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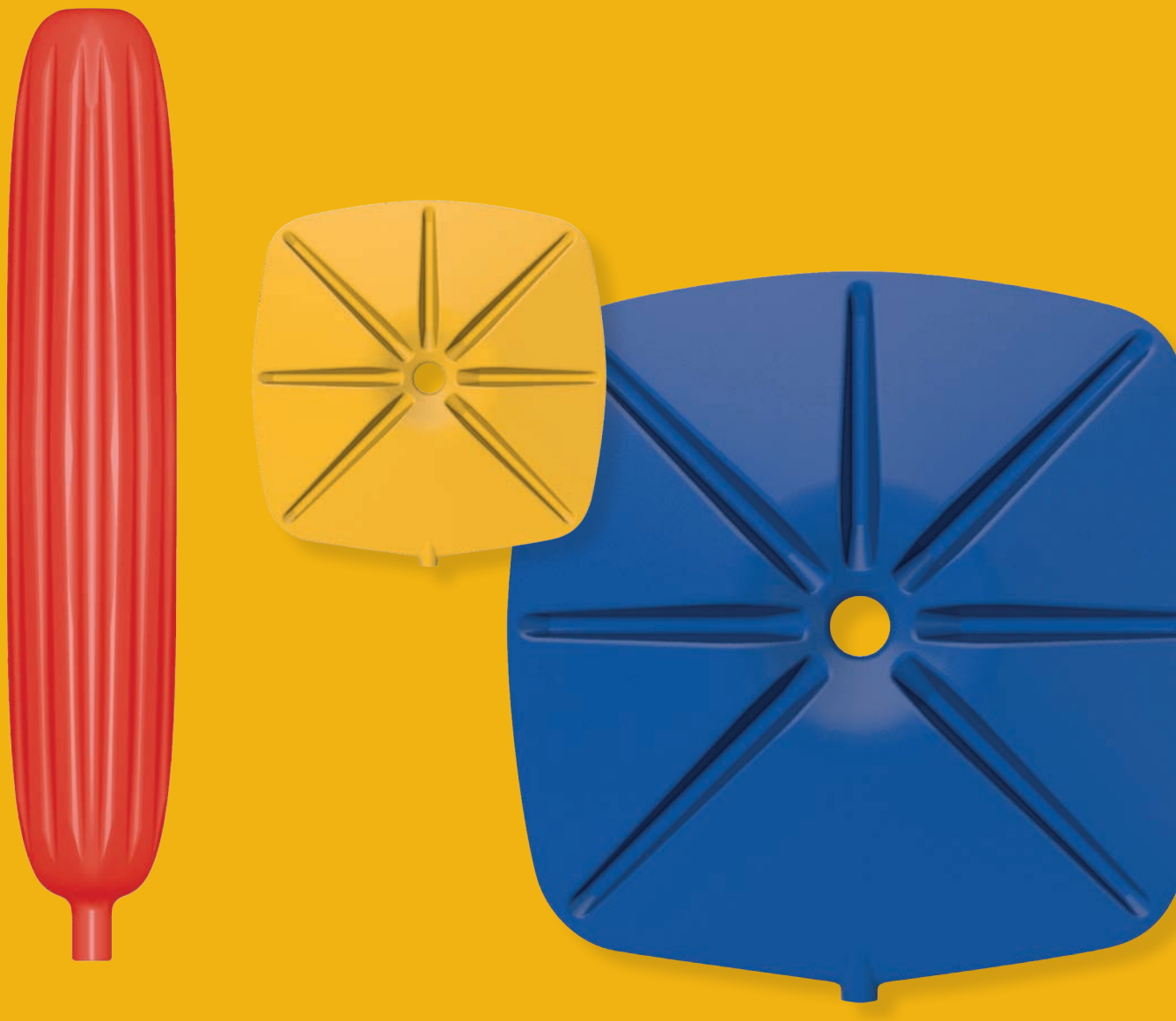
heatStixx

The innovative solution for increasing storage capacity!



PREFACE

The idea of using PCM (Phase Change Materials) for thermal energy storage has existed for many years. So far, however, there has been a lack of reliable systems to harness the existing potential which the use of PCM offers. Market penetration was hindered primarily by the fact that there was no simple and reliable option for use.

In order to resolve this dilemma, we are looking to successfully launch the "heatStixx" on the market with our partners.

Michael Kaiser
pro KÜHLSOLE GmbH

Klaus Rauch
kraftBoxx gmbh

Egon Schmitz
Axiotherm GmbH

CONTENT

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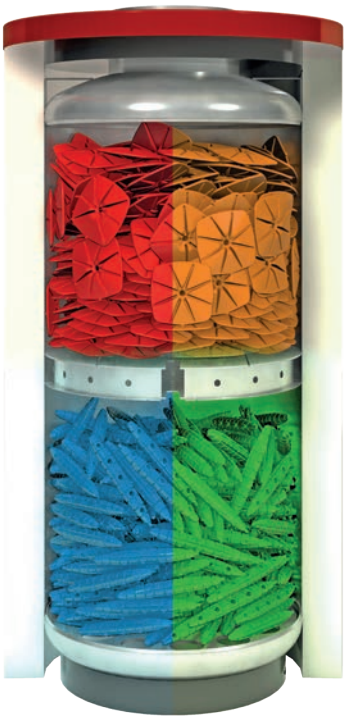
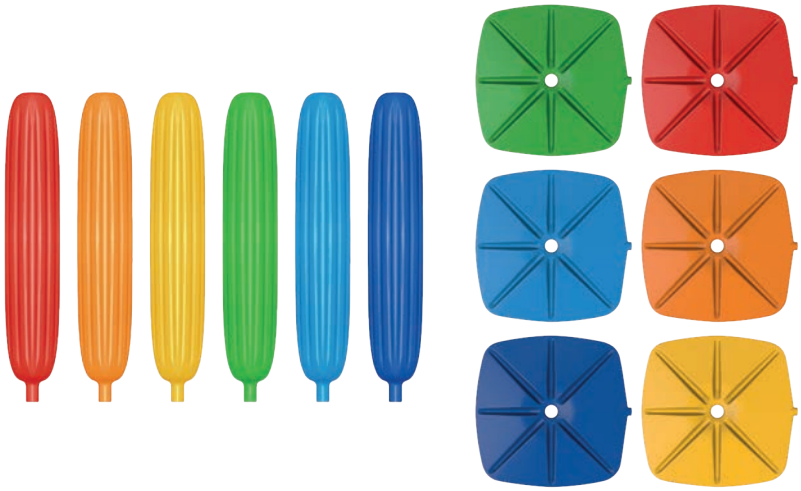
heatStixx FOR EFFECTIVE HEAT STORAGE



It has never been easier to store ecologically generated heat!

Our heatStixx and heatSel are designed such that, in addition to a large surface area, the PCM layer thicknesses are kept so small that the entire PCM participates in the phase change process, thus achieving efficient heat transfer (fast charging and discharging) even with very low temperature differences.

The design as a hybrid heat accumulator enables the greatest possible dynamic due to the water content; it is therefore perfectly suited for a large number of applications in refrigeration, air conditioning and heating technology.



Optimised material properties compared to conventional PCM encapsulations

- Fixed cycle - high phase change resistance
- Flexible - heatStixx can be adapted to almost any storage system
- Climate neutral - for a better environment and future
- Maintenance-free
- Quality assurance by accredited laboratory for the fulfillment of the PCM RAL quality specifications

➔ Simply select the application temperature, fill with the appropriate heatStixx and immediately use the latent energy.

Why PCM?

PCM (Phase Change Material) is used to store and withdraw thermal energy. The phase change plays the crucial role. Depending on the PCM material (paraffins, salt hydrates, etc.), the binding forces are "broken up" energetically when a certain temperature is reached (phase change temperature, depends on the PCM). This is the melting process. This takes place at a constant temperature. If the PCM is cooled down again, i.e. the stored energy is extracted at a constant temperature, it becomes solid again.

➔ The energy is thus stored in the phase transition and released again.

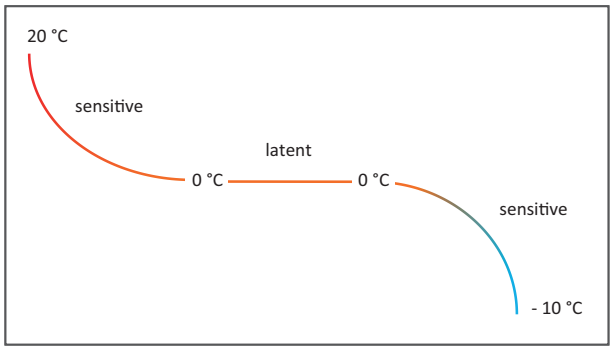
WATER

A look at ice water shows what a difference this energy can make

To turn 1 kg of water from 0 °C solid to 0 °C liquid, you need as much energy as for heating 1 kg of water from 0 °C (liquid) to 80 °C.

The specific phase transformation enthalpy is therefore relatively high in comparison to the specific heat capacity (for water: melting enthalpy 334 kJ/kg, specific heat capacity approx. 4.19 kJ/(kg - K)), where the energy density of the storage tank is considerably higher than that of hot water storage tanks.

➔ This is the latent effect!



Example melting energy of water

- 1 kg of water requires 1.16 Wh to heat it from 0 °C liquid to 1 °C liquid.
- 92 Wh are needed from 0 °C solid to 0 °C liquid; this is approx. 80 times as much.

➔ A very high energy density is possible

PCM IN THE SYSTEM - TESTED PHASE CHANGE MATERIAL!

MATERIALS

Since the melting temperature of water, which is known to be 0 °C and is unsuitable for most applications, specially developed salts, esters or paraffins are used as PCMs. Depending on the design, they have a phase change temperature between -33 °C and +89 °C. Some of our PCM materials are food-certified by the NSF under HT1 and can therefore be used safely in the food industry. Thanks to this broad product range, the right PCM can be found for almost any application.

Material properties of organic PCM

ATP - Paraffins

- Available in many temperature ranges
- Cycle stable
- Compoundable
- Storage capacity > 70 Wh/kg (250 kJ/kg)
- Low sensitive heat (0.5 Wh/kg - K)
- Low to no subcooling
- Low density (approx. 0.74 kg/l)
- Low storage density 50 Wh/l (185 kJ/l)
- Low heat conduction (0.2 - 0.4 W/m - K)
- flammable

ATE - Esters

- Available in a few temperature ranges
- Cycle stable
- Compoundable
- Storage capacity > 60 Wh/kg (220 kJ/kg)
- Low sensitive heat (0.5 Wh/kg - K)
- Low to no subcooling
- Low density (approx. 0.84 kg/l)
- Low storage density 50 Wh/l (185 kJ/l)
- Low heat conduction (0.2 - 0.4 W/m - K)
- Flammable but slightly higher flash point

Inorganic PCM material properties

ATS/PKS - Salts and salt hydrates

- Available in selected temperature ranges
- Cycle stable
- Storage capacity 40 - 90 Wh/kg (180 - 320 kJ/kg)
- Higher sensitive heat (0.8 - 1 Wh/kg - K)
- Low subcooling
- High density (1 - 1.7 kg/l)
- High storage density 60 - 90 Wh/l (200 - 320 kJ/l)
- Higher thermal conductivity (0.4 - 0.6 W/m - K)
- Non-flammable

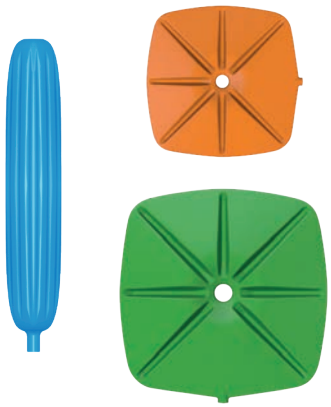
CONVENTIONAL METHODS AND BENEFITS OF heatStixx

The idea of using latent materials to store energy has been around for many decades.
Many solutions have already been developed and tested for heating and cooling applications.
None of them was able to assert itself in the market, but why?

Many PCM's can store a large amount of energy through the use of latent heat, but they also often have poor thermal conductivity, which makes them good insulators. This leads to:

- Poor melting performance
- Poor output transferability

➔ For a heat or cold accumulator it is important to achieve the highest possible transferable output in addition to using the entire energy potential.



Installation in the storage tank
heatStixx through 1½" sleeve

Our heatStixx optimally combine these properties

In our **proprietary format**, proven through **years of research** and **validation,** we combine high transferable output, thanks to the large surface area, with the largest possible amount of PCM that we can incorporate into your system. The surface area to volume ratio plays a decisive role.

Experience the performance of our heatStixx

Our heatStixx and heatSel are available for different temperature ranges. This enables us to cover a very broad spectrum of application areas and heat storage options.

➔ If there is no suitable temperature/application range for your application, we will jointly develop it for your project.

Application benefits

- Optimised encapsulation form
- Good melting performance due to low layer thicknesses
- Optimised surface-to-volume ratio
- High transferable output
- Easy to use in existing systems or new installations
- Designed as a hybrid accumulator
- Storing and drawing heating water/anti-freeze mixes
- Temperature-resistant plastics
- Extremely long service life
- Low-maintenance

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MAIN APPLICATIONS FOR OUR heatStixx

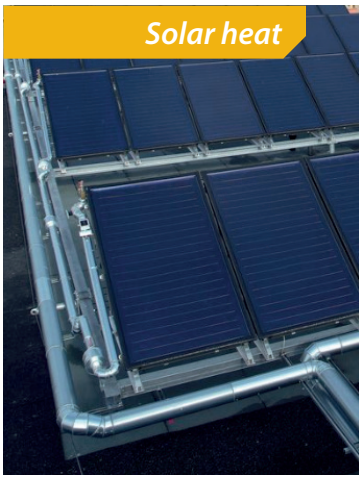
Heat

- Solar heat
- PV heat
- Heat pump
- Condensing technology
- Boiler
- Process heat
- Local and district heating networks
- Concrete core activation
- Solar house
- Ventilation/heat recovery

Cooling

- Ventilation/air conditioning technology
- Process cold
- Refrigerated cabinets
- Supermarket refrigeration system
- Ice accumulator

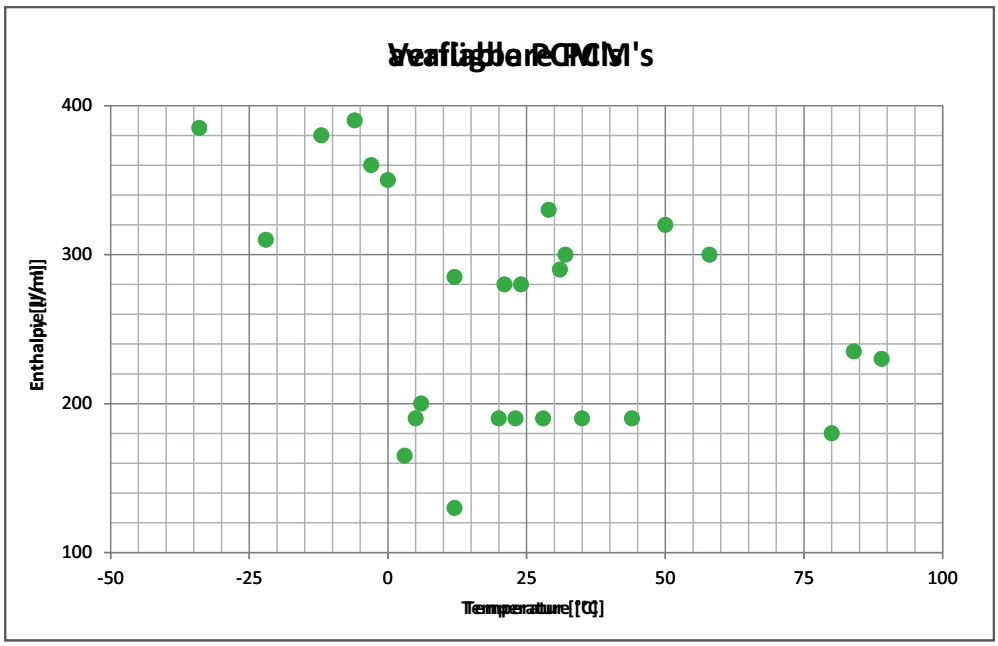
➔ Further potential applications on request



The right temperature is decisive!

- This is why we offer a variety of PCMs.
- To suit your project!

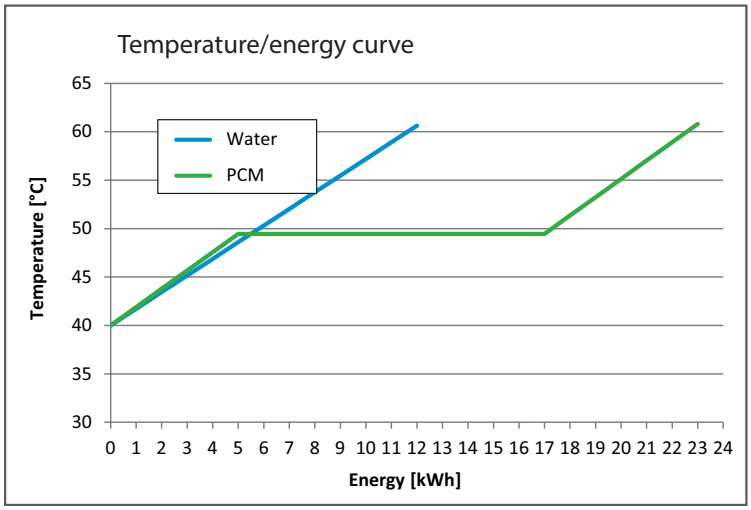
Explore your options!



How do you choose the right temperature?

The phase change always takes place at a certain temperature. In order to achieve this, however, there must be a specific temperature drop from the carrier medium to the PCM, i.e., from the ambient water to the phase change temperature.

This is important for both the energy consumption and the energy output. The phase change temperature of the PCM should therefore be selected so that it lies between the minimum and maximum system temperatures at each operating point of the system.



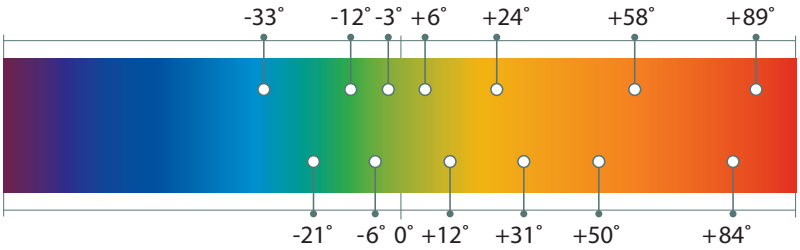
➔ If, for example, you normally operate your storage tank between 40 °C and 60 °C, the optimum PCM temperature should be approx. 50 °C.

➔ Your storage tank will then still be discharged at 40 °C and fully charged at 60 °C, but the process will take much longer. This allows you to store far more energy.

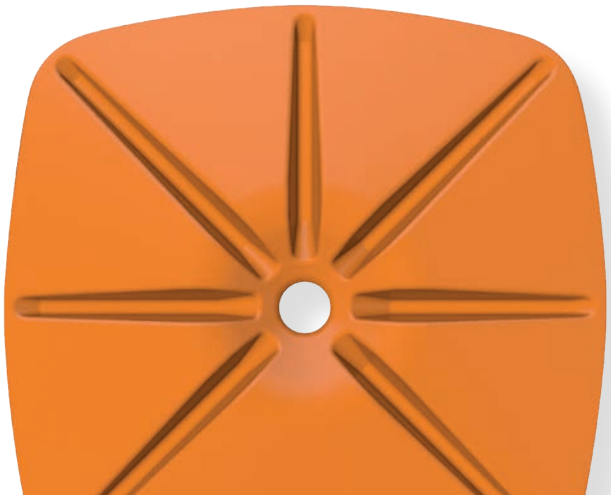
AVAILABLE USABLE TEMPERATURES

OUR MAIN AREAS OF APPLICATION

Our heatStixx and heatSel are available for different temperature ranges. This enables us to cover a very broad spectrum of applications and possibilities for heat and cold storage. In the following figure you can see our main areas of application and the most common materials. They have proven their value over time.



➔ If there is no suitable application temperature for your application, we will collaborate with you to find it for your project.



WHICH STORAGE POTENTIAL CAN BE ACHIEVED?

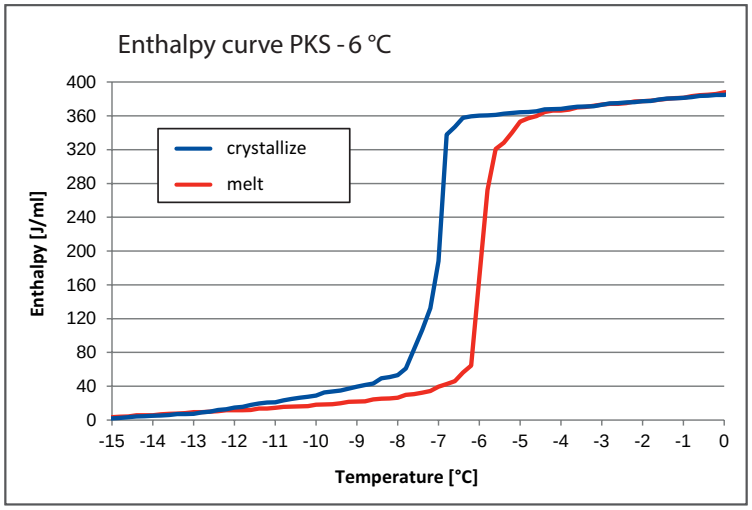
To determine how large or how small your storage tank can become, it is important to consider what your application temperatures look like. The temperatures between which your system is operated is important for your choice of the right PCM.

Sample application for a cooling application

The temperature range in the storage tank can be as follows:

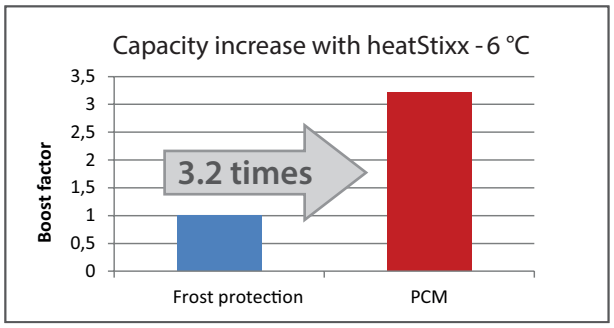
Min. storage tank temperature: -10 °C (The minimum temperature necessary to ensure your application)
Max storage tank temperature: 5 °C (The temperature up to which your storage tank is normally heated)

➔ Results in a storage delta of 5 °C to -10 °C = 15 K



Application

Boost factor of the storable energy quantity in comparison to water (frost protection) with a delta of 15 K and a completely filled storage tank.



Charging example

- Thermal energy storage tank with 40 kWh capacity with PCM latent material
- Immediately usable heat due to stratified charging
- 30 % increase in own consumption due to higher storage capacity

A 1 m^3 buffer storage tank, filled with
1,500 heatStixx PKS -6 °C stores approx. 40 kWh

heatStixx tool for calculating storage capacity and factors*

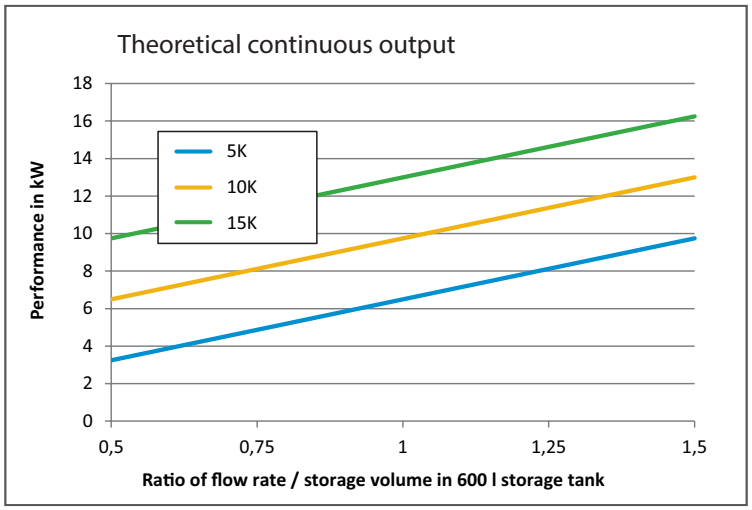
To do so, you need to enter the following values:

Tank size, degree of filling and delta

In the column for the PCM you will be using, you can read off the values for your storage boost factor and the storable energy quantity.

* the calculation tool is available on request at: info@kraftboxx.de

In addition to choosing the right phase change temperature, temperature deltas and outputs also play an important role in ensuring that your heatStixx application is a complete success.



What thermal output can you exploit?

When the storage tank is filled to the maximum, the thermal capacity that you draw from the storage tank or that you can store is limited by three variables:

- The temperature difference between the phase change temperature and return flow temperature of your system
- The size of your storage tank
- The volume flow of your system

In the performance diagram, you can see which output you can obtain or store.

Sample heating application:

Storage tank size: 600 l

Volumetric flow rate 900 l/h

Ratio of volumetric flow rate to storage tank size: 1.5

Phase change temperature of the PCM: 58 °C

Return temperature into the tank: 53 °C

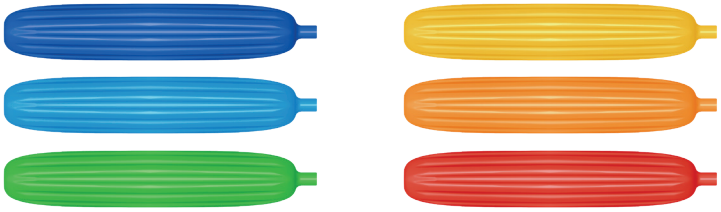
➔ Delta 5 K: Blue line in the diagram

This results in a possible continuous output of approx. 9.8 kW

In addition, it is important to note that you should not exceed the factor of 1.5 of the volumetric flow to the storage tank size for continuous output. Of course, higher outputs can also be drawn at short notice, e.g., by fresh water stations.

heatStixx FUNCTIONALITY AND QUALITY

heatStixx from – 33 °C to + 89 °C



Installation in the storage tank

heatStixx through 1½" sleeve

Application options

In smaller storage tanks, normal heating systems, private households, tanks up to 1,000 l and also optimal for existing tanks

Potential applications

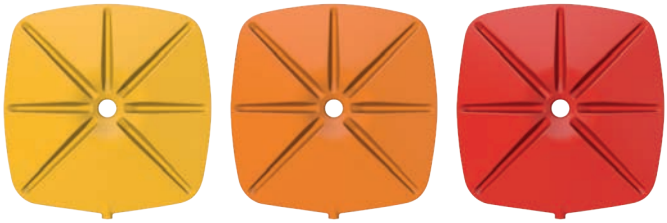
Cold accumulators, heating accumulators

heatSel from – 33 °C to + 89 °C

Installation in the storage tank

heatSel through ND 200 flange

heatSel XL from – 33 °C to + 89 °C



Installation in the storage tank

heatSel XL through ND 300 flange

Application options

In large heatSel storage tanks up to 2,000 l and in heatSelXL storage tanks up to 20,000 l and optionally also for existing equipment

Potential applications

Cold accumulators, heating accumulators

EFFICIENT RETROFITTING OF YOUR STORAGE SYSTEMS

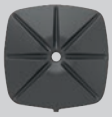
Upgrade your system for state-of-the-art energy savings.
Storage tanks are easily retrofitted by insertion through the standard 1½" sleeve or flange.

Potential applications

Heat pump systems, power-to-heat systems and energy storage systems of all kinds

➔ Virtually any storage tank type with a 1½" sleeve is suitable for unproblematic installation of heatStixx . We will find the right latent material for you to ensure effective heat storage.

PRODUCTS/AREAS OF APPLICATION

heatStixx	heatStixx L 	heatSel 	heatSel XL 
Dimensions	Ø 35 x 260 mm	185 x 185 x 32 mm	275 x 275 x 32 mm
Storage tank size	50 - 1,000 l	500 - 2,000 l	1,500 - 20,000 l
Storage tank diameter	400 - 1,000 mm	600 - 1,200 mm	From 1,200 mm
Number of heatStixx / Sel's per 100 l storage volume	Approx. 200	Approx. 90	Approx. 40
Installation	1½" sleeve	DN 200 flange	DN 300 flange
Max. operating pressure of storage tank	3 bar	3 bar	3 bar
Pressure loss in the storage tank per m layer thickness	Approx. 20-50 mbar	Approx. 20-50 mbar	Approx. 20-50 mbar
Expansion volume due to phase change	Approx. 5 %	Approx. 5 %	Approx. 5 %
Factor for capacity increase to water (<=0 °C compared to frost protection) at storage tank useful temperature of (varies depending on PCM)	10 K approx. 2.4 to 4.8	10 K approx. 2.5 to 4.9	10 K approx. 2.5 to 4.9
	15 K approx. 2.0 to 3.6	15 K approx. 2.0 to 3.6	15 K approx. 2.0 to 3.6
	30 K approx. 1.5 to 2.4	30 K approx. 1.5 to 2.4	30 K approx. 1.5 to 2.4

made in germany

CHP UNIT PROJECT

Task

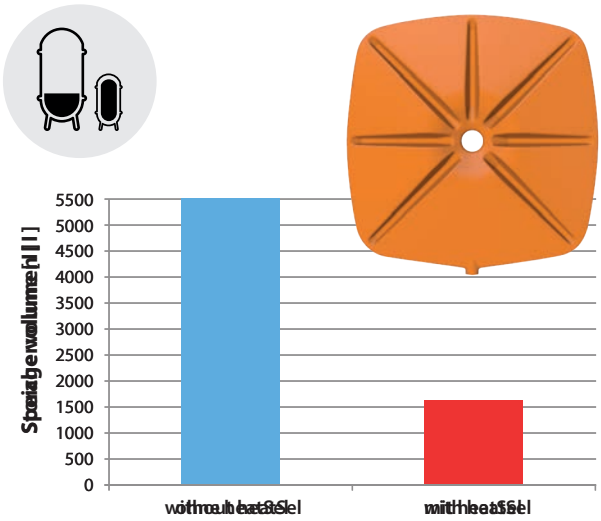
Minimising the storage tank size for a smaller local heating network operated by a CHP unit.

Data:

- Required storage capacity of 5.5 m^3 water volume.
- Local heating network in winter with 55 °C flow and 45 °C return

Solution:

Reduction of the storage volume by up to 30 % compared with a conventional buffer accumulator at a selected size of 1,700 l.



HEAT PUMP PROJECT

Task

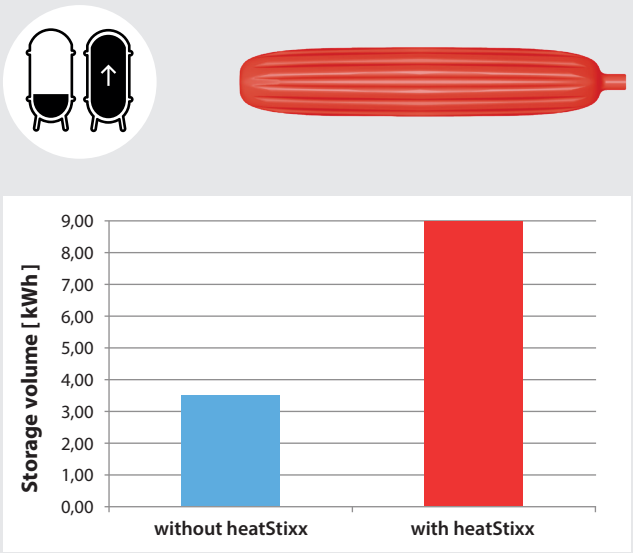
Maximising the storage capacity of a heat pump buffer accumulator tank to make operating times more flexible.

Data:

- 300 l tank capacity
- Cooling of the total capacity from 55 °C to 45 °C

Solution:

258 % increase in storage capability.



ICE ACCUMULATOR PROJECT

Task

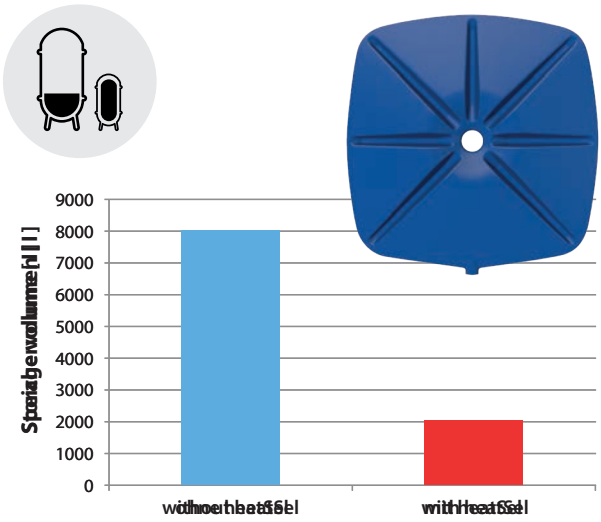
The task was to reduce the volume of a water/glycol cold accumulator to the extent possible.

Data:

- 8,000 l storage tank capacity
- Temperature range from -5 °C to 5 °C

Solution:

Simple implementation of an ice accumulator without expensive heat exchangers and building overhead, plus minimisation of the storage volume to 2,000 l, which is equivalent to 25 % of the original volume.



Innovative thermal energy storage solutions – various potential applications

THE FUTURIUM

The "Futurium - House of the Future" is a project initiative by scientific institutions and networks, several commercial enterprises and foundations, as well as the German Federal Government.

The House of the Future offers around 3,200 square metres of exhibition space on three floors. On the roof of the house, the skywalk not only offers a view of the numerous collector systems for photovoltaics, but also a great view of the River Spree.

Cold accumulators – installation in the Futurium

In 2017, Axiotherm installed five modern cold storage units in the Futurium with a total volume of about 46,000 litres. Filled with more than 55,000 heatSels, the storage capacity is more than 1 MWh:

To reduce peak load during events and enable efficient charging at favourable (night rate) times with a smaller chiller!

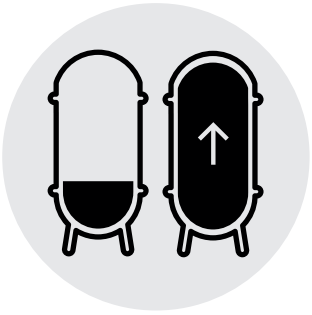
Installed system

Storage tank:	5 x 9,150 litres
Project partner:	Axiotherm GmbH
Info:	www.futurium.de

The PCM storage system is designed to meet demand as a cold storage system rather than a heat storage system in the classic sense. Thermal energy is stored in a hydraulic system which couples different energy converters and consumers. The time offset between energy generation and consumption is bridged by the size of the storage tank, which is five times 9,150 litres. At the same time, the current output can also be controlled by the variable mass flow on the primary and secondary sides.

➔ It is possible to temporarily draw a greater output from the accumulator than was fed into it on the primary side.

ADVANTAGES OF SYSTEM-BOUND LATENT STORAGE



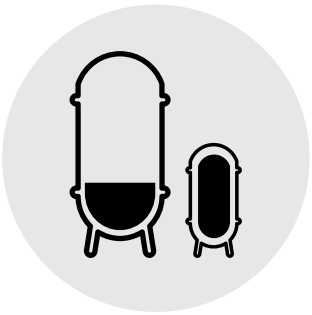
Increase in storage capability.

by 3-4 times with the same volume, simple retrofitting also possible.

Using our heatStixx and heatSel you can significantly increase the storage capacity of your storage tank.

Whether in a cold or heat application, the temperature delta used is decisive. The lower this is, the greater the boost factor becomes.

Our products are therefore ideally suited for achieving a high storage capacity even with a low temperature delta.



Reduction of the storage tank volume

by 3-4 times while maintaining the same capacity, ideal for cramped spatial conditions.

The effect described above allows you to reduce the storage tank size while keeping the storage capacity constant.

heatStixx helps you make optimum use of the available space, especially when space is limited. At the same time, you benefit from the smaller installation dimensions of the smaller storage tank.

➔ Then simply fill with heatStixx and enjoy the benefits!

Extending service life

You can benefit twice over! - Peak shifting and extended operating times.

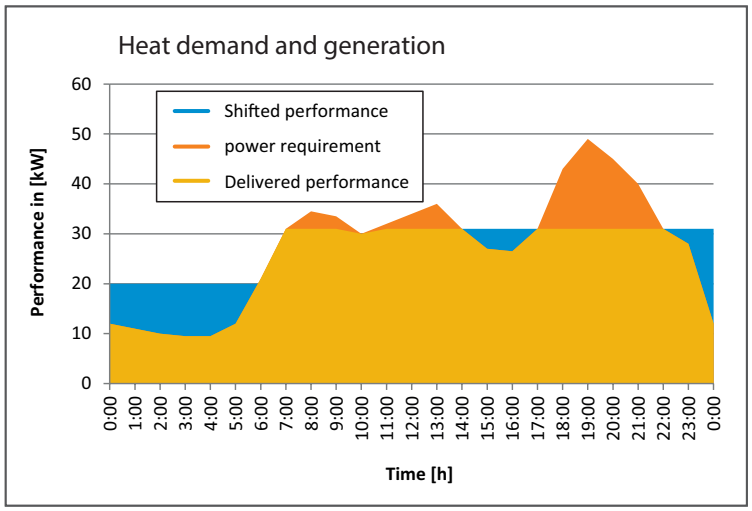
This not only means that you can reduce the output of your heat generator and significantly reduce your purchase costs, but also significantly extend the operating period and thus the economic efficiency as well as the service life.

Because short operating times and high cycle rates reduce the service life and lead to high maintenance costs.

Reduction of operating costs

Reduce power peaks (= rated power) (peak cutting/peak shifting), use of inexpensive "night-time electricity rates" and in-house production.

You benefit in various ways from the increased storage capacity. Let us take a look at a typical daily load curve of a heat generator:



This daily load curve shows a typical output requirement distributed over one day. To cover the highest peaks, you need to install a heat generator that can cover the output peaks.

But at times of lower demand this does not run at full power or starts to cycle. This time can also be used more efficiently by allowing your heat generator to keep running.

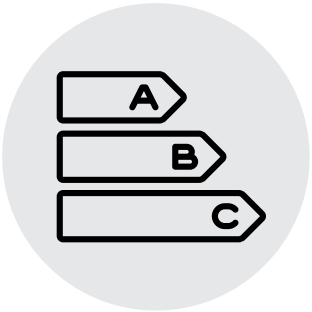
However, this is only possible if you can generate against these output peaks at a different time.

To do this, you need to store the energy to make it available later. This requires a higher storage capacity.

➔ This is exactly where our heatStixx come in.

Simplified process control

by transforming the temperature peaks to phase change temperature and thus constant charging and withdrawal temperature. Integration as a thermal switch.



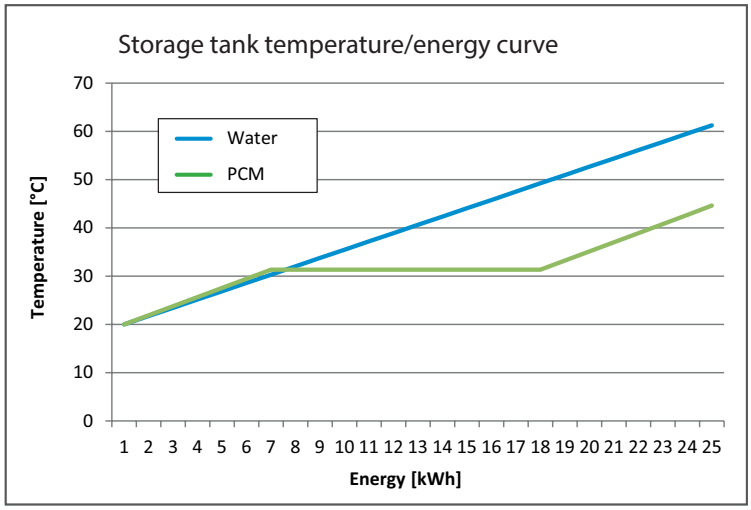
Highly efficient

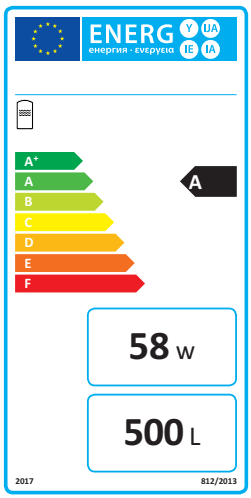
Increase of the COP (Coefficient of performance) and reduction of heat losses through a constant temperature level (40 % lower operating costs!), use of smaller cold/heat generators possible.

Boost the efficiency of your heat pump.

Your storage tank temperature remains constant for longer if you use heatStixx. When you charge your storage tank, the storage tank temperature remains significantly lower after the phase change. This converts to cash for your heat pump. Because every higher °C that it has to provide requires more energy and the curve is logarithmic! This will result in a higher COP and a higher annual energy yield.

It also improves the use of condensing technology. This benefits from a similar effect. Again, it requires the lowest possible application temperature and is only really profitable given this.





Increase your efficiency class - ErP label!

No matter whether you reduce the storage tank size or increase the storage capacity, you benefit in every case.

By reducing the storage tank size, you can significantly reduce the storage losses due to the reduced surface area. For example, your class B storage tank (ErP label) becomes class A and saves you money every year.

Even if you keep the storage tank size, you still benefit. The losses remain the same, but by using heatStixx you achieve a far higher storage equivalent, i.e., your label improves!

STATE AID

BAFA funding

Invest in environmentally friendly heating technology and use BAFA-subsidised products created on behalf of the German Federal Government to secure a subsidy for your plant.

Examples of BAFA funding - the following, and others, are eligible:

Biomass - Requirements for your plant	**Solar heat** - Requirements for your plant
Basic funding: € 80/kW – min but at least € 3,500	Solar heat: € 140/m^2 - but at least € 2,000
Additional subsidy for buffer storage tank: at least 30 l/kW	Vacuum tube collectors: 50 l/m^2, at least 7 m^2
Nominal heat output: At least 5 kW	Flat plate collectors: 40 l/m^2, at least 9 m^2

Valid on: 31 August 2018

But what should you do if you can't meet the requirements?

Use our heatStixx to increase your storage capacity and qualify for potential subsidies.

Example pellet boiler plant

Nominal heat output 14 kW integrated buffer storage tank 335 l

Requirement for additional aid eligibility

14 kW X 30 l/kW = 420 l
Therefore, this system is normally not eligible. This is where our heatStixx enter the scene, because they can achieve a significantly higher storage buffer equivalent:

You operate your storage tank with a delta of 30 K
And thus achieve a boost factor of 1.69.
This means you reach a storage buffer equivalent of: 335 l x 1.69 = 566 l

➔ Your plant is therefore eligible for funding and you receive an additional grant of € 500

We have clarified this with BAFA!

For further help on funding, see the FAQs

FAQs - THE MOST IMPORTANT ANSWERS TO YOUR QUESTIONS

Here we have listed the most frequently asked questions about our products.
If you do not find the answer you are looking for there, you can contact our support for technical or functional questions:

Email to info@kraftBoxx.de

Technical questions

How heavy, how big are the Stixx in as-delivered condition?

- *heatStixx: 180 g – 410 g*
- *heatSel: 260 g – 570 g*
- *heatSel XL: 740 g – 1,500 g*
- *Size: See table*

Which technical requirements must be observed/met for filling with heatStixx?

- *Suitable sleeve or flange, see technical data sheet*
- *Protection against excessively high temperatures by perforated plates or similar.*
- *Protection against clogging of the connections by baffle plates or similar.*
- *Hydraulic separation between drinking water and heating water. Do not use heatStixx in drinking water*

Does movement/friction between the individual capsules cause fatal damage to the capsules?

- *In general, the capsules are static in the tank and do not move.*

What happens if the max. permissible application temperatures are exceeded or not reached?

- *Deviation from the specified temperature range can result in reduced durability of the phase change material. Excessive temperatures, e.g., due to contact with electric heating elements etc., can destroy the encapsulation and cause the phase change material to leak.*

What happens when the phase change material is released?

- *The physical and chemical properties of the various phase change materials differ considerably. While paraffins are usually non-corrosive, other materials can lead to increased corrosion.*

What is the service life of the products?

- *We design our products for 10,000 cycles, while maintaining the specified temperatures. Our PCMs are continuously tested for cycle stability.*

What happens at the end of the product's useful life?

- *After the use phase, Axiotherm is happy to accept the products again for recycling.*

Is the product tested/certified?

- *In addition to our own tests for quality assurance, tests are currently carried out in accordance with the new quality and test specifications of the RAL Gütegemeinschaft für PCM (Quality Assurance Association for PCM, RAL-GZ 896).*
- *Some of our products are even NSF certified and can therefore also be used in food processing.*

Who fills the storage tank?

- *The Stixx must be placed in the storage tank by a heating technician in order to ensure perfect commissioning. Observe the operating instructions in this respect.*

OUR SERVICE PORTFOLIO

We are happy to provide advice and practical assistance with a view to optimising your building project

- Consulting and project planning
- Support for guidelines (BAFA)
- Marketing, POS
- Preparation of documents
- Distribution of liquid carrier-based heat and cold accumulators and special applications
- Development of PCM/latent material and encapsulations
- Production of blow moulded parts & filling
- Standardisation
- W&A heat tests
- Technical support

➔ Ask us about the projects you intend to implement for a confidential solution proposal.

FURTHER POSSIBLE FIELDS OF APPLICATION

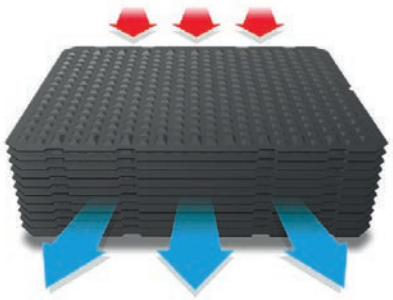
heatStaxx and heatStaxx Air are high-performance macro-encapsulations, specially designed for mobile heat storage and air applications, which are blow-moulded from plastics developed for this purpose. At the same time, the special design enables the highest possible heat transfer coefficients with low pressure loss and is therefore ideal for applications in air conditioning technology and mobile heat accumulators.

heatStaxx

- Make full and flexible use of your waste heat potential in biogas plants and industrial processes
- Deliver your heat by truck, e.g. to schools, hospitals or hotels in your vicinity
- Specially designed for mobile heat accumulators
- High charging and output capacities – thus short downtime

heatStaxx Air

- Simple air conditioning with minimal temperature deltas
- Simply stackable and scalable
- Minimum pressure loss, maximum heat transfer
- Cooling with night air
- Heating with solar collectors
- Heat recovery in ventilation systems



CONTACTS

kraftBoxx
POWER TO HEAT SYSTEMS

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Riedweg 5, 88326 Aulendorf

Telefon: +49 7525 / 924 382
E-mail: info@kraftBoxx.de
Web: www.heatStixx.de

System expertise and sales

In cooperation with Axiotherm and pro Kühllsole we are responsible for the sales organisation and therefore your contact for the implementation of your projects.

kraftBoxx gmbh's key competences include:
development, consulting, product management and system integration.

PARTNERS

AXIOTHERM® INSIDE

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Email: mailbox@axiotherm.de
Web: www.axiotherm.de

Development and production

Axiotherm GmbH focuses on the use of phase change materials in all technical areas. The storage of "cold" or "heat" in fluid carrier-based storage tanks is only one area of application.

Technical thermal management is another generic term where the PCM's function is to provide stability and prolong the life of thermally stressed systems.

pro KÜHLSOLE

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Production and sales of refrigeration applications

Pro KÜHLSOLE GmbH deals with the production, distribution and on-going development of heat transfer fluids.

Cooperation with specialist institutes supports us in the task of offering you innovative, state-of-the-art products that meet today's requirements.

Published: 09/2020

heatStixx

THE smarter E award 2019 FINALIST

haustec.de PRODUKT DES JAHRES 2019

3rd Place in the installation category

RAL GÜTEZEICHEN

PHASE CHANGE MATERIAL

Product in audit www.pcm-ral.org

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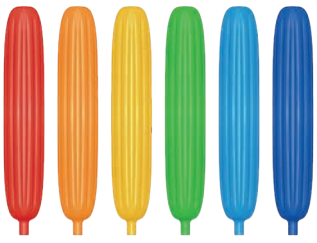

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