

## 6.06 Cooling Water Systems

The water cooling can be arranged in several configurations, the most common system choice being:

- A low temperature seawater cooling system Fig. 6.06.01, and a freshwater cooling system only for jacket cooling Fig. 6.06.03
- A central cooling water system, with three circuits: a seawater system, a low temperature freshwater system for central cooling Fig. 6.07.01, and a high temperature freshwater system for jacket water.

The advantages of the *seawater cooling* system are mainly related to first cost, viz:

- Only two sets of cooling water pumps (seawater and jacket water)
- Simple installation with few piping systems.

Whereas the disadvantages are:

- Seawater to all coolers and thereby higher maintenance cost
- Expensive seawater piping of non-corrosive materials such as galvanised steel pipes or Cu-Ni pipes.

The advantages of the *central cooling system* are:

- Only one heat exchanger cooled by seawater, and thus, only one exchanger to be overhauled
- All other heat exchangers are freshwater cooled and can, therefore, be made of a less expensive material
- Few non-corrosive pipes to be installed
- Reduced maintenance of coolers and components
- Increased heat utilisation.

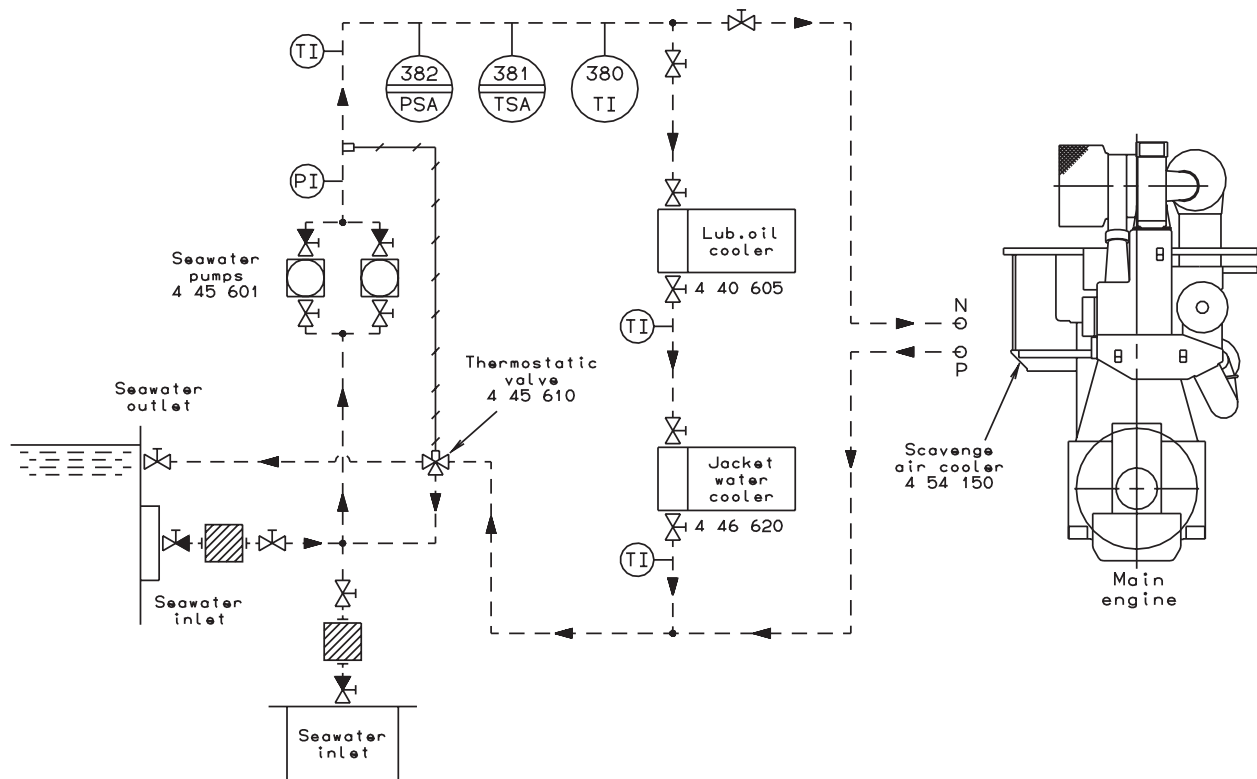
whereas the disadvantages are:

- Three sets of cooling water pumps (seawater, freshwater low temperature, and jacket water high temperature)
- Higher first cost.

An arrangement common for the main engine and MAN B&W Holeby auxiliary engines is available on request.

For further information about common cooling water system for main engines and auxiliary engines please refer to our publication:

P. 281 Uni-concept Auxiliary Systems for Two-stroke Main Engine and Four-stroke Auxiliary Engines.



The letters refer to “List of flanges”

178 15 01-4.0

Fig. 6.06.01: Seawater cooling system

## Seawater Cooling System

The seawater cooling system is used for cooling, the main engine lubricating oil cooler (4 40 605), the jacket water cooler (4 46 620) and the scavenge air cooler (4 54 150).

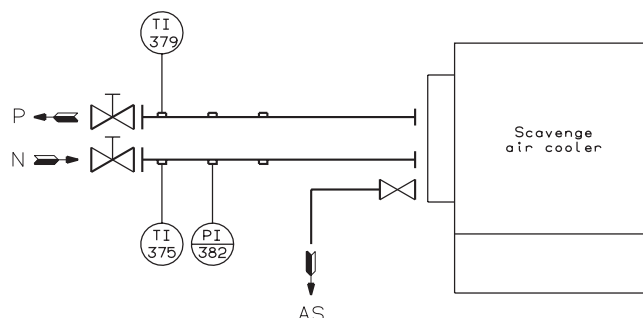
The lubricating oil cooler for a PTO step-up gear should be connected in parallel with the other coolers. The capacity of the SW pump (4 45 601) is based on the outlet temperature of the SW being maximum 50 °C after passing through the coolers – with an inlet temperature of maximum 32 °C (tropical conditions), i.e. a maximum temperature increase of 18 °C.

The valves located in the system fitted to adjust the distribution of cooling water flow are to be provided with graduated scales.

The inter-related positioning of the coolers in the system serves to achieve:

- The lowest possible cooling water inlet temperature to the lubricating oil cooler in order to obtain the cheapest cooler. On the other hand, in order to prevent the lubricating oil from stiffening in cold services, the inlet cooling water temperature should not be lower than 10 °C
- The lowest possible cooling water inlet temperature to the scavenge air cooler, in order to keep the fuel oil consumption as low as possible.

The piping delivered with and fitted onto the engine is, for your guidance shown on Fig. 6.06.02.



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The letters refer to "List of flanges"  
 The pos. numbers refer to "List of instruments"  
 The piping is delivered with and fitted onto the engine

Fig. 6.06.02: Cooling water pipes, air cooler, one turbocharger

## Components for seawater system

### Seawater cooling pump (4 45 601)

The pumps are to be of the centrifugal type.

Seawater flow . . . . . see "List of capacities"  
 Pump head . . . . . 2.5 bar  
 Test pressure . . . . . according to class rule  
 Working temperature . . . . . maximum 50 °C

The capacity must be fulfilled with a tolerance of between 0% to +10% and covers the cooling of the main engine only.

### Lub. oil cooler (4 40 605)

See chapter 6.03 "Uni-Lubricating oil system".

### Jacket water cooler (4 46 620)

The cooler is to be of the shell and tube or plate heat exchanger type, made of seawater resistant material.

Heat dissipation . . . . . see "List of capacities"  
 Jacket water flow . . . . . see "List of capacities"  
 Jacket water temperature, inlet . . . . . 80 °C  
 Pressure drop  
 on jacket water side . . . . . maximum 0.2 bar  
 Seawater flow . . . . . see "List of capacities"  
 Seawater temperature, inlet . . . . . 38 °C  
 Pressure drop on SW side . . . . . maximum 0.2 bar

The heat dissipation and the SW flow are based on an MCR output at tropical conditions, i.e. SW temperature of 32 °C and an ambient air temperature of 45 °C.

### Scavenge air cooler (4 54 150)

The scavenge air cooler is an integrated part of the main engine.

Heat dissipation . . . . . see "List of capacities"  
 Seawater flow . . . . . see "List of capacities"  
 Seawater temperature,  
 for SW cooling inlet, max. . . . . 32 °C  
 Pressure drop on  
 cooling water side. . . . . between 0.1 and 0.5 bar

The heat dissipation and the SW flow are based on an MCR output at tropical conditions, i.e. SW temperature of 32 °C and an ambient air temperature of 45 °C.

### Seawater thermostatic valve (4 45 610)

The temperature control valve is a three-way valve which can recirculate all or part of the SW to the pump's suction side. The sensor is to be located at the seawater inlet to the lubricating oil cooler, and the temperature level must be a minimum of +10 °C.

Seawater flow . . . . . see "List of capacities"  
 Temperature range,  
 adjustable within . . . . . +5 to +32 °C

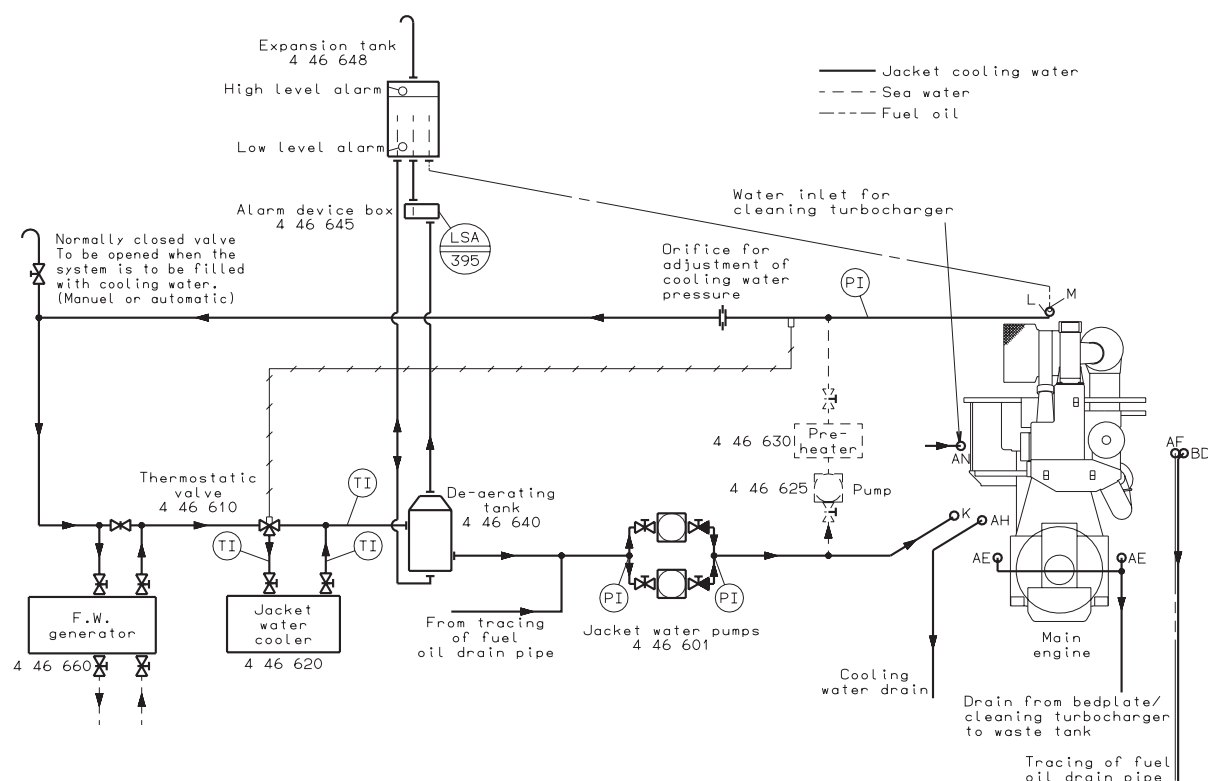


Fig. 6.06.03: Jacket cooling water system

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## Jacket Cooling Water System

The jacket cooling water system, shown in Fig. 6.06.03, is used for cooling the cylinder liners, cylinder covers and exhaust valves of the main engine and heating of the fuel oil drain pipes.

The jacket water pump (4 46 601) draws water from the jacket water cooler outlet and delivers it to the engine.

At the inlet to the jacket water cooler there is a thermostatically controlled regulating valve (4 46 610), with a sensor at the engine cooling water outlet, which keeps the main engine cooling water outlet at a temperature of 80 °C.

The engine jacket water must be carefully treated, maintained and monitored so as to avoid corrosion, corrosion fatigue, cavitation and scale formation. It is recommended to install a preheater if preheating is not available from the auxiliary engines jacket cooling water system.

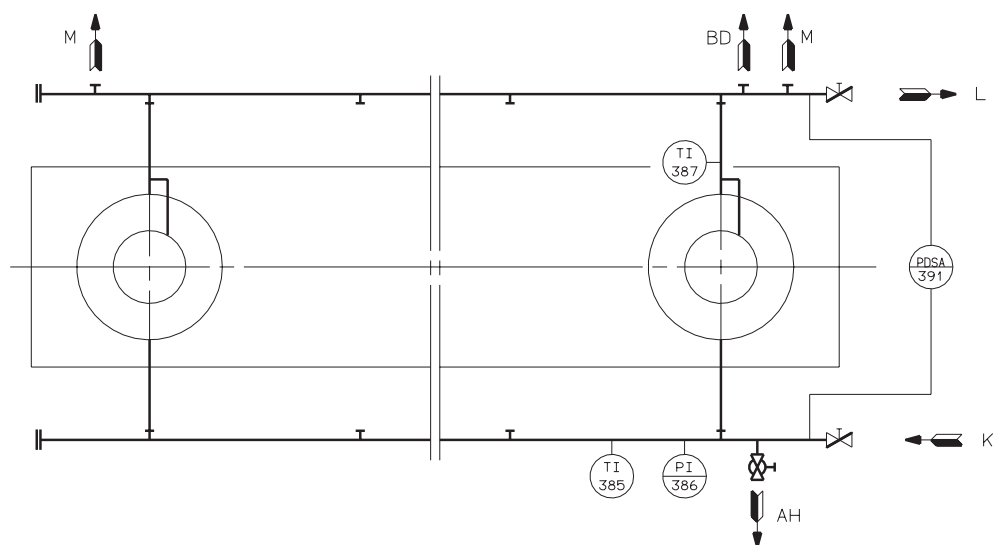
The venting pipe in the expansion tank should end just below the lowest water level, and the expansion tank must be located at least 5 m above the engine cooling water outlet pipe.

MAN B&W's recommendations about the fresh-water system de-greasing, descaling and treatment by inhibitors are available on request.

The freshwater generator, if installed, may be connected to the seawater system if the generator does not have a separate cooling water pump. The generator must be coupled in and out slowly over a period of at least 3 minutes.

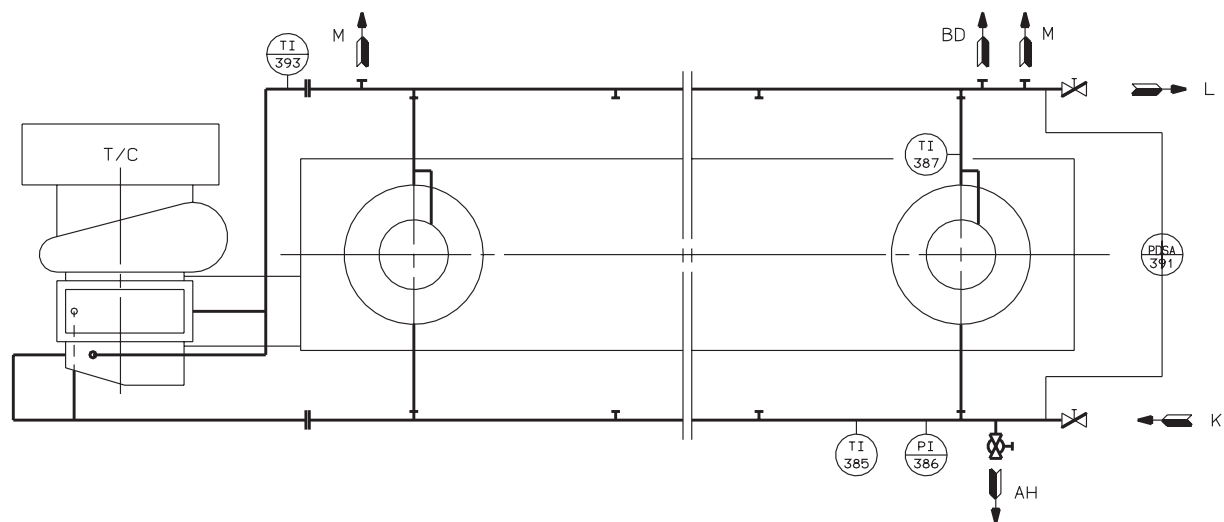
For external pipe connections, we prescribe the following maximum water velocities:

Jacket water	3.0 m/s
Seawater	3.0 m/s



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Fig. 6.06.04a: Jacket water cooling pipes for uncooled turbochargers



The letters refer to "List of flanges"  
 The pos. numbers refer to "List of instruments"  
 The piping is delivered with and fitted onto the engine

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Fig. 6.06.04b: Jacket water cooling pipes for water cooled turbochargers

The sensor is to be located at the outlet from the main engine, and the temperature level must be adjustable in the range of 70-90 °C.

**Jacket water cooling pump (4 46 601)**

The pumps are to be of the centrifugal type.

Jacket water flow . . . . . see “List of capacities”  
Pump head . . . . . 3.0 bar  
Delivery pressure . . . . . depends on position  
of expansion tank  
Test pressure . . . . . according to class rule  
Working temperature, . normal 80 °C, max. 100 °C

The capacity must be met at a tolerance of 0% to +10%.

The stated capacities cover the main engine only. The pump head of the pumps is to be determined based on the total actual pressure drop across the cooling water system.

**Freshwater generator (4 46 660)**

If a generator is installed in the ship for production of freshwater by utilising the heat in the jacket water cooling system it should be noted that the actual available heat in the jacket water system is **lower** than indicated by the heat dissipation figures given in the “List of capacities.” This is because the latter figures are used for dimensioning the jacket water cooler and hence incorporate a safety margin which can be needed when the engine is operating under conditions such as, e.g. overload. Normally, this margin is 10% at nominal MCR.

The calculation of the heat actually available at specified MCR for a derated diesel engine is stated in chapter 6.01 “List of capacities”.

### Jacket water thermostatic valve (4 46 610)

The temperature control system can be equipped with a three-way valve mounted as a diverting valve, which by-pass all or part of the jacket water around the jacket water cooler.

**Jacket water preheater (4 46 630)**

When a preheater see Fig. 6.06.03 is installed in the jacket cooling water system, its water flow, and thus the preheater pump capacity (4 46 625), should be about 10% of the jacket water main pump capacity. Based on experience, it is recommended that the pressure drop across the preheater should be approx. 0.2 bar. The preheater pump and main pump should be electrically interlocked to avoid the risk of simultaneous operation.

The preheater capacity depends on the required preheating time and the required temperature increase of the engine jacket water. The temperature and time relationships are shown in Fig. 6.06.05.

In general, a temperature increase of about 35 °C (from 15 °C to 50 °C) is required, and a preheating time of 12 hours requires a preheater capacity of about 1% of the engine's nominal MCR power.

**Deaerating tank (4 46 640)**

Design and dimensions are shown on Fig. 6.06.06 “Deaerating tank” and the corresponding alarm device (4 46 645) is shown on Fig. 6.06.07 “Deaerating tank, alarm device”.

**Expansion tank (4 46 648)**

The total expansion tank volume has to be approximate 10% of the total jacket cooling water amount in the system.

As a guideline, the volume of the expansion tanks for main engine output are:

Between 2,700 kW and 15,000 kW . . . . . 1.00 m<sup>3</sup>

## Fresh water treatment

The MAN B&W Diesel recommendations for treatment of the jacket water/freshwater are available on request.

## Temperature at start of engine

In order to protect the engine, some minimum temperature restrictions have to be considered before starting the engine and, in order to avoid corrosive attacks on the cylinder liners during starting.

### Normal start of engine

Normally, a minimum engine jacket water temperature of 50 °C is recommended before the engine is started and run up gradually to 90% of specified MCR speed.

For running between 90% and 100% of specified MCR speed, it is recommended that the load be increased slowly – i.e. over a period of 30 minutes.

### Start of cold engine

In exceptional circumstances where it is not possible to comply with the abovementioned recommendation, a minimum of 20 °C can be accepted before the engine is started and run up slowly to 90% of specified MCR speed.

However, before exceeding 90% specified MCR speed, a minimum engine temperature of 50 °C should be obtained and, increased slowly – i.e. over a period of least 30 minutes.

The time period required for increasing the jacket water temperature from 20 °C to 50 °C will depend on the amount of water in the jacket cooling water system, and the engine load.

#### Note:

The above considerations are based on the assumption that the engine has already been well run-in.

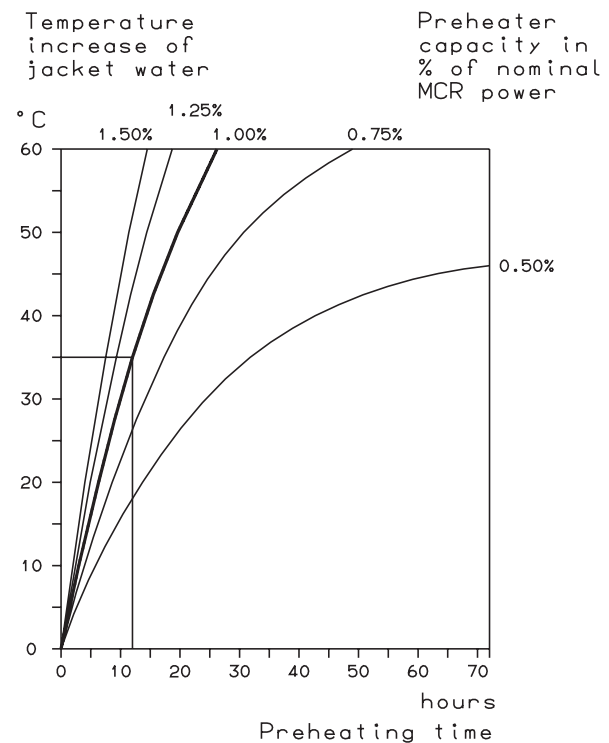


Fig. 6.06.05: Jacket water preheater

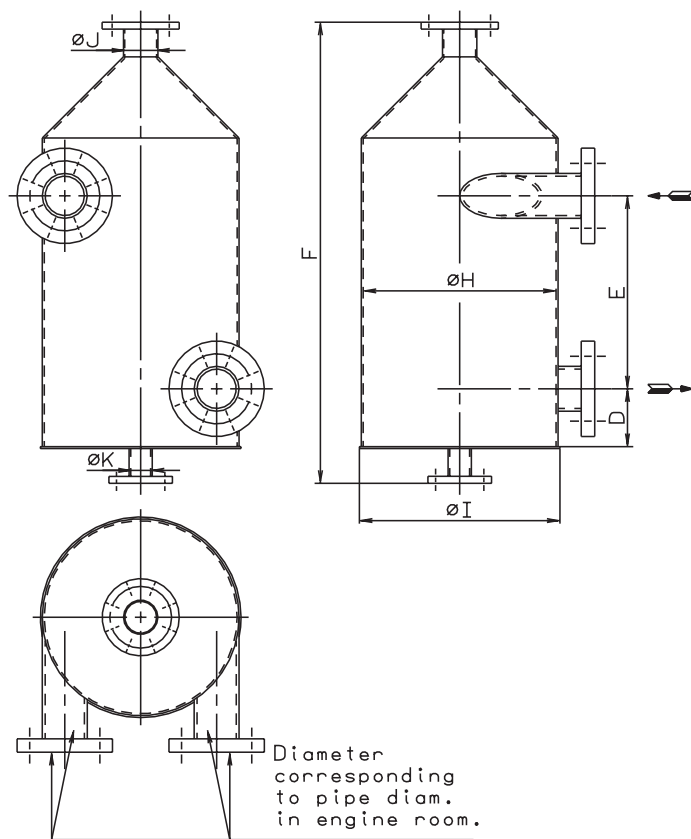
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## Preheating of diesel engine

### Preheating during standstill periods

During short stays in port (i.e. less than 4-5 days), it is recommended that the engine is kept preheated, the purpose being to prevent temperature variation in the engine structure and corresponding variation in thermal expansions and possible leakages.

The jacket cooling water outlet temperature should be kept as high as possible and should – before starting-up – be increased to at least 50 °C, either by means of cooling water from the auxiliary engines, or by means of a built-in preheater in the jacket cooling water system, or a combination.



Dimensions in mm	
Tank size	0.05 m <sup>3</sup>
Maximum J.W. capacity	120 m <sup>3</sup> /h
Maximum nominal bore	125
D	150
E	300
F78	910
$\varnothing H$	300
$\varnothing I$	320
$\varnothing J$	ND 50
$\varnothing K$	ND 32

ND: Nominal diameter

Working pressure is according to actual piping arrangement.

In order not to impede the rotation of water, the pipe connection must end flush with the tank, so that no internal edges are protruding.

Fig. 6.06.06: Deaerating tank, option: 4 46 640

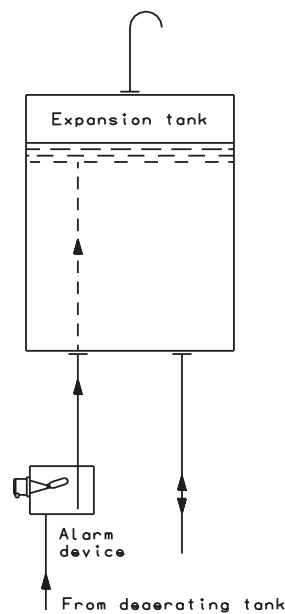
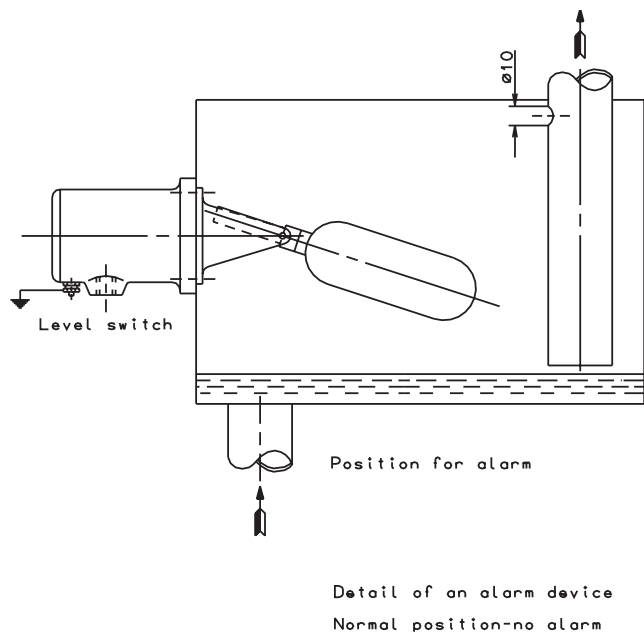


Fig. 6.06.08: Deaerating tank, alarm device, option: 4 46 645