OPTIMISE YOUR ENGINE COOLING SYSTEM

CALCULATIONS ON COST AND ENERGY SAVINGS IN GRUNDFOS PUMP SYSTEMS VS. STANDARD SYSTEMS
**OPTIMISE YOUR ENGINE COOLING SYSTEM**

Save both energy and money with Grundfos pump control units

Vessel owners can optimise engine cooling systems with a Grundfos solution that controls pump speed according to seawater temperature and load on main engine and auxiliaries, saving up to 50-90% in energy and its related costs, as this study shows.

Marine engine cooling system pumps run at full speed all the time regardless of operating conditions. Whether a vessel sails in the warm Persian Gulf or the cold Atlantic Ocean and regardless of whether the vessel is slow steaming or operating at full speed, the pumps carry a constant flow of seawater to the cooling system. Most importantly, it means that vessel owners waste both energy and money.

**How it works**

In the main propulsion engine on a ship, standard cooling systems begin with a seawater cooling cycle. The system’s pumps bring in seawater, chilling a closed, freshwater circuit.

Marine classification rules require system design to be based on 32°C. When the seawater is colder, the system needs less of it. If the seawater is 15°C, for instance, the cooling system needs less water flow. By controlling the operation of the cooling water pumps according to your actual needs, you save a lot of energy and money. Marine classification rules require system design to be based on a sea water temperature of 32°C and 100% full speed on main engine and auxiliary equipment. When the seawater is colder and/or the load is less than 100% full speed, water can be reduced and money saved.

**Big savings**

Grundfos intelligent pump control units use frequency converters to control the speed of a vessel’s cooling pumps according to the temperature of the sea. The units can be mounted to existing cooling systems and can control the speed of any Grundfos pump, new or old, irrespective of size and power range.

This paper presents the results from a study showing potential savings on two different engine cooling systems – on a 4700 TEU container vessel and a 17000 DWt vessel.

**GRUNDFOS ENGINE COOLING SOLUTIONS**

**Expertise leads the way**

Speed control with frequency converters has been part of the Grundfos portfolio for 25 years. The advanced controls are part of Grundfos’ comprehensive E-solution programme of speed-controlled pump systems, developed to make way for more energy-efficient operations.

**Cost-efficient, superior features**

The Grundfos pump controls offer:

- Automatic speed-control of cooling pumps according to seawater temperature
- Annual savings of up to 50-90%
- Unmatched performance and reliability
- Easy installation (plug and play)
- Low life cycle costs
- User-friendly interface

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**VLS**

Ideal for seawater and freshwater cooling.

**FREQUENCY CONVERTER**

Designed for speed control.

**GRUNDFOS PUMP CONTROL UNIT**

Reduces energy use with frequency converters, which control the speed of a vessel’s cooling pumps according to the temperature of the sea.
Here, we calculate the potential energy and cost savings with a Grundfos cooling water system aboard a 4700 TEU container vessel. The vessel’s main engine is MAN 6S80 ME, Tier II. The vessel has five auxiliary engines.

The basis for determining the pumps’ sizes is based on the cooling requirements for the main engine and the auxiliary engines only.

**STANDARD SYSTEM VS. GRUNDFOS OPTIMISED SYSTEM**

The standard engine cooling system consists of both a sea water cooling cycle and two fresh water cooling cycles. Each cycle has two pumps, one duty and one standby. The pumps in this system operate continuously at 100% load and the temperature of the cooling water in each freshwater cycle is controlled by the two 3-way valves.

In the Grundfos optimised system the cooling pumps are controlled by frequency drives, along with additional valves and instruments. Furthermore the operating profile is divided into two: seagoing and harboring. When the vessel is at sea, the main engine and two auxiliary engines are cooled. When harboring, only two auxiliary engines are cooled.

The standard system is designed to ensure sufficient cooling of the engine at sea water temperatures of 32°C. The Grundfos optimised system fulfils requirements for 32°C and 100% load but is optimised to control and maintain a constant cooling temperature of the engine according with the water temperature. For example if the water temperature drops to 20°C, the Grundfos optimised system only uses half the energy compared to full capacity at 32°C. The sea water temperatures are often lower than 32°C, which means the cooling system needs less water flow. By controlling the operation with a frequency converter according to your needs, you can save both energy and money.

To optimise power consumption, the pump configuration changes from 2 x 100% (two pumps running 100% of the time) to 3 x 50% for both seawater and freshwater pumps.

**THE FUEL PRICES ARE:**
- Heavy Fuel Oil: $630/ton – $0.135/kWh
- Low Sulphur: $950/ton – $0.205/kWh

The specific fuel consumption on typical aux. engine is 215 g/kWh.

The annual operating hours are 8,000, divided between seagoing (6,000 hours) and harboring (2,000 hours).

<table>
<thead>
<tr>
<th>Operation costs</th>
<th>Specifications</th>
<th>Total</th>
<th>Specifications</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea water pumps</td>
<td>- power consumption: 2 x 1.250 m³/h x 25 mWc</td>
<td>120 kW</td>
<td>- power consumption: 2 x 1.950 m³/h x 25 mWc</td>
<td>150 kW</td>
</tr>
<tr>
<td>Freshwater pumps</td>
<td>- power consumption: 2 x 1.250 m³/h x 25 mWc, 8 x 1.250 m³/h x 120 mWc</td>
<td>120 kW</td>
<td>- power consumption: 2 x 1.950 m³/h x 25 mWc, 8 x 1.950 m³/h x 120 mWc</td>
<td>150 kW</td>
</tr>
<tr>
<td>Total cost per year</td>
<td>$1,395,300</td>
<td>$68,200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual cost</td>
<td>$349,820</td>
<td>$10,250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total per year</td>
<td>$419,630</td>
<td>$69,450</td>
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</tbody>
</table>

**Annual Potential savings with Grundfos optimized systems**
- Cost savings = $1,156,470
- Energy savings = 83%
Seawater pumps will be controlled so that the freshwater temperature is maintained at 36°C. On the freshwater side, the water flow to the main engine and the auxiliary engines is controlled by on/off valves, while the flow to the lube oil cooler is controlled by a control valve. With this equipment installed in the system, the freshwater pumps will be controlled to maintain a constant pressure in the system. The flow in the system is based on requirements and the power consumption is significantly reduced.

**Case 1: 4700 TEU Container Vessel**

**The principle for the pump control:**

Seawater pumps will be controlled so that the freshwater temperature is maintained at 36°C.

On the freshwater side, the water flow to the main engine and the auxiliary engines is controlled by on/off valves, while the flow to the lube oil cooler is controlled by a control valve. With this equipment installed in the system, the freshwater pumps will be controlled to maintain a constant pressure in the system. The flow in the system is based on requirements and the power consumption is significantly reduced.

**Case 2: 17000 DWT Vessel**

**Optimised Engine Cooling in a 17000 DWT Vessel**

On these pages, we calculate the potential energy and costs savings with a Grundfos-optimised engine cooling system aboard a 17000 DWT vessel. The vessel’s main engine is MAN 6S50MC6.

**Standard System vs. Grundfos Optimised System**

The standard engine cooling system consists of both a sea water cooling cycle and two fresh water cooling cycles. Each cycle has two pumps, one duty and one standby. The pumps in this system operate continuously at 100% load and the temperature of the cooling water in each freshwater cycle is controlled by the two 3-way valves.

In the Grundfos optimised system the cooling pumps are controlled by frequency drives and additional valves and instruments are installed. Furthermore the operating profile are divided into two, seagoing and harboring. When the vessels are seagoing the main engine, one auxiliary engine, the atmospheric condenser and the air conditioning units is cooled. When harboring the major consumers will be two auxiliary engines and the air-conditioning units.

The standard system is designed to ensure sufficient cooling of the engine at sea water temperatures of 32°C. The Grundfos optimised system fulfills requirements for 32°C and 100% load but is optimised to control and maintain a constant cooling temperature of the engine according with the water temperature. For example if the water temperature drops to 20°C, the Grundfos optimised system only uses half the energy compared to full capacity at 32°C. The sea water temperatures are often lower than 32°C, which means the cooling system needs only half as much water flow. By controlling the operation with a frequency converter according to your needs, you can save both energy and costs.

The calculation is based on the assumptions that:

- **The fuel prices are:**
  - Heavy Fuel Oil: $630/ton – $0.135/kWh
  - Low Sulphur: $950/ton – $0.205/kWh

- The specific fuel consumption on typical aux. engine is 215 g/kWh.
- The annual operating hours are 6,000, divided between sea going (5,000 hours) and harboring (1,000 hours).

**The principle for the pump control:**

Seawater pumps will be controlled so that the freshwater temperature is maintained at 36°C.

On the freshwater side, the water flow to the main engine and the auxiliary engines will be controlled by on/off valves, the flow to the atmospheric condenser will be controlled by a self-regulating valve and the flow to the air conditioning units will be adjusted by frequency drives for the booster. With this equipment installed in the system the freshwater pumps will controlled to maintain a constant pressure in the system. The flow in the system is based on requirements and the power consumption is significantly reduced.
**CASE 2: 17000 DWT VESSEL**

### POTENTIAL SAVINGS

<table>
<thead>
<tr>
<th>Operation costs</th>
<th>Specifications</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seawater pumps</td>
<td>2 x 30 m³/h x 20 mW</td>
<td>164,200 kWh</td>
</tr>
</tbody>
</table>

- **Total cost per year:** $194,200

<table>
<thead>
<tr>
<th>Annual cost</th>
<th>Seawater pumps: $194,200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harboring</td>
<td>$11,014</td>
</tr>
</tbody>
</table>

- **Total per year:** $205,214

**Cost savings:** $79,206

**Energy savings:** 71%

### SET SAIL WITH A RELIABLE PARTNER

As your marine pump supplier, Grundfos offers global presence, solid know-how and high quality, thanks to more than 65 years of experience in the pump business.

*Get your spare parts in 24 hours*

When you are sailing the seven seas, Grundfos is never far away. With more than 70 sales and service companies in more than 50 countries, you are guaranteed local service and support in your native language whenever you need it. Thanks to our close cooperation with international express transport companies, we can get spare parts to any port in the world within 24 hours. This reduces the risk of downtime onboard your ship and offers peace of mind to both ship owners and engineers. Should a more critical problem occur, a Grundfos service specialist will meet you at the nearest port to find a solution.

**Customised solutions**

All Grundfos marine pumps can be adapted to meet individual customer requirements. In fact, we can manufacture more than a million different variants of our standard products – and we add new variants to that number every day. Every year, we devote 5% of our turnover to research and development, striving to push the boundaries in pump technology and bringing to life the pumps of tomorrow. This is why we are confident that you, too, will find a unique solution for your application within our extensive and already thoroughly-tested range.

**Savings in the long run**

In a highly competitive market, it is natural to focus on price. Experience shows, however, that on average the purchase price of a pump amounts to just 5–10% of the total cost – while as much as 90% stems from the energy the pump uses in operation. This is why one of our main objectives when developing new products is to ensure low energy consumption – consequently reducing your operating costs.

**Grundfos Facts**

- 60 sales and service companies in 56 countries
- 580 certified service partners worldwide
- 18,000+ employees
- More than 16 million pumps produced every year
- 5% of turnover dedicated to R&D

**www.grundfos.com/marine**

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**COST ANALYSIS**

This graph illustrates the cost savings achieved by this system optimisation. Over five years, the standard system will cost $336,080, whereas the Grundfos system will cost $155,650. A total saving of $180,430.