LAUDA

WHITEPAPER

ENERGY-EFFICIENT COOLING FOR INDUSTRIAL SYSTEMS AND MACHINES

Contents

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Industrial lasers must be cooled permanently in order to ensure consistent quality. Circulation chillers are perfect for this application.

Energy consumption during continuous operation

Industrial process circulation chillers are usually used to dissipate process heat from different systems during continuous operation. If these chillers are capable of partial load operation, in the best case scenario, they can save half the energy required and make considerable cost savings.

Typical application areas for process circulation chillers include the printing industry, metal processing, laser technology and UV exposure. The energy consumed during continuous operation can sometimes incur astronomical electricity costs for the user. It therefore makes sense to examine the operating conditions closely and determine any scope for potential energy savings before purchasing a chiller.

Another typical application area for process circulation chillers is the printing industry.

1 Quantifying energy efficiency

Energy efficiency is quantified using EER and SEPR values, which are defined in the Ecodesign Directive of the European Union. Ecodesign Directive 2009/125/EC was created as a framework for defining requirements relating to the environmentally compatible design of energy-related products (ErP). High-temperature (HT 7 °C) process circulation chillers are also affected by this Directive. However, the Directive only applies to products that are sold on the EU market. This Directive is not valid outside the EU and so standard devices with a higher energy consumption are often used in non-EU countries.

SEPR values for high-temperature chiller

	Cooling capacity	since 1/1/2018	after 1/1/2021
Air-cooled	< 400 kW	4.5	5.0
Water-cooled	< 400 kW	6.5	7.0

EER value

The EER value (Energy Efficiency Ratio) of a chiller unit is the ratio of the cooling capacity in relation to the electrical energy required at a defined operating point.

It is determined under the following measurement conditions: 35 °C outside air temperature, 27 °C inside air temperature.

EER = QK / PEL

QK: Cooling capacity
PEL: Electric power consumption

SEPR value

The EER value is used to calculate the SEPR value (Seasonal Energy Performance Ratio). The SEPR is an annual performance coefficient calculated according to criteria such as full and partial load operation at four specified ambient temperatures with a corresponding number of running hours at these temperatures. The value is calculated by dividing the annual cooling requirement by the annual electrical energy requirement.

2 Cooling requirement, partial load operation and energy consumption

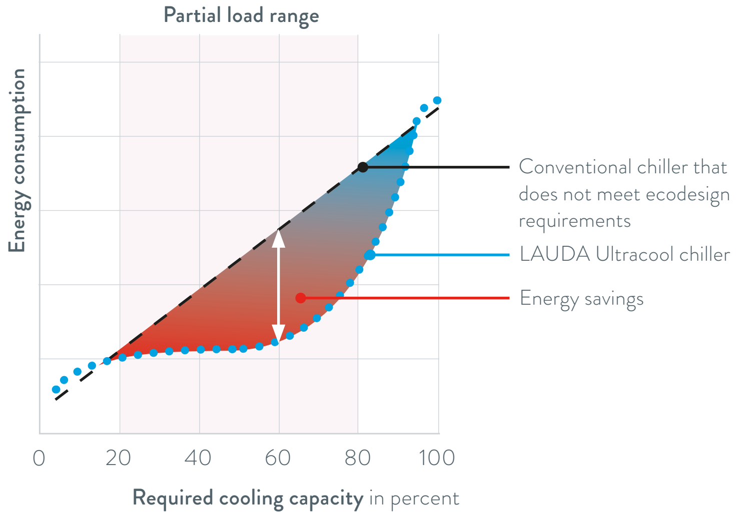
In order to estimate the energy savings for an application, the first important step is to closely examine the type of cooling requirement. A distinction must be drawn between basic consumption and energy consumption based on the specific use case. Basic consumption is needed to operate the system, while use-based energy consumption depends on the specific application situation. Factors such as cooling capacity requirements, environmental conditions, and the type and number of connected consumers play an important role here. The consumption share is also the decisive lever for greater energy efficiency.

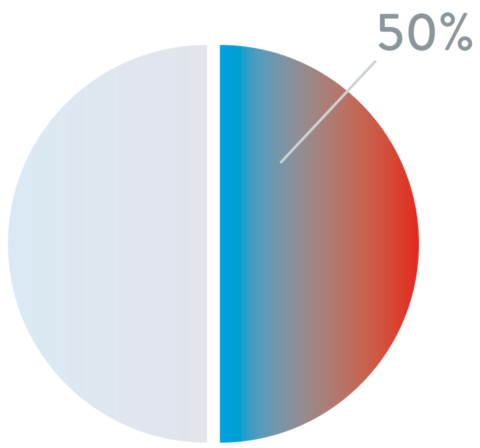
Cooling requirements using the example of digital printing

One example application is the cooling of digital printing machines, where the ink tanks are cooled and the process heat generated in the machine must be dissipated. The outflow temperature is 7 °C. This is a typical application example of a machine that experiences load changes and frequently operates at partial load. Load changes occur due to the changes in operating temperature inside the machine. Since the set point is a constant 7 °C, the refrigerating machine does not have to continuously run at maximum capacity once the temperature has been reached, but instead operates in the partial load range over a longer period. In this type of operating scenario, an energy-efficient chiller would help save energy.

A modern chiller that conforms with the EU Directive has clear advantages over older devices or products still in use and available outside the EU, which are not subject to the Directive. Some chillers exceed the required SEPR values for energy efficiency by some distance, such as the new generation of LAUDA Ultracool circulation chillers, which meet ecodesign requirements and incorporate a speed-controlled compressor, ventilator fan and electronic expansion valve.

The degree of chiller utilization is decisive in determining the amount of energy saved. The energy savings clearly demonstrate the efficiency of the new Ultracool model types from LAUDA.





Energy-efficient chillers from the LAUDA Ultracool series consume up to 50 percent less energy than conventional devices that do not meet ecodesign standards.

3 Energy and cost savings

Any investment in a system with demanding cooling requirements and high temperature fluctuations pays off more quickly. If load changes occur and the chiller frequently operates in the partial load range, significant energy and cost savings are possible. It is therefore important for the user to know the performance requirements of the chilling application as accurately as possible because it will allow him to select a chiller that is not excessively large but still capable of handling the performance peaks of the system. Costs can be saved throughout the service life of the device as a result.

Calculating cost savings

The new generation of Ultracool circulation chillers uses speed-controlled compressors, ventilator fans, and electronic expansion valves to adapt the cooling capacity directly to the respective load requirements instead of switching the refrigerating machine on and off in the usual way. This system of cooling also improves temperature stability. The higher costs of energy-efficient components quickly amortize due to the energy savings made. Use of a process circulation chiller that complies with ecodesign regulations outside the EU is both economical and sustainable.

If you know the energy consumption and procurement costs of the new LAUDA Ultracool models and chillers that use conventional technology (no speed-controlled compressor, no electronic expansion valve) with the same rated output, you can calculate and compare the amortization times.

Energy savings can be calculated using the SEPR values of both chillers: savings potential is calculated by dividing the cooling capacity by the SEPR value of a conventional chiller and subtracting the ratio of the cooling capacity in relation to the SEPR value of the energy-efficient chiller. This differential value must then be multiplied by the number of running hours to produce the energy savings:

$$\text{Energy savings} = \left(\frac{\text{Cooling capacity}}{\text{SEPR Conventional chiller}} - \frac{\text{Cooling capacity}}{\text{SEPR Energy-efficient chiller}} \right) \times \text{running hours}$$

Conventional chiller*	SEPR value	Ultracool type	SEPR value	SEPR required from 1/1/2021
8 kW	2.59	UC 8 (8 kW)	5.75	5.0
14 kW	2.79	UC 14 (14 kW)	6.41	5.0
24 kW	3.38	UC 24 (24 kW)	5.63	5.0
50 kW	3.59	UC 50 (50 kW)	5.63	5.0
65 kW	3.55	UC 65 (65 kW)	5.16	5.0

SEPR values of LAUDA Ultracool model types and equivalent conventional types

* Older devices used in the EU and conventional products available in markets outside the EU

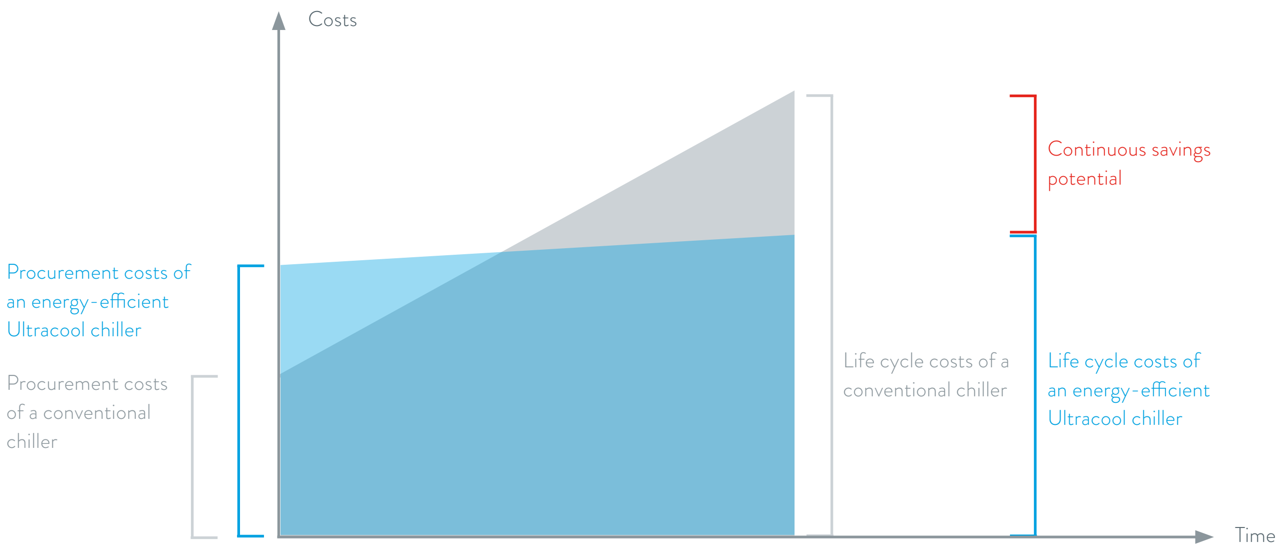
Amortization times

Savings are made due to the reduced power consumption of the respective cooler. The cost savings are a product of the energy savings and electricity costs.

LAUDA Ultracool UC 24			
Temperature profile (annual average temperatures)	Oslo/Helsinki/Stockholm (10 °C)	Amsterdam/London/Paris (15 °C)	Barcelona /Milan/Athens (20 °C)
Required cooling capacity	22 kW		
Outflow temperature	10 °C		
Energy costs	0.12 €/kWh		
Operating time per day/year	12 hrs/260 days		
Energy savings	7913 kWh/year	5384 kWh/year	2716 kWh/year
Cost saving/year	€ 950	€ 646	€ 326

The higher purchase price of an energy-efficient chiller compared to a conventional device typically amortizes between 1.5 and 2.5 years as a result of savings made from reduced energy requirements.

The customer can determine the amortization time of a modern, energy-saving circulation chiller compared to conventional devices already in operation based on calculated energy savings, lower water/glycol costs, a tank content reduced by up to 80 percent and the lower maintenance costs of the new device.



Long-term savings potential with the latest generation of energy-efficient Ultracool circulation chillers

4 Conclusion

If the cooling requirements of the application are constantly changing, energy-efficient chillers operating at partial load can reduce energy consumption by up to 50 percent, which leads to a significant reduction in operating costs and short amortization periods. The new LAUDA Ultracool process circulation chillers were developed with a focus on energy efficiency. The chillers conform with the Ecodesign Directive, which came into force across the EU on January 1/2018.
In addition to saving money, the user can also contribute to the primary objectives of the Ecodesign Directive: Reducing CO_2 emissions to help combat climate change.

Extended functionality

The speed-controlled compressor and ventilator fan, and the electronic expansion valve are all regulated by the controller using specially developed software.
The software ensures that the operating parameters are adapted perfectly to the cooling output requirements in order to achieve maximum energy efficiency.
The use of modern refrigeration technology can reduce the tank volume by up to 80 percent. The lower volume of heat transfer liquids also reduces operating costs.

Additional advantages

Design innovations offer the user other advantages in addition to improved energy efficiency:

- Operation at ambient temperatures as low as −15 °C
- Silent operation
- Smaller footprint compared to older equivalent models
- Remote control with LC display
- Working temperature range from −10 to 35 °C
- Bi-frequency power supply (50/60 Hz) allows the same model types to be used worldwide

Connectivity – Prepared for Industry 4.0

The new UC 8, UC 14, UC 24, UC 50 and UC 65 process circulation chillers are fitted as standard with an Ethernet interface for connection to a computer or local area network (LAN). An Internet connection linked to a cloud can also be integrated here, if necessary.

An integral web server gives the user the option of viewing or modifying settings by calling up the IP address in any standard web browser.
A wide range of options and accessories ensure that the right device is available for every application.
Options include speed-controlled pumps, flow meters and heaters, for example.

About LAUDA

We are LAUDA - the world leader in precise temperature control. Our constant temperature equipment and heating and cooling systems are at the heart of many applications. As a complete one-stop supplier, we guarantee the optimum temperature in research, production and quality control. We are your reliable partner, particularly in the fields of automotive, chemical/pharma, semiconductor and laboratory/medical technologies.
We have been inspiring our global customers with competent advice and innovative, environmentally friendly concepts every day for the last 65 years.

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