x 250 mm	or	280 mm
680 x 680 mm	or	770 mm	**3 L 41**	310 x 310 mm	or	350 mm
790 x 790 mm	or	890 mm	**4 L 41**	355 x 355 mm	or	400 mm
580 x 580 mm	or	650 mm	**2 M 41**	260 x 260 mm	or	295 mm
710 x 710 mm	or	800 mm	**3 M 41**	320 x 320 mm	or	360 mm
820 x 820 mm	or	930 mm	**4 M 41**	365 x 365 mm	or	410 mm

At engine speeds below the maximum you can reduce the shaft dimensions, namely:

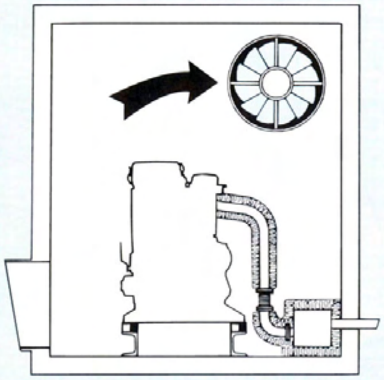
at n = 2300 min-1 by the factor 0.9

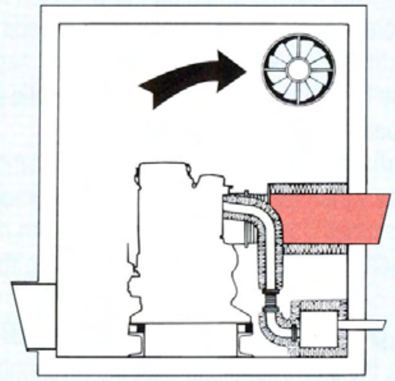
at n = 1500 min-1 by the factor 0.8

If screens are used in the fresh air shaft the area has to be increased by approx. 1/4.

Recommended values for the minimum delivery rate required of waste air ventilators in m³ / hour

Assumptions: Efficiency of the driven machines approx. 80 %. Temperature increase compared with outside air 10 °C
Exhaust pipe and waste air shaft with heat insulation





for motors ***WITHOUT*** waste air shaft at an engine speed of ... min^{-1}				**Engine**	for motors ***WITH*** waste air shaft at an engine speed of ... min^{-1}			
1500	**1800**	**2300**	**max**		**1500**	**1800**	**2300**	**max**
600	830	1160	1530	**E 673**	290	410	565	750
695	880	1200	1575	**1 B 20 .**	340	430	590	770
1020	1250	1440	2040	**E 75**	500	610	700	995
1065	1340	1575	2270	**1 B 30 .**	520	660	770	1110
1300	1620	2130	2590	**1 D 41 .**	630	790	1040	1270
1660	2080	2700	3380	**1 B 40 .**	810	1010	1320	1650
1710	2130	2780	3470	**1 D 50**	840	1040	1360	1695
2550	3150	3520	4860	**1 D 81 .**	1240	1540	1720	2370
2780	3430	3845	5330	**1 D 90 .**	1360	1670	1880	2600
3150	3980	5370	6760	**2 G 40**	1540	1940	2620	3300
4400	5790	6580	9265	**Z 790**	2150	2830	3210	4520
6950	8660	10890	11300	**2 L 41**	3390	4230	5310	5520
10610	12970	16630	17000	**3 L 41**	5180	6330	8115	8300
13900	17140	21770	22610	**4 L 41**	6780	8360	10620	11030
7600	9360	11770	12180	**2 M 41**	3710	4570	5740	5945
11580	14410	18020	18440	**3 M 41**	5650	7030	8790	9000
15750	19130	24090	24600	**4 M 41**	7690	9340	11750	12000

The ventilator delivery rates quoted here have to be achieved after allowing for the air resistance presented by windows, frames, shafts, etc.! These resistance values normally add up to a total back-pressure of approx. 12 mm water column.

Recommended values for ventilator dimensions (approx.):

Delivery rate w/o back-pressure	Diameter	Power consumption
3 000 m³ / h	300 mm	0.2 kW
5 000 m³ / h	400 mm	0.4 kW
10 000 m³ / h	500 mm	1.0 kW
18 000 m³ / h	600 mm	2.5 kW

At a back-pressure of e.g. 12 mm water column, the delivery rate decreases by approx. 30 %.

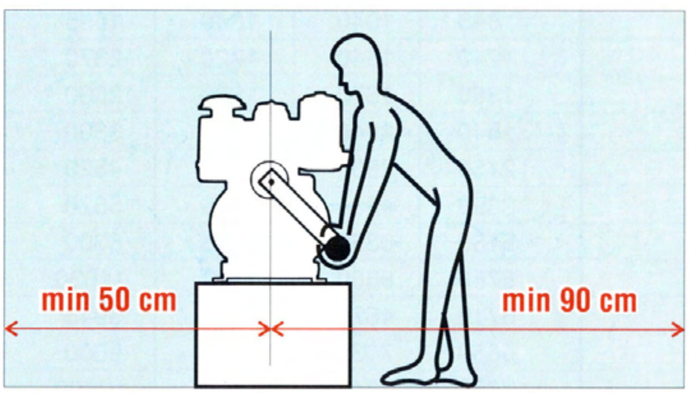
6.1 The hand-started engine

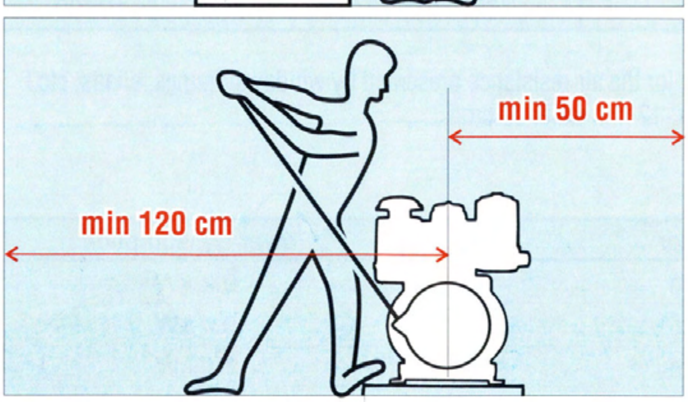
HATZ Diesel engines fulfil all the conditions for safe and effortless starting, e.g. easy-starting combustion processes. For hand starting there is the additional advantage of automatic decompression (not always a standard feature) and high transmission from the drive shaft to the crank shaft for high crank shaft speeds and hence easy starts. A starting crank with kick-back damping has been specially developed by HATZ for engines with crank handle starting covered by the European Machine Guideline.
For cold starting the engines are equipped as standard with a start charge device which feeds extra fuel into the combustion chamber at the right moment for the starting operation. An oil dosing device is also included to increase compression during the cold start.

6.2 The person at the crank handle

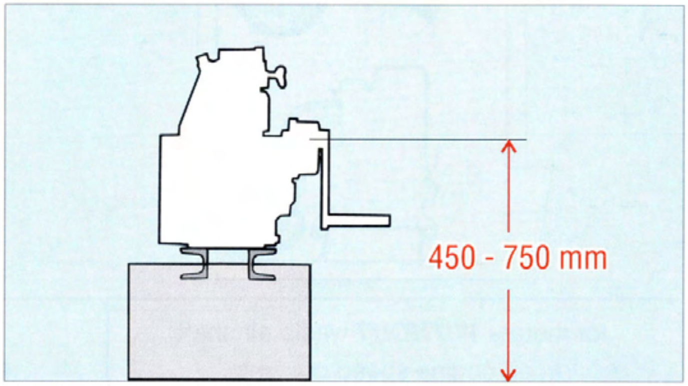
Starting with the crank handle or with the reversing starter means that the start is performed by a person. Now that the engine fulfils all the requirements for an easy start it is necessary to create the right conditions at the machine for enabling the engine to be started with the limited strength of human being. Please note the following recommendations in this connection:

- There has to be sufficient space for the operator to perform the various movements required during the starting operation. It is not enough to consider what movements the hands make - you have to allow for all movements from head to toe.

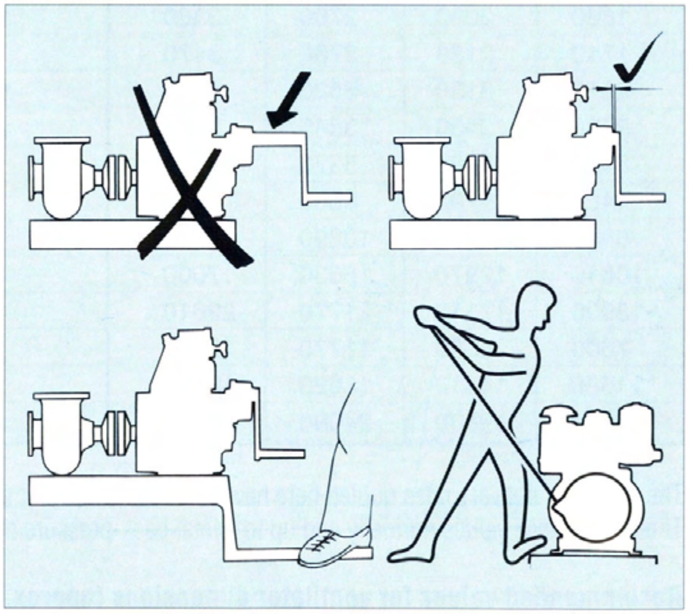




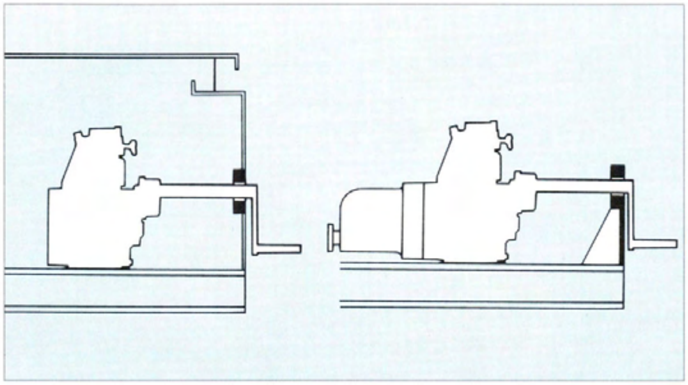
- The optimum height of the crank pivot is approximately 450 to 750 mm. The larger the engine capacity, the more important it is to observe this recommended height.
  A crank pivot below this height or higher than 1 m makes conditions for the operator extremely difficult. A platform has to be provided for pivot heights of over 1 m.



- Particularly light machines, machines with very soft elastic mounts and machines with little inherent stability (e.g. single-axle machines) need a foot rest for safe starting. The foot rest ensures that the machine does not lift or slip sideways out of position when overcoming the compressor point.



- For safety reasons starting cranks need a good guide and long starting cranks need an additional support. You should always select the shortest possible crank because then the leverage on the crank guide remains low (caution: increased friction).



European standard DIN-EN 500-1 (governing mobile road construction machines) imposes particularly high safety standards for crank handle starting and describes safety criteria for hand crank starts. EN 500 is also part of the European Machine Guidelines 89/392 EEC. For machines with hand crank starting subject to the European Machine Guideline HATZ can supply its starting crank with KICK-BACK DAMPING feature.

6.3 Disconnecting starting resistances

Driven machines and equipment with a high level of friction power or high starting torque have to be disconnected by an engaging and disengaging coupling (clutch) during the starting operation.

- An exception to using a clutch is possible only for driven machines which display low resistance to rotation, e.g. generators, fans, small concrete mixers and centrifugal pumps (but not deep-well pumps)
- All other machines with a high resistance to rotation, e.g. piston pumps, piston compressors and deep-well pumps (usually crossed belt drives with large shaft-centre distances and high initial bearing friction) or rock crushers etc. need a clutch for the starting operation. Vibrating equipment of all types is another typical example of machines with a high level of starting torque. Be careful when working with multiple-disk clutches running in an oil bath - the oil viscosity may be so high as to negate the effect of an engaging/disengaging coupling. Dry clutches are to be preferred for this reason. It is not enough to award good marks to a machine's starting characteristics in the warm summer months. On the contrary, the right time to assess how much effort is needed for the starting operation is in the cold season.
- Be particularly careful with hydraulic drives. Even if it is possible to switch over the hydraulic system to free circulation (short-circuiting), as is the case with constant pumps, it is not always easy to start with the crank handle. Experience shows that particularly in the cold season the residual resistance to rotation is usually too high for muscle power to overcome. In the cold season the resistance of the hydraulic system may be between two and three times greater than the resistance of the engine, leaving just 1/2 to 1/3 of the available power for starting the engine. Even when variable displacement pumps can be changed over to "zero delivery", hand starting is not always easy because often this position is not exactly defined. To be sure of safe and easy hand starting even in the cold season we have only one piece of advice: Use a clutch !

N.B.:

If hydraulic pumps are connected they can make it difficult not only for the engine to start but also for it to accelerate - a fact that again becomes more evident in the cold season. If an engine is impeded in its free acceleration after starting, the large amount of starting fuel may cause the engine to overheat, leading to damage.
Our recommendation once again is: Use a clutch !

- Human muscle power is sufficient to overcome only relatively small resistances. It is important, therefore, to consider the ambient temperature during starting as explained in the operating manual when selecting the lubricating oil viscosity. This is essential in order to reach the necessary starting speed.

AUXILIARY EQUIPMENT

Auxiliary equipment transforms the basic engine into an engine capable of performing specific functions.
Some auxiliary equipment is essential for an engine to work, e.g. equipment for:

- fuel supply
- combustion air filtration
- exhaust system
- mechanical or electrical starting
- lubricating oil supply

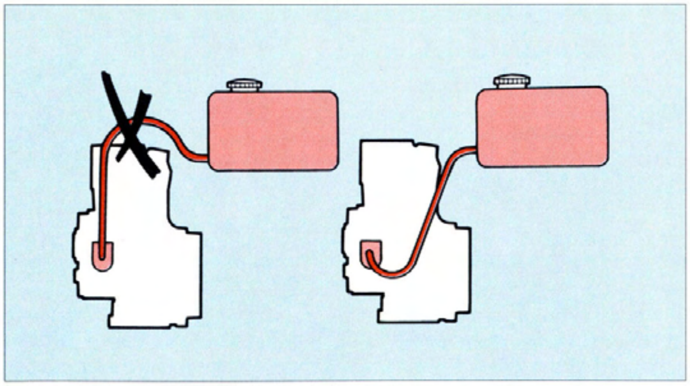
The second category of auxiliary equipment is concerned with installing the engine in the specific machine. This category covers the following items of equipment:

- engine feet, engine mountings
- speed adjustment devices
- stop elements, automatic switch-off devices and remote starting systems
- flywheels and adapter housings
- shafts and couplings
- accessories for hydraulic pumps and hydraulic oil coolers

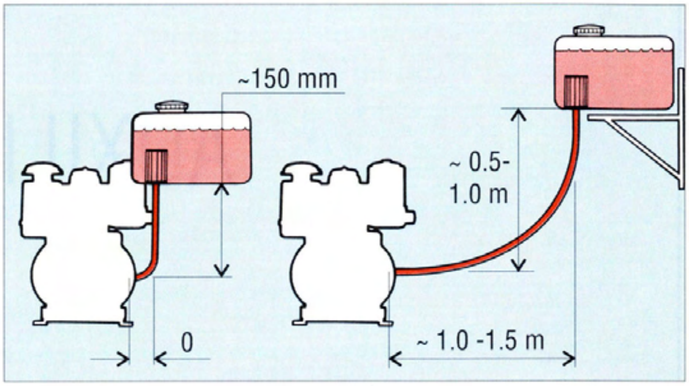
Recommendations for the use of auxiliary equipment
Sizes are specified in the HATZ dimension sheet folders.
In the following sections we would like to give you some tips on the use of auxiliary equipment.

1. FUEL:

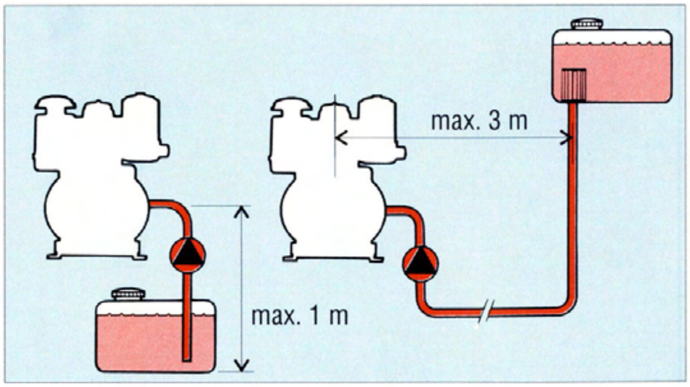
It has to be possible to ventilate fuel pipes. A fuel pipe can be ventilated if it is laid in U configuration or with a rising gradient.
A fuel pipe cannot be ventilated if it is laid horizontally or as an inverted U.



If the fuel tank is not mounted on the engine but, for example, on the wall, there should be a drop of approximately 0.5 to 1 m in order to overcome the pipe resistance. If there is any doubt, use a fuel pump.
If the fuel tank is not mounted on the engine but is located directly next to the engine, a drop of approx. 150 mm from the tank outlet to the injection pump is normally sufficient. Be sure to make allowance for possible tilting during operation.



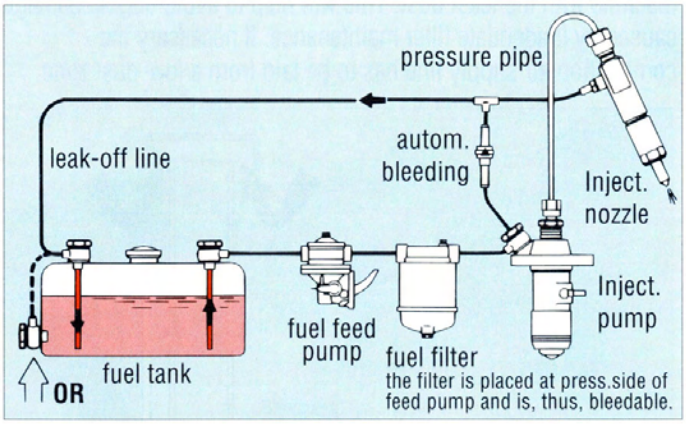
A fuel pump is necessary if the fuel is unable to flow by force of gravity, i.e. if the tank lies lower than the filter and the injection pump. A fuel pump will also be necessary, however, on pipe lines longer than approximately 1.5 m from a tank above the engine in order to overcome the pipe resistance. Alternatively you can use a larger pipe cross section.
Diaphragm pumps have a delivery head of approx. 0.8 m when used with a straight line of DN 8 hose. For a greater delivery head we recommend using an electric fuel pump that is installed so that the fuel runs to it freely from the tank. The pump is then used to overcome the pressure head.



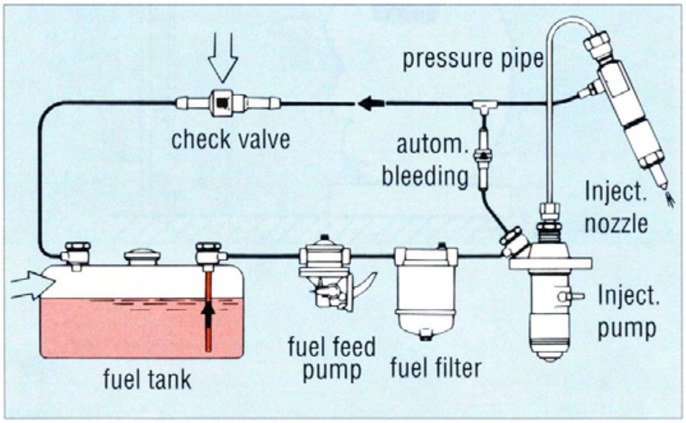
If a fuel pump is used and the fuel tank is not mounted on the engine, the fuel filter has to be installed in the fuel line in accordance with the following rules:

- the fuel filter has to be installed in such a way that it can be ventilated
- it has to be possible to ventilate the fuel pipe
- troublefree operation is assured only by the following pipe configurations:

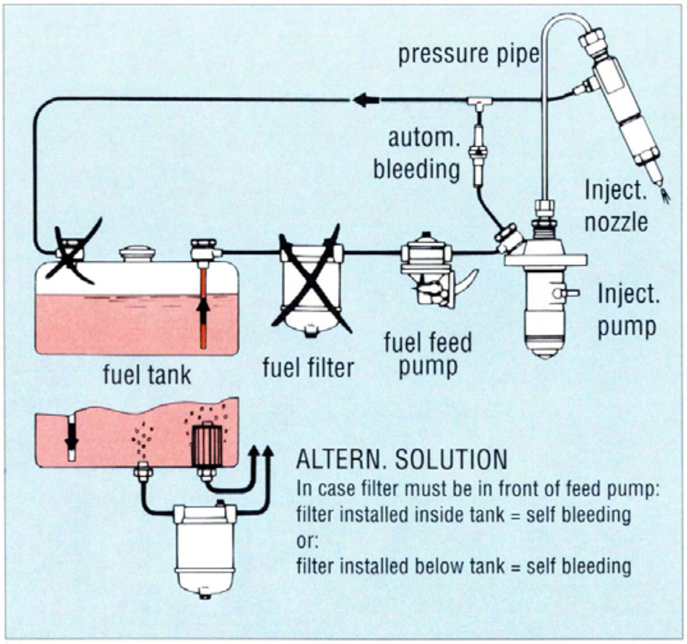
The leakage pipe has to extend to the bottom of the tank.



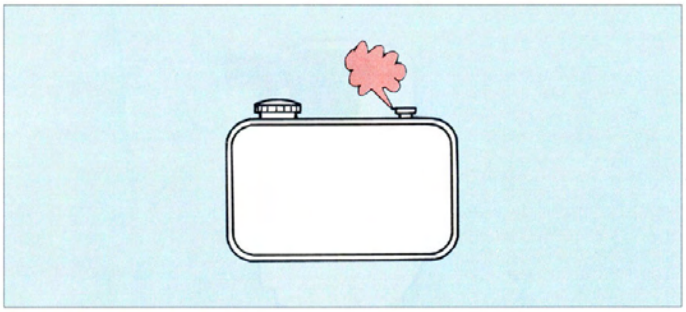
A leak-proof non-return valve is essential if the leakage pipe is not laid to the bottom of the tank.



The following fuel filter cannot be ventilated because it is installed AHEAD of the feed pump.

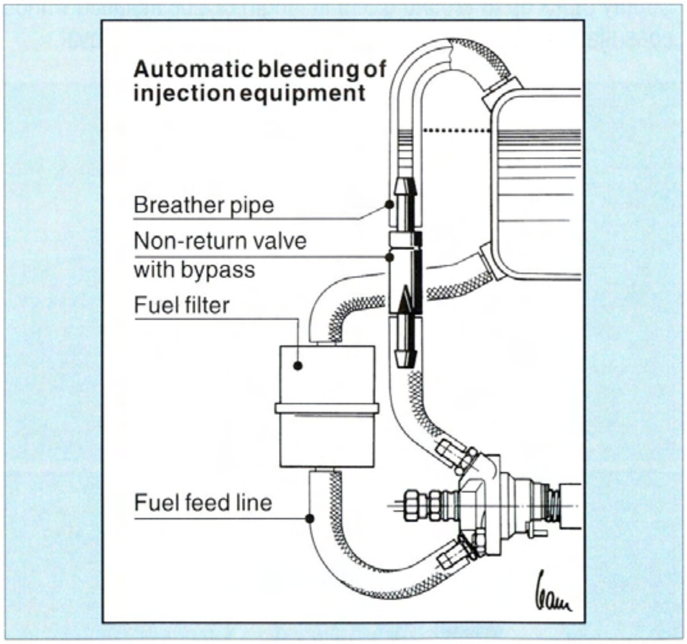


For very dirty fuel we recommend using a coarse filter as a preliminary filter ahead of the fuel pump. This filter has to be selfventilating, i.e. it must be installed in a vertical or inclined section of pipe. Water traps are essential if the fuel has a higher water content than specified by the standard.
Fuel tanks have to have a ventilation hole for essential pressure compensation (original HATZ fuel tanks are normally ventilated via the tank cap).



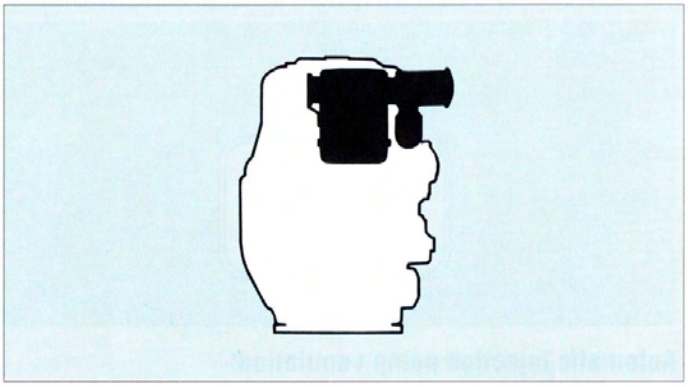
Automatic injection pump ventilation:

This device can be fitted to any HATZ Diesel engine motor if it is not already present. The advantages of automatic injection pump ventilation are:
No contamination of the engine / machine / ground by escaping fuel and no ingress of dirt in the high-precision parts of the injection system.

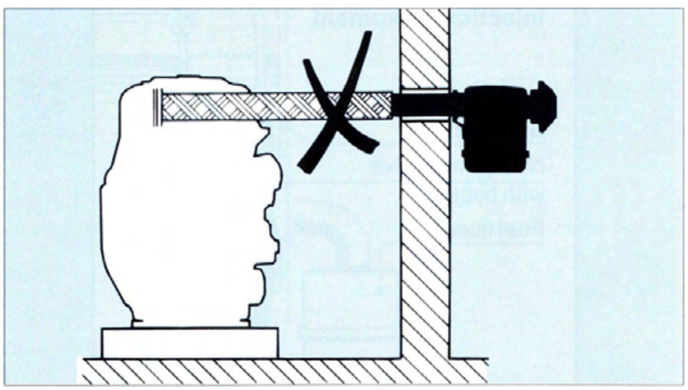


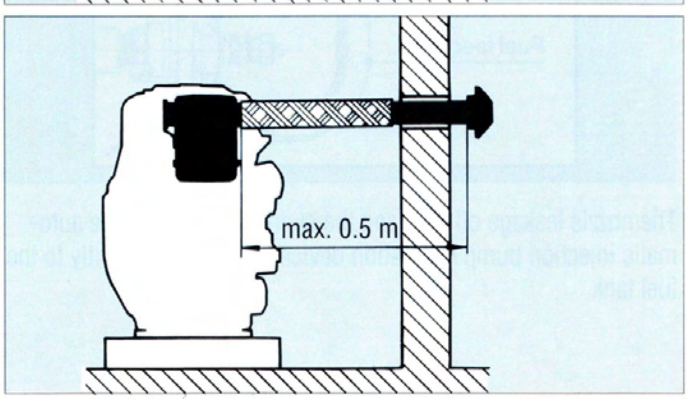
The nozzle leakage oil pipe and the overflow pipe from the automatic injection pump ventilation device are returned directly to the fuel tank.

The air filters in our delivery range are tuned to HATZ Diesel engines. All rights under the warranty are forfeited if other makes of filter are used without obtaining our written approval for each instance of installing a different make of air filter.
If the dust content of the intake air is high (approx. 200 mg dust per m^3 air and more), we recommend using a preliminary dust trap. This will extend filter life (maintenance interval) by roughly three-fold.

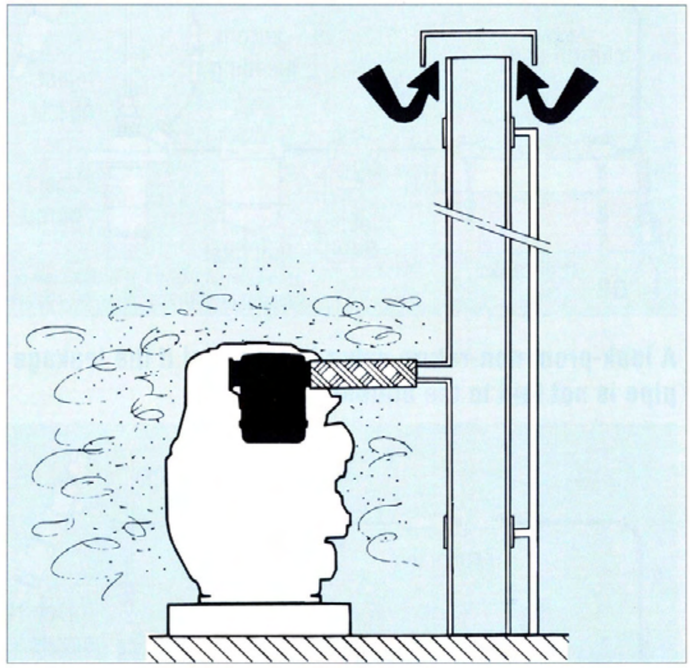


If fresh air pipes are necessary, they should always be fitted ahead of the filter and the filter should always remain on the engine. This will rule out leaks on the clean air side. The supply pipe has to be able to withstand the pulsation of the intake air. Hence a suitable pipe material would be e.g. a hose with spiral wire reinforcement. Supply pipes up to around 0.5 m in length can be installed without consultation. For longer lengths, please ask for our approval.





The inlet opening for the intake air must always lie in that area of the machine with the least dust. This will help to avoid engine damage caused by inadequate filter maintenance. If necessary the combustion air supply line has to be laid from a low-dust zone.

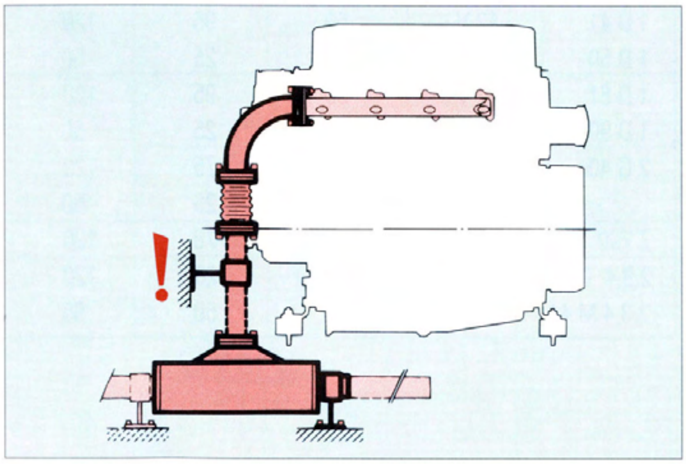


Exhaust silencers from our range of auxiliary equipment are tuned to HATZ Diesel engines as regards back-pressure and noise. All rights under the warranty are forfeited if other makes of exhaust silencer are used without obtaining our written approval for each instance of installing a different make of exhaust silencer.

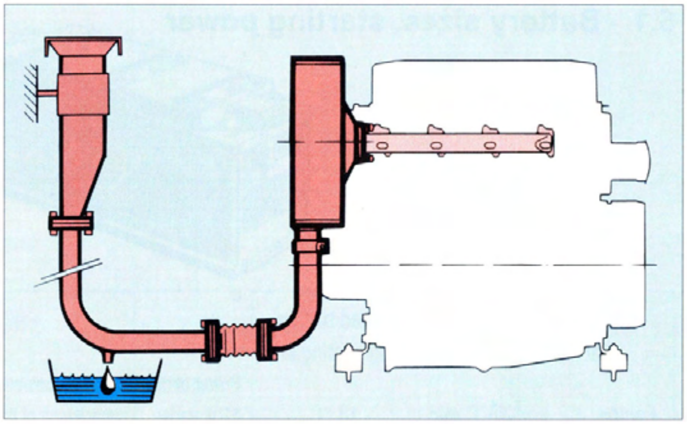
The following table provides a rough guideline for the specification of a straight exhaust pipe line. Please note, however, that the maximum permissible total back-pressure of the exhaust system with exhaust silencer must not be exceeded and has to be checked.

	recommended pipe Ø (approx. in mm) at lengths up to:			max. perm. back-pressure
Engine type	7.5 m	15 m	25 m	(mm / WS)
E 573/673 1 B . E 71/75/79		50	75	270
1 D .		75	100	270
2 G 40		75	100	480
Z 790		75	110	480
2 L / M 41		75	110	480
3 L / M 41		110	130	630
4 L / M 41		110	130	720

If cases of doubt we recommended using the next size of pipe.
A bend of 45 ° and more shortens the permissible straight length by one metre.
In the case of exhaust pipes installed on engines with elastic mountings, an elastic link has to be incorporated in the pipe to compensate engine movements. This elastic link should be installed as close as possible to the centre of the elastic mounting because this is where amplitudes are smallest.
The elastic link has to be followed by a fixed point.



Exhaust gas condenses in long exhaust pipes and on engines that are run at low capacity. Typical examples are welding units with long idle running times. In these cases the exhaust pipes must be fitted with a condensate drain pipe as recommended in the HATZ - ABC of Engines, Chapter 8.



Exhaust volume flow Q (m^3/ h)

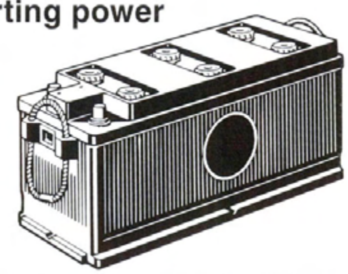
	n (min^{-1})	1500	1800	2300	3000	3600
1B20 .	P (kW-IFN) Q (m^3/ h)	1.5 20.0	1.9 26.0	2.6 37.0	3.1 49.0	3.4 61.0
1B30 .	P (kW-IFN) Q (m^3/ h)	2.3 29.0	3.0 38.0	3.9 54.0	4.6 71.0	5.0 91.0
1B40 .	P (kW-IFN) Q (m^3/ h)	3.6 39.0	4.4 51.0	5.7 71.0	6.8 95.0	7.3 121
1D41 .	P (kW-IFN) Q (m^3/ h)	2.8 36.0	3.5 45.0	4.6 63.0	5.6 87.0	6.0 113
1D50 .	P (kW-IFN) Q (m^3/ h)	3.7 46.0	4.6 59.0	6.0 83.0	7.5 111	7.3 138
1D81 .	P (kW-IFN) Q (m^3/ h)	5.5 65.0	6.8 86.0	8.5 109	10.5 157	10.5 195
1D90 .	P (kW-IFN) Q (m^3/ h)	6.1 85.0	7.6 102	9.6 131	11.5 166	
2G40	P (kW-IFN) Q (m^3/ h)	6.8 88.0	8.6 110	11.6 146	14.6 200	
2L41C	P (kW-IFN) Q (m^3/ h)	15.0 186	18.7 231	23.5 307	24.4 382	
3L41C	P (kW-IFN) Q (m^3/ h)	22.9 279	28.0 347	35.9 460	36.7 573	
4L41C	P (kW-IFN) Q (m^3/ h)	30.0 357	37.0 463	47.0 628	48.8 773	
2M41	P (kW-IFN) Q (m^3/ h)	16.4 176	20.2 217	25.4 303	26.3 384	
3M41	P (kW-IFN) Q (m^3/ h)	25.0 264	31.1 339	38.9 460	39.8 573	
4M41	P (kW-IFN) Q (m^3/ h)	34.0 371	41.3 457	52.0 613	53.1 763	

4.0 Starting cranks

Please see chapter A 6.0

5.0 Electrical Starting

5.1 Battery sizes, starting power



Engine	Required capacitance of a 12 V lead battery at an air temperature during starting of: 0 °C min min. required	- 18 °C min. required	Power of the 12 V starter in kW	max. permissible capacitance of the 12 V lead battery
1 B 20 . / 30 .	16 Ah	25 Ah	0.8	55 Ah
1 B 40 .	25 Ah	45 Ah	1.0	55 Ah
E 573 / 673	35 Ah	45 Ah	0.8	55 Ah
E 71 / 75 / 79	35 Ah	45 Ah	0.8	55 Ah
1 D 41. / 50.	45 Ah	66 Ah	1.6	88 Ah
1 D 81. / 90.	45 Ah	66 Ah	1.5	88 Ah
2 G 40	45 Ah	70 Ah (88)	1.7 (2.0)	88 Ah (110)
Z 790	50 Ah	88 Ah	1.9	96 Ah
2 L 41	55 Ah	96 Ah	2.7	143 Ah
3 L 41	70 Ah	110 Ah	2.7	143 Ah
4 L 41	88 Ah	125 Ah	2.7	143 Ah
2 M 41	55 Ah	96 Ah	2.7	143 Ah
3 M 41	70 Ah	110 Ah	2.7	143 Ah
4 M 41	88 Ah	125 Ah	2.7	143 Ah

For a system voltage of 24 V it is normal to use two 12-volt batteries, e.g.: 2 x 12 V / 35 Ah as minimum unit
2 x 12 V / 55 Ah as maximum unit.

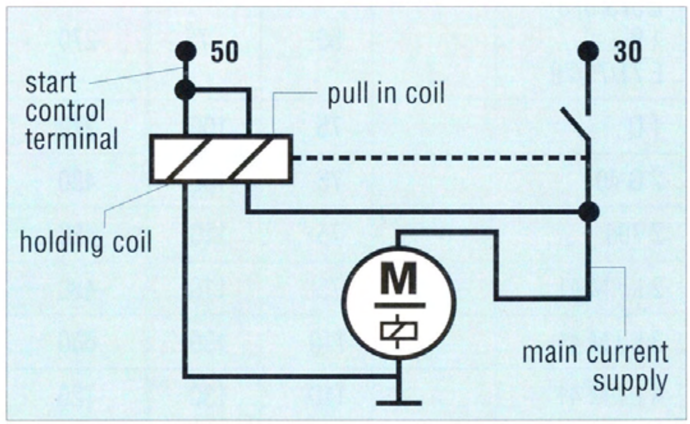
Temperature limits of standard batteries:

- self-discharge increases and battery life decreases sharply at approx. + 60 °C and above.
- semi-charged batteries may freeze at approx. - 22 °C and below. A frozen battery has to be thawed prior to charging.
- the freezing threshold for fully charged batteries is approx.- 60 °C.

A battery's degree of discharge can be assessed by measuring its voltage in the loaded state (at least 1 A). A discharged battery in the unloaded state has its nominal voltage at the terminals!

5.2 Starters

The start-switch (terminal No. 3) is used to switch on the pull-in and hold-in winding of the starter solenoid at the starter (terminal No. 50) (max. 70 A for short time in the pull-in winding).
At the end of the engage travel (the start pinion is engaged in the ring gear) the main starter current is switched on (approx. 600 to 1300 A according to the starter and its condition). The starter motor is now connected directly to the battery via terminal No. 30 and the main starter cable.



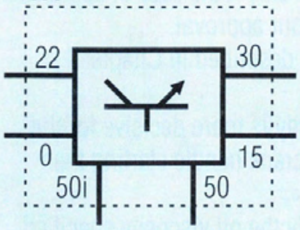
Required cross section or the main starter cable (DIN 72551)				
		Cable length (mm²)		
Engine	Voltage	1 m	2 m	4 m
1 B .				
E 673	12 V	16	25	50
E 75 / 79	12 V	16	25	50
1 D 41	12 V	50	95	120
1 D 50 .	24 V	25	25	50
1 D 81	12 V	50	95	120
1 D 90 .	24 V	25	25	50
2 G 40	12 V	50	75	120
	24 V	25	25	50
Z 790	12 V	50	70	120
2,3,4 L41	12 V	50	120	120
2,3,4 M 41	24 V	50	50	95

5.0 Electrical Starting

Starter Protection Module

Symbol

A4

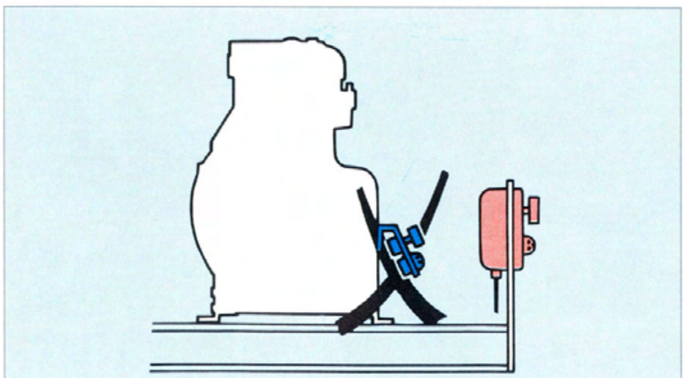


0 ground
15 swith on
22 frequency signal (W)
30 battery main supply
50 start control in
50i start control out

A starter protection module is used if it is not possible to rule out inadvertent switching of the starter.
The starter protection module is not a simple relay but an electronic component which responds to an engine's rotational frequency.
It performs the following safety functions:

- Actuation of the starter when the engine is running is prevented. After the engine starts and accelerates, the starter control line will be disconnected at a certain frequency.
- Actuation of the starter when the engine is slowing down is prevented. A new start is not enabled until the frequency drops below a certain level and a period of approx. 4 seconds elapses.
- If the start is interrupted (false start) and the switching frequency was not yet reached, a new start will not be enabled until a period of approx. 8 seconds has elapsed.

The starter protection module prevents damage (and costs) to the starter and ring gear!



5.3 HATZ designations
- on terminals strips
- on cable ends
- in circuit diagrams

Terminal	Designation
0	ground
1	generator B+
2	on a three-phase generator: D+, on a flywheel dynamo: terminal L on the controller
3	starter terminal 50
4	oil pressure switch
5	temperature switch on the cylinder head
6	heater plug I
7	solenoid for switching off the engine (hold-in winding)
8	heater plug II
9	Start-Stop input
10	positive terminal for fine speed adjustment of d.c. motor
11	negative terminal for fine speed adjustment of d.c.
12	oil pressure sensor
13	* reserved for special use *
14	speed adjust solenoid - hold-in winding
15	* reserved for special use *
16	solenoid actuator for decompression
17	maintenance switch for air filter
18	engine switch-off solenoid (pick-up winding)
19	temperature sensor on cylinder head
20	oil temperature switch
21	fan monitoring switch
22	terminal W for speed measurement
23	starter 30 (with ammeter connection)
24	terminal C with controller on flywheel dynamo
25	oil temperature sensor
26	terminal 50f on starter protect module
27	* reserved *
28	speed adjust solenoid - pick-up winding
29	* reserved *

Check for good ground connection. If possible do not install the switchbox on the engine but on vibration-free components.

Please enquire about special starting methods such as the use of spring-energy starters or pneumatic starters etc.

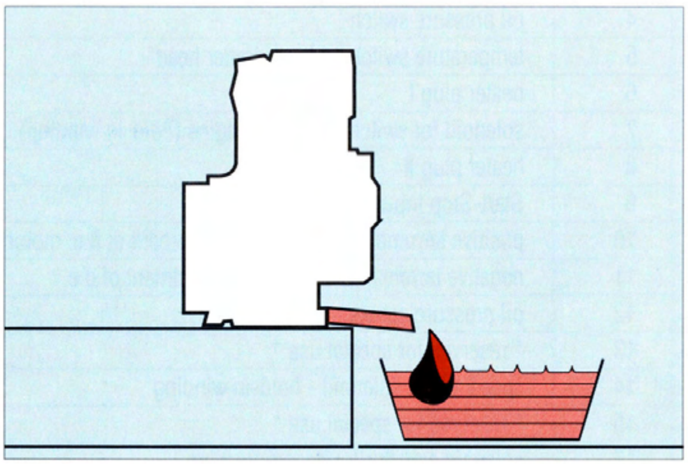
6.0 Engine Mounting

Please see Chapter A 3.0

7.0 Lubricating Oil

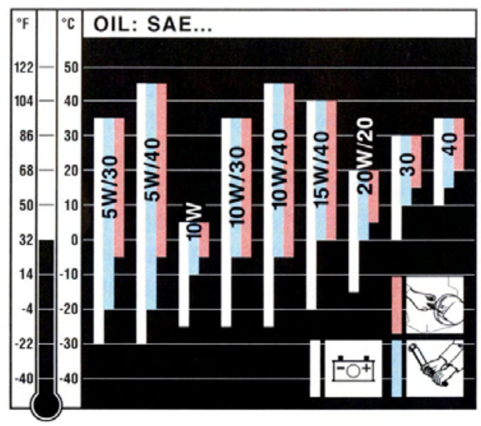
For the engine's operation it is important that the oil dipstick, oil filler, oil drain and oil filter are all easy to reach. If necessary, use extensions for filling and draining the oil. Please ask us for suggestions.

Our tip:
Test for yourself how easy it is to fill oil, drain oil and change the oil filter on the prototype machine. Only if you are satisfied with the convenient handling of these important tasks on the prototype can you expect the series machine to be serviced in accordance with the operating manual later.



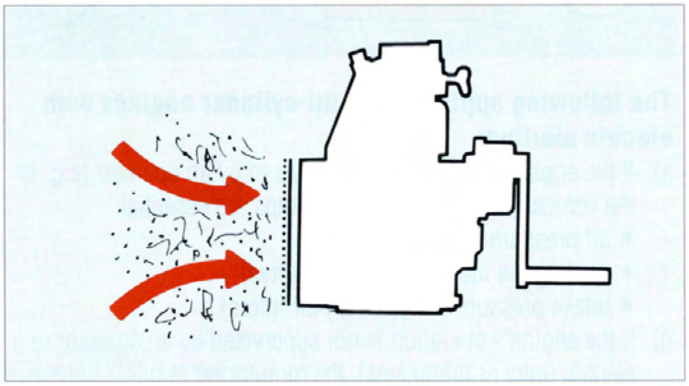
Tilting and longer oil change intervals:
According to the engine type and its use, we can supply supplementary oil pans for larger tilts and / or longer oil change intervals. The permissible maximum tilts are specified in the type data sheets. Larger tilts are allowed only if the case of application is discussed with us and we issue our approval.
Suitable oil monitoring devices are described in Chapter 11.

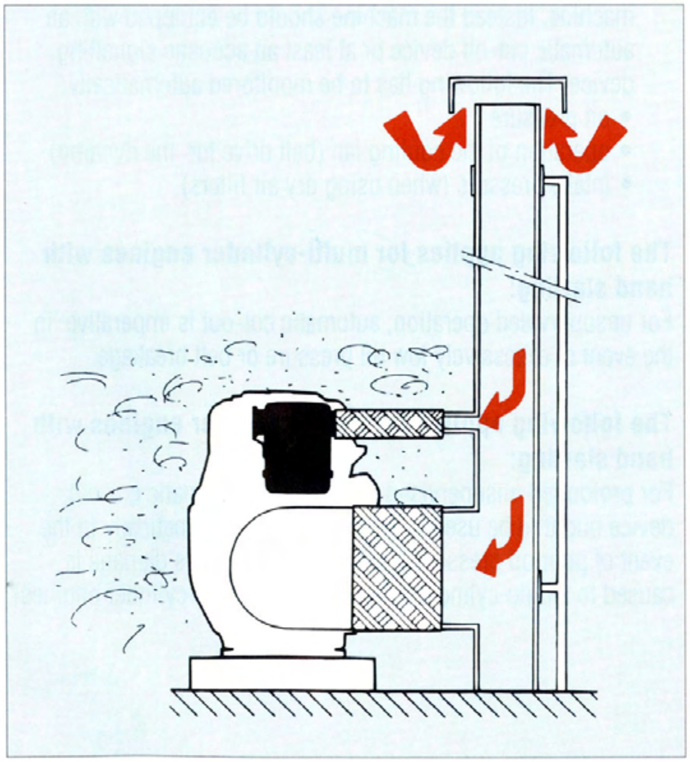
The choice of lubricating oil viscosity is more decisive for the starting behaviour of engines with crank handle starting than engines with electric starting.
It is important, therefore, to use only the oil viscosity specified.



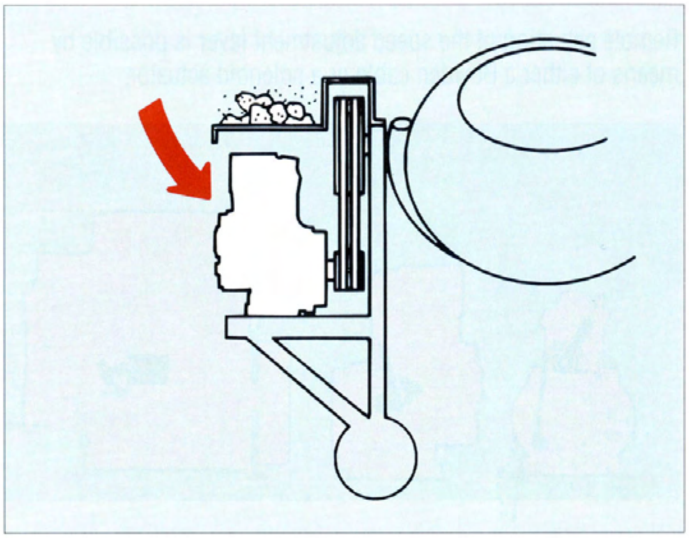
In very dusty environments, and particularly in the case of organic dust (originating from grass, hay, leaves, ears of corn etc.) in agriculture - suitable measures have to be introduced to prevent fouling of the cooling air lines and cooling fins. "Suitable measures" are, for example:

- If the cooling air inlet point lies within the operator's field of vision, a screen in front of the inlet can certainly help to keep the cooling air lines inside the engine (fan, fins in the head and cylinder) free of blockage.
  The screen is cleaned when necessary by the operator.
  This method is used e.g. on bar-type cutters and wood choppers.
- You can install a fresh air shaft with its opening positioned in a dust-free zone.
- A rotating screen in front of fan entrance throws off any deposits.





Suitable cover plates or cover grilles have to be used if there is a risk of solid materials (e.g. stones or concrete) getting into the cooling air lines.

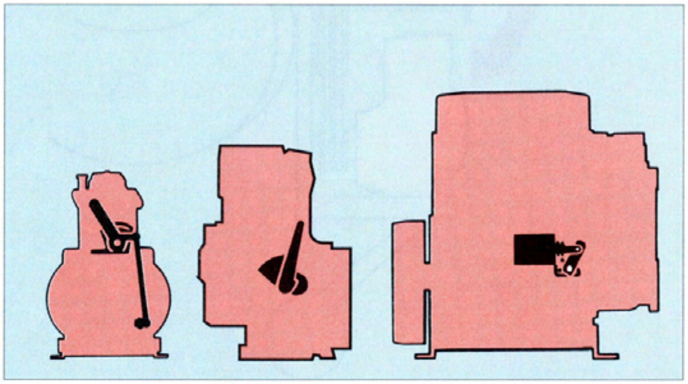


Make sure you have good access to the cleaning points on the cooling air lines and cooling fins, particularly in areas affected by organic dust.
Tapping off cooling air for other purposes is prohibited without our written approval.
Please read also Chapter A4 and A5 which deal with installing engines under enclosures and in closed rooms.

9.0 Speed adjustment

The basic models of all HATZ Diesel engines are equipped with a adjustment lever that enables infinitely variable adjustment of the speed between top speed and stop.

Remote actuation of the speed adjustment lever is possible by means of either a Bowden cable or a solenoid actuator.

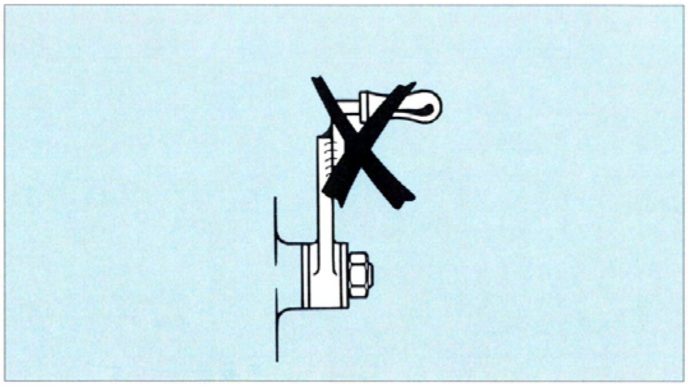


Variable speed adjustment levers are indispensable when using centrifugal couplings in order to prevent operation of the couplings in the slip zone.

Variable speed adjustment levers can be installed directly on the engine or take the form of variable Bowden cable actuator levers, e.g.:
The speed lever on the engine is held at the lower idle stop by a spring. The Bowden cable moves the speed lever against the spring force to the operating speed position. The Bowden cable lever is locked in the operating speed position (by a latch or spring-loaded ball etc.). When the lock is released, the spring pulls the speed lever to lower idle position and the centrifugal coupling leaves the hazardous slip zone immediately.

Variable Bowden cable levers provide greater operating convenience because they can be fitted to the control console.

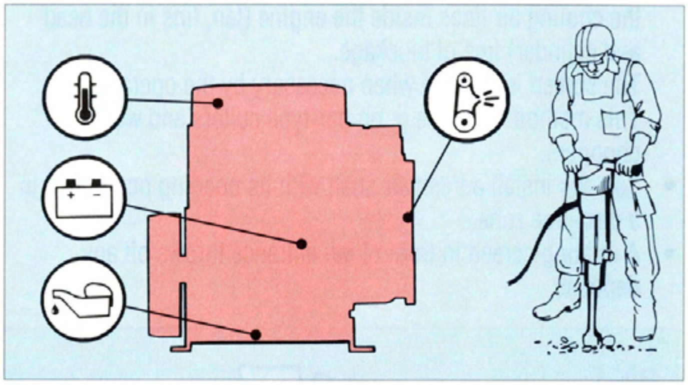
You should never change the speed adjustment lever; never extend it and never equip it with a larger mass.



10.0 Engine monitoring

11.0 Automatic systems

Visual monitoring of the operating conditions only makes sense if the operator actually has the pilot lamps in his field of vision at all times. All engines which are left to run unsupervised - and this applies in particular to electric units, pump sets and welding units etc. - need an automatic cut-off device to protect them from the effects of poor maintenance.



The following applies for multi-cylinder engines with electric starting:

a) If the engine's operation is supervised by an operator (e.g. in the vehicle), the following pilot lamps are essential:
   - oil pressure indicator
   - cooling fan indicator (dynamo drive)
   - intake pressure (only for dry air filters)

b) If the engine's operation is not supervised by an operator (e.g. electric units or pump sets), the monitoring of pilot lamps is in itself insufficient because there is not always an operator at the machine. Instead the machine should be equipped with an automatic cut-off device or at least an acoustic signalling device. The following has to be monitored automatically:
   - oil pressure
   - operation of the cooling fan (belt drive for the dynamo)
   - intake pressure (when using dry air filters)

The following applies for multi-cylinder engines with hand starting:

For unsupervised operation, automatic cut-out is imperative in the event of excessively low oil pressure or belt breakage.

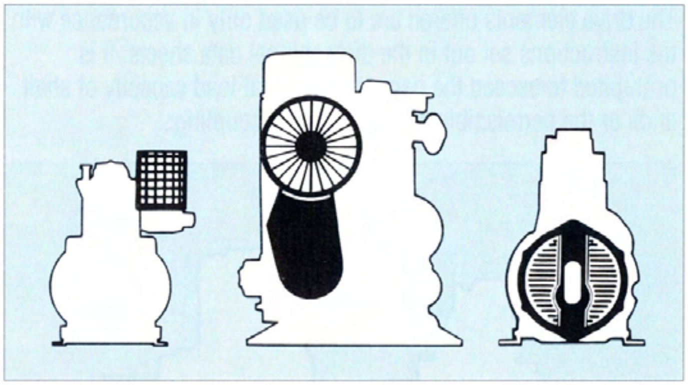
The following applies for single-cylinder engines with hand starting:

For prolonged unsupervised operation an automatic cut-out device ought to be used to stop the engine automatically in the event of poor oil pressure and belt breakage (less damage is caused to single-cylinder engines than to multi-cylinder engines).

12.0 Touch guards - equipment safety

If an engine incorporated in a machine is governed by any specific safety regulations is a question which has to be answered by the manufacturer or owner of the machine. This is his responsibility. This applies in particular to free-standing engines.

The equipment overview gives you details of available safety guards.



14.0 Flywheels

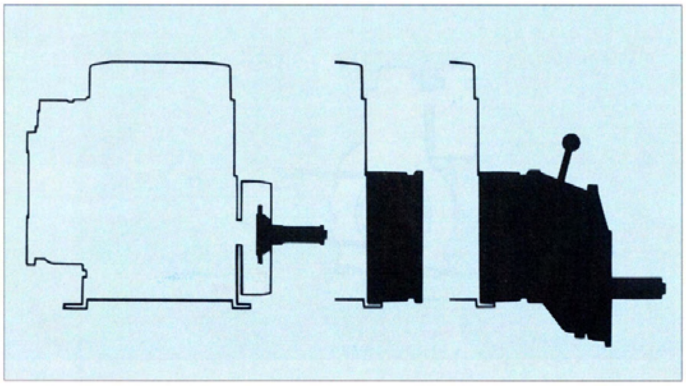
Flywheels of suitably large centrifugal mass are available (see equipment overview) to enable generators driven by two-cylinder engines to supply flicker-free light even at speeds of 1500 / 1800 min^{-1}.
Centrifugal masses for flicker-free light from single-cylinder engines at 1500 / 1800 min^{-1} are not possible in practice because they would be too big, too heavy and far too expensive.
If SUPRA 1D... single-cylinder engines are to be used to produce
a) flicker-free light
b) for operating periods of over 1000 hours per annum
then the following options are possible:

- the engine speed is reduced to approx. 2300 min^{-1},
  a) enabling the engine to run smoothly enough to produce flicker free light and
  b) adapting the engine's likely useful life to the demand for over 1000 operating hours per annum.
- the generator is driven via a flange-mounted gear unit designed to enable the flange-mounting of 4-pole single-bearing generators (housing SAE 5 / disk 6 ½)
- the generator is driven by V-belt.

15.0 Adaptations

(Attachment and flanging options):

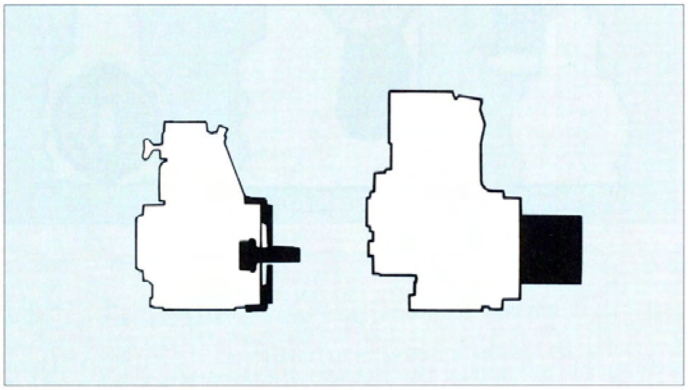
The equipment overview lists the standard offering of housings, flanges, attachments for hydraulic pumps, attachments for gear units, etc.



In addition there is also a large selection of prepared assembly proposals that are too diverse to include in the equipment overview but which we shall be glad to send you on request after receiving details of your installation conditions.
For details of standard adapter housings, e.g. for single-bearing generators, please see page 52.

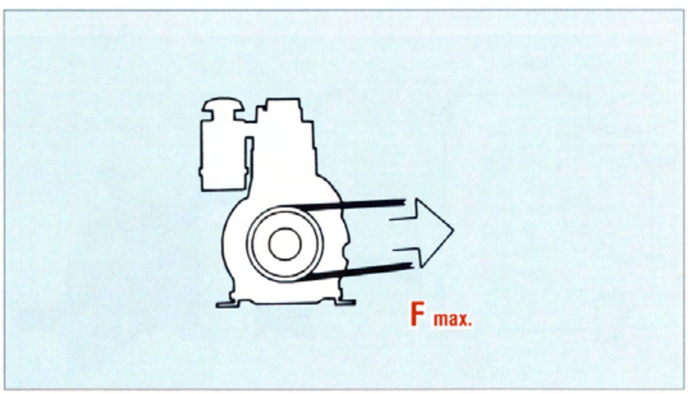
16.0 Non-disconnectable power take-off

The drive elements offered are to be used only in accordance with the instructions set out in the dimensional data sheets. It is prohibited to exceed the permissible radial load capacity of shaft ends or the permissible offset of flexible couplings.



The load capacity of power take-off points on the engine is quoted in the type sheet. The overloading of power take-off points, particularly as the result of uncontrollable belt tensioners, may result in damaged bearings and broken shafts. Information about belt drives can be found in the HATZ ABC of Engines, Chapter 3.

Recommendations for the simple configuration of belt drives are to be found on page 53.



If our quoted permissible limits are not possible, please let us know so that we can submit alternative proposals.

17.0 Disconnectable power take-off

Disengaging couplings (clutches) may be necessary for starting the engine, as described in Chapter A 6.0, or they may be required by a special feature of the machine.
We distinguish between the following disengaging couplings:

a) ***short-time disengaging couplings:***
These are used during starting, for accelerating and for gear shifting in vehicles.

b) ***long-time disengaging couplings:***
These are able to disconnect the engine from the machine for hours without the engine being switched off. Applications are to be found e.g. in agitators, deep-well pumps and machines where switching off and on is part of the work cycle.

c) ***long-time disengaging*** couplings for shock loads, e.g. for driving piston compressors, rock crushers, piston pumps, gang saws, grinding and screening machines, presses, rope winches for forestry work, etc.
Drives of this type require couplings that are able to absorb the torque peaks involved.

d) ***Centrifugal couplings*** are pure starting and accelerating couplings. Centrifugal couplings are not be operated in the slip zone. Their use is possible, therefore, only in conjunction with variable speed adjustment devices.

Disengaging couplings described in a) to c) in a closed housing with a free shaft end have a shaft bearing that also absorbs radial forces and which acts therefore as an outboard bearing. The permissible load capacity of the coupling shaft is always quoted in the dimensional data sheet.

18.0 Hydraulic pumps - Hydraulic oil coolers

The permissible transmission power values of our attachments for hydraulic pumps are laid down in the type sheets and in the dimensional data sheets.

Hydraulic pumps are an obstacle particularly during crank handle starting (see Chapter A 6.3).

Hydraulic oil coolers are available. The design of the hydraulic oil cooler has to be discussed with us and approved for each case of application.

Hydraulic oil coolers with their own electric powered fans can be supplied with electricity from the dynamos. It is possible to install these hydraulic oil coolers in any favourable position independently of the room where the engine is installed.

Controlled by switching the fans on and off, these hydraulic oil coolers permit continuous operation at the most favourable oil temperature. Furthermore, the waste air from the hydraulic oil cooler can be used to heat a driver's cabin.

HATZ Diesel engines have couplings for hydraulic pumps, particularly couplings for hydraulic pumps with SAE flange and BOSCH flange.

30.0 Engines for seagoing vessels

Many HATZ engines have been issued with acceptance certificates for:

GL, LR, BV, ABS, RINA and Deutsche Seeberufsgenossenschaft.

Engines which are to be approved by these institutions have to be built with specially tested components. It is not possible, therefore, to use ex-stock engines. Each engine has to be newly ordered.

Preservation

Each HATZ engine has to pass a test run before it is shipped. All parts inside the engine are therefore coated with a protective film of oil. Our experience indicates that all these engines can be stored for up to one year without being affected by any signs of corrosive damage which could influence the engine's function (protection lasts for only approx. 6 months at very high levels of rel. air humidity and in sea air).
For distinctly longer storage periods and for conditions calling for preservation of the engine we recommend the following preservation method:
Drain off the normal lubricating oil, fill up with preserving oil (viscosity as specified in the operating manual), and mix preserving oil with the fuel in a ratio of 1 : 4 (e.g. 0.5 L preserving oil to 2 L fuel). Now run the engine for a short time (approx. 10 - 15 minutes) with these preserving agents.
When the preserving run is completed, close the openings at the air filter and exhaust silencer in order to keep out atmospheric influences. The engine is then sufficiently preserved to withstand a storage period of up to approx. 24 months.
We do not recommend running the engine during the storage period. There is a risk, namely, of the operating temperature not being reached, which would be detrimental rather than beneficial to the original preservation.
For engines run with preserving oil the oil change interval is 15 operating hours. Adding preserving oil to the fuel may result in a power loss of up to 15 %.
The engine does not need to be cleaned or flushed when the preserving oil is replaced.

INSTALLATION TEST
INSTALLATION APPROVAL

Testing the engine installation - PARTICULARLY IMPORTANT! -

An engine can only work as well as its conditions of installation allow. Engine damage resulting from poor installation, improper power calculation or an unsuitable choice of speed is not covered by the warranty.
Please use the information in the previous chapters of this guide as a check-list when carrying out the final inspection of the engine installation!

We recommend the following procedure:

1. Checking the engine's selection and its environment:

- Has the speed been correctly selected, set and coordinated with the number of operating hours per annum (See Chapter A1.1) ?
- Is the engine's capacity utilization acceptable (Chapter A1.3). One way to assess the capacity utilization is to measure the engine speed with the speed adjustment lever fully pulled
  a) with the machine at zero load
  b) with the machine at full load
  The difference in speed is a rough measure of the engine's capacity utilization. The test is performed on a warmed-up machine.
- Has account been taken of the climate at the point of use (Chapter A1.3 and A4.0, 5.0) ?
  Has allowance been made in the power calculation for the change of climate if the engine is installed under an enclosure or in a room? The difference between the outside air temperature and the temperature directly in front of the air filter intake socket is a measure of the installation's quality.
- Is the machine as vibration-free as possible? Have our recommendations for engine mounting been observed (Chapter A3.0) ?
- Are all the conditions for good hand starting fulfilled (Chapter A6.0). The best test is to start the engine yourself. You will then know what you are asking of your customers.

2. Checking the engine's equipment:

- Has the essential engine monitor (warning or cut-off device) been installed (Chapter B11)?
- Have the fuel pipes been flexibly laid and can they be ventilated (Chapter B1)?
- Is the tank capacity big enough for the planned operating time?
- Does the air filter equipment meet the requirements of the location?
- Is the engine adequately protected against environmental Influences ?:
  - sand storms
  - driving rain
  - corrosive substances in the air
- Where present, are the fresh air and waste air pipes flexible, are they of the correct size, and are they laid in the correct place (Chapter B8) ?
- If the machine runs unsupervised, is the engine equipped with an automatic cut-out for the event of excessively low oil pressure?
- Where present, does the exhaust pipe have the correct cross section and is it flexibly laid (Chapter B3) ?
- Have the load capacity limits been observed at the power take-off points (see type sheets - dimensional data sheets)?
- Does the engine's performance match the customers requirements ?
  - vibrations
  - speed stability, controller performance
  - starting smoke
  - acceleration time
- Is the head of oil big enough for the planned operating time?
- Is the possible machine tilt compatible with conditions at the engine?
- Does the equipment
  - comply with the equipment regulations in the planned areas of use ?
  - with the safety regulations ?
  - with the exhaust regulations ?
- Are the limits set for the scope of the warranty ?

3. Checking the ease of access to operating and Maintenance points:

It has to be easy to operate and service the engine. The easier it is to reach the maintenance points, the more reliable the maintenance work will be performed and the better the engine will function. Hard-to-reach maintenance points are ignored by maintenance personnel, shortening the engine's working life.

Please check personally that the operating and maintenance points are easy to reach by going through the actions yourself.

Operating points:

(see also the type sheet and the installation drawing):

- fuel filler
- fuel pipe ventilator
- fuel filter
- fuel pump
- speed adjustment lever
- decompression lever
- start charge button
- starting aid (oil / heater plug)
- room for crank handle starts / recoil starts
- start fittings

Maintenance points:

(see also the installation drawing)

- oil dipstick
- oil filler
- oil drain
- oil filter
- oil screen
- air filter
- fuel filter
- injection pump
- injection nozzle
- valve cover
- belt (fan, dynamo)
- cooling air lines
- coupling lever
- is the engine easy to dismantle for repair ?

4. Installation approval

HATZ-Ruhstorf reserves the right to carry out an installation test and to issue an installation approval for engines in series equipment. Please get in touch with the TA Department.

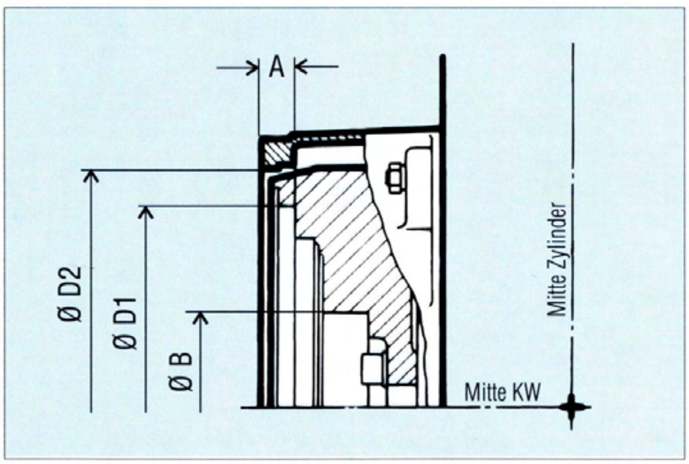
The respective HATZ agency or subsidiary may be delegated with carrying out the installation test.

In the case of series equipment, the engine's warranty pledge is conditional on obtaining an installation approval.

DIMENSIONS AND APPLICATION LIMITS OF MAJOR POWER TAKE-OFF POINTS

a) standard international combinations

* Flywheel combined with ** adapter housing		Dimensions (mm)			
* SAE size	** SAE size	D1	D2	A	B
	6		266.70		
6 ½	5	215.90	314.32	30.20	52
7 ½	5	241.30	314.32	30.20	52
8	5	263.52	314.32	53.00	62
8	4	263.52	361.95	62.00	62
8	3	263.52	409.58	62.00	62
10	4	314.32	361.95	53.80	72
10	3	314.32	409.58	53.80	72
10	2	314.32	447.68	53.80	72



b) SAE sizes available on HATZ Diesel engines:

■ lowest price, available ex stock
● available ex stock
❍ on request

Engine Type	Flywheel SAE size		Adapter housing SAE size	
1D41.	6 ½	■	6	■
1D50.	6 ½	●	5	●
1D81.1D90.	6 ½	■	5	■
	6 ½	●	5	●
2G40	6 ½		5	❍
Z 790			4	❍
	7 ½	❍	5	●
2L41C	8	■	5	●
3L41C	8	■	4	■
4L41C	8*	■	3*	●
	10	❍	4	❍
	10	❍	3	●
	7 ½	❍	5	●
	8	■	5	●
2M41	8	■	4	■
3M41	8 *	●	3*	●
4M41	10	❍	4	❍
	10	❍	3	●
	10 **	●	2	●

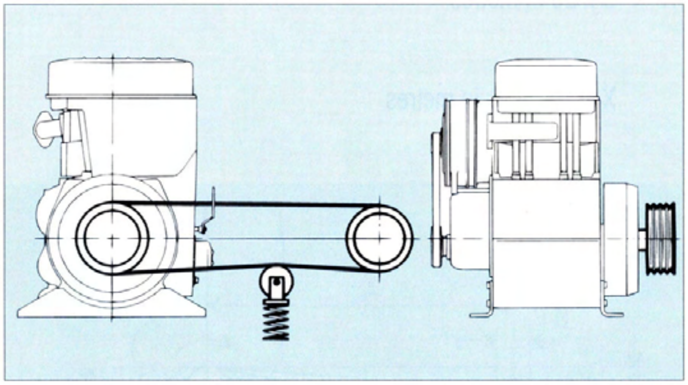
* $n_{max} = 2800\ min^{-1}$; Particularly for 2L41C and 2M41 at 1500 / 1800 min^{-1} on generators, I total = 1.6 kgm^2.

** $n_{max} = 2600\ min^{-1}$; Flywheel for crankhandle starting. Particularly for 2M41 at 1500 / 1800 min^{-1} on generators. I = 1.95 kgm^2.

Power take-off by belt is possible on all HATZ Diesel engines. It goes without saying, however, that there are limits to the load capacity of the shaft bearing and the shafts. The limits of the permissible load capacity are not normally reached or exceeded by the transmission of torque, but the way in which the belts are tensioned is critical for the load level.

As a general rule it can be said that:

a) only controllable belt tensioning devices guarantee that bearings and shafts are not overloaded and do not fracture. The belt tension can be controlled, for example, by a spring loaded belt pulley.



b) if belt drives are tensioned with tensioning bolts, this is bound to result in tension values which would overload any bearing and any shaft on the engine!

And because the type of belt tensioning device results in either

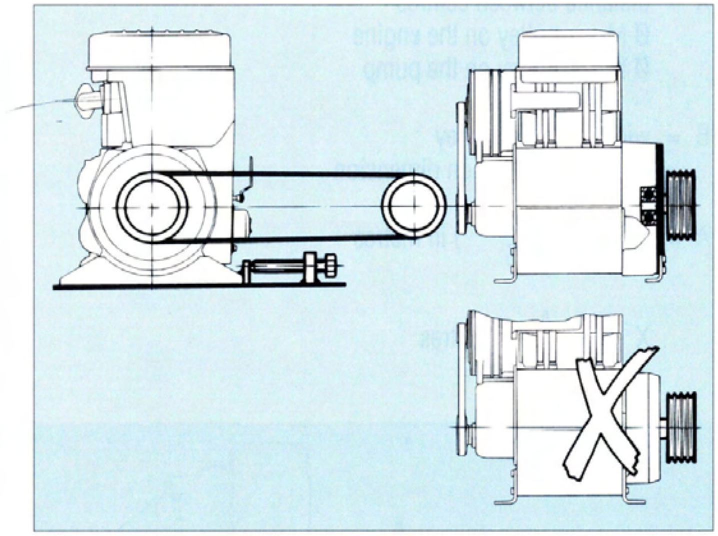
a) controllable belt tension values or

b) uncontrollable belt tension values

our recommendation is easy to sum up:

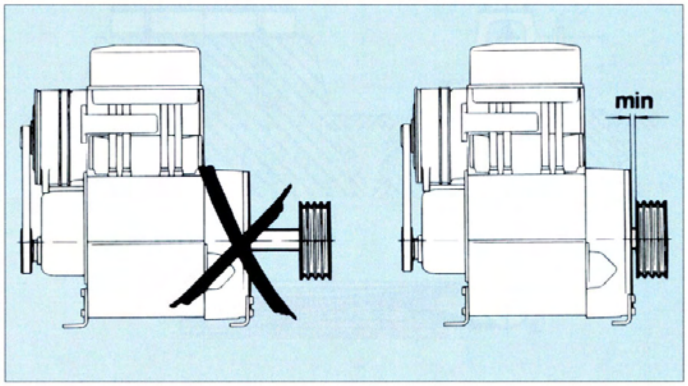
If the belt tension is controllable, i.e. if there is e.g. a spring-loaded belt pulley, you can dispense with an outboard bearing at the power take-off point. And vice versa: if the belt is tensioned with tensioning bolts, an outboard bearing is indispensable.

If a disengaging coupling is being used in any case in the housing with a free shaft end (because e.g. the engine has to be disconnected from the excessive rotational resistance of the drive machine during starting), then the outboard bearing is already present in the form of the coupling.



Two further principles for belt drives:

1. The pulley has to be moved as close as possible to the bearing point in order to keep the load low.



2. The pulley on the engine should be as big as possible because this minimizes the load which results from transmitting the torque.

3. Recommendation for the geometrical design of a crossed belt drive for e.g. deep-well pumps

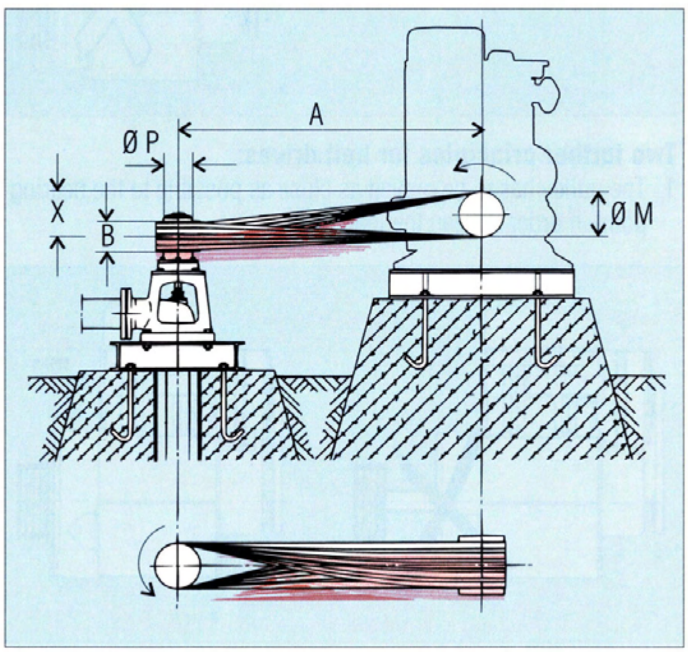
a) with V-belt

A = distance between centres
Ø M = pulley on the engine
Ø P = pulley on the pump

B = width of pump pulley
X = installation dimension

$$A = 5{,}5 \times \left(\frac{ØM + ØP}{1.5}\right) \text{ in metres}$$

$$X = \frac{A}{25} \text{ in metres}$$



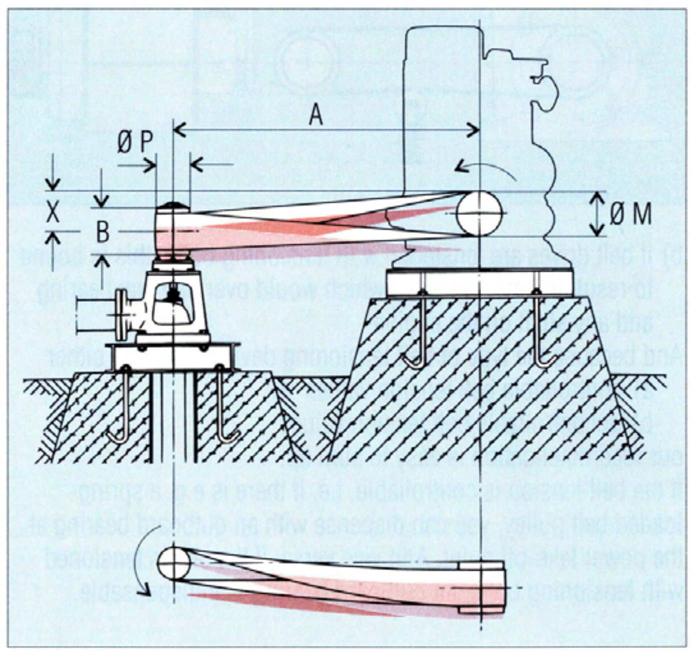
b) with flat belt

A = distance between centres
Ø M = pulley on the engine
Ø P = pulley on the pump

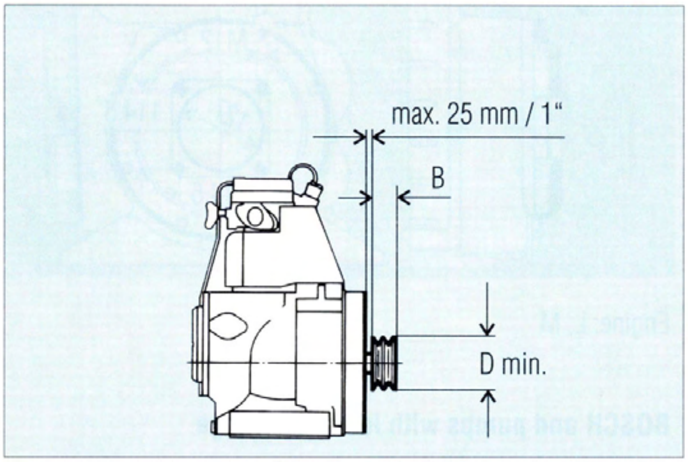
B = width of pump pulley
X = installation dimension

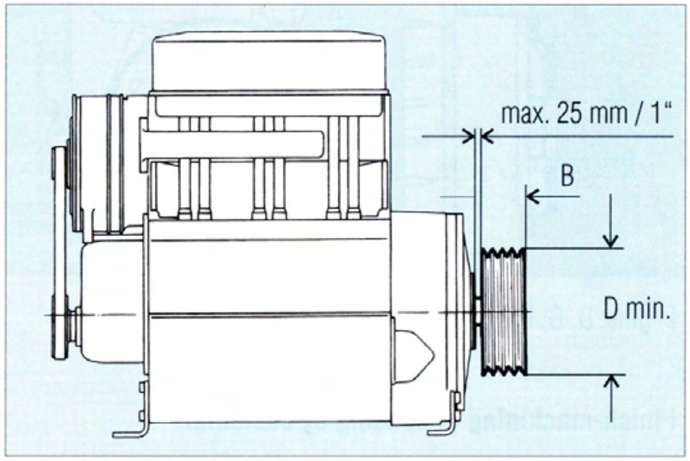
$$A = B \times 20 \text{ in metres}$$

$$X = \frac{A}{25} \text{ in metres}$$



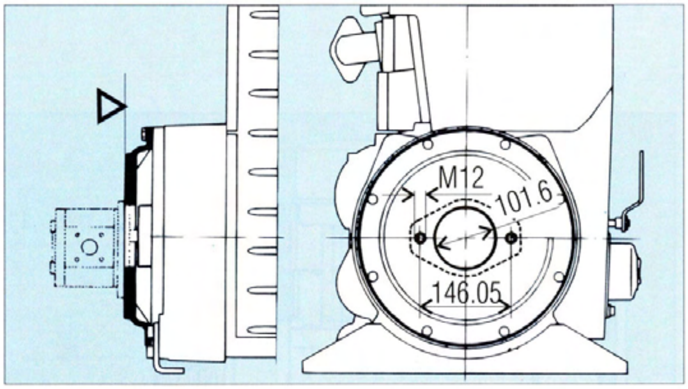
If you choose a controllable belt tensioning device, fit the pulley no further than 25 mm (approx. 1 inch) from the edge of the flywheel and select a pulley diameter no smaller than that listed in the following table. The belt drive will then work satisfactorily.





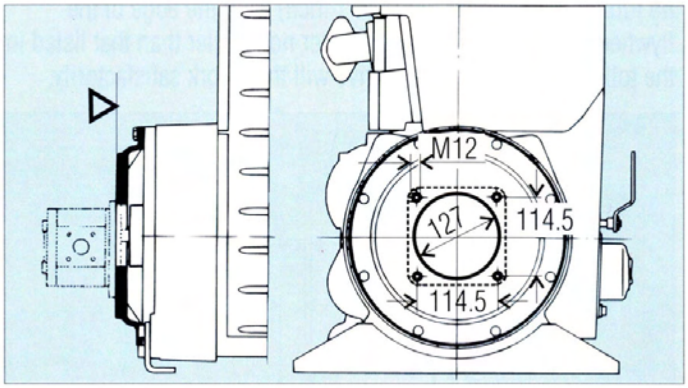
Engine	min. Ø D (mm)	Pulley width B approx. (Mm)	Remarks	Number of belts	Belt size
1B20./30./40.			pulley on control side		
E 673	90	50		2	SPA
E 75 / 79	90	75		3	SPA
				2	SPA at D > 125
1D41./1D50.	90	75		2	SPA
1D81./1D90.	90	80	outboard bearing recommended	4	SPA at D < 125
				3	SPA at D > 125
2G40	110	90		4	SPA
Z 790	110	110		6	SPA
				4	SPA at D > 125
2L41	140	110	outboard bearing needed at D <150	4	SPB
3L41	220	110	outboard bearing needed at D <2205	5	SPB at D > 160
				3	SPB at D > 220
4L41	300	110	outboard bearing needed	4	SPB at D > 220
				7	SPB at D > 160
2M41	150	110	outboard bearing needed at D <160	4	SPB
3M41	220	110	outboard bearing needed at D <220	4	SPB
4M41	300	110	outboard bearing needed	5	SPB

SAE size B



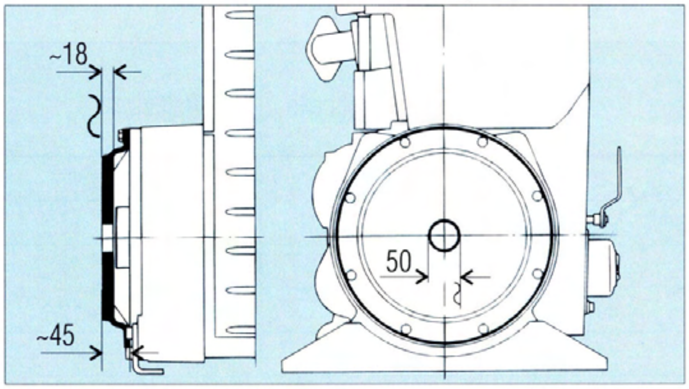
Engine: D, G, L, M

SAE size C



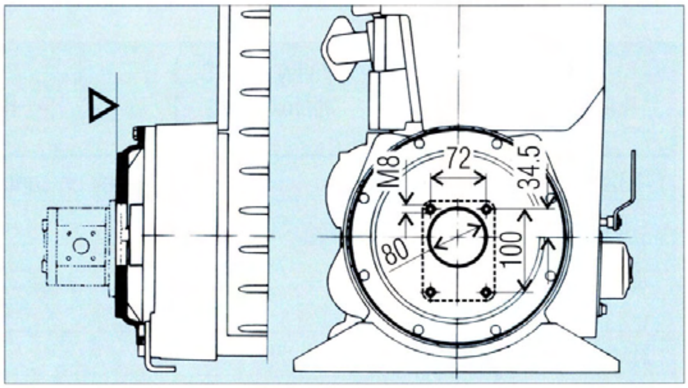
Engine: L, M

Finish-machining of housing by customer



Engine: D, G, L, M

BOSCH and pumps with identical flange



Engine: B, D, G, L, M

Further attachments are available for hydraulic pumps!
Please enquire.
Fax us the flange dimensions and the shaft dimensions of the planned hydraulic pump (Fax No. +49-8531-319-418).

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11 / 429 e - 07.00 - 1.5 Printed in Germany