NISSENS' **WATER-COOLED CHARGE AIR COOLER**

NISSENS' WCAC

WCAC is short for Water-cooled Charge Air Cooler. A water-cooled charge air cooler is a charge air cooler, where the charge air is cooled by a coolant, and not by the passing air. A traditional cooler is designed to provide maximum cooling whenever necessary, but under normal circumstances only approximately 70-80% of the maximum cooling capacity is required. An optimal solution is thus a combination cooler like Nissens' WCAC, since the size of the cooler may be reduced significantly without affecting the efficiency.

NISSENS WCAC

With more than 90 years of experience, Nissens feels a strong commitment to keeping a constant focus on development and improvement within all our product segments. Our comprehensive pool of technical knowledge and in-depth know-how within cooling has enabled us to develop a cooling concept that is superior to the traditional charge air coolers.

Nissens' WCAC takes the traditional cooling principle to an entirely new level by adding essential competitive advantages for our widespread portfolio of global customers. Our cooling solution is based upon the principles of water-cooled charge air, providing more efficient cooling, smaller sizes and improved ease of installation. The benefits of Nissens' WCAC offers numerous new possibilities to the engine manufacturers.

In principle, Nissens' WCAC is a charge air cooling system where the air is cooled by means of a coolant from a low temperature cooler instead of cooling air as in a conventional system. Nissens' WCAC is a recognized and highly demanded product, which has proved its performance in demanding applications like gen-sets, marine engines and large diesel engines. It can be integrated into several cooling systems; indirect and direct cooling systems, retarder systems and heating systems. The WCAC system offers various benefits depending on different application specifics, and is renowned for offering the following benefits:

- **Reduced fuel consumption**
- **Reduced noise levels**
- **Faster engine response**
- **More stable fan operation**
- **Reduced fan requirements**
- **Lower pressure drop on charge air**
- **More compact installation**
- **More stable charge air temperature**
- **Easier compliance with the Euro 6/Tier 4F regulations**

To learn more about potential benefits and possible configurations of the WCAC system from Nissens, please contact our engineering support, or visit our website at www.nissens.com.

Why choose Nissens' WCAC?

COMPACT DESIGN

Every single design element of the WCAC product is subject to careful assessment; and professional technical considerations has been given to shape, size and weight of this compact cooling package throughout the design process, since they play a crucial role when the package is mounted in a cooling system in a given industrial application or installation. The compact design of Nissens' WCAC offers a space-saving solution, when it is implemented in the cooling system just as it facilitates easy transportation and storage.

LOW WEIGHT

Thanks to the product-technical selections that have been made in relation to optimized materials for the construction of Nissens' WCAC, the product weight is very low. The light-weight material, aluminum, gives a significant cost-saving benefit, when the WCAC is installed in a given industrial application or installation. Furthermore, the low weight of this product enables simple and easy installation.

PREMIUM DURABILITY

The proven performance of Nissens' WCAC is achieved thanks to an optimal material and component selection – all materials and components are thoroughly tested in our in-house test facilities and are subject to approval by Nissens. The product design, as well as applied raw materials with specially selected long-life alloys, have gone through a careful examination process to ensure a strong, durable construction guaranteeing a long product life and trouble-free operation.

HIGH COOLING EFFICENCY

Our WCAC solution is a very complex and balanced construction offering a high cooling efficiency. Based on more than 90 years of experience, we have profited from our comprehensive technical knowledge and experience from the automotive industry. Nissens' WCAC consists of a pack construction, where all elements are brazed together, which creates a strong, solid structure with plates equipped with turbulators intertwined with fins. The optimally fitted fins between the flow channels are additionally equipped with louvres that offer extended heat exchange and a significantly higher cooling performance.

FLEXIBILITY

Nissens' WCAC is designed in a modular way, making it easy to customize a solution that meets a customer's specific requirements and needs for dimensioning. Customized dimensioning makes it possible to calculate the optimal product size in terms of cooling need, pressure drop and space requirements, when the WCAC is implemented into the engine compartment. Since the WCAC is a customized solution offering a high level of flexibility in the vital design phase, the WCAC offers the possibility of creating an even better engine layout in the individual application or installation.

Nissens®
DELIVERING THE DIFFERENCE

WCAC PRODUCT-TECHNICAL FEATURES

Nissens' WCAC offers numerous product-technical features that distinguish this product from the traditional air-to-air charge air coolers. Below we have indicated relevant technical information on the product. However, since Nissens' WCAC is a flexible concept that offers customization to meet any customer-specific requirements, we invite our customers to contact our experienced sales & project team for information and advice of the possibilities that Nissens' WCAC offers.

ACCORDANCE WITH INTERNATIONAL STANDARDS

The WCAC is designed and manufactured according to the Pressure Equipment Directive PED 97/23/EC article 3.3

OPERATIONAL CONDITIONS

Work load – charge air	80 kPa (a) - 480 kPa (a)
Work load - coolant	80 kPa (a) - 300 kPa (a)
Temperature range – charge air	-40°C to 250°C
Temperature range - coolant	-40°C to 130°C

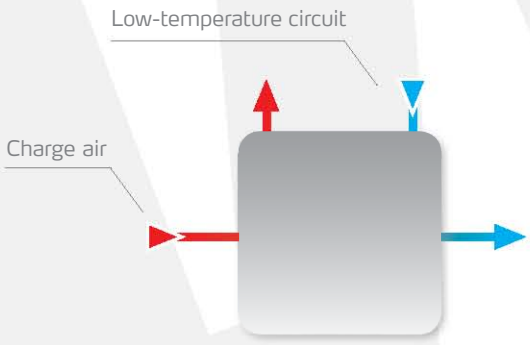
COOLING MEDIUM

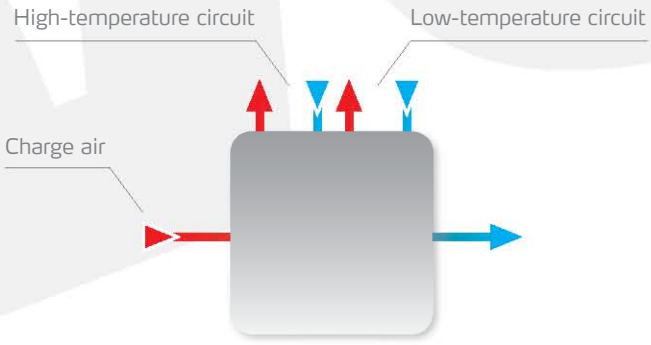
Mixture of water and ethylene or propylene glycol (minimum 30% glycol)

STANDARDIZED RANGE OF CONNECTION TYPES

Coolant side	**Socket:** G½" - G1½"
	Hose connection: Ø25-Ø50
Charge air side	**Cast connection -** project/application specific

CONNECTION CONFIGURATIONS





HOW DOES A WCAC SYSTEM WORK

A WCAC system is in principle a charge air cooling system, where the charge air is cooled by means of coolant from a low-temperature radiator. In a WCAC system, the individual coolers help each other, depending on the engine load profile. A charge air cooler is designed for a maximum power at 25°C ambient temperature. This means that the fan in a normal system has to operate at maximum power already from 25°C ambient temperature. However, the design ambient temperature for the engine radiator is typically around 50°C, and the fan will thus cool the water circuit down to a temperature that is well below what is actually required. It is inexpedient to have the fan run at a high speed, since this increases the power consumption and the noise.

In order to avoid such inconveniences, Nissens' WCAC offers the right solutions since the high-temperature cooler, called an HT cooler, and the low-temperature cooler, called an LT cooler in the WCAC system, help each other, and that results in a reduced fan speed, lower power consumption and reduced noise.

A normal cooling system has to be designed to meet the maximum possible cooling requirements at any time and under any conditions. For some cooling applications, a combi-cooler does not use the maximum cooling effect on all circuits at the same time. This means that by applying the WCAC system, the size of the cooling units may in some cases be reduced by 20-30%; and with less power put into the fan drives, Nissens' WCAC offers important benefits.

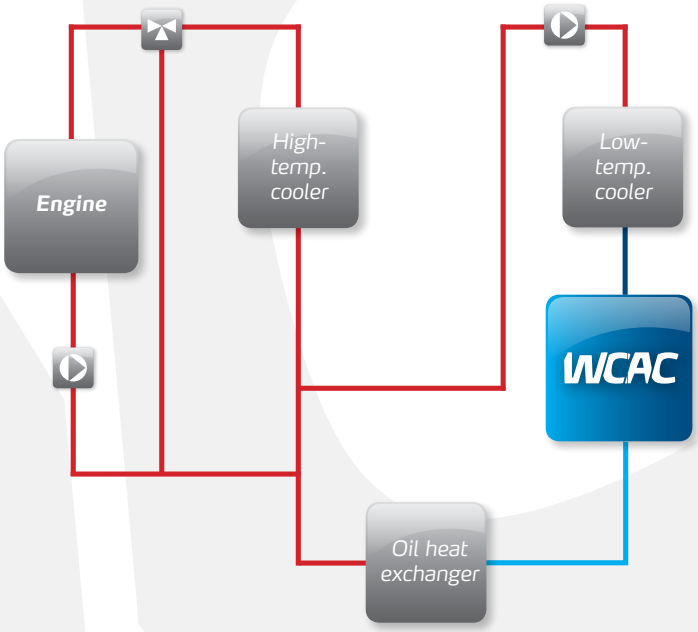
ADVANTAGES OF THE SYSTEM

Nissens' WCAC is a product which offers proven performance in a large variety of demanding applications such as gen-sets, marine engines and large diesel engines. The system advantages of a WCAC system can differ from one application to another.

One of the advantages is a significant **reduction in fuel consumption**. Inertia in the system creates a smoother fan operation, and this reduction in fan power leads to a considerable **noise reduction**. The actual reduction depends on the load of the engine, since the noise level will drop concurrently with the loads on the engine. The noise level will, however, at any time be lower compared to a conventional cooling system.

Furthermore, the **reduced pressure drop of charge air** will increase the efficiency and thus reduce the fuel consumption, which is an important feature that supports our customers' focus on Total Cost of Ownership.

Example of a WCAC system layout



In addition, the WCAC system from Nissens is designed to comply with the applicable emission standards (Euro 6/Tier 4F), since a constant, lower charge air temperature leads to **lower emission levels**. This offers a vital contribution to ensuring environmental benefits and an increasing green focus in the market.

OTHER APPLICATIONS OF THE WCAC SYSTEM

In case our customer's vehicle is equipped with a retarding unit, both the high-temperature and the low-temperature radiators can be used for cooling the retarder. This means that the retarder can be used more efficiently and during longer decelerations without overheating and without exposing the vehicle's normal braking system to wear.

Nissens' WCAC system offers a number of alternative cooling or heating options. Utilization of the charge air energy in the heating circuits for vehicles equipped with auxiliary heating equipment, e.g. city busses, will provide significant fuel savings and support a growing concern for assuming an environmental responsibility.

Cooling system components, cooling modules and complete cooling systems for any industrial application

ON- & OFF-ROAD APPLICATIONS

We offer cooling solutions for excavators, dozers, mining and drilling rigs, forestry equipment, agricultural equipment, crushing and processing, material handling, trucks and busses, construction equipment, road construction equipment, trains and special compressors. Our cooling solutions cover different cooling needs:

Direct systems:

- Engine cooling
- Oil cooling
- Fuel cooling

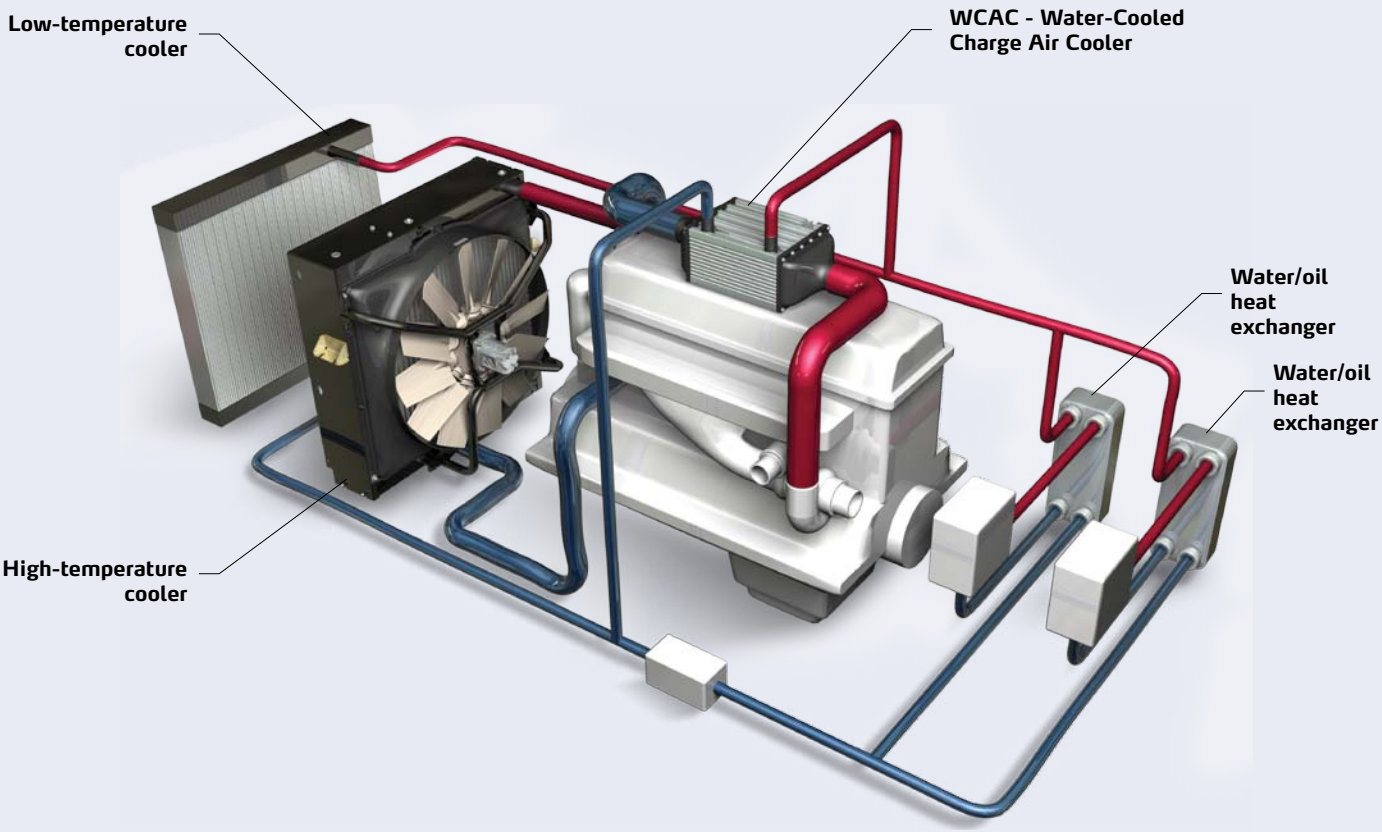
Indirect systems:

- Water-cooled CAC
- Heat exchangers
- Low-weight water coolers

PRODUCT PORTFOLIO

- Radiators
- Charge air coolers
- WCAC – Water-Cooled Charge Air Coolers
- Oil coolers
- Fuel coolers
- Trafo oil coolers
- Condensers
- Water/oil heat exchangers

TYPICAL COOLING SYSTEMS DEVELOPED BY NISSENS FOR AN ON- & OFF-ROAD APPLICATION:



Delivering The Difference

Our passion for cooling and climate solutions is fundamental to promote our customers' growth and success. Nissens focuses on meeting the needs of our customers and Delivering the Difference.

For several decades, Nissens has supplied thousands of cooling components and cooling systems for industrial applications in the on- & off-road business segments as well as in the global wind turbine industry.

Our global footprint allows us to combine our in-depth knowledge of products and applications with the characteristics and needs of the markets across all continents. We know cooling, and we are ready to offer you an excellent cooling solution.

For years, we have built a comprehensive portfolio of customers - some of them are:

- **Atlas Copco**
- **Bomag**
- **Bosch Rexroth**
- **Cargotec Group**
- **FPT**
- **Liebherr**
- **Manitou**
- **MTU**
- **General Dynamics Land Systems**
- **Ponsse**
- **Sandvik Group**
- **Siemens**
- **VDL Group**
- **Vestas**
- **Volvo**
- **Wirtgen**
- **ZF**

...and many more

On- & Off-Road & Wind

- **Customized and innovative cooling solutions for leading OEMs**
- **Coolers, complete cooling systems and modules**
- **Wide product range for different cooling needs**

Providing our customers with customized and technically advanced cooling solutions that match any industrial application need

World-class Customization

Experience & Innovation

THE DIFFERENCE

Global Support & Supply

Quality & Technology

Ensuring sales and technical support to our customers in local regions combined with fast and smooth deliveries

- **Production and engineering support** in USA, China and Europe:
  - local sales and technical support
  - EDI solutions
  - a reliable logistics network

On- & Off-Road & Wind

Experience
- 25 years of experience in the wind industry
- More than 4,500 MW offshore installations
- Short time to market

Innovation
- TCO optimization - reduced energy consumption and maintenance
- Reduced top head mass through low-weight products

Wind

Experience
- 50+ years of experience in the on & off-road industry
- Proven application knowledge
- Compliance with Euro 6 / Tier 4F even in space-constrained surroundings

Innovation
- Reduced fuel consumption
- Lower noise level
- Reduced fan requirements
- Reduced weight and surface of the cooling system

On- & Off-Road

Offering our customers the right and innovative solution on the first try and reducing the time to market

Limiting the risk of product failure and the occurrence of quality issues by virtue of proven performance

- In-house design & test center - prototypes in 3 weeks
- Superior reliability – up to 20 years' design life time
- Products manufactured according to DIN EN 15085-2
- Certified according to the strict automotive ISO 9001 / TS 16949 standards

On- & Off-Road

- In-house design & test center - prototypes in 3 weeks
- Superior reliability – 20/30 years' design life time
- Certified according to the strict automotive ISO 9001 / TS 16949 standards

Wind

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SLOVAKIA
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