The right temperature worldwide

LAUDA

Heating and cooling systems

for the processing industry

Heating, cooling and chilling
from -150 up to 400 °C

The future is modular

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Key competence

Global markets, high quality requirements, demanding safety concepts – industrial heating and cooling systems are a matter of confidence and a question of innovative design. The correct temperature control, combined with the most economically efficient solution, determines quality and price of your products. You will be working with a manufacturer who can claim nearly 50 years of R&D and manufacturing experience in this area and who will support you during the processes with competence and reliance. Our key competence is to control process temperatures for the chemical, pharmaceutical, biological nuclear and medical industries. Our heating and cooling

The development of LAUDA heating and cooling systems

1956 – 1958

In 1956 in the small-town of Lauda in Baden, Germany, Dr. Rudolf Wobser founded MESSGERÄTE-WERK LAUDA Dr. R. Wobser KG.

In 1957 he started developing laboratory heating and cooling systems with mechanical cooling and innovative laboratory equipment.

1964

This year saw the first small-scale heating and cooling units for industrial temperature control applications. The first industrial systems ITH 1/8 and ITH 2/24 are developed and quickly proved to be successful in the industrial market providing accurate temperature control for a wide range of processing.

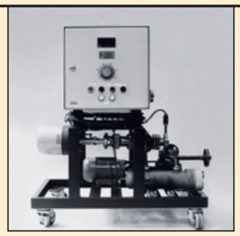
1972 – 1975

The success of the industrial ITH range led to the development of the smaller LTH series for laboratories and colleges. The first high-performance refrigeration based systems are manufactured for the vacuum coating industry, and the first explosion proof systems are developed.

1979

The temperature control units type LTH 140 using water and type LTH 303 using thermal oil as heat transfer fluids are developed for the temperature control of closed consumers for use in the plastics industry and for quality control.

1982 – 1983



Due to the increasing demand to use primary energy, LAUDA developed the first secondary circuit units. Using a suitable heat transfer fluid, these units controlled temperature within the total temperature range from -50 up to 200 °C with an accuracy of ±1 °C.

1983 – 1984

LAUDA industrial systems grew larger in capacity and size with new ITH 350/400 and 600 units being developed to control temperatures for research into solar power installations. Their open construction offered advantages in maintenance and service.

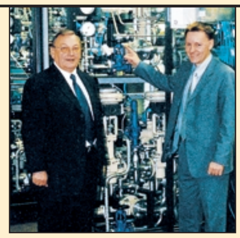
1987 – 1993

LAUDA developed the first integrated process heating and cooling systems type SUK 400 for the pharmaceutical and chemical industries. Advances in the LAUDA temperature control system led to the complete amalgamation of master controller, master programmer and remote controller. The company changed its name to reflect the expanding product line from MESSGERÄTE-WERK to LAUDA DR. R. WOBSER GMBH & CO. KG in 1989.

1996

The analogue industrial control system SR 200 was replaced by a new digital controller SR 500/SR 501. The new system allowed communication via a powerful interface which enables central DCS/PLC control possibilities, or alternatively users can use the controller's in-built programs to control jacket, product and cascade, modes. The controller is available for use in both Ex-hazardous and non-hazardous areas.

1997 – 2000



As the demand for even wider temperature ranges increased in batch reactor plants, LAUDA developed a new generation of secondary temperature control units, type TR 400. These new temperature control units (TCU's) utilised an innovative design that brings together the primary energy sources of steam, thermal oil, water glycol etc. The technique in temperature control is a real LAUDA passion.

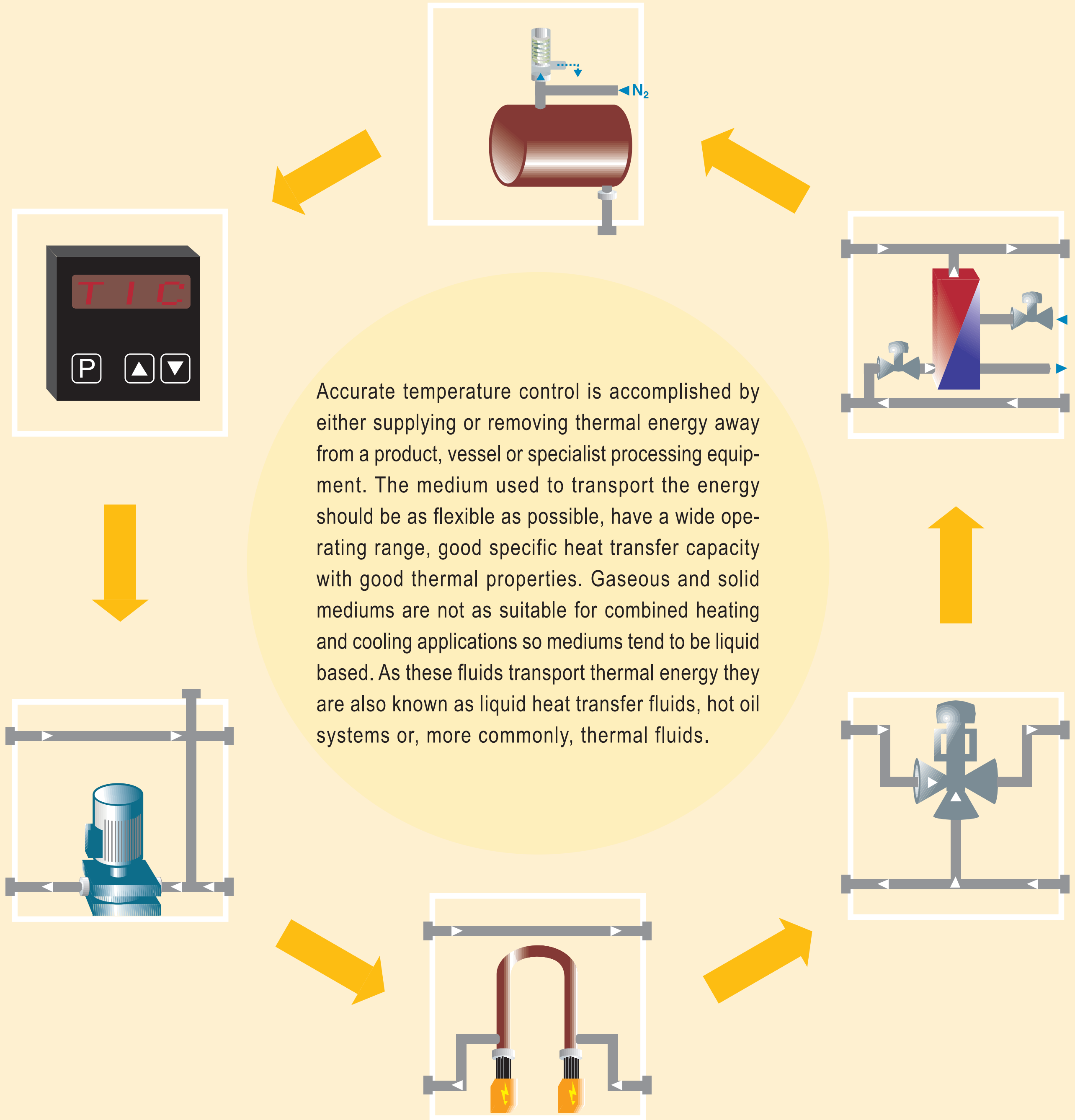
2000 – 2002

In 2002 LAUDA was granted the European Patent for its revolutionary LN_2-Kryopac system which prevents freezing of thermal fluid when operating at extreme temperatures from -150 up to 400 °C. LAUDA presents a modular technique system.

Modular construction

systems follow a modular design concept, we are able to customise our systems and get optimal performance for the process. All safety requirements are harmonised. With our global sales and services network, we are at your disposal in more than 70 countries and we are able to guarantee you full customer service. LAUDA have always produced state-of-the-art products. We have helped to determine developments decisively. With our new modular systems, we are able to implement innovations more efficiently and more rapidly than ever before. This allows our customers to develop and scale-up production more quickly, and get to market faster.

Our modular techniques: To control temperature using fluids



Accurate temperature control is accomplished by either supplying or removing thermal energy away from a product, vessel or specialist processing equipment. The medium used to transport the energy should be as flexible as possible, have a wide operating range, good specific heat transfer capacity with good thermal properties. Gaseous and solid mediums are not as suitable for combined heating and cooling applications so mediums tend to be liquid based. As these fluids transport thermal energy they are also known as liquid heat transfer fluids, hot oil systems or, more commonly, thermal fluids.

Process chain

Worldwide markets, especially in the pharmaceutical sector, mean that international quality requirements go far beyond the conventional documentation of the product quality. LAUDA's engineers are your competent partners who with their expertise and experience will be able to implement your customer requirements on time and who will support you fully during process validation. From the drawing up of a system concept to its production and commissioning, and total operational life cycle of the unit, the experienced LAUDA team is at your side.

Consultation

The fundamental component: Competent consultation

From the start of your project, LAUDA's experts are available for consultation. We know that the correct temperature decision determines the quality of the final product and we can advise you on system configurations on an individual and confidential basis. We use our collective knowledge of single fluid heat transfer systems and experience from manufacturing so many systems in the past. LAUDA's experts also possess knowledge and experience in project management for technologically demanding systems. Competent consultation is the prerequisite for successful order processing, to give timely delivery and customer satisfaction.

Modular engineering

The connecting element: Modular engineering

Our speciality is modular engineering. We work in close co-ordination with our customers during the planning process. Our concept is for true 'module engineering', we use this principle throughout the design, construction, and documentation phases of a project. By using components which have been designed and proven for use with single fluid heat transfer systems, together with the relevant design regulations we are able to tailor-make solutions which are optimised to meet the requirements of specific customer applications. Every single LAUDA planning module has been universally approved, and is continuously developed and adapted thus guaranteeing high quality standards and performance.

Production

The difference: Individual units, highest quality standards

The best planning is not worth anything without sound implementation. Our experts in the production are experienced and know exactly how to implement customers' special wishes into heating and cooling systems. Through continuous qualification of our staff and the implementation of relevant standards, all our products have one thing in common: high quality and optimal performance. The quality of all our materials and technical features of the components are documented in detail and can be referred to at any time.

Customer advantages

Performance testing

The confirmation: A proven design

Unlike most systems constructed for use in single fluid heat transfer systems, all LAUDA systems are fully tested in a sophisticated test facility before shipment to site. This gives us a real opportunity to fully evaluate the performance of systems and allows customers to witness their systems under simulated conditions. Customers have even used the test bed for operator training purposes, which ultimately saves time and money and avoids awkward surprises.

Start-up

The optimal interaction: Plug & Play techniques

Since LAUDA heating and cooling systems are comprised of individual modules built together to make complete systems, and the designs are well proven and well tested, the future is for ready-to-install units, which can be docked on site to other modules to create completely different temperature possibilities. Questions on installation, pipe routing, insulation, security techniques and explosion protection can be clarified in advance. Such modularity is exclusive to LAUDA and with our experts' vast experience they will answer your enquiries enthusiastically.

After sales service

The service network: Worldwide near you

LAUDA heating and cooling units are designed for continuous operation and are easy-to-service. International safety regulations prescribe periodic maintenance. Scheduled maintenance plans are tailored to the customers' requirements and can be developed with our service teams to meet production schedules around the clock. LAUDA's experienced service technicians carry out planned maintenance and training functions for all levels of customer staff and are trained to work on customer sites to the relevant health and safety requirements. In foreign countries, qualified partners support our German based service centre. Therefore, for you, as the operator of the unit, the installation is always serviced in due time and safety systems assured.

Overview

Nothing is more important than the right concept in order to choose the optimal temperature control unit. First, you have to fix the temperature range for the required application. It is therefore necessary to know some details on the process and the process equipment you plan to use. Maximum and minimum heat transfer fluid temperatures need to be determined, not only the required process temperature range but also it is important to determine the 'driving force' temperature difference so that energy transfer rates can be calculated based on the available surface areas of the process equipment to be utilised. Often equipment surface areas are fixed and cannot be changed without modifications to expensive process

Heat transfer fluids and product families

equipment. The only effective possibility to increase energy transfer rates to a process is by increasing the driving force temperature difference. Next, you have to clarify the question on which heating or cooling utilities are used. Maybe you have an existing utility infrastructure that can be used for primary heating or cooling purposes via heat exchangers such as in a secondary temperature control unit or, if no site utilities are available, you may require a separate individual heat transfer unit with electric heating or a process-cooling unit with mechanical compressors. No matter what type of unit is chosen we will tailor your installation according to your wishes. It will belong to one of these modular families.

Liquid heat transfer fluids

	Min.	Max.
[Water]	5 °C	200 °C
[Water/Glycol]	-35 °C	160 °C
[Thermal oils/Low temperature]	-120 °C	280 °C
[Thermal oils/High temperature]	-20 °C	400 °C
[Special heat transfer fluids/ Ultra-Chilling temperature]	-150 °C	100 °C

Liquid heat transfer fluids
In the first place, the available heat transfer fluids differ in their possible operating temperature ranges. High vapour pressures above 100 °C are often a disadvantage of the aqueous based heat transfer fluids. Cross contamination with products and materials of construction of the processing equipment itself are other considerations to be taken into account. Flammability, toxicity, price, lifetime, as well as local regulations, represent further selection criteria. Fluid selection can be a difficult decision and LAUDA will help you to make the right choice using their vast experience and testing facilities.

Product families

	Min.	Max.
Heat transfer units		
[Series ITH]	-20 °C	400 °C
[Series ITHW]	-35 °C	200 °C
Process cooling systems		
[Series SUK]	-100 °C	150 °C
[Series DV]	-110 °C	20 °C
[Series KH]	-100 °C	400 °C
Secondary circuit units		
[Series TR]	-150 °C	400 °C
[Series KP]	-150 °C	280 °C

Heat transfer units use, depending on the required outflow temperature, either synthetic thermal oils or water as the heat transfer fluid. ITH systems are electrically heated and can then heat or cool the fluid to produce a controlled liquid flow with a highly accurate temperature. LAUDA heating and cooling systems from the ITH family always consist of the electric heater module and a maximum of one additional heat exchanger module (cooler). In this combination it is possible to build systems with an extended working temperature range.
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Process cooling units are individual cooling units that control temperatures of different consumer circuits. They have single-stage refrigeration circuits or two-circuit cascade cooling systems and are water- or air-cooled. A unique feature of LAUDA chiller technology allows the combination of an additional electric heater or heat exchanger for running a large working temperature range. Depending on the application, different heat transfer fluids may be used.
Page 18 – 19

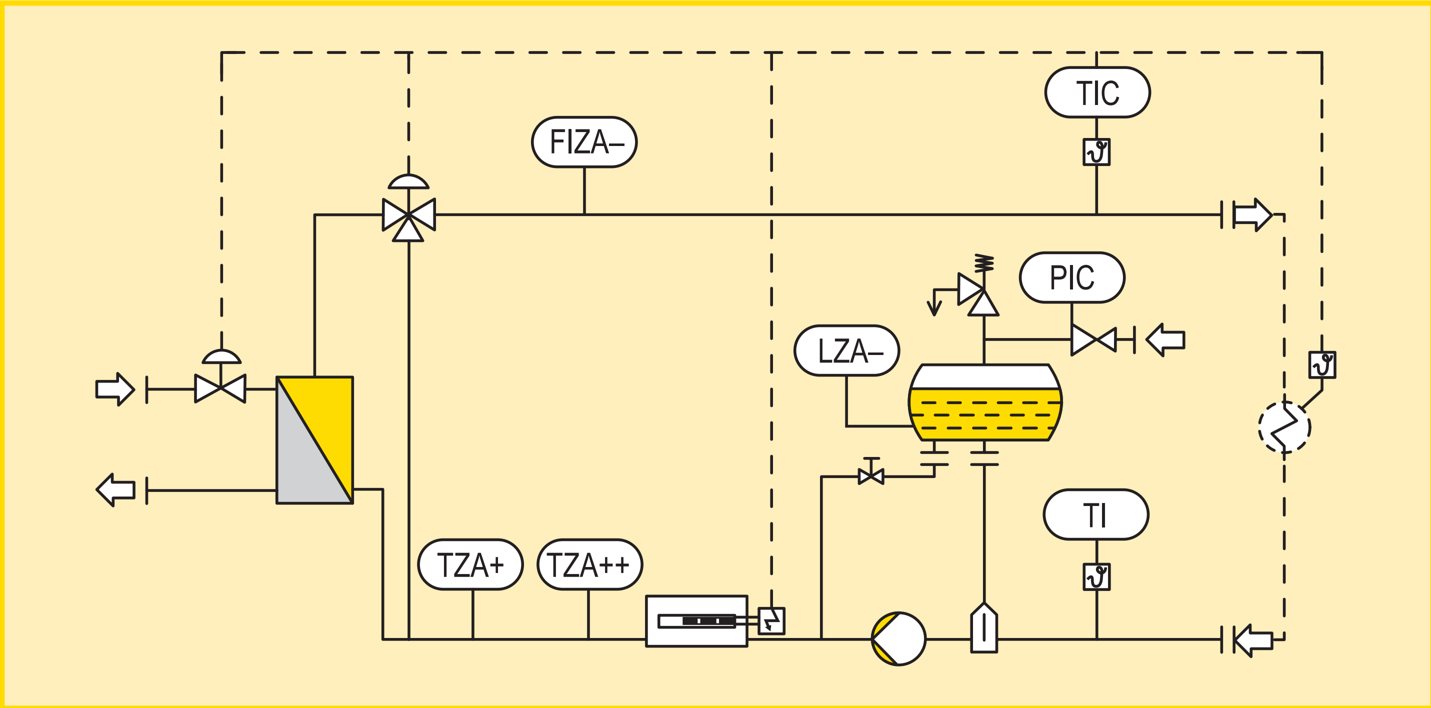
Process cooling units DV are a specialty for all kinds of applications and are supplied without heat transfer fluid circuits (i.e. as in VOC condensers by direct cooling with the actual evaporating refrigerant and not via a heat transfer fluid).

Kryoheaters are again individual systems but with an extreme temperature range and are the optimal link between future requirements for temperature control systems and the possibilities of the most modern heat transfer fluid techniques. They contain numerous LAUDA innovations: from single-stage compressors to two-circuit cascades and simultaneous control of the highest temperature ranges. Kryoheaters form the ideal solution for universal equipment.
Page 20 – 21

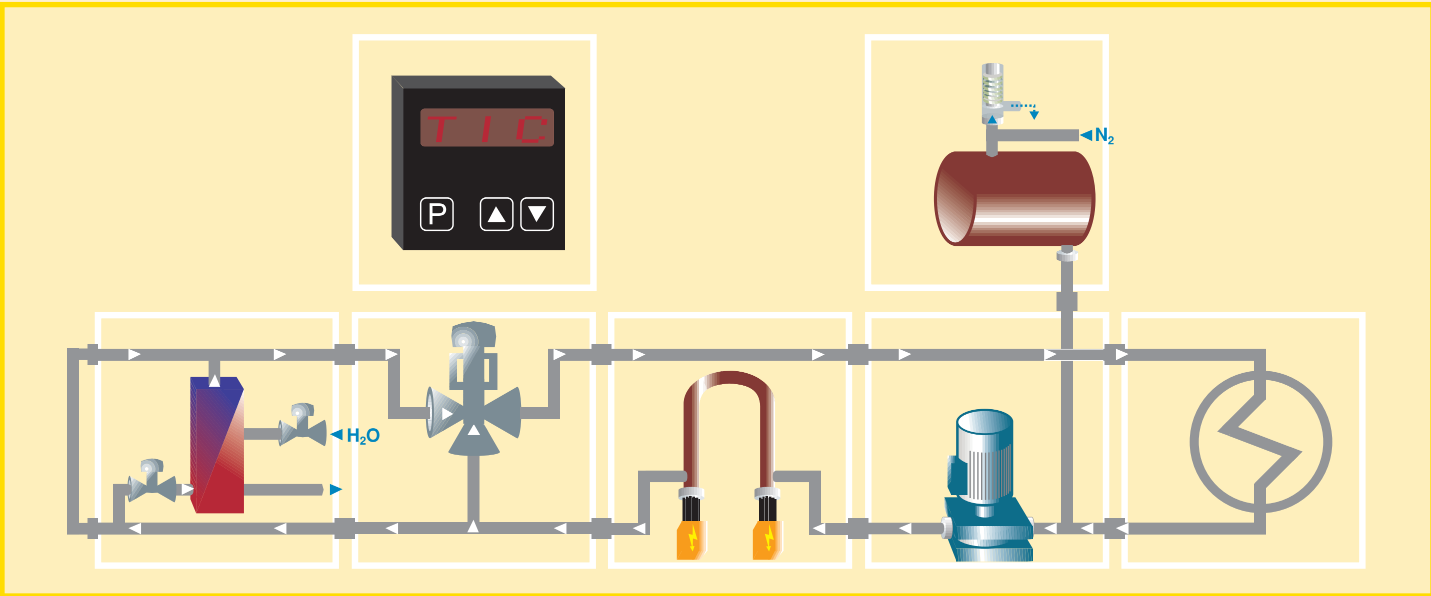
Secondary circuit units use primary thermal energy from available steam, central thermal fluid ringmains, cooling water and cooling brine networks. Temperature control is made possible via the automatic bleeding of the required energy from the respective primary source. The energy extraction and supply takes place via heat exchangers or through a direct connection into a central ringmain circuit in the case of heat transfer fluids.
Page 22 – 23

Kryopac are special secondary circuit units. In order to obtain even higher purity in modern production processes, chemical reactions are now run at very low temperatures. Therefore, LAUDA have developed and patented the LN_2-Kryopac for use in its module range. Here the cold of evaporating nitrogen is used and transferred on a liquid heat transfer medium. All further modules can be used together with the Kryopac.
Page 24 – 25

Technical sophistication and innovation have always formed part of LAUDA's knowledge modules. What you get on top is an economically efficient solution, which is tailored exactly to your needs. Our sophisticated engineering systems knit together our optimised single modules into complete systems to match exactly your specifications and process parameters. Today's modern methods and chemistry have developed production processes which require even larger temperature ranges, and systems need to operate seamlessly, if possible, with only one heat transfer fluid – that is to say: without having to switch over transfer medium. Only if the complete system, reactors, processes and temperature control systems are co-ordinated can batch times and energy use be minimised. LAUDA single fluid heat transfer systems have to be 'seamlessly' integrated into the process instrumentation. Only then can they produce the decisive conditions for high-quality products. Validation of the process is one of the most important prerequisites.



Schematic representation of a compact heat transfer unit with additional heat exchanger (cooler) for non-central installation



Modular representation of the heat transfer unit, all modules are exchangeable and can be supplemented

Elementary parts with system: The individual solution for your unit

For customers who want accurate temperature constancy, flexibility, automated processes and to install environment-friendly solutions then the requirements for temperature control units are permanently increasing. Modern production methods and plant flexibility demand that heating and cooling modules have to be extendable, alterable and capable of acting together in combinations.

In comparison with conventional installations (i.e. central single fluid systems of the 80's/90's) decentralised modules have added much more flexibility to modern production requirements. One of the important conditions for the calibration and qualification of the unit is, for example, its independence. Influences from central energy networks often have a negative effect on the respective availability of the temperature modules. Thus, the temperature requirements of one unit can affect the input parameters of all the other units.

Only with a decentralised strategy, the increased requirements with regard to reproducible control results can be met. In the world of validated processes, repeatable and accurate product temperature control is of utmost importance.

At LAUDA all modules are – so to say – made of one piece. They are manufactured in our production plant. One of our special strong points has become the immediate proximity of project engineering, production, test bench and service.

For almost 50 years now LAUDA have produced and qualified temperature control systems with an extraordinary range between -150 and 400 °C. As far as reliability, lifetime, control precision and quality are concerned, LAUDA holds a leading position. Apart from that, LAUDA is also a competent partner in all questions concerning explosion protection, plant engineering and safety of the installation.

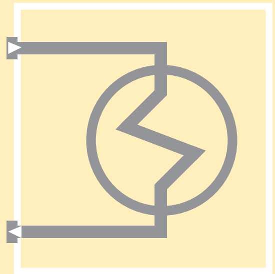
Modular construction of heat transfer fluid systems. The picture shows the new production site at ALTANA, Singen, Germany

We consider ourselves not only specialists but also pioneers for future technologies, making use of our experience and market overview.

Pump | Three-way valve | Expansion tank | Electric heater | One-stage compressor | Two-stage compressor | Controller | Steam trap | Automatic fitting | Heat exchanger/ Evaporator/ Condenser | Fan | Apparatus/ Consumer

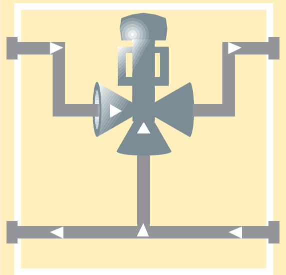
Heat transfer takes place at different locations within a single fluid heat transfer system. Whenever the heat transfer medium flows around vessels, exchangers or other interface surfaces that are colder or warmer than the medium, then thermal energy endeavours to be transferred from higher to lower temperatures. It is the temperature difference and size of the exchange surface area that are decisive variables in single fluid heat transfer systems. Other important influences are flow velocity that creates turbulence and good mixing capabilities within the vessel or heat exchangers, as well as the thermodynamic properties like density, thermal conductivity, specific heat capacity, and viscosity. Fouling, surface areas and materials used also have an important influence on heat transfer. Once these factors are all known then the technical specifications of the apparatus can be calculated with heating or cooling performance being simulated by hand or even better by computer program. Accurate simulation of the process makes it possible to find the optimum solution from the LAUDA modular system at the very beginning of a project.

Basic modules



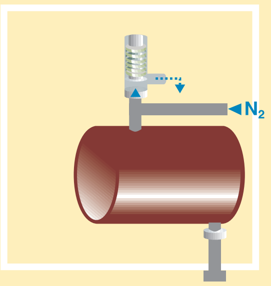
Consumer

Accurate temperature control depends on the object or equipment required to be controlled. The complete thermal circuit consists of the consumer, the LAUDA temperature control unit, the pipework system, mass and system volume in order to determine the final control quality. All these items have to be taken into consideration early in the planning stage.



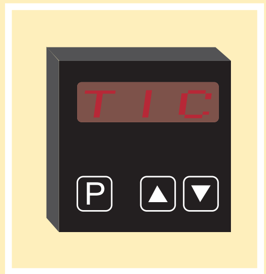
Three-way valve

LAUDA systems use their clever three-way control valve arrangement, especially when precise control is necessary. This final control element is able to smoothly and precisely mix two flows. All you need is a single position controller. This is an advantage you cannot beat with other valve circuits. Through the hydraulic balance of both flows, pressures and volume flows remain stable.



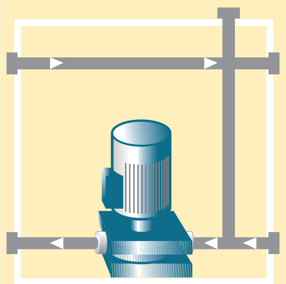
Expansion tank

Expansion tanks may be executed atmospherically open, pressure blanketed inerted or as a diaphragm tank for pressurised hot water systems. Type, size and material are engineered individually according to the requirements.



Controller

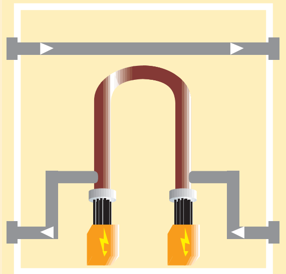
Temperature control always means to regulate temperature, i.e. to run if possible without temperature fluctuations, or even to run with controlled temperature ramps. In this case, the temperature control system has to be able to control along definite time/temperature profiles. The LAUDA control module SR 500/501 records setpoint and actual value data and makes possible very precise control results via the cascade operation.



Pumps

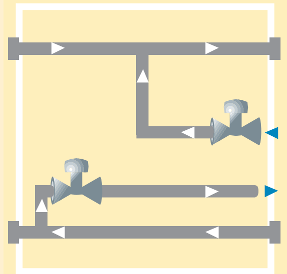
Pumps are responsible for the circulation of the heat transfer fluid. The following considerations play a big part when choosing the right pump: the pumping medium, the temperature range and even the type. Thermal fluid flow is always ensured via the three-way valve.

Additional modules



Electric heater

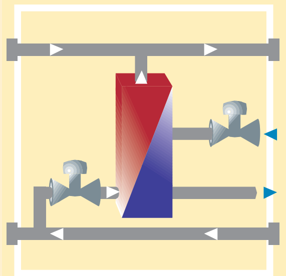
Electric heaters are used if heating capacities are small or if steam or other hot mediums are not available, or provided at too low temperatures. For energy conservation reasons, a combination system with a second heating source could be of interest. The LAUDA modular system makes it possible.



Direct medium injection

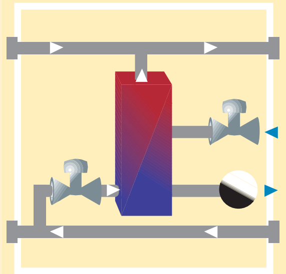
If the primary utility system uses the same medium as is used in the secondary circuit, a direct coupling, without heat exchanger may be advantageous, providing temperature ranges are achievable. This is especially true in low-temperature systems which use a central cooling ringmain configuration and where every single degree saved reduces operating costs.

Heat exchanger modules



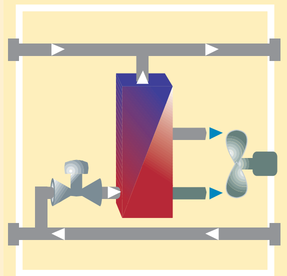
Heat exchanger for heating and cooling liquid mediums

Heat exchangers are applied whenever heating or cooling energy of different mediums is to be utilised. Through intelligent control, the efficiency of the system can be further increased through the recycling of heat and cold fluids and the use of thermal storage techniques.



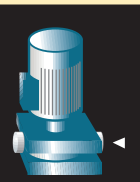
Heat exchanger for heating with steam

Chloride containing mediums are very corrosive. Special materials have to be used here. High pressure steam vapour requires a different heat exchanger design, so do exchangers which use very cold thermal fluids or liquid nitrogen. The design of the heat exchangers, the materials, operation conditions and the cleanability of heat transfer surfaces are all important.

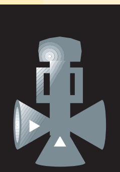


Heat exchanger for heating or cooling with air

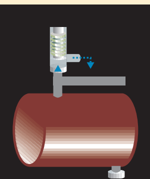
The environmental and cost-conscious engineer always checks the possibility of using existing cold or heat sources. An air-cooled thermal oil heat exchanger uses, for example, the refrigeration capacity at nil-tariff. In winter it serves as a heating and in addition saves the environment. River water or a cooling tower may be an interesting alternative to the cold water network, which has to be cooled electrically and is expensive.



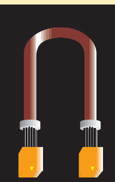
Pump



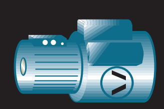
Three-way valve



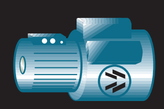
Expansion tank



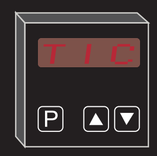
Electric heater



One-stage compressor



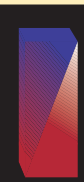
Two-stage compressor



Controller

Steam trap

Automatic fitting



Heat exchanger/
Evaporator/
Condenser

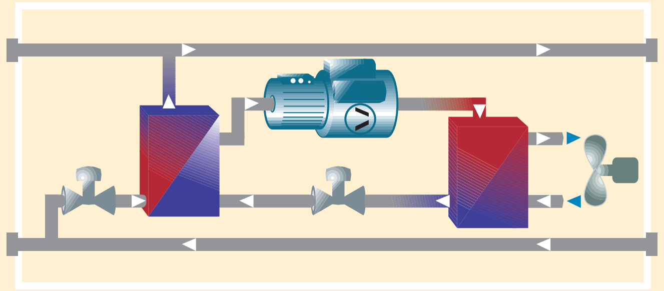
Fan

Apparatus/
Consumer

Modular safety

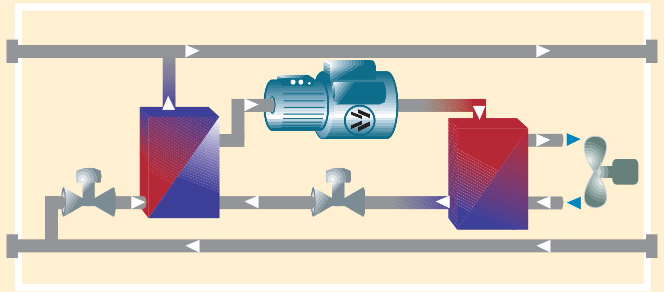
Modular safety: Safety is LAUDA's highest priority, and conformity to the new European directives. The modular design makes it possible to carry out hazard analysis of every functional unit. We ensure that with LAUDA you are always one step ahead. In the case of safety we have always been a competent and experienced partner and this is becoming more important in the future. At LAUDA safety concerns are analysed on a project by project basis. Results and recommendations are continuously updated with the relevant regulations. LAUDA heating and cooling systems are an important part of the whole installation.

Refrigeration modules, air-cooled



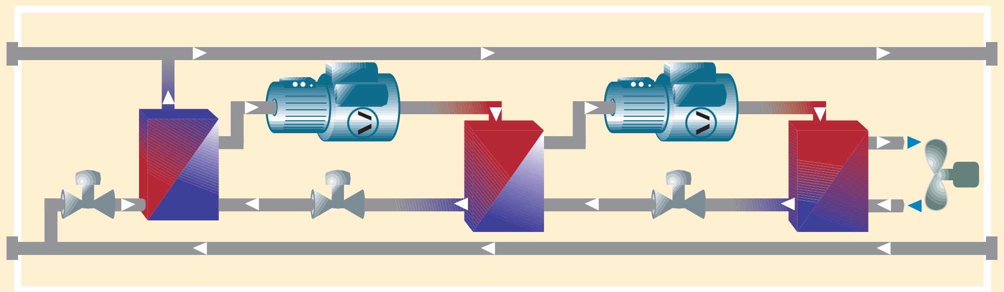
one-stage refrigeration, air-cooled

One-stage refrigeration system, with air-cooled condenser for the production of temperatures between -35 and 20 °C, consisting of one-stage piston compressor, evaporator, condenser, control components and lubricating oil system.



refrigeration system with two-stage compressor, air-cooled

One-stage refrigeration system, with air-cooled condenser for the production of temperatures between -50 and 20 °C, consisting of two-stage piston compressor, evaporator, condenser, control components and lubricating oil system.



cascade refrigeration, air-cooled

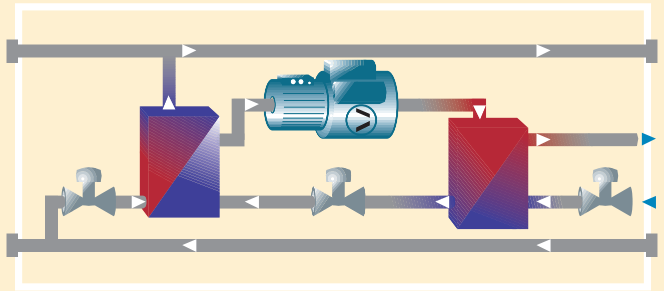
Two-circuit cascade refrigeration system, with air-cooled condenser for the production of temperatures between -100 and 20 °C, consisting of two piston compressors, evaporator, condenser, interim heat exchanger, control components and lubricating oil system.

Modular construction

Most important type standards:

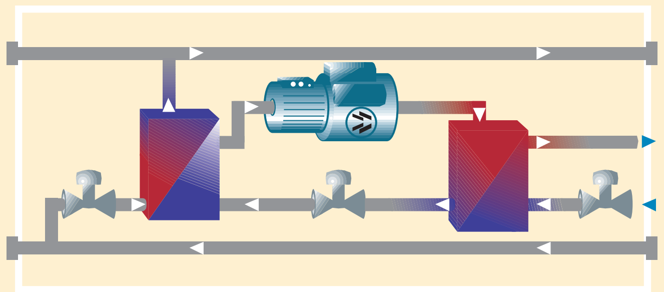
DIN 4754 (thermal oil), DIN 4751-52 (water), EN 378 (Process cooling units), PED Pressure equipment directives 97/23/EG, AD 2000, CE-Machine Directives 98/37/EC, CE – Low Voltage Directives 73/23/EEC, CE-EMV-Directives 89/36/EEC, CE-Explosion proof Directives 94/9/EC (ATEX), IEC 60204 (electrical safety for systems and machines). For all representative module configurations TÜV design certificates in accordance with DGRL, including category III, are available.

Refrigeration modules, water-cooled



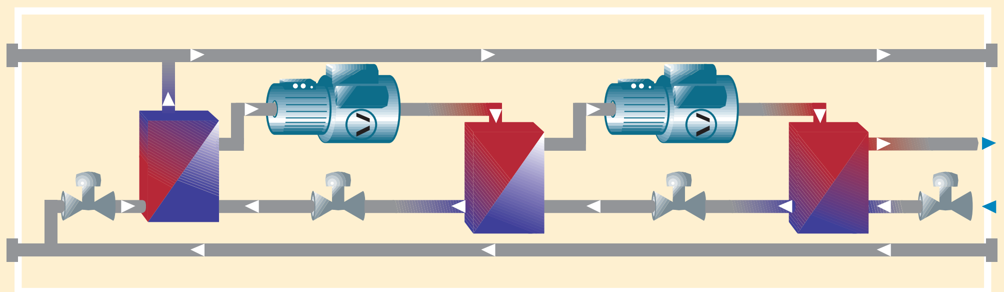
one-stage refrigeration, water-cooled

One-stage refrigeration system, with water-cooled condenser for the production of temperatures between -35 and 20 °C, consisting of one-stage piston compressor, evaporator, condenser, control components and lubricating oil system.



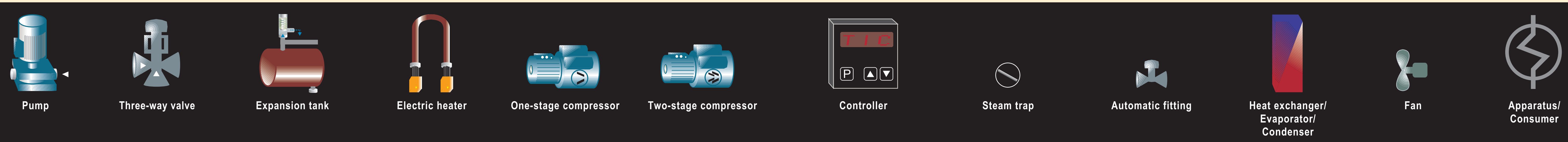
refrigeration system with two-stage compressor, water-cooled

One-stage refrigeration system, with water-cooled condenser for the production of temperatures between -50 and 20 °C, consisting of two-stage piston compressor, evaporator, condenser, control components and lubricating oil system.



cascade refrigeration, water-cooled

Two-circuit cascade refrigeration system, with water-cooled condenser for the production of temperatures between -100 and 20 °C, consisting of two piston compressors, evaporator, condenser, interim heat exchanger, control components and lubricating oil system.

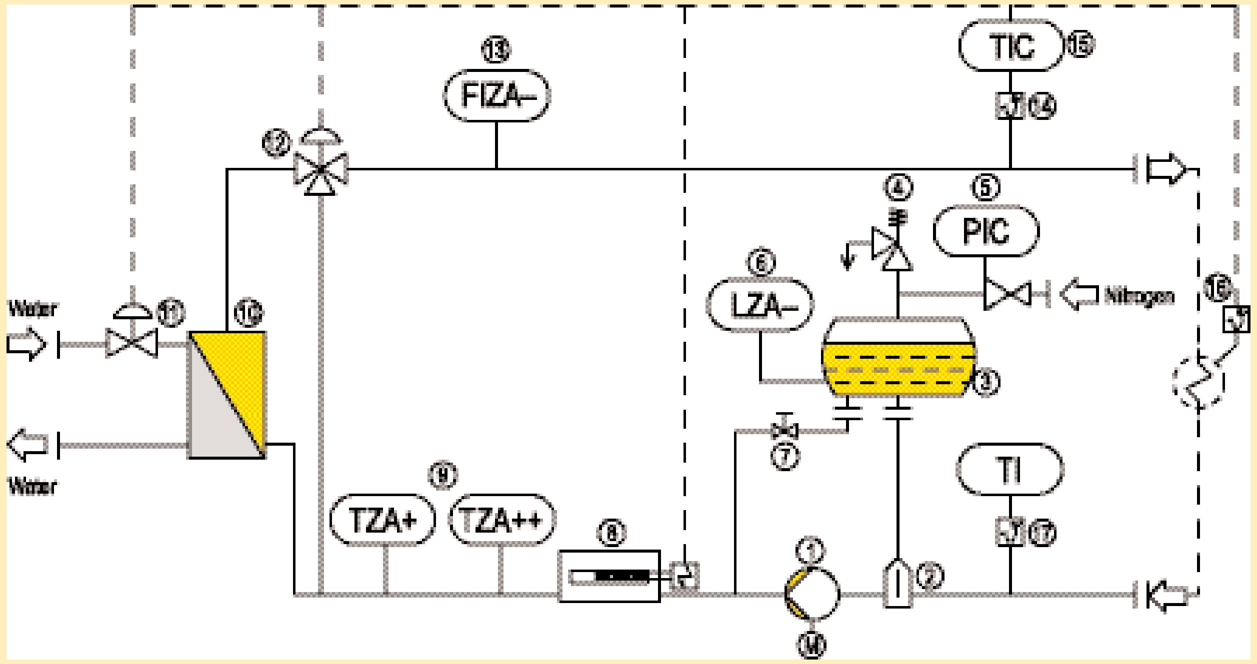


Electrically heated thermal oil units are especially used to heat or control the temperature of a consumer at high operating temperatures and low pressures. These systems can be installed quickly and easily and require little maintenance. They can be equipped with an additional heat exchanger (cooler), so you can have a complete heating and cooling system ready for connection to a consumer.

Thermal oil is the perfect heat transfer fluid for working at high temperatures. The wide temperature range offers a high flexibility in the user applications. There is no danger of corrosion or freezing, and the units can be easily installed outside.

LAUDA heat transfer units with thermal oil as the heat transfer fluid
Operating temperature range up to 400 °C

LAUDA heating and cooling systems from the ITH unit family consist of the electric heater, circulating pump, expansion tank and a maximum of one additional heat exchanger module (cooler). The ITH units can be used with water, brine or air-cooled heat exchangers. If there is an existing central thermal fluid cooling network, then the heat transfer fluid can be directly injected. The heat exchanger and the expansion tank are removed. ITH units produce a temperature controlled liquid flow and are delivered in compact, completely insulated packages including control cabinet and are fully tested, ready for connection to consumers.



1 Circulating pump
2 Air/Gas separator
3 Expansion tank
4 Safety valve
5 Pressure controller
6 Level indication
7 Vent-off valve
8 Electric heater
9 Temperature indication
10 Heat exchanger "Cooling"
11 Valve "Cooling"
12 Three-way valve
13 Flow indication
14 Temperature probe "Outflow"
15 Temperature controller
16 Temperature probe "Consumer"
17 Temperature probe "Return"

Heat transfer unit with air-cooled heat exchanger for the temperature control of a 20 m³ reactor in a temperature range from 20 up to 300 °C for installation in hazardous areas.
Heating capacity 250 kW
Cooling capacity 300 kW at 80 °C
Type ITH 600 Ex

Heat transfer unit with water-cooled heat exchanger for the temperature control of a reactor in a temperature range from 20 up to 350 °C for installation in hazardous areas.
Heating capacity 48 kW
Type ITH 350 Ex

Technical data Standard Modules (standard see page 12 and 13)

Series	ITH 150	ITH 250	ITH 350	ITH 400	ITH 600
Heat transfer fluid			Thermal oil		
Operating temperature [°C]			Max. 350 *		
Pump capacity [m³/h]	0,5...2	2...4	4...10	10...30	30...80
Electric heating [kW]	3...6	9...12	18...50	60...100	120...500
Cooling			water-cooled heat exchanger		
Overall dimensions W x D x H [mm]	400x800x1000	500x1000x1500	500x1000x1500	600x1500x1500	1000x1500x1900
			600x1500x1500	1000x1500x1900	1300x1900x2000

Explosion-proof types available for all units.

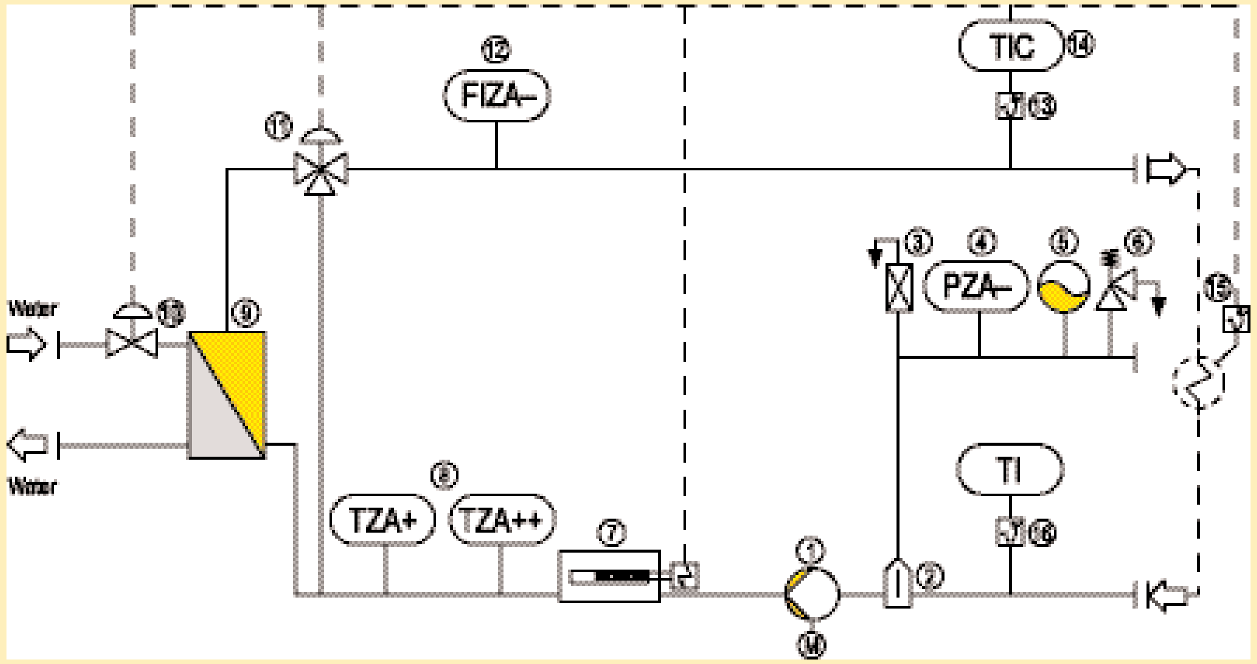
* On demand up to 400 °C

Electrically heated thermal oil units are especially used to heat or control the temperature of a consumer at medium operating temperatures and high heat transfer values. These systems can be installed quickly and easily and require little maintenance. They can be equipped with an additional heat exchanger, so you can have a complete heating and cooling system ready for connection to a consumer.

Water is the perfect heat transfer fluid for working at medium temperatures. Water is favourable in price, non-toxic, non-inflammable and has very high heat transfer values. This makes the surfaces transferring the heat as small as possible. However, the danger of freezing and corrosion, as well as water's very high vapour pressure (15 bar at 200 °C) have to be taken into consideration during planning. Very often additives like glycols are used to protect the system from freezing and corrosion.

LAUDA heat transfer units with water as the heat transfer fluid
Operating temperature range up to 200 °C

LAUDA heating and cooling systems from the ITHW unit family consist of the electric heater, circulating pump, expansion tank and a maximum of one additional heat exchanger module (cooler). The ITH units can be used with water; brine or air-cooled heat exchangers. If there is an existing central cooling water network, then the heat transfer fluid can be directly injected. The heat exchanger and the expansion tank are removed. ITH units produce a temperature controlled liquid flow and are delivered in compact, completely insulated packages including control cabinet and are fully tested, ready for connection to consumers.



1 Circulating pump
2 Air/Gas separator
3 Automatic vent valve
4 Pressure indication
5 Expansion tank
6 Safety valve
7 Electric heater
8 Temperature indication
9 Heat exchanger "Cooling"
10 Valve "Cooling"
11 Three-way valve
12 Flow indication
13 Temperature probe "Outflow"
14 Temperature controller
15 Temperature probe "Consumer"
16 Temperature probe "Return"

Heat transfer unit with water-cooled heat exchanger for the temperature control of calander rollers in a temperature range up to 160 °C.
Heating capacity 200 kW
Type ITHW 600

Flexible heat transfer unit in stainless steel for the temperature control of different consumer circuits in a temperature range from -30 up to 160 °C.
Heating capacity 50 kW
Type ITHW 350

Technical data Standard Modules (standard see page 12 and 13)

Series	ITHW 150	ITHW 250	ITHW 350	ITHW 400	ITHW 600
Heat transfer fluid			Water/Glycol		
Operating temperature [°C]			Max. 160 *		
Pump capacity [m³/h]	0,5...2	2...4	4...10	10...30	30...80
Electric heating [kW]	6...12	18...24	30...50	60...100	120...500
Cooling			water-cooled heat exchanger		
Overall dimensions W x D x H [mm]	400x800x1000	500x1000x1500	500x1000x1500	600x1500x1500	1000x1500x1900
			600x1500x1500	1000x1500x1900	1300x1900x2000

Explosion-proof types available for all units.

* On demand up to 200 °C

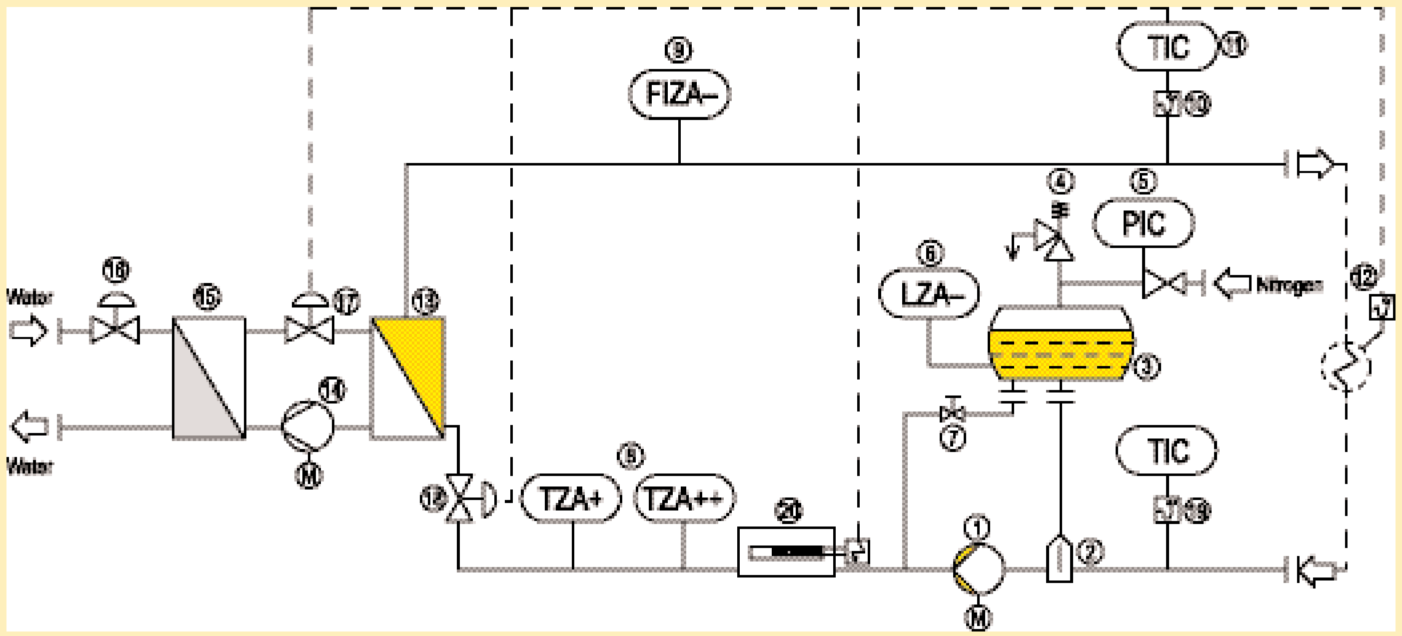
Process cooling units use an active refrigeration system, i.e. refrigeration is produced via an electrical drive motor driving a compression refrigeration process. Depending on the working temperature range these cooling units can be operated with most heat transfer fluids. If heating is also required, the high vapour pressure of water based heat transfer fluids has to be taken into consideration. Synthetic or silicone based thermal fluids are recommended when working in a wide temperature range.

Only refrigerants which are non-toxic, free from chlorine, ozone-friendly and comply with the Montreal protocol are used. Chlorine-free H-CFC refrigerant substitutes, like for instance R 404A, R 410 etc., have been proved to be good and LAUDA use them with much success.

There is still a demand on research and development and therefore LAUDA regularly test and evaluate new refrigerants including natural ones as and when they become available.

Process cooling units
Operating temperatures from -100 up to 150 °C

LAUDA heating and cooling systems from the SUK family consist of the modules compressor, pump, expansion tank, evaporator and condenser. For units series DV pump module and expansion tank are removed. Depending on the lowest operating temperature LAUDA use one-stage (down to -35 °C) or two-stage compressors (down to -50 °C), cascade switching of two refrigeration systems down to -100 °C for very low temperatures.The condensing of the refrigerant takes place via cooling water or air (-W or -L) with energy conservation being controlled by the infinitely variable and precise cooling water injection valve or variable speed fan control in air cooled applications. If there are several compressors, a sequencing system ensures energy saving, equal-wear, partial load operation.
With an electric heater or steam heat exchanger added, the SUK line can be expanded to make a compact, ready-for-connection heating and cooling system for temperatures between -100 and 150 °C. Additional pre-cooling via in-house brine or air can easily be put into practice with the help of the modular system, and as far as energy is concerned, this often implies economic advantages compared to conventional systems. Some very exothermic processes require the additional cold storage buffer tanks that again are easily incorporated into the LAUDA modular approach.



1 Circulating pump
2 Air/Gas separator
3 Expansion tank
4 Safety valve
5 Pressure controller
6 Level indication
7 Vent-off valve
8 Temperature indication
9 Flow indication
10 Temperature probe "Outflow"
11 Temperature controller
12 Temperature probe "Consumer"
13 Evaporator
14 Compressor
15 Condenser
16 Valve "Cooling"
17 Control valve "Cooling"
18 Valve "Cooling"
19 Temperature probe "Return"
20 Electric heater

Process cooling unit with water-cooled condenser for installation in hazardous area to control the temperature within a temperature range from -30 up to 150 °C.
Cooling capacity 300 kW/0 °C
Additional heating steam 500 kW
Type SUK 600 W Ex

Process cooling unit with water-cooled condenser to control the temperature within a temperature range from -70 up to 150 °C.
Cooling capacity 2 kW/-70 °C
Additional electric heating 12 kW
Type SUK 350 W II

Technical data Standard Modules (standard see page 12 and 13)

Series	SUK 150 W/L	SUK 250 W/L	SUK 350 W/L	SUK 400 W/L	SUK 600 W/L
Heat transfer fluid	Water/Glycol/Thermal oil/Special fluids				
Operating temperature [°C]	-40...150	-50...150	-70...150	-100...150	-100...150
Pump capacity [m³/h]	0,5...2	2...6	2...20	4...30	5...50
Electric heating [kW]	up to 9	up to 18	up to 50	up to 60	up to 120
One-stage compressor					
Cooling capacity [kW] at 20 °C	up to 10	up to 20	up to 50	up to 150	up to 300
Cooling capacity [kW] at 0 °C	up to 5	up to 15	up to 35	up to 120	up to 240
Cooling capacity [kW] at -20 °C	up to 3	up to 6	up to 18	up to 60	up to 120
Cooling capacity [kW] at -40 °C	up to 1	up to 2	up to 7	up to 45	up to 90
Two-stage compressor					
Cooling capacity [kW] at -50 °C		up to 1	up to 4	up to 35	up to 70
Two-cascade switching					
Cooling capacity [kW] at -60 °C			up to 3	up to 25	up to 50
Cooling capacity [kW] at -70 °C			up to 2	up to 10	up to 20
Cooling capacity [kW] at -80 °C			up to 0,5	up to 5	up to 10
Overall dimensions W x D x H [mm]	400x800x1000	500x1000x1500	800x1700x1500	1000x1500x1900	1500x2200x2000
	500x1000x1500	600x1500x1500	1000x1500x1900	1300x1900x2000	2000x2500x2000

Explosion-proof types available for all units.

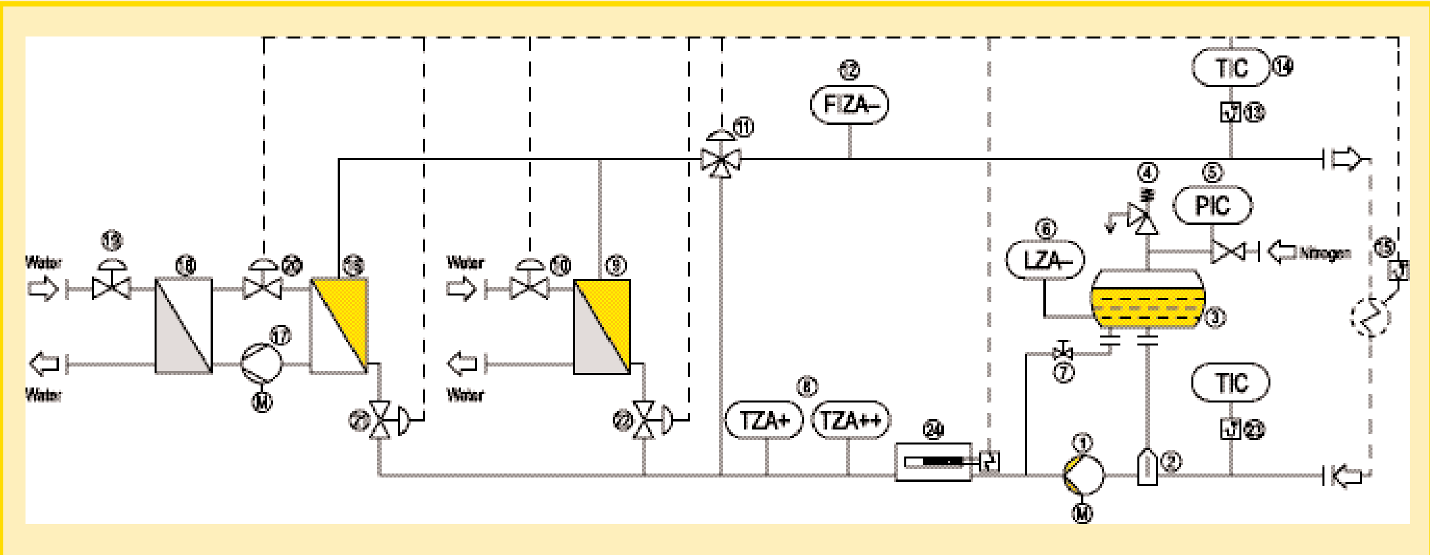
Constantly changing batch processing or pilot plant manufacturing demand wider temperature ranges. Only with highly dynamic temperature control systems like the LAUDA heating and cooling systems can exothermic batch reactions be controlled. The new Kryoheaters are the optimal link between future requirements for temperature control systems and present possibilities of the most modern heat transfer mediums. With the Kryoheater technology it is possible to operate in temperature ranges from -100 up to 400 °C. This temperature range is at the moment only limited by the physical properties of existing heat transfer fluids.

Like the process cooling units series SUK, the Kryoheaters also use an active refrigeration system, i.e. refrigeration is produced via an electrical drive motor driving a compression refrigeration process. Only refrigerants which are non-toxic, free from chlorine, ozone-friendly and comply with the Montreal protocol are used.

LAUDA Process cooling units
Operating temperature from -100 up to 400 °C

LAUDA heating and cooling systems from the KH family consist of the modules compressor, pump, expansion tank, evaporator and condenser. Depending on the lowest operating temperature LAUDA use one-stage (down to -35 °C) or two-stage compressors (down to -50 °C), cascade switching of two refrigeration systems down to -100 °C for very low temperatures. The condensing of the refrigerant takes place via cooling water or air (-W or -L) with energy conservation being controlled by the infinitely variable and precise cooling water injection valve or variable speed fan control in air-cooled applications. If there are several compressors, a sequencing system ensures energy saving, equal-wear, partial load operation.

With an electric heater or medium heated heat exchanger added, the Kryoheater can be expanded to extreme temperatures between -100 and 400 °C. Additional pre-cooling via in-house brine or air can easily be put into practice with the help of the modular system, and as far as energy is concerned, this often implies economic advantages compared to conventional systems. Some very exothermic processes require the additional cold storage buffer tanks that again are easily incorporated into the LAUDA modular approach.



1. Circulating pump
2. Air/Gas separator
3. Expansion tank
4. Safety valve
5. Pressure controller
6. Level indicator
7. Vent-off valve
8. Temperature indication
9. Heat exchanger "Cooling"
10. Valve "Cooling"
11. Three-way valve
12. Flow indication
13. Temperature probe "Outflow"
14. Temperature controller
15. Temperature probe "Consumer"
16. Evaporator
17. Compressor
18. Condenser
19. Valve "Cooling"
20. Control valve "Chilling"
21. Valve '"Chilling"
22. Valve "Cooling"
23. Temperature probe "Return"
24. Electric heater

Modular plant for temperature control made by LAUDA;
coupling of heat transfer system with process cooling unit
Operating range from -40 up to 200 °C
Pressure reaction centre at Merck KGaA/Darmstadt

Kryoheater with water-cooled condenser for temperature control within a temperature range from -50 up to 200 °C; equipped with possibility to connect the chilling module LN_2-Kryopac.
Cooling capacity 10 kW/-40°C
Electric heater 48 kW
Chilling capacity 10kW/-100°C
Type Kryoheater KH 400 W

Technical data Standard Modules (standard see page 12 and 13)

Series	KH 150 W/L	KH 250 W/L	KH 350 W/L	KH 400 W/L	KH 600 W/L
Heat transfer fluid			Thermal oil/Special fluids		
Operating temperature [°C]	-40...250 *	-50... 250 *	-70...250 *	-100...250 *	-100...250 *
Pump capacity [m³/h]	0,5...2	2...6	2...20	4...30	5...50
Electric heating [kW]	up to 9	up to 18	up to 50	up to 60	up to 120
One-stage compressor					
Cooling capacity [kW] at 20 °C	up to 10	up to 20	up to 50	up to 150	up to 300
Cooling capacity [kW] at 0 °C	up to 5	up to 15	up to 35	up to 120	up to 240
Cooling capacity [kW] at -20 °C	up to 3	up to 6	up to 18	up to 60	up to 120
Cooling capacity [kW] at -40 °C	up to 1	up to 2	up to 7	up to 45	up to 90
Two-stage compressor					
Cooling capacity [kW] at -50 °C		up to 1	up to 4	up to 35	up to 70
Two-cascade switching					
Cooling capacity [kW] at -60 °C			up to 3	up to 25	up to 50
Cooling capacity [kW] at -70 °C			up to 2	up to 10	up to 20
Cooling capacity [kW] at -80 °C			up to 0,5	up to 5	up to 10
Overall dimensions W x D x H [mm]	500x1000x1500	600x1500x1500	800x1700x1500	1000x1500x1900	1500x2200x2000
	600x1500x1500	800x1700x1500	1000x1500x1900	1300x1900x2000	2000x2500x2000

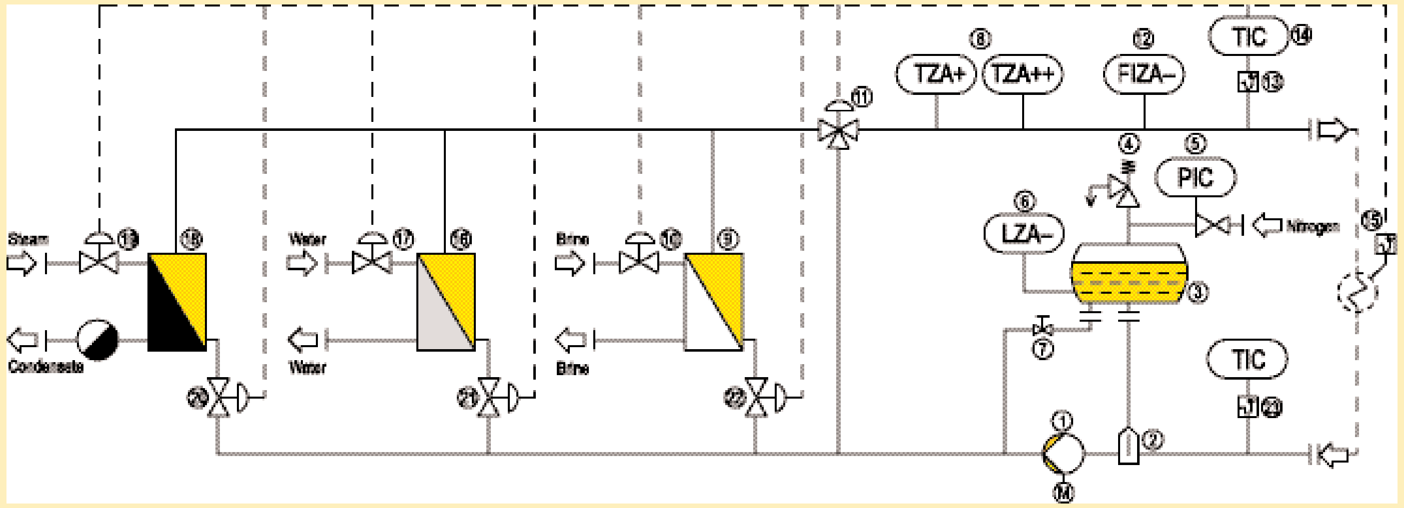
Explosion-proof types available for all units.

* On demand up to 400 °C

Secondary circuit units use existing thermal energy, like for example steam, cooling water and brine – so called 'primary systems'. The difficult part is to integrate the existing infrastructure into a single fluid system or secondary loop that controls the temperature of the processing equipment. This makes only one single fluid heat transfer service (monofluid) to a reactor jacket (instead of steam, cooling water and brine). By using a single fluid heat transfer system the following advantages arise: you can achieve seamless and reproducible temperature control over an extremely wide temperature range and you can avoid and eliminate the traditional requirement for utility changeovers and jacket service blow-downs. The small fluid volume leads to fast acting control loops with very small thermal inertia. The use of thermal oil also reduces the high pressure requirements of steam systems and is a medium separating product and environment.

Secondary circuit units for the use of primary energy
Operating temperature range from -150 up to 400 °C

LAUDA heating and cooling systems from the secondary circuit unit family of the TR product line consist of one up to several heat exchanger modules or direct injection couplings or they have an electric heater module. The subsequent suffix characters, as for example 'HKT', indicate the number and type of heating or cooling modules. LAUDA TR units produce a temperature controlled liquid flow and are delivered in compact, completely insulated packages including control cabinet and are fully tested, ready for connection to consumers.



1 Circulating pump
2 Air/Gas separator
3 Expansion tank
4 Safety valve
5 Pressure controller
6 Level indication
7 Vent-off valve
8 Temperature indication
9 Heat exchanger "Chilling"
10 Valve "Chilling"
11 Three-way valve
12 Flow indication
13 Temperature probe "Outflow"
14 Temperature controller
15 Temperature probe "Consumer"
16 Heat exchanger "Cooling"
17 Valve "Cooling"
18 Heat exchanger "Heating"
19 Valve "Heating"
20 Valve "Heating"
21 Valve "Cooling"
22 Valve "Chilling"
23 Temperature probe "Return"

Secondary circuit unit for installation in hazardous area; with two heat exchangers; for the temperature control of a 630 litre reactor; operating temperature from 0 up to 180 °C
Primary energies Steam 200 °C/Brine -20 °C
Type TR 350 HK Ex

Secondary circuit unit for installation in hazardous area; with two heat exchangers; for the temperature control of a 6300 litre reactor; operating temperature from 40 up to 180 °C
Primary energies Steam 200 °C/Cooling water 20 °C
Type TR 600 HK Ex

Technical data Standard Modules (standard see page 12 and 13)

Series	TR 150	TR 250	TR 350	TR 400	TR 600
Heat transfer fluid	Water/Glycol/Thermal oil/Special fluids				
Operating temperature [°C]	-100...400 *				
Pump capacity [m³/h]	0,5...2	2...4	4...10	10...30	30...150
Temperature control function	H (Heating)/K (Cooling)/T (Chilling)/Ts (Ultra-Chilling)				
Primary energies	Electric/steam/hot oil/hot water/air/cooling water/brine/cold oil/nitrogen				
Energy transfer	indirect injection by heat exchanger or electric heater/direct injection				

Explosion-proof types available for all units.

* On demand up to -150 °C

Reactions that are carried out at very low temperatures achieve an even higher degree of purity and yield which is essential for modern pharmaceutical production processes. For this reason LAUDA offer the Kryopac. It uses the energy of evaporating nitrogen to cool a liquid heat transfer fluid via an intermediate medium.

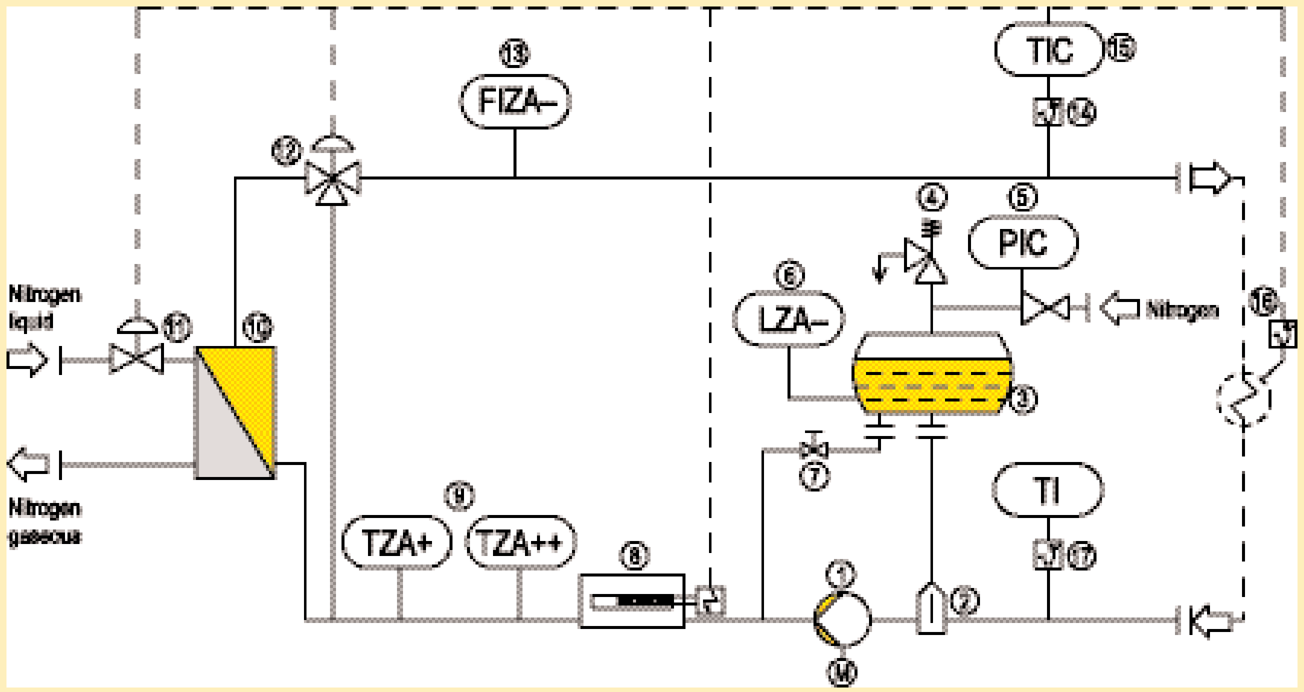
Kryopac systems are also secondary circuit units which are primary cooled with liquid nitrogen. For these extreme applications in refrigeration, only heat transfer fluids especially developed for chilling purposes can be used. LAUDA developed a special procedure to solve the famous problems with freezing.

A suitable intermediate medium transfers the energy of the chilled nitrogen (-196 °C) precisely set to the heat transfer fluid. For this innovative procedure LAUDA was granted the European patent no. 1 030 135.

Secondary circuit units for use with liquid nitrogen
Operating temperature from -150 up to 280 °C

LAUDA heating and cooling systems from the secondary circuit unit family of the KP product line consist of the modules circulating pump, expansion tank, electric heater and the special Kryopac system – one heat exchanger especially designed for evaporating liquid nitrogen. The Kryopac units produce a temperature controlled liquid flow and are delivered in compact, completely insulated packages including control cabinet and are fully tested, ready for connection to consumers.

Freezing problems in the heat exchangers belong to the past. Commercially sold heat transfer fluids can now be chilled down to their pour point. LAUDA technology makes it possible to operate very precisely at these temperatures. Compact construction, high quality standards and favourable pricing are some advantages of the Kryopac system.



- **1** Circulating pump
- **2** Air/Gas separator
- **3** Expansion tank
- **4** Safety valve
- **5** Pressure controller
- **6** Level indication
- **7** Vent-off valve
- **8** Electric heater
- **9** Temperature indication
- **10** Heat exchanger Kryopac
- **11** Valve “Ultra-Chilling”
- **12** Three-way valve
- **13** Flow indication
- **14** Temperature probe “Outflow”
- **15** Temperature controller
- **16** Temperature probe “Consumer”
- **17** Temperature probe “Return”

Kryopac system on the test bench.
If theory and practise are in harmony, it is a pleasure for the inventor.
Operating temperature from -100 up to 200 °C
Cooling capacity 18 kW/-100 °C
Type KP 350 HK

Hydraulic part of a LN_2-Kryopac, system.
Operating temperature from -100 up to 200 °C,
Cooling capacity: 9 kW at -100 °C
Pumps for run and standby operation
Type KP 250 HK

Technical data Standard Modules (standard see page 12 and 13)

Series	KP 150	KP 250	KP 350	KP 400	KP 600
Heat transfer fluid			Thermal oil/Special fluids		
Operating temperature [°C]			-120…200*		
Pump capacity [m³/h]	0,5…2	2…4	4…10	10…30	30…80
Electric heater [kW]	3…6	9…12	18…50	60…100	120…500
Cooling capacity [kW] at -100 °C	up to 5	up to 10	up to 15	up to 30	up to 80
Overall dimensions (W x D x H) [mm]	500x1000x1500	600x1500x1500	800x1700x1500	1000x1500x1900	1500x2200x2000
	600x1500x1500	800x1700x1500	1000x1500x1900	1300x1900x2000	2000x2500x2000

Explosion-proof types available for all units.

* On demand up to -150 resp. 280 °C

At the API plant of the company ALTANA Pharma AG situated in Singen/Germany several consumers had to be controlled in a temperature range from -20 up to 160 °C. It was requested to integrate the existing infrastructure and to use the primary thermal energies in an optimum way. Chilling had to be provided by a mobile refrigeration system that – if requested – could be docked at the secondary circuit units by means of quick couplings.

In this case LAUDA built a compact Plug & Play solution including the monitoring and control systems, all being part of the LAUDA module system range. All units communicate with the central process management system (SCADA/DCS) via exactly defined interfaces. All units were completely factory acceptance tested (FAT) in the LAUDA test area in order to arrive at the customer site ready for connection. All 11 units were commissioned by LAUDA and ALTANA in record quick time.

Heating, cooling and chilling of reactors in colleges

Application

Heating, cooling and chilling of reactors in a temperature range from -20 up to 160 °C.

Heating

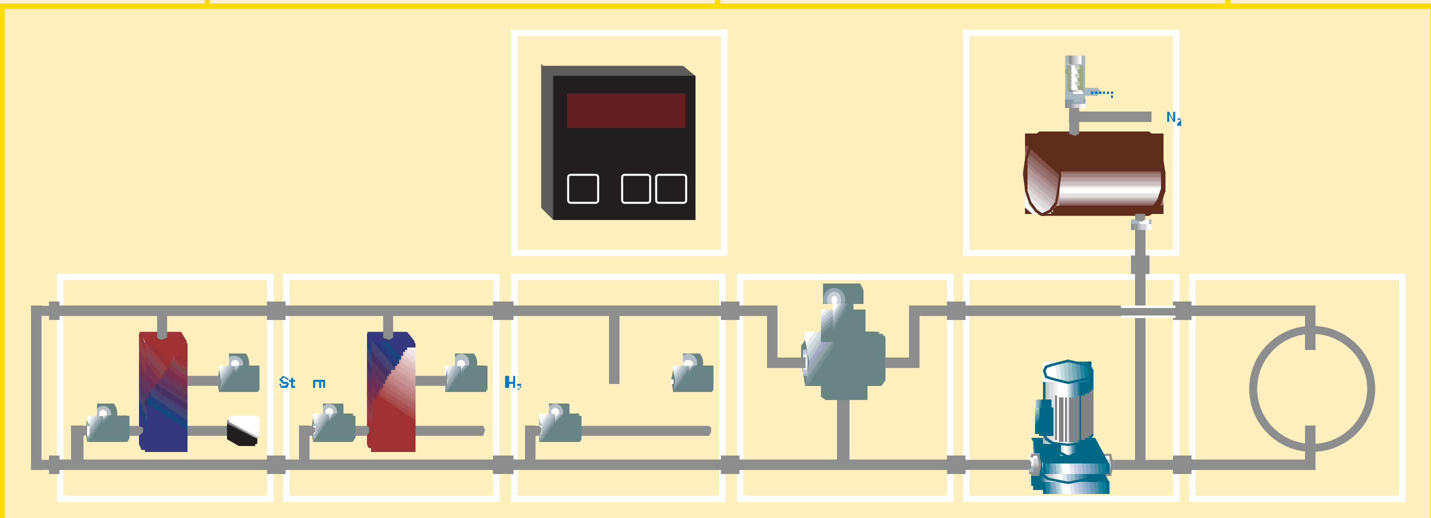
A steam network of 170 °C was available. The heat transfer fluid was heated to the desired temperature by means of a heat exchanger.

Cooling

A cooling water network of 25 °C was available. The heat transfer fluid was cooled down to the desired temperature by means of a heat exchanger.

Chilling

As there was no refrigeration source at site, it was necessary to generate one. As chilling was only required from time to time, a mobile refrigeration unit was used, which can be easily connected by means of quick couplings.



LAUDA modular solution: Secondary circuit unit Type TR 400 HKT

Installation concept of the LAUDA Plug & Play modules

Module construction of the secondary circuit units

Discussions at customer site

Operator panel with visualisation

AVECIA Limited, in Huddersfield, UK, is one of the leading producers of pharmaceutical ingredients (API = Active Pharmaceutical Ingredients). They placed an order with LAUDA to controll a highly sensitive low-temperature process stage for the synthesis of a product for the treatment of the ophthalmic disease, Glaucoma.

The problem was to control the very exothermic reaction at a temperature level of -80 °C. In order to meet the requirements of high reliability and low operating costs, LAUDA and AVECIA chose a process cooling unit. An electric heater of 36 kW had to be installed in the unit in order to meet the requested heating cycle.

The unit had to be independent from central energy systems and installed outside in a hazardous area (Zone 1/T4). This decentralised concept increased the customer's flexibility to move the unit to a different place – if required – in order to react to changed market conditions.

High purity by chilling

Application

Heating/chilling of a reactor in a temperature range from -80 up to 140 °C; outside installation in hazardous area.

Heating

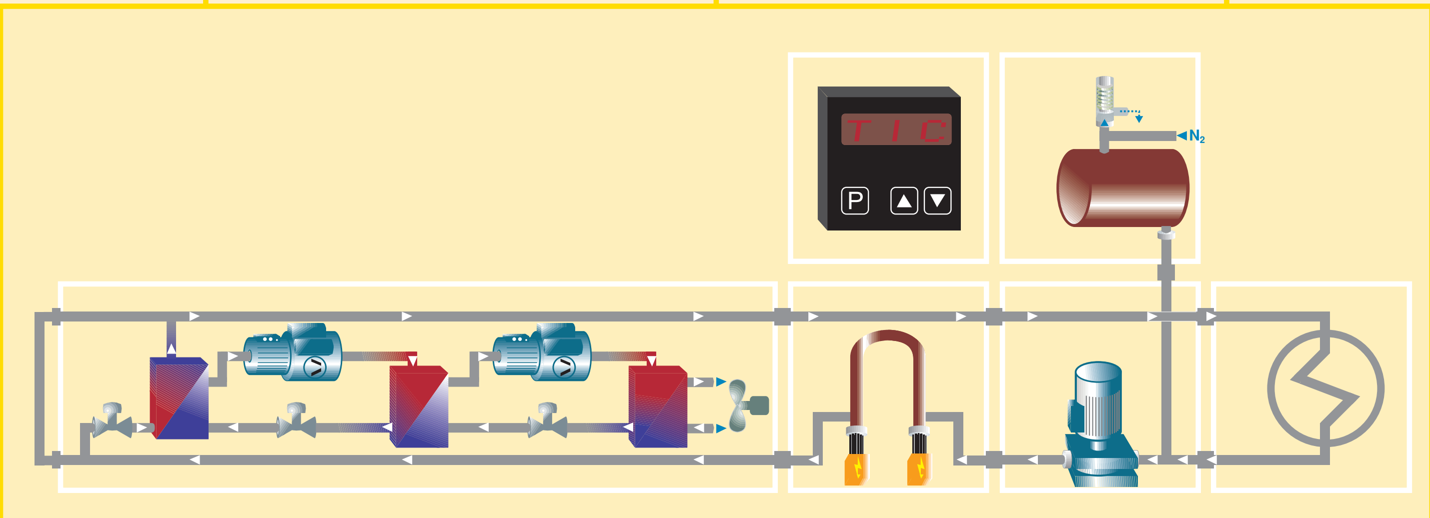
The was independent from the customer's steam system; heating was generated by means of an electric heater.

Chilling

It was decided not to use liquid nitrogen; chilling was generated by using a process cooling unit (two-circuit cascade).

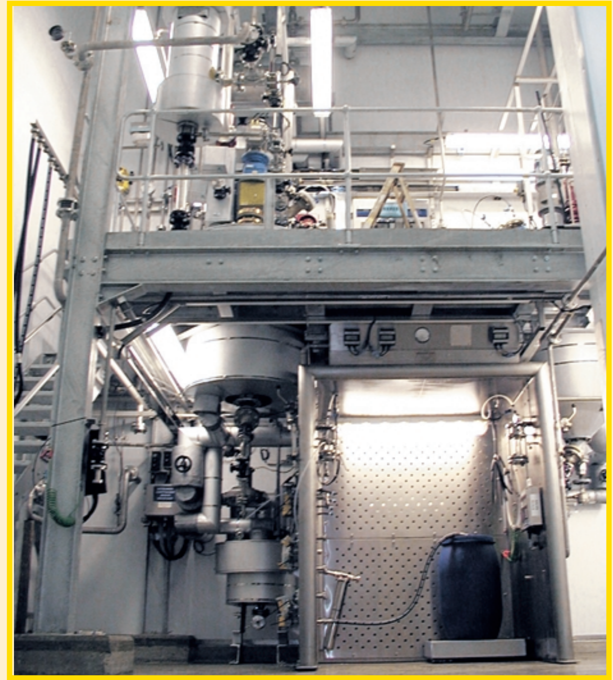
Air- or water-cooled refrigeration module

Due to the fact that cooling water was not used, an air-cooled lamella condenser with fans was mounted on the top of the unit.

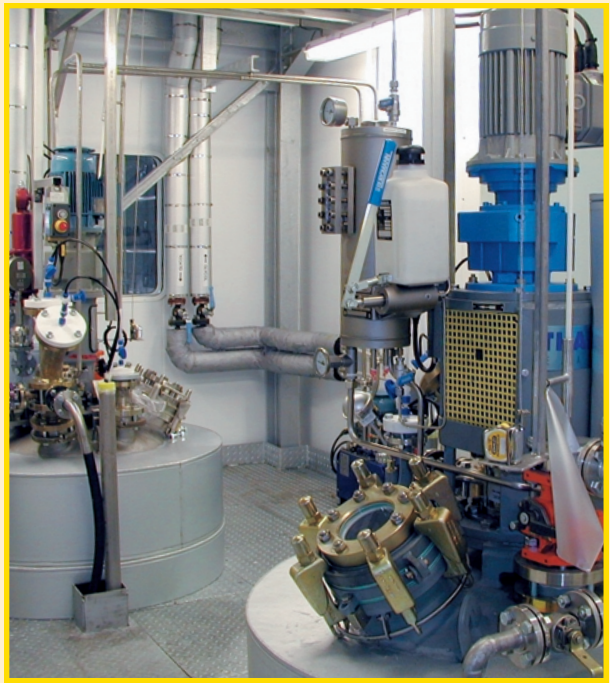


LAUDA modular solution: Process cooling unit Type SUK 400 L II Ex

The two LAUDA process cooling units installed outside. Chilling unit with temperature range from -80 up to 140 °C at the front.



Many creative ideas were realised by the engineers: inner life of process technology.



Perfect validation in detail: starting point for a competitive pharmaceutical production.

Operator panel of the LAUDA process cooling unit in explosion-proof version

Glossary

Explanation of expressions used

Actuator
The actuator is an active component of the so-called control circuit. It is controlled through an adjusting command (see control variable) of the controller (see temperature controller) and triggers a measure that counteracts to the control deviation.

ATEX
Directive 94/9/EC, also known as ATEX 100a, has been issued by the EC in order to harmonise fundamental safety and health requirements for devices, protection systems and components that are provided for use in accordance with the regulations for hazardous areas. This definition includes devices for safety, test and control which are required for use outside hazardous areas with regards to their explosion risks. Directive 94/9/EC is applicable to electric and non-electric devices, protection systems and components (electric and non-electric operating supplies).

Bus system
See interface.

Cascade control
See external control.

Component tested safety facilities
As a rule all temperature control units fall within the pressure equipment directive (see DGRL 97/23 EC). Depending on the heat transfer medium and the temperature, the installations have to be equipped with special safety facilities, for example safety valves, pressure, temperature or levelling switches. These facilities serve as a protection for the temperature control unit at exceeding the admissible limits of the application. In this connection it has to be strictly observed that only component tested parts, i.e. qualified components, from a named testing laboratory are used. These components have to be equipped with the identification numbers of the named testing laboratory and conformity declarations of the manufacturers have to be on hand.

Compessor control
See injection control.

Condenser
See refrigerant.

Control circuit
Control circuit is the totality of control section (see control section) and controller. Sensors and signals, their processing and transmission also form part of the control circuit. For example, transformers, clamps and electric lines.

Control deviation
Control deviation is the deviation of the actual value from the preset setpoint.

Control section
Control section is the part of the control circuit to be influenced according to its application. Pipework, sensors and heat transfer areas with their walls and coatings also form part of the control section. Through distances from the test point to the final control element and through inertia at the heat transfer for example, a characteristic response time of a control section arises. Depending on the response time, a control section is classified from 'good' to 'difficult'.

Control variable
Adjusting command of the controller that acts on the so-called actuator.

Controller characteristic
Different controllers are distinguished according to their so-called controller characteristic: proportional response (P-controller), integral response (I-controller) and differential response (D-controller). As for temperature controllers, combined characteristics have stood the test. Modern PID-controllers can be perfectly adapted to difficult control sections through freely eligible parameters. They are therefore widely used.

Controlling temperature
To control temperature means to control supply or carry away heating or cooling energy in order to reach a constant temperature at the consumer.

Cooling power
With medium cooled heat exchangers the cooling capacity always depends on the temperature difference between cooling medium and heat transfer fluid. The cooling capacity reduces at falling outflow temperature and tends to zero when it reaches the cooling medium temperature. At mechanical cooling the characteristics are similar. The cooling capacity thus always relates to a definite outflow temperature. At LAUDA the performance data of refrigeration machines is based on cooling water or air with a temperature of 20 °C.

Cooling process
See refrigerant.

Delivery head
The delivery head is a theoretical value which is used within the pump characteristics (see pump characteristic) instead of the feed pressure (see feed pressure). The advantage is that the delivery head is valid for any given liquid. The feed pressure is then calculated for the respective feed medium by multiplying the density with the delivery head (see feed pressure).

Environmental temperature range
This is the admissible temperature range in which the unit can be operated in accordance with the regulations.

Evaporator
See refrigerant.

Expansion volume/Expansion tank
When heating up the heat transfer medium to the desired operating temperature, the heat transfer medium expands. This expansion volume results from the expansion coefficient, the temperature change and the contents of the unit. The expansion tank installed in the temperature control unit has to collect the expansion volume safely. The assessment of the dimensions of the expansion tank for thermal oils depends on DIN 4754. The following applies for hot water: about 0.8 % per ΔT = 10 K., for mineral oils: about 1 % per ΔT = 10 K. and for silicone oils: about 2 % per ΔT = 10 K.

External control
If the outflow temperature is not the controlled and a temperature measured outside the temperature control unit is used, then the outflow temperature of the heat transfer fluid is tracked in such a way that the setpoint is reached at the external point. In practice this is achieved via a so-called cascade control (see cascade control). The so-called 'master controller' produces in its capacity as the control variable (see control variable) the setpoint for the post-connected slave controller (see slave controller), the slave controller controls the outflow temperature of the heat transfer medium liquid.

Feed pressure
Feed pressure is the manometric pressure measured at the outlet nozzle of a pump or a compressor. As far as pumps are concerned, the feed pressure also results from the pump characteristics and is the product of delivery head (see pump characteristic) and the density of the flow medium.

Fill volume
In connection with a LAUDA unit, the recommended filling amount of the system (volume) which is required in order to guarantee a trouble-free operation, and to allow for expansion or contraction of the system throughout its operating temperature range.

Film temperature
The maximum film temperature, which the manufacturer indicates with reference to organic heat transfer mediums, describes the temperature at which the heat transfer mediums begin to decompose. Especially when organic heat transfer mediums are heated up with the help of electric heaters, attention must be paid to the heat flux values because otherwise the heat transfer medium is destroyed by a high surface or film temperature. In this connection it has to be proven through a flow or a heat technological lay-out according to DIN 4754 that the admissible film temperature cannot be reached with an adequate safety distance.

Flow rate
Volume flow of a pump or a compressor. The flow rate depends on the respective operating point and the characteristics (see pump characteristic) of each component.

GMP/FDA
In processes in which the reaction temperature or the respective temperature control represent a critical quantity, the temperature control unit has to be qualified and validated. Qualification takes place according to the 'Good Manufacturing Practice' (GMP). If, for example, pharmaceutical products are produced for the American market, the manufacturing process – and with it the process equipment including the temperature control unit – is subject to the requirements of the American 'Food and Drug Administration' (FDA).

Hazard evaluation (HAZOP)
As far as hazard evaluation is concerned, which has to be generated by the operating company, the information relevant for safety from the operating manual of the manufacturer has to be considered. These are especially: mounting and integration of the temperature control unit into the total system, commissioning, operation, maintenance and inspection and indications for possible improper use, as far as such an application has not already been prevented by the lay-out/technical measures.

Heating power
With electric heating, the heating power is identical to the power consumption of the built-in electric heaters. It is always the maximum possible heating power and, in the case of electric heating, it remains invariable at all operating temperatures. With medium heated heat exchangers, the heating power always depends on the temperature difference between heating medium and heat transfer fluid. The heating power reduces at increasing outflow temperatures, and tends to zero when it reaches the heating medium temperature. The brought-in pump output is helpful but not taken into account.

Heat transfer medium/Fluids
These are liquids which supply or carry away energy at the consumer. The heat transfer medium is supplied through a circulating pump of the temperature control unit. The bigger the circulating quantity, the lower the temperature difference at the consumer. The lower the temperature difference the better the control precision.

Injection control
With LAUDA process cooling units, the cooling power (see cooling power) is permanently controlled by adjusting the injection flow (0 – 100 %). The final control element is a continuously working control valve that is placed in the feeding pipe of the refrigerant in front of the evaporator. If several compressors are shunted, an automatic cascade connection (compressor controlled) ensures energy-saving partial-load operation.

Interface
Always serves to exchange data and may be set up on an analogue basis (mostly standard signal 4-20 mA or 0-10 V) or on a digital basis. In the digital area you find the single serial interfaces (RS 232) or the more powerful, parallel addressable systems for many users (RS 485 or the different industrial bus systems).

Modular engineering
Describes the modular design from which any possible temperature control unit can be planned and assembled according to a recurrent pattern, thus saving on costs during the planning process, execution, commissioning, documentation and maintenance, because every module alone has already been approved many times. By using modular engineering, a maximum safety standard is achieved.

Monofluid (single fluid) system
This is a heat transfer medium which works with only one heat transfer fluid. It is useful when heating, cooling and freezing must be done simultaneously and heating and cooling units are working together.

Operating temperature range
The temperature range that can be run in the heat transfer medium flow line to the process equipment (outflow).

Overlay pressure/Inert gas covering
Through an inert gas covering (nitrogen) on the expansion tank, oxidation of the heat transfer medium and seeping of water vapour from the air can be prevented. If the heat transfer medium is operated below its evaporation point, overlay pressure should be as low as possible (about 0.1 bar), so that when heating up through the reduction of the gamma space the pressure increase is not too high. If the heat transfer medium operated above its evaporation point and atmospheric pressure (1.013 bar), an overlay pressure of at least the respective vapour pressure is necessary in order to safely prevent cavitations. In both cases a safety valve has to be installed on the expansion tank.

Peripheral wheel pump
Peripheral wheel pump is a centrifugal pump with a running wheel that has a so-called 'peripheral' shape. The almost linear characteristics of a peripheral wheel differs fundamentally from the characteristics of a radial running wheel. At highest feed pressure and lowest feed flow rate the highest drive energy is required with the peripheral shape. Peripheral wheel pumps are especially suited for small feed flow rates and high pressures.

Permanent control deviation
Permanent control deviation is a purely proportional controller used; 'permanent deviation' is always the consequence. In this case the control variable(s) will always be proportional to the deviation. There is no adjusting command without deviation.

Plug & Play modules
Temperature control units and modules arrive at the construction site with clearly defined interfaces, ready for connection, complete with pipework and insulated. They only have to be docked (see modular engineering).

Pressure Equipment Directive (DGRL 97/23 EC)
Temperature control units are in the control of the pressure equipment directive considered as modules, which are assembled from several pressure devices (expansion tank, pipelines, fittings, safety valve, etc). The fundamental safety requirements for this are described in annex I of the pressure equipment directive (DGRL). The process of conformity assessment for the module to be applied depends on the category in which the module is classified. This category is determined through the highest category of the respective built-in pressure device. In this connection, parts of equipment with a safety function are ignored. The category that describes the hazard potential depends on the maximum operating pressure, heat transfer medium, content and type of the built-in pressure device. Before the temperature control unit is commissioned, the manufacturer has – according to the operating conditions – to classify the module into a category and to submit it to a process of conformity assessment. The temperature control unit has to be labelled with the CE-label and, starting from category II, has to be labelled with the identification number of the named testing laboratory.

Primary side
Denominates primary energy carriers such as vapour, cooling water, air, brine, liquid nitrogen, etc., that have to be connected to the temperature control unit by the customer. These primary energies can be gaseous, vaporous or fluid.

Protection type IP
Pursuant to EN 60529 two numerals assess the electric degree of protection. The first numeral represents the quality of the touch and foreign body protection (dust). The second numeral assesses the protection against water.

Pump characteristic
This is a diagram that shows the function of the delivery head in relation to the flow rate.

Illustration Title and rear site
Front page: Using secondary circuit units in pressure reaction centre at Merck KGaA
Rear site: Consultation and design by LAUDA

Radial pumps
Radial pumps are centrifugal pumps with a running wheel that has a so-called 'radial' shape. The non-linear characteristics of a radial wheel differ fundamentally from the characteristics of a peripheral wheel. At lowest feed pressure and highest feed flow rate the highest drive energy is required with the radial shape. Standard pumps for the chemical industry are radial pumps. Radial pumps are especially suited for small feed pressures and high flow rates.

Refrigerant
Operating material of the cooling process that is located in the closed refrigeration system. The compressor sucks it from the evaporator, where it changes to gaseous condition under heat absorption. On the warmer side of the evaporator the medium cools down through heat absorption. On the high pressure side of the compressor the cooling medium is liquefied in the condenser/heat exchanger under heat transfer. The condenser/heat exchanger is water- or air-cooled.

Risk analysis
The risk analysis has to be generated by the manufacturer of the temperature control unit. The analysis serves to determine the dangers in connection with the unit with reference to the provided operating conditions. Lay-out and construction of the temperature control unit take place in consideration of the risk analysis. As to the remaining dangers which cannot be covered through technical solutions, as well as measures required from the operator, the manufacturer has to inform the operator through indications in the operating manual, and if necessary through mounting alert labels on the temperature control unit.

Refrigeration system
See refrigerant.

Secondary side/Heat transfer medium side
Denominates the side of the temperature control unit from which the heat transfer medium is flown through. Heat transfer mediums (thermal oil, water) are chosen according to the operating temperature range and their respective application.

Slave controller
See external control.

Sound pressure level
Sound pressure level is the measure for the sound radiation according to DIN EN ISO 11200. In contrast to the acoustic power level, the pressure level is always assigned to a defined distance. In practice both quantities are stated in dba.

System pressure
This is the pressure which is produced by pump pressure, vapour pressure at operating temperature and overlay pressure in the heat transfer medium system. Please pay special attention to the maximum system pressure because all components that are flown through by the heat transfer medium have to be suitable for the maximum system pressure (see pressure equipment directive).

Through-flow cooler
Through-flow cooler is a mechanical or otherwise cooled heat exchanger, where a fluid positively flows through the system. The cooler mainly serves as a cooler for the fluid that is flowing through. Usually the positive flow is generated by a pump.

Through-flow heater
Through-flow heater is an electrical or otherwise heated heat exchanger, where a fluid positively flows through the system. The heater mainly serves as a heater for the fluid that is flowing through. Usually the positive flow is generated by a pump.

Two-circuit cascade refrigeration
This is a cascade connection of two refrigeration systems with cooling mediums (see refrigerant) of different thermodynamic properties. Two-circuit cascades with compression refrigerating processes are used at working temperatures below -50 °C. The first cascade (high-temperature stage) produces temperatures of about -35 °C in the evaporator. On the warm side of the evaporator the cooling medium of the second stage (low-temperature stage) condenses at about -30 °C and vaporises at about -90 °C, and is cooling the heat transfer fluid to about -80 °C.

Temperature controller
Temperature controller is an active component which compares at least one temperature actual value with one setpoint, and depending on the deviation (see control deviation) outputs an adjusting command (see control variable). This so-called 'adjusting command(s)' acts on the so-called 'final control element(s)' which also actively triggers a measure that acts against the deviation. Temperature controllers can act purely mechanically (for example the so-called 'heating unit thermostat') or electronically – be set up analogue or digitally. Often several operating modes are combined.

Temperature control unit (TCU)
This is a comprehensive term for differently laid out heating or cooling systems which in a defined working temperature range can control temperature of the consumer by means of a liquid.