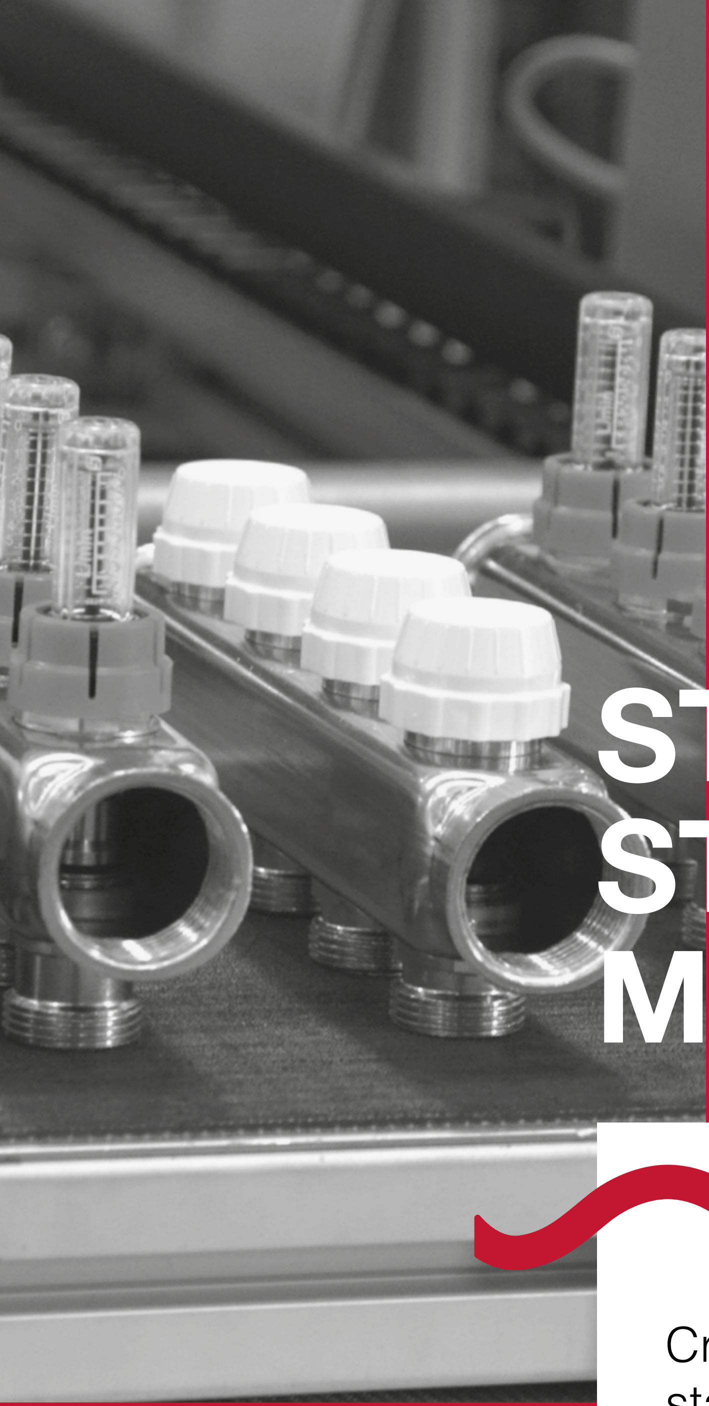

STAINLESS STEEL MANIFOLDS

Creation and diffusion of the
stainless steel manifold.
Dynamic balancing solutions.

#1

WHITE PAPER

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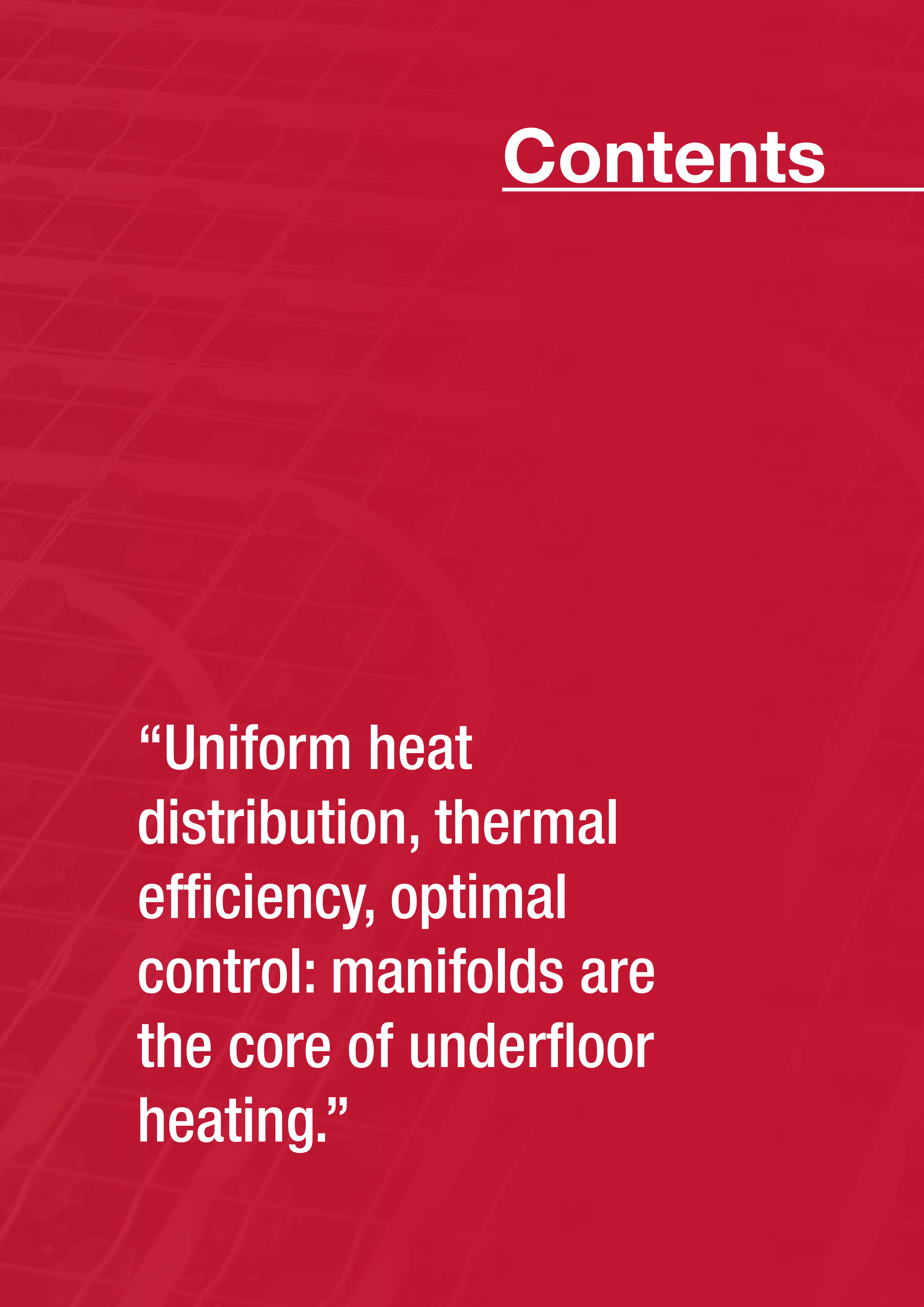


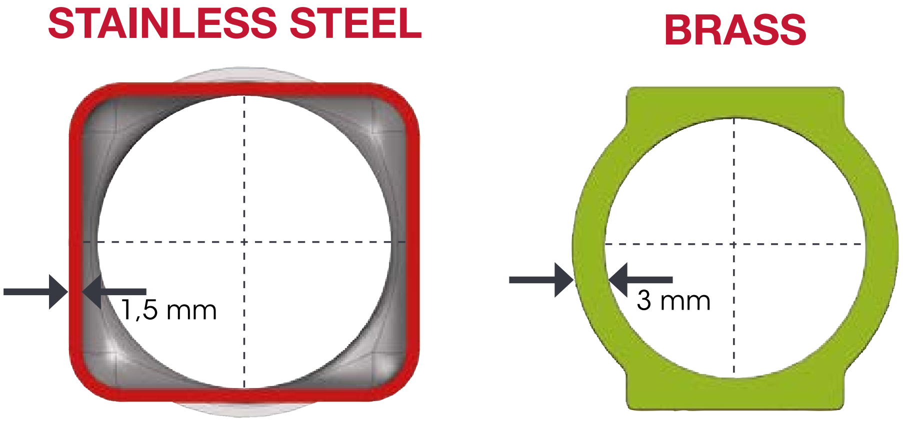
Contents

“Uniform heat distribution, thermal efficiency, optimal control: manifolds are the core of underfloor heating.”

Origin and spread of the stainless steel manifold

The use of steel manifolds for domestic and commercial heating systems has its origin in the German market.
The manifolds made of AISI 304 stainless steel (1.4301 according to the German DIN nomenclature) began being studied and produced in the late 1990s; they were made from a tubular profile and featured alternating parallel flat sections with threaded holes used to install the components designed to balance and intercept the individual circuits.

The extreme resistance of stainless steel and the resulting possibility of creating machined **items with low thickness** immediately attracted the interest of the market. When we consider that a brass manifold is made with an average wall thickness of about 3 mm, while a stainless steel manifold only requires 1.5 mm (Fig.1), it is easy to understand how the latter is definitely **lighter** and therefore **cheaper** than the former.


STAINLESS STEEL

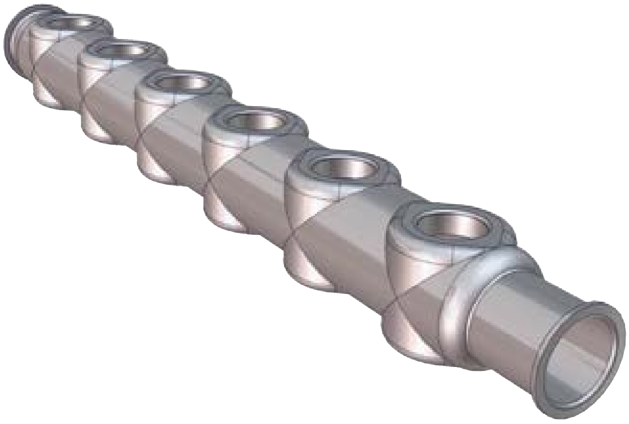
BRASS

Fig. 1 - Steel and brass manifold thickness

The profile with alternating flat sections (Fig. 2), although interesting from an economic point of view, had a technical limitation: its maximum obtainable flow rate.

Due to the section restrictions between one outlet and the next, the maximum flow rate of this product was not very different from that of brass and polymer manifolds. The maximum value was around 3.5 m^3/h.

Over time, with the introduction of new production techniques, an important innovation was achieved: **the profile with continuous parallel flat sections**. Thanks to this design improvement, the stainless steel manifold was able to ensure a **much higher flow rate** than had ever been achieved up to that point, guaranteeing up to a maximum level of 5 m³/h.



3,5 m³/h

Fig. 2 - Stainless steel manifold with alternating parallel flat sections

5 m³/h

Fig. 2 - Stainless steel manifold with continuous parallel flat sections

In the early 2000s, brass manifolds were dominating the German and European markets unchallenged, mainly because most systems were based on radiators.
The distribution manifold was often obtained directly with moulding procedures, and high flow rates were not necessary to provide the thermal load required by the designer.

Over time, however, two phenomena largely contributed to the success of the stainless steel manifold:

1. the technological evolution of heating systems, with the use of radiators gradually being replaced by the use of **radiant floor systems**

2. the increase in the cost of raw materials needed to produce brass manifolds (during 2006 the base price of a brass bar increased by 50% due to macro-economic trends not dependent on actual metal consumption).

The increase in the number of radiant panel systems forced the production of more complex distribution manifolds (Fig. 5) equipped with more accessories than those used combined with radiators (Fig.4).

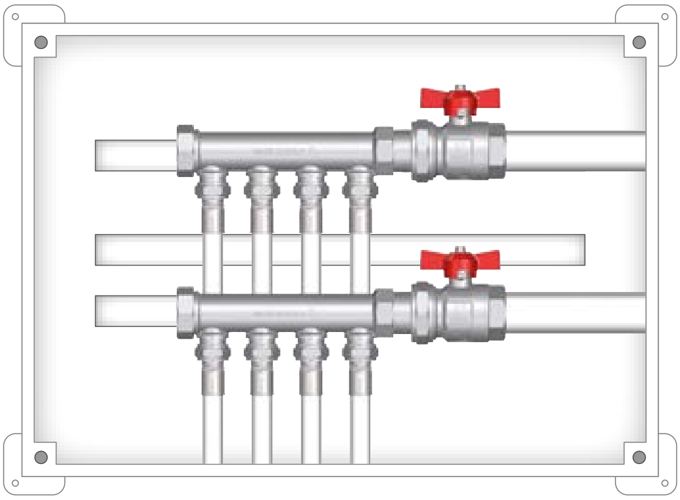


Fig. 4 - Manifold for radiator systems

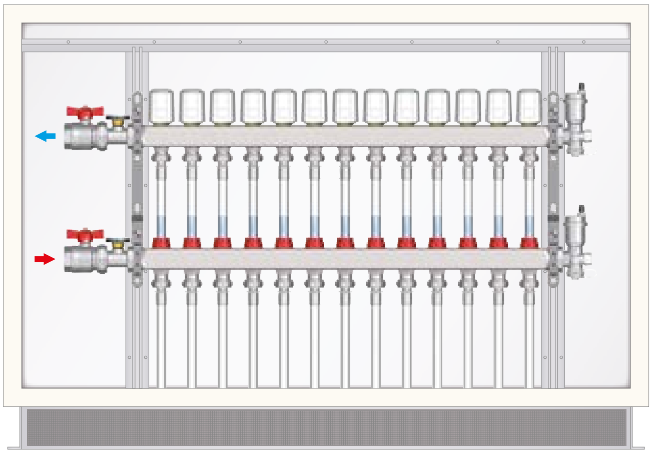


Fig. 5 - Manifold for radiant panel systems

In addition, radiant systems required higher flow rates than traditional systems. These purely technical needs, together with the sudden increase in the cost of brass manifolds (due to the increased price of the raw material), significantly favoured the diffusion of the new stainless steel manifold. All this, combined with the fact that German thermo-technical engineers and designers have always had an inclination for stainless steel, explains how the product in question actually conquered the water-based heating market in just a few years.
The following chart (Fig. 6) shows how, within about 15 years, the stainless steel manifold has become the undisputed leader, with a market share of more than 50%:

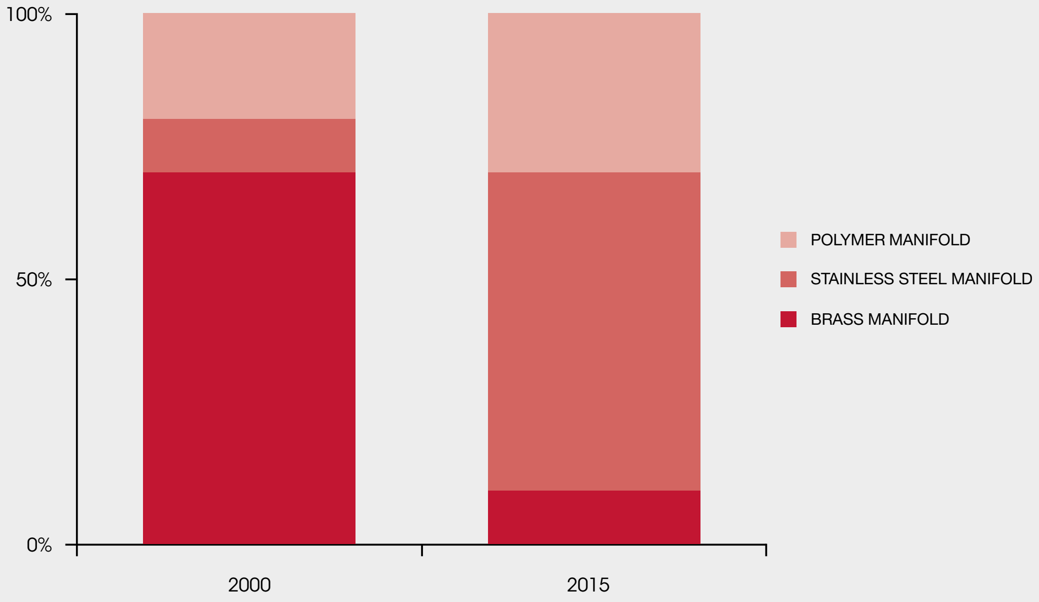


Fig. 6 - Market share of manifolds for radiant systems - German market [internal source]

In recent years, following what happened in Germany, the rest of Europe has begun a slow but gradual technological change. Radiant system installations, thanks to energy saving policies imposed at EU level and increasingly implemented by the member countries, represent the state of the art of water-based heating systems. Stainless steel manifolds are spreading beyond the German borders, and the technical-productive level achieved allows us to confirm that this product is destined to become the standard in watersystem.

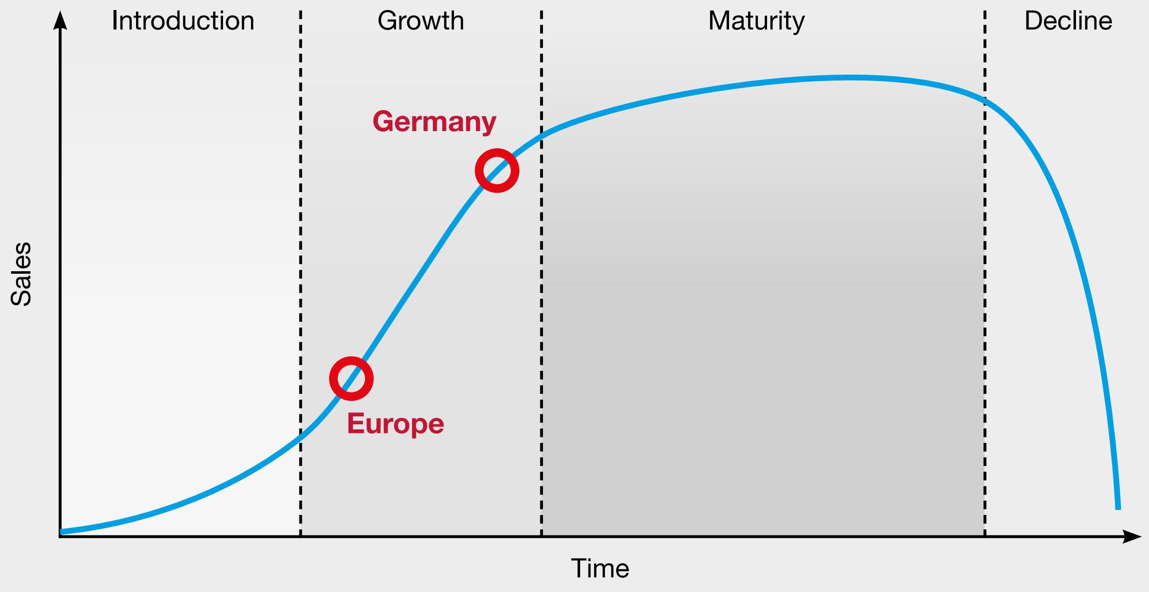


Fig. 7 - Life cycle and sales trends of stainless steel manifolds – [Internal source]

The advantages of the stainless steel manifold

They are numerous, compared with traditional brass and polymer manifolds:

- MECHANICAL STRENGTH
- GREAT LIGHTNESS
- PURCHASE PRICE
- ABSENCE OF CORROSION PHENOMENA
- HIGH FLOW RATE
- LOW AND HIGH TEMPERATURE
- ABSENCE OF JUNCTION POINTS
- AESTHETIC PERFORMANCE AND VISUAL QUALITY

The advantages

MECHANICAL STRENGTH

+20,93%

AISI 304L stainless steel has a rupture load equal to 520 N/mm^2. CW614N brass (used for manifolds) has a rupture load equal to 430 N/mm^2.
The mechanical strength of stainless steel is 20.93% greater than that of brass.

GREAT LIGHTNESS

-50%

A pre-assembled stainless steel manifold weighs up to 50% less than a brass manifold having the same size and characteristics.

PURCHASE PRICE

-15%

A pre-assembled stainless steel manifold costs up to 15% less than a brass manifold with the same size and features.

ABSENCE OF CORROSION PHENOMENA

No stress-corrosion.
No electrolytic corrosion.

HIGH FLOW RATE

+20%

Stainless steel manifolds have a flow rate up to 20% higher than brass manifolds, thanks to their increased section.
The inlet flow rate for 1” stainless steel manifolds is 5 m^3/h; for brass manifolds of the same size, it is 4.2 m^3/h.

LOW AND HIGH TEMPERATURE

Composite material manifolds can operate only with low temperatures. If high temperature branch circuits are required, the distribution control unit needs to be equipped with metal manifolds.

ABSENCE OF JUNCTION POINT

Manifolds using composite materials are provided with modules of polymer, which are usually reinforced with fibreglass and need to be connected together using fixing systems. The water-tightness between the different modules is guaranteed thanks to the use of elastomers. This means that every junction point can represent a potential leak point. **Stainless steel manifolds are made of a single piece with 2 to 13 outlets along the entire length of the bar.**

AESTHETIC PERFOMANCE AND VISUAL QUALITY

Stainless steel is a more aesthetically pleasing material than brass or polymer.
Furthermore, it is universally recognised and perceived as a premium material.

The possibility of combining an **expanded polyethylene shell** with the stainless steel manifold also makes the product also suitable for use in radiant cooling systems.

Radiant floor systems are effective in countering the summer sensitive loads, but are unable to intervene against latent loads. Where there are flow temperatures between 15°C and 18°C, there is often condensation on the stainless steel bar; thanks to the polyethylene shell it is possible to avoid this phenomenon and therefore **the stainless steel manifold becomes a replacement for the polymer manifold, with the advantage of having a significantly higher flow rate than the latter** (which is very important in the radiant cooling systems).

The possibility of having high flow rates, can **improve the performance of the system.**

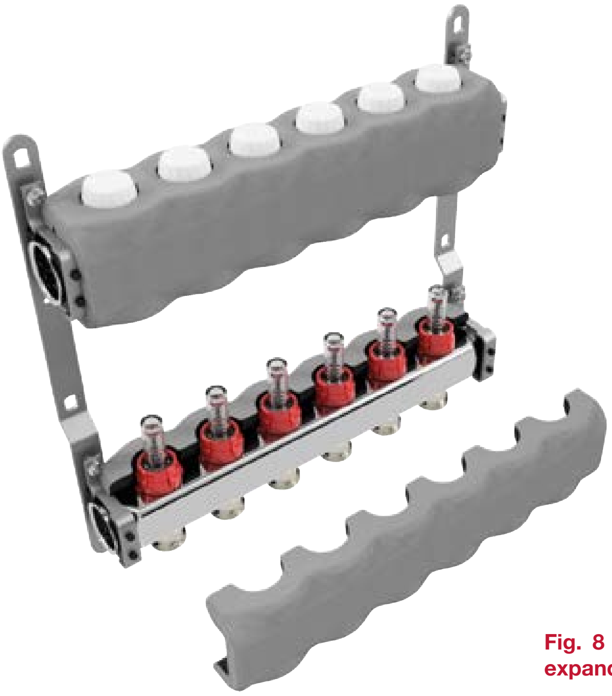


Fig. 8 - Stainless steel manifold with expanded polyethylene shell

It will therefore be possible to obtain a greater cooling capacity and to neutralise a greater level of heat.

Floor systems mainly work by radiation and are governed by the following formula:

$$dE/dt = \varepsilon \sigma A (\text{room } T - \text{surface } T)$$

Where [Ɛ Ϭ]are constants, while [A] is the extension of heat exchange surface (i.e. the floor). The value [dE/dt] represents the amount of energy dissipated per time unit: to increase this amount, the temperature of the floor must be lowered. With a constant flow temperature towards the panels, this action is favoured by the increase in the heat exchange mass, i.e. by the available water flow rate.

The use of a stainless steel manifold, thanks to a large flow section (Kv = 5 m3/h compared to about 3.5 m3/h of a compact polymer manifold), allows the cooling capacity curve to move upwards obtaining a more significant drop in the ambient temperature:

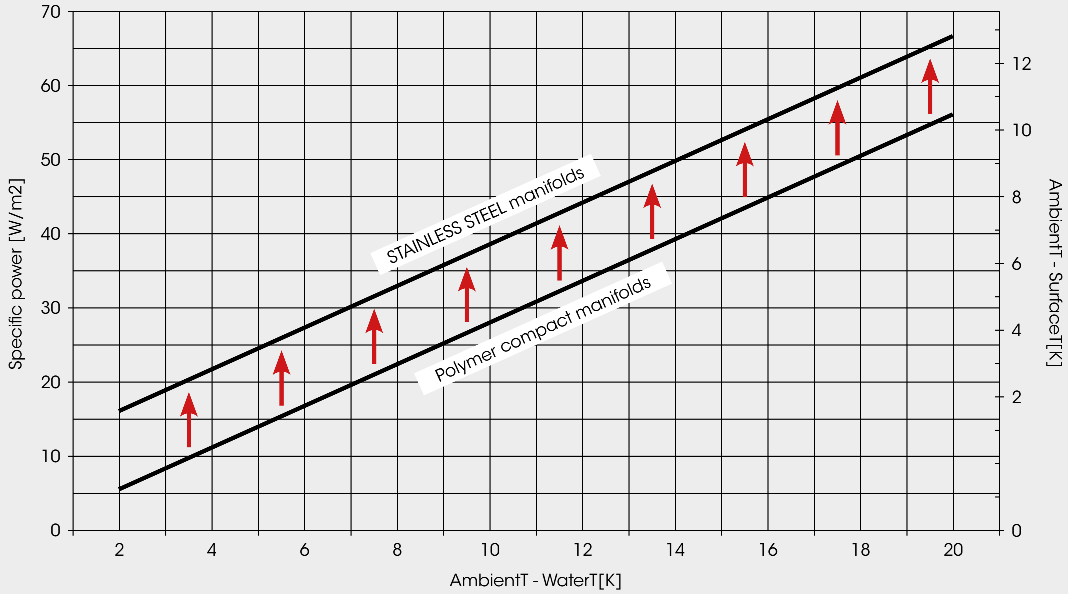


Fig. 9 - Cooling performance comparison between stainless steel and polymer manifolds [Internal source]

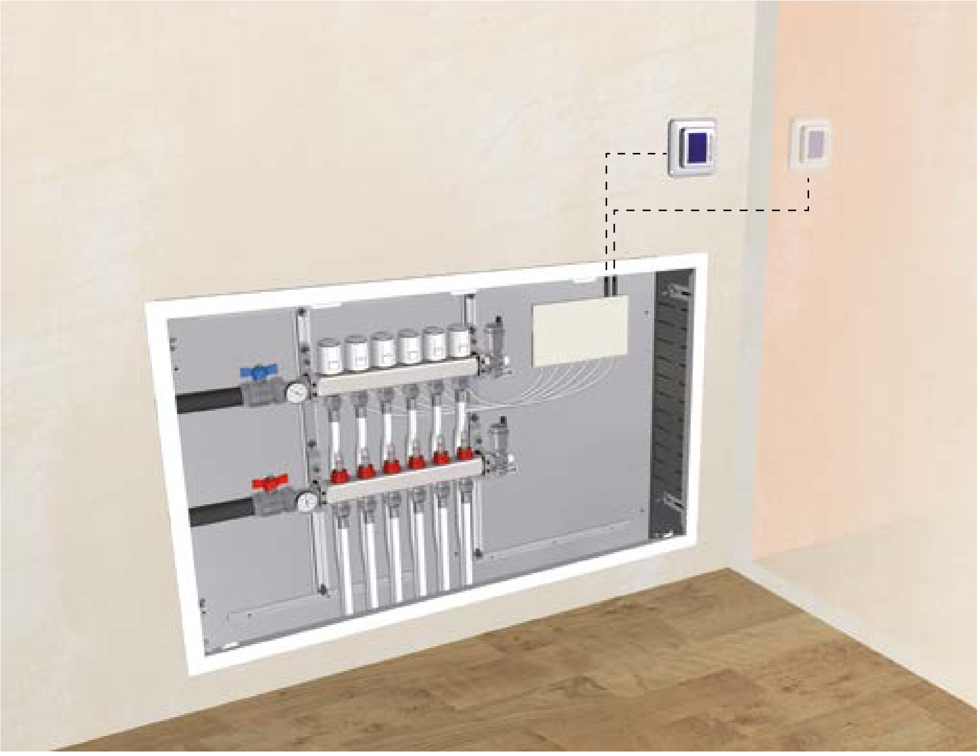
The described benefits have enabled stainless steel manifolds to surpass brass and polymer manifolds in terms of performance and have contributed to their success.

The diffusion of this product will be evident in the next few years, thanks to the fact that new water-based systems (heating and cooling) are sized with high flow rate levels in order to limit the energy consumption. The possibility of working with high Kv levels will undoubtedly encourage the use of stainless steel manifolds against his competitors.

If we also consider that condensing boilers (heating only) and heat pumps (hot and cold) are becoming more and more frequently used, it is easy to see that the near future will be characterised by high capacity systems, assisted by stainless steel manifolds.

Variable flow systems and use of differential by-pass

It is worth discussing the increasing popularity of variable flow systems.
In such systems, the individual outlets are regulated by control valves which interact with the temperature of the room to be heated.
Specifically, in the context of underfloor heating, each circuit can be controlled by an electro-thermal actuator, which is connected to a temperature sensor (or room thermostat) located inside the room.

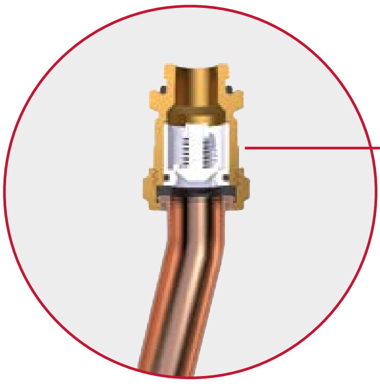


When the temperature set on each sensor is reached, the corresponding electro-thermal actuator closes. This brings a change in the flow rate, which in turn causes an increase in differential pressure.
This process incurs a number of problems, including:

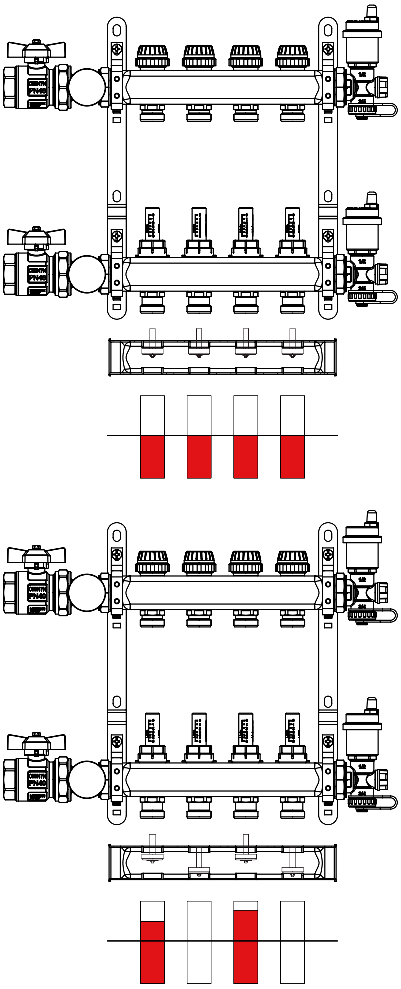
- noise
- excessive wear of internal components
- imbalance of the individual circuits. This latter aspect is quite critical, since it generates an increase of flow towards the open circuits.

To minimize the imbalance in the system, we recommend

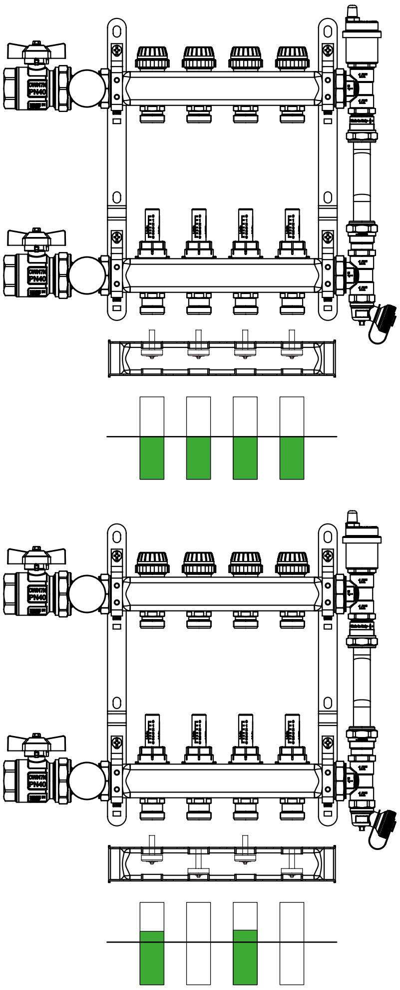
installing our differential by-pass.
With its internal check valve, set to 25 kPa, it ensures that there is always a connection between supply and return, in order to relieve excess pressure and keep the flow rate in each individual circuit



By-pass valve, set to 25 kPa

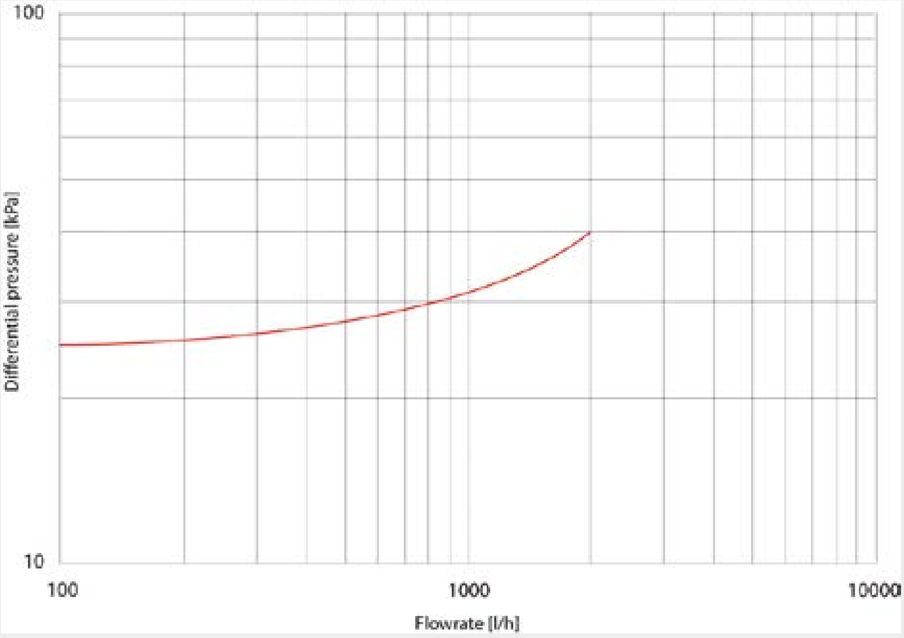


Without by-pass



With by-pass

constant.
The following graph shows the flow rate of the differential by-pass valve as a function of the pressure differential between supply and return:



Let's consider a practical example of the benefits determined by the use.

Using the previous graph and assuming a differential pressure of 30 kPa, we derive a flow rate of around 15 [l/min].

If we think of an average flow rate value per circuit, realistic for medium sized residential installations, of the flow per circuit of 3 [l/min], the differential by-pass is able to balance the excess pressure up to a maximum of 5 completely closed circuits.

Beyond this value, there will be an imbalance in the open circuits, although it will be lower than that experienced with an installation without differential by-pass.

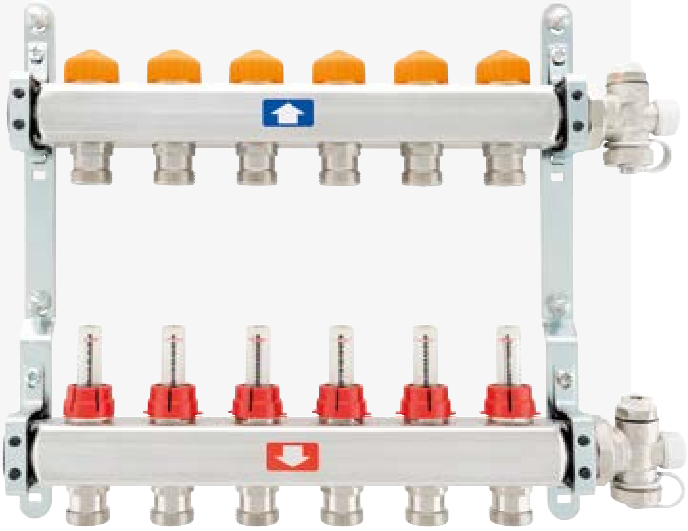
In order to radically solve the problem of unbalanced circuits, it is necessary to install manifolds with dynamic balancing, supplied with the IMI HEIMEIER Dynacon Eclipse screw.

Manifolds with automatic flow control

The Dynacon Eclipse system automatically regulates the flow rate in the individual heating circuits. The set flow rate is continuously monitored: if it is too high, e.g. as a result of adjacent circuits being closed, the system automatically intervenes, reducing it until the defined set point is reached. **The control insert ensures that a constant flow rate is maintained under all operating conditions.** In addition, thanks to the automatic hydraulic balancing, Dynacon Eclipse prevents excessive flow rates, ensuring optimal and maximised temperature distribution throughout the system.

Eclipse inside AFC

IMI HEIMEIER



HOW TO SET THE FLOW RATE

Return flow manifold supplied with DYNACON ECLIPSE screw fitting
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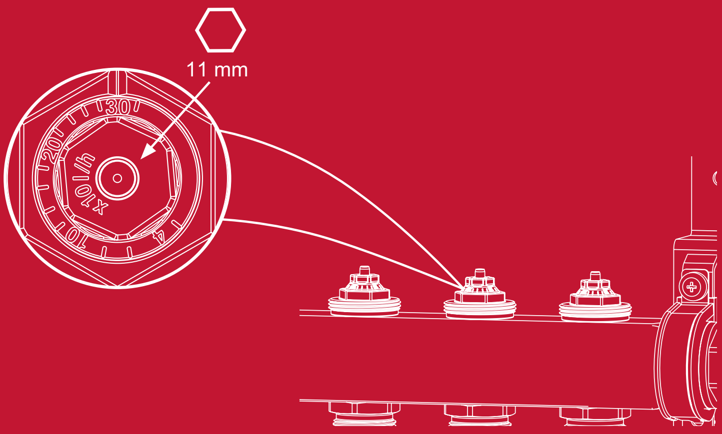
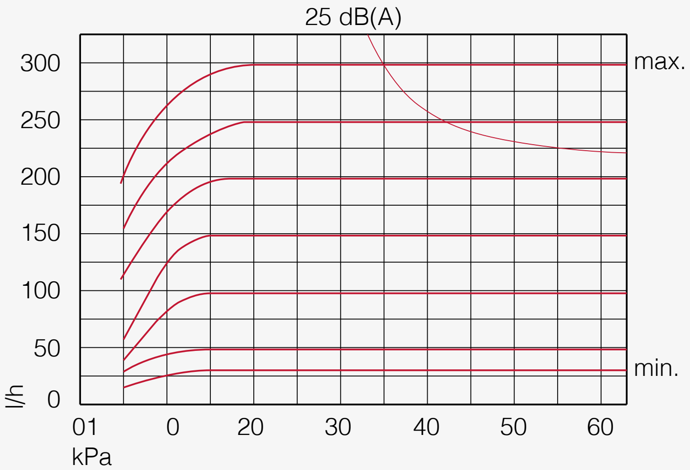


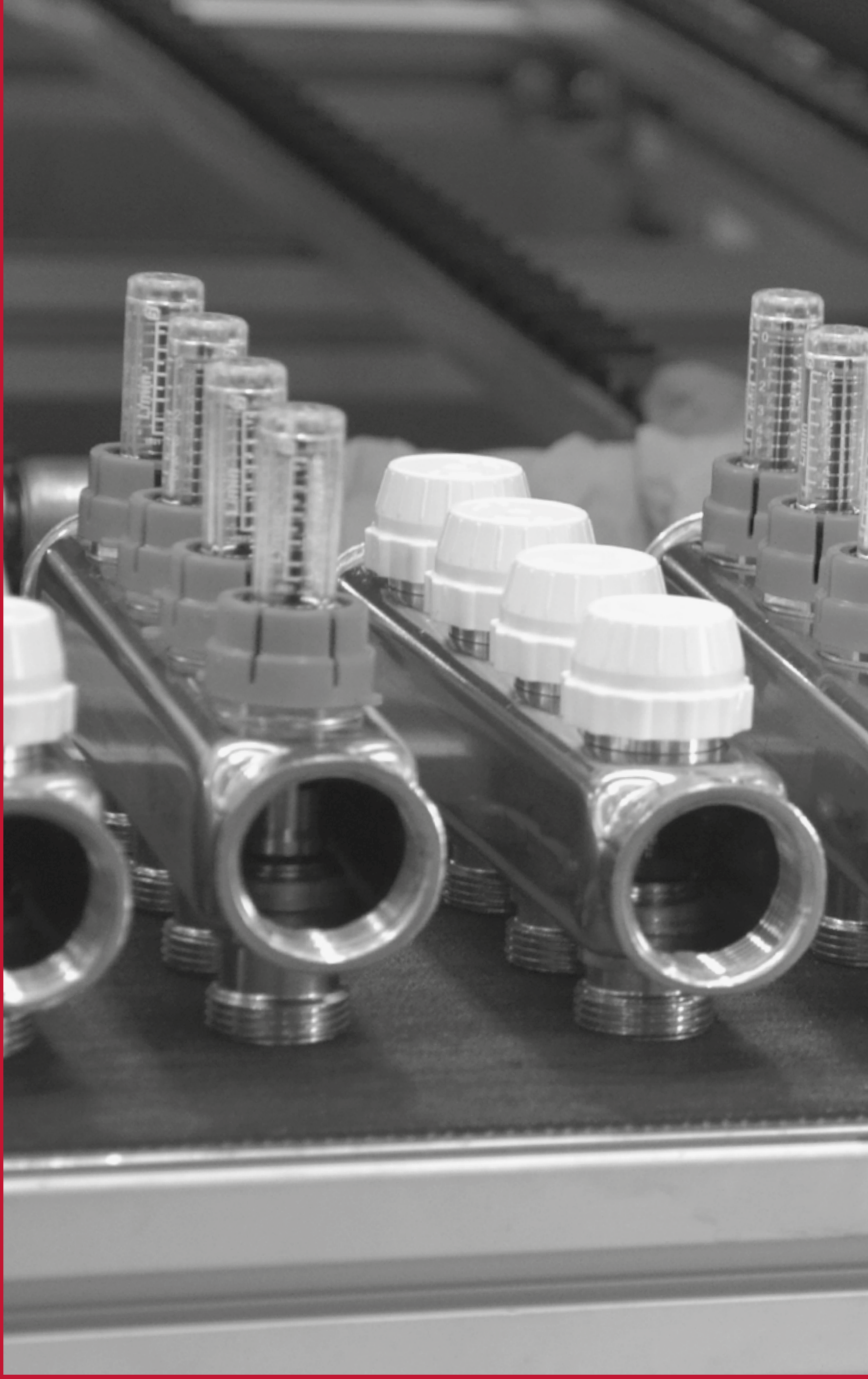
DYNACON ECLIPSE	|	**4**	|	|	**10**	|	|	|	|	**20**	|	|	|	|	**30**
l/h	30	40	60	80	100	120	140	160	180	200	220	240	260	280	300

REGULATION AND FLOW RATE DIAGRAM



Δp min. 30 - 150 l/h= 17 kPa
Δp min. 150 - 300 l/h= 25 kPa
Δp max. 60 kPa

Notes.



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