DESCRIZIONE E TEORIA

DESCRIPTION AND THEORY

INDEX

GENERAL INFORMATION

With respect to other types of heat exchangers, the plate heat exchangers have unique characteristics. They differ from the shell and tube, spiral, coil, blade, etc. types above all because they are the only extensible exchangers. That is, they are so constructed as to permit increasing or decreasing the exchange power even after the system has been installed and for whatever reason, while guaranteeing continued perfect operation of the system. As is only logical, selection of the type of heat exchanger will depend on a great number of factors. The most important are undoubtedly the physical nature of the fluids, temperature and pressure, flow rates, pressure drops, tendency to fouling, construction materials in relation to required performance, ease of maintenance, and cost. Only naturally, the final assessment for selection will always be made by comparing the overall costs of the different types of exchangers that are suitable for resolving a given technical problem. Problems of selection can arise even among heat exchangers of the same type (we will deal with plate-type heat exchangers in particular). Clearly, the factors to be considered are those mentioned above, and the differences among the products of the various manufacturers are often considerable. In some cases, however, comparison points up only differences in price. Although all plate heat exchangers are manufactured and assembled in more or less the same manner, they do fall into two broad categories. One type has corrugated exchanger plates with various surface patterns, manufactured by pressing, and rubber gaskets, glued or clipped directly on the plates.

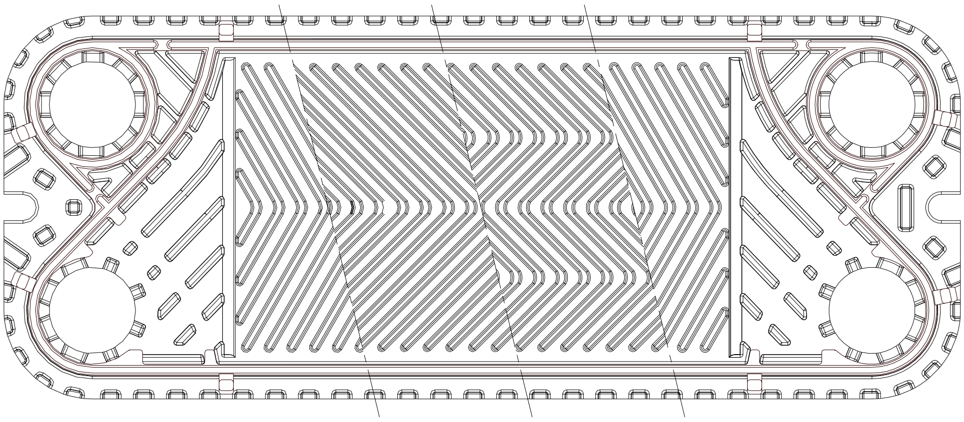


Fig. 1 (Corrugated TECHNO SYSTEM plate)

The other type, instead, features smooth plates, mechanically-secured and easy-to-replace rubber gaskets, and wire net turbulators laid over the plates and secured by housings on the gaskets (see Figure 4). This is the type of exchanger designed, perfected, and patented by TECHNO SYSTEM S.R.L.

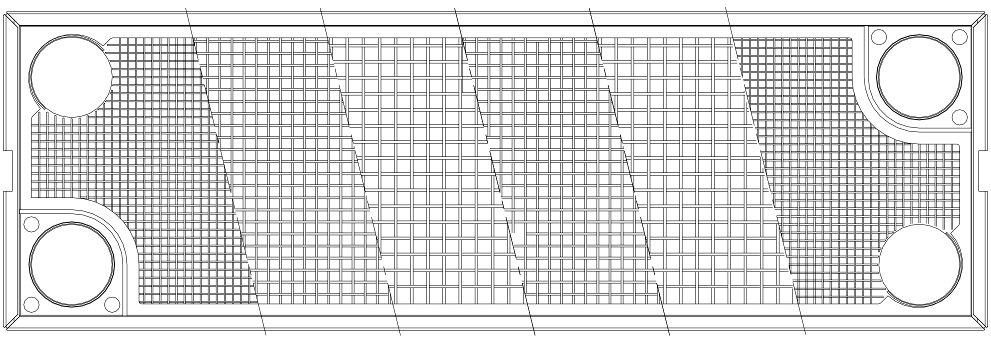


Fig. 2 (TECHNO SYSTEM's smooth plate with turbulator)

The TECHNO SYSTEM offer therefore consists of heat exchangers with smooth plates and corrugated plates and thus can provide the ideal solution for any type of thermal exchange problem.

FIELDS OF APPLICATION

Plate heat exchangers can be used in an enormous variety of applications, since they offer compactness, high efficiency, easy maintenance, the possibility to create complex circuit designs, and, last but not least, increasingly competitive costs. Therefore, this type of heat exchanger is increasingly used frequently in district heating, energy recovery, refrigeration, chemical, pharmaceutical, and food processing systems, and in civil engineering. The original construction solutions developed by TECHNO SYSTEM through years of experience in the sector have further expanded the field of application of plate heat exchangers by offering increased resistance to differential and absolute pressures - although there remains the limit determined by the admissible operating temperatures for the rubber gaskets (see Fig. 8 e Fig. 9).

MATERIALS AND PED (97/23/CE) NORMATIVE

Following the entry into force of the Pressure Equipment Directive (PED), TECHNO SYSTEM immediately decided, in line with a policy in act for some time, to certify the quality and compliance with the Directive of all the models of heat exchangers it produced.
For the company, this meant completing the procedure for obtaining certification of the internal Quality System and at the same time earning Module H PED certification.
Accurate revision of design and construction for all the heat exchangers involved redefinition and consequent improvement of all the relevant safety and quality parameters through use of only materials with excellent mechanical characteristics, such as P355 NH (EN 10028) for the large plates and A 193 B7 (ASTM) for the clamping bolts.

THE PLATE HEAT EXCHANGER – OPERATION

The essential components of any plate heat exchanger (see Fig. 3) are the frame and the plates.

A) The frame is made up of two large plates (one fixed and one movable) and a system of clamping bolts that holds the exchanger plates together in a single pack. Since it must withstand considerable weights and pressures, the frame is generally quite robust. Correct tightening of the clamping bolts compresses the gaskets and assures perfect seal in the exchanger.

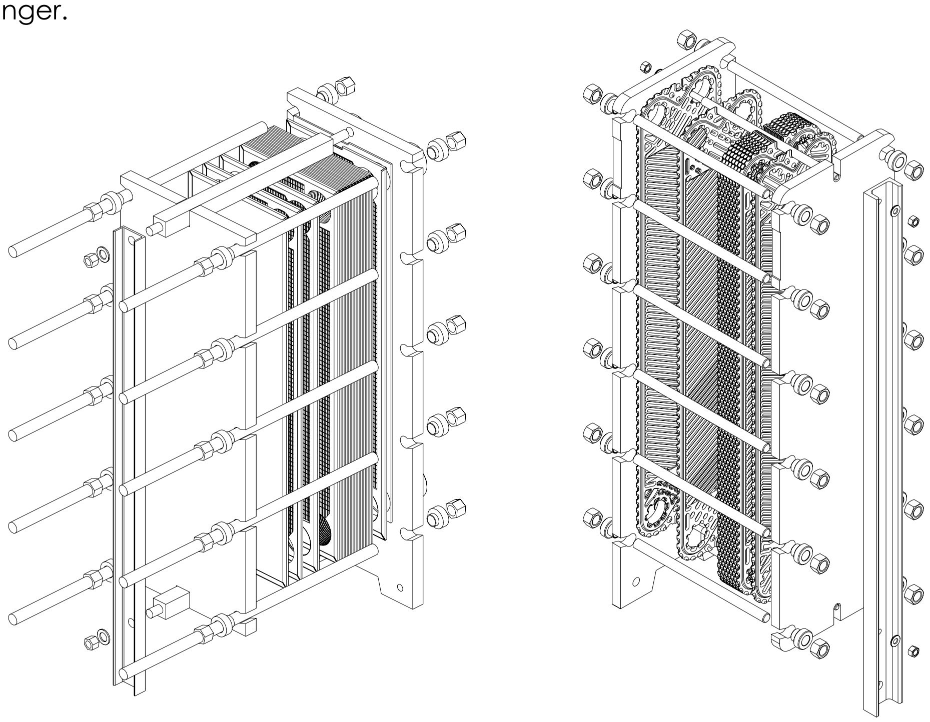


Fig. 3 (Assembling of a TECHNO SYSTEM plate heat exchanger)

Insofar as possible, the exchanger connection nozzles (which may be of various types) are located on the fixed plate in order to facilitate maintenance operations, but as we will see, this is not always feasible. The two plate alignment (or guide) rods, other essential components of the heat exchanger, often also act as supports for the plates.

B) It is understood that the plates are the most important parts of a heat exchanger. As we have already mentioned, they can be manufactured in a variety of different geometries and incorporate different construction features (see Fig. 1, Fig. 2 and Fig. 5). Drawing on its years of experience in resolving thermal exchange problems, TECHNO SYSTEM produces three types of plates, two of them incorporating innovations with respect to other plates available on the market. The first case makes use of plates in smooth steel sheet, rubber gaskets secured under a U-profiled border, and wire net turbulators each inserted in a housing on the gaskets (see Fig. 4).

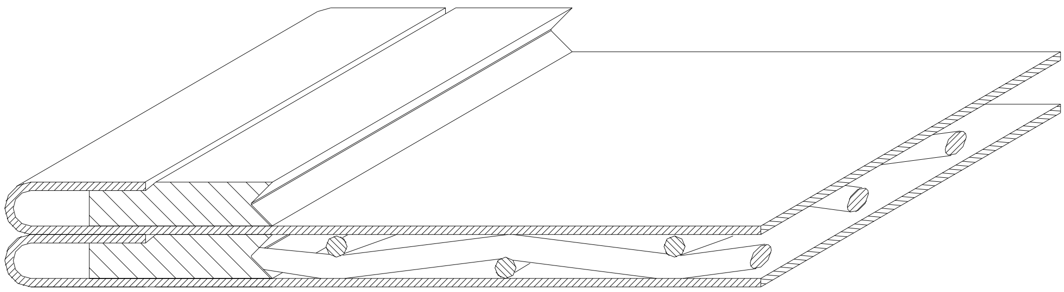


Fig. 4 (Particular of the gasket anchorage – smooth plate with turbulator)

This configuration is recommended for use with "clean" fluids, for high-pressure applications, and in all cases in which optimization of the heat exchanger is a priority concern because of great differences in the flow rates and/or fluids in the two circuits.

In the second case, the plates are made of pressed corrugated sheet steel; the gaskets are not glued and secured mechanically.

The play in the gaskets permits the two circuits in the pack of plates to reciprocate (counterflow) in such a manner that the fluid in any one channel exchanges with that in the two contiguous channels.

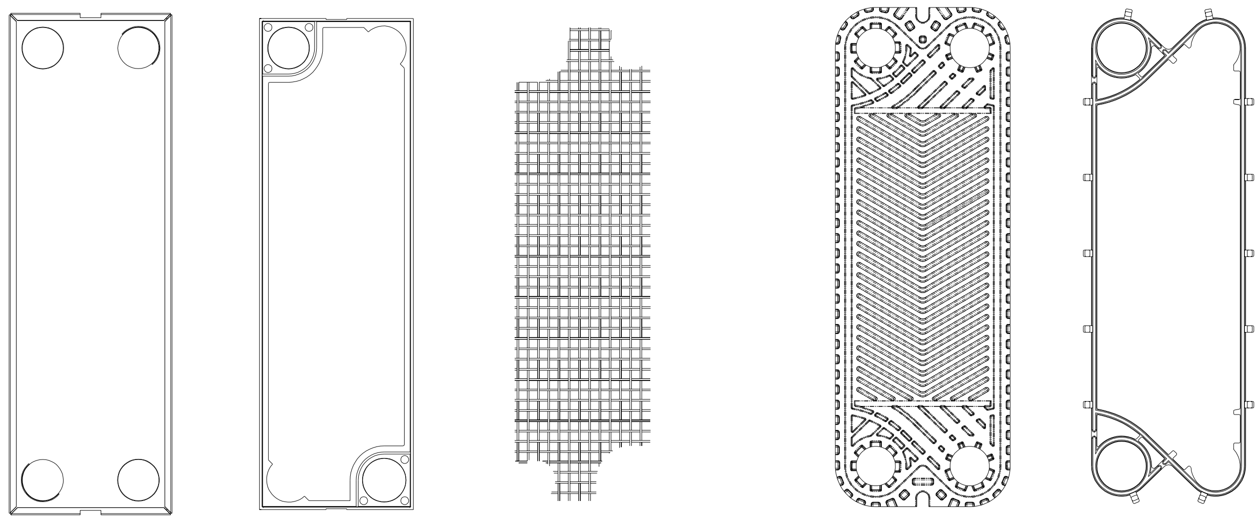


Fig. 5 (Componens of TECHNO SYSTEM's plates)

The flow patterns (see Fig. 6 and Fig. 7) are normally symmetrical with parallel channels, but it is a simple matter to arrange flows with channels in series and mixed parallel/series flows. Selection of one or another configuration will depend on the thermal program and on the "thermal length" (geometrical characteristics) of the plates.
The exchangers with smooth plates and turbulators have crossed connections, while the exchangers with corrugated plates have parallel non-crossed connections (see Fig. 6 and Fig. 7).

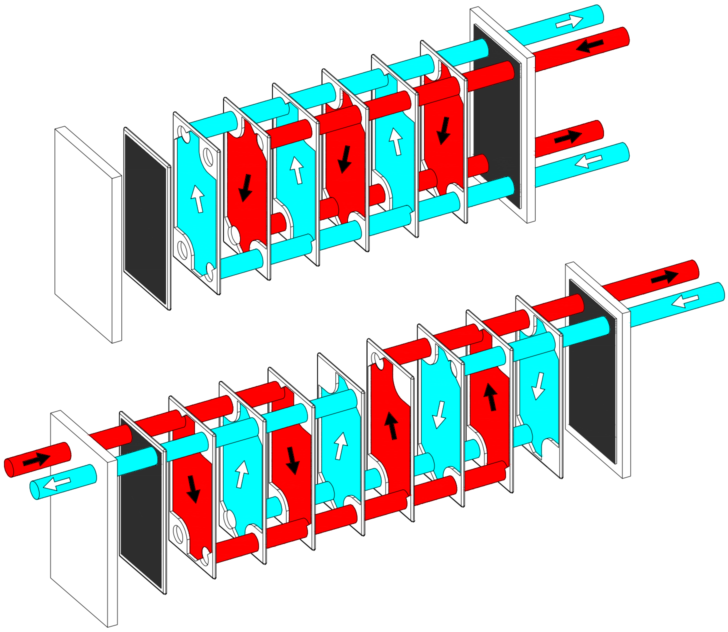


Fig. 6 (Example of exchanger flow in a smooth-plate exchanger)

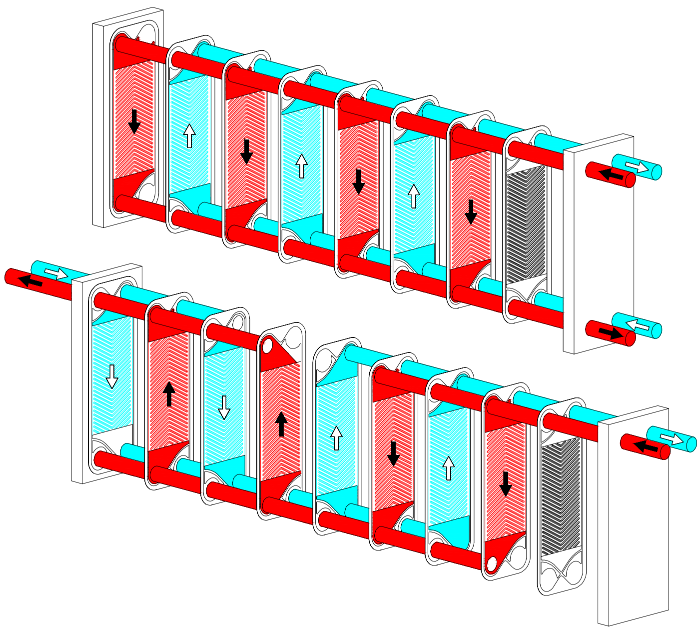


Fig. 7 (Example of exchanger flow in a corrugated-plate exchanger)

CONSTRUCTION MATERIALS

A) PLATES

Corrugated exchange plates (and therefore plates manufactured by drawing) can be made of any material suitable for pressing. However, there exist severe limits on use of very ductile and malleable materials (for example, copper) since in this case the plates risk alteration of their original form when they are assembled on the exchangers and tightened down. This will result in irreparable alteration of the cavities and the channels, with easily imaginable consequences.
The smooth plate with turbulator can be made also with these materials. In any case, the materials commonly used for the plates are:
AISI 304 stainless steel, AISI 316 stainless steel, titan, monel, incoloy, hastelloy, copper (only smooth plate) etc. Choice of material will depend mainly on its compatibility and chemical inertness in contact with the various fluids; that is, on the degree of its resistance to corrosion. Final selection will of course also take into account cost factors in relation to system type.

B) GASKETS

The materials used for manufacturing the gaskets are generally special rubbers of the nitryl, butyl, ethylene-propylene (EPDM, EPM), silicon, fluoridated (Viton), and other types.
When chemical compatibility is assured, the maximum operating temperatures for the various types of rubber gaskets are the following:

Nitryl	130 °C	(Standard Techno System)
Butyl	110 °C	
EPDM	155 °C	(Standard Techno System)
EPM	165 °C	
Silicon	210 °C	
FKM (Viton)	210 °C	(Standard Techno System)

These values refer to operating pressures not exceeding 25 Atm, with TECHNO SYSTEM heat exchangers with smooth plastes and turbulators. With exchangers with corrugated plates the maximum operating temperatures are much lower (see Fig. 8).

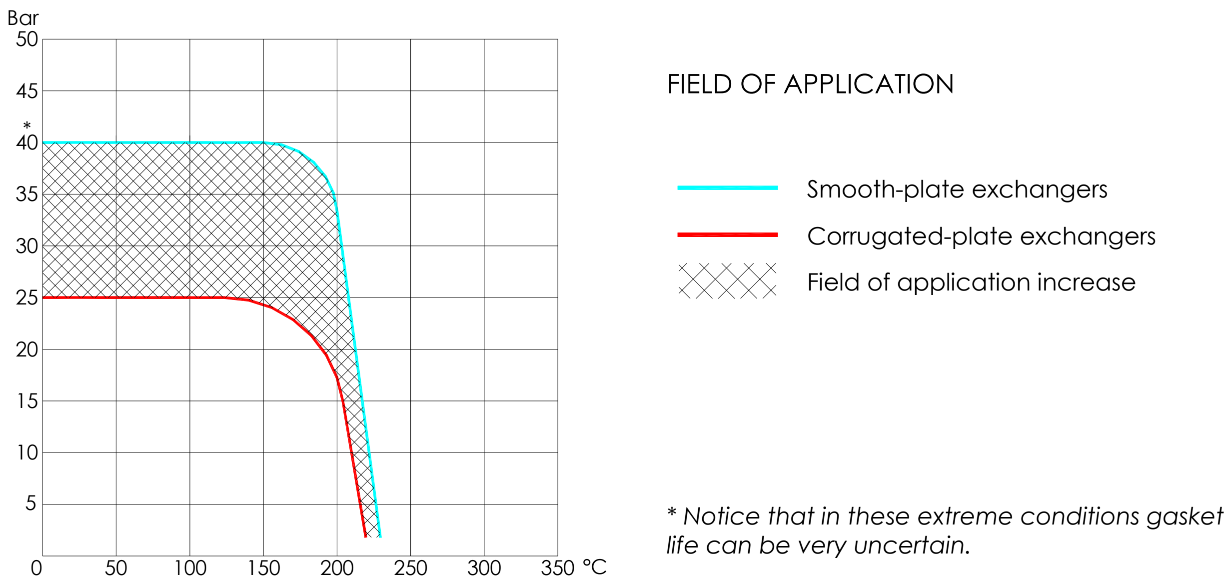


Fig. 8

The construction design of TECHNO SYSTEM's smooth plate with turbulator assures that, once the exchangers is tightened, the gaskets are contained inside the plate pack and cpmletely protected against aging agents for rubber materials like UV-rays, Ozon, etc. This makes gasket's mean life very longer.

C) FRAME

Suitably-painted carbon steels with excellent mechanical characteristics are usually used for the frame (for example P355NH). For special applications (e.g. food industry), stainless steel, finished in various manners, can be used.

D) CLAMPING BOLTS

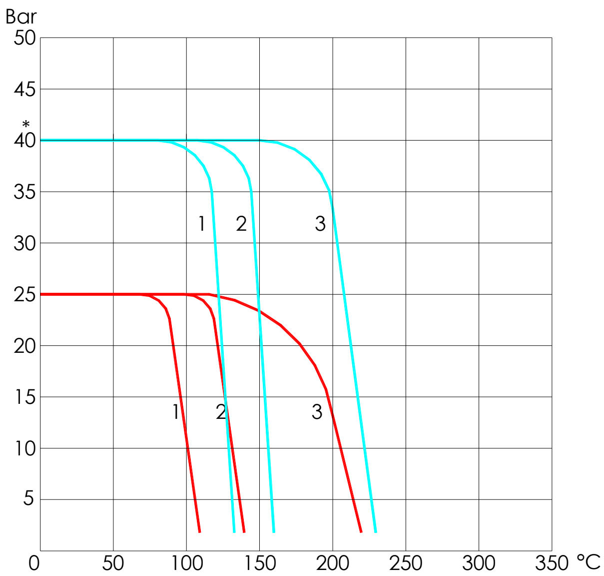
High tensile carbon steel or alloy steel is used for bolts, nuts and clamping bolts (for example A193B7). For special and not particularly demanding applications, stainless steel can also be used for the clamping bolts.

E) COMPARISON WITH SHELL AND TUBE HEAT EXCHANGERS

Generally, and above all when dealing with costly materials, the final choice between a shell and tube heat exchanger and a plate heat exchanger will favor the latter type, which can guarantee a higher overall heat transfer coefficient and therefore a reduction in surface area. Plate exchangers also require vastly inferior thicknesses, which in no way compromise the life or the safety of the devices. The shell and tube heat exchangers are generally welded at many points; the welds can trigger corrosion and lead to perforation of even the thickest materials. In comparison with the corrugated plate exchangers, the TECHNO SYSTEM smooth-plate heat exchangers also offer advantages as regards corrosion. In the former type the roughness of the material and the stress to which it is subjected during manufacture (both of which factors are due to the pressing process), can trigger corrosion phenomena. The smooth plate, which is neither pressed nor drawn, clearly offers the best guarantees against corrosion.

MAXIMUM OPERATING PRESSURES AND TEMPERATURES

A) Diagram in Fig. 9 illustrates the temperature/pressure ranges in which plate heat exchangers can be safely used with different types of gaskets. It is clear that the performance of the TECHNO SYSTEM smooth-plate exchangers with turbulators is vastly superior to that of the corrugated-plate exchangers.



FIELD OF APPLICATION

1. Nitryl
2. EPDM
3. FKM (Viton) - Silicon

Smooth-plate exchangers

Corrugated-plate exchangers

** Notice that in these extreme conditions gasket life can be very uncertai.*

Fig. 9

B) Comparison with shell and tube heat exchangers.
The operating temperature and pressure ranges for the shell and tube type of heat exchanger are obviously much broader than the ranges of the plate heat exchangers, since the former are not limited by reduced thicknesses and rubber gaskets. Paradoxically, however, the limits for this type of exchanger are dictated by the excessive thicknesses and the welds, which, at high temperatures and pressures, due precisely to the excessive thickness and non-uniformity, always produce fatigue phenomena with concentration of fatigue phenomena resulting from vibrations and thermal stress. These problems obviously do not exist in the case of plate heat exchangers, thanks to the uniformity of the thicknesses and the absence of welds.

PERFORMANCE AND EFFICIENCY

The performance of a heat exchanger is normally measured with reference to a certain number of parameters that characterize the type of duty. The most common of such parameters are thermal length, flow rates, pressure drops, fouling coefficients, seal efficiency, maintenance needs, etc.
In the paragraphs that follow we will discuss the above-listed parameters in detail in order to clarify certain concepts that are of fundamental importance for understanding the problems involved in thermal exchange.

A) THERMAL LENGTH

The thermal length of a heat exchanger (also called number of transfer units or NTU) is calculated according to the dimensionless ratio:

$$NTUs = \frac{K*S}{G*c}$$

where:

K	=	Overall transfer coeff.	(Kcal/m²h°C)
S	=	transfer surface	(m²)
G	=	Mass flowrate	(kg/h)
c	=	Specific heat	(Kcal/Kg°C)

For any given type of duty, this number must be equal to or greater than:

$$NTUp = \frac{Ti-To}{\Delta Tml}$$

where:

Ti	=	Inlet temperature	(°C)
To	=	Outlet temperature	(°C)
ΔTml	=	Mean logarithmic temperature diff.	(°C)

The inlet and outlet temperature parameters are referred to one of the two circuits (usually the primary circuit). With low-pressure drops, and in a water/water exchange single-channel system, TECHNO SYSTEM heat exchangers can attain NTU values equal to or even greater than five per passage.
Once the fluids, temperatures, and flow rates have been defined, the thermal length of a heat exchanger will depend on the exchange surface and the overall transfer coefficient; that is, in the last analysis, exclusively on the geometry of the plates.
TECHNO SYSTEM smooth-plate heat exchangers make it extremely easy to optimize thermal length, since the geometry of the plates can be altered by simply inserting turbulators with suitable characteristics - and there are a great number of types of wire nets on the market. Contrariwise, in the case of corrugated plates, once the geometry of the plates is set the thermal length cannot be altered. The only modification possible is to insert types of plates with different patterns into the same exchanger. This operation can only yield intermediate thermal lengths and in any case cannot optimize, independently the two circuits one from the other. In the conditions described above, the shell and tube exchanger can attain maximum NTU values of 0,6 per passage. From the point of view of thermal length, the plate heat exchanger (and the TECHNO SYSTEM exchanger in particular) is clearly superior to the shell and tube type. It is so superior, in fact, that it is possible to design devices that operate with logarithmic mean temperature differences of just 1°C.

B) FLOWRATES

Obviously, the maximum flow rates of the plate heat exchangers are determined by the diameter of the nozzles. In general, in this type of exchanger and for liquids with low viscosity (e.g., water), pressure drops of up to 2 mWG (corresponding to a flow rate of about 6 m/sec) are admissible. Instead, for high-viscosity fluids, the factor limiting maximum flow rate is normally not the pressure drop in the nozzles but rather the pressure drop in the channels. The only plate heat exchangers that permit optimizing the pressure drops and the heat transfer coefficients in the case of very different flow rates in the two circuits (or in the case of fluids with different physical characteristics) are the TECHNO SYSTEM smooth plate exchangers with turbulators. As we have already mentioned, these heat exchangers can incorporate plates with completely different geometries, by making use of turbulators with coarser or finer meshes and/or different wire diameters (see Fig. 10). In the TECHNO SYSTEM heat exchangers, the ratio between the flow rates in the two circuits can be as high as 1:4; only the finned heat exchangers can perhaps obtain a similar value.

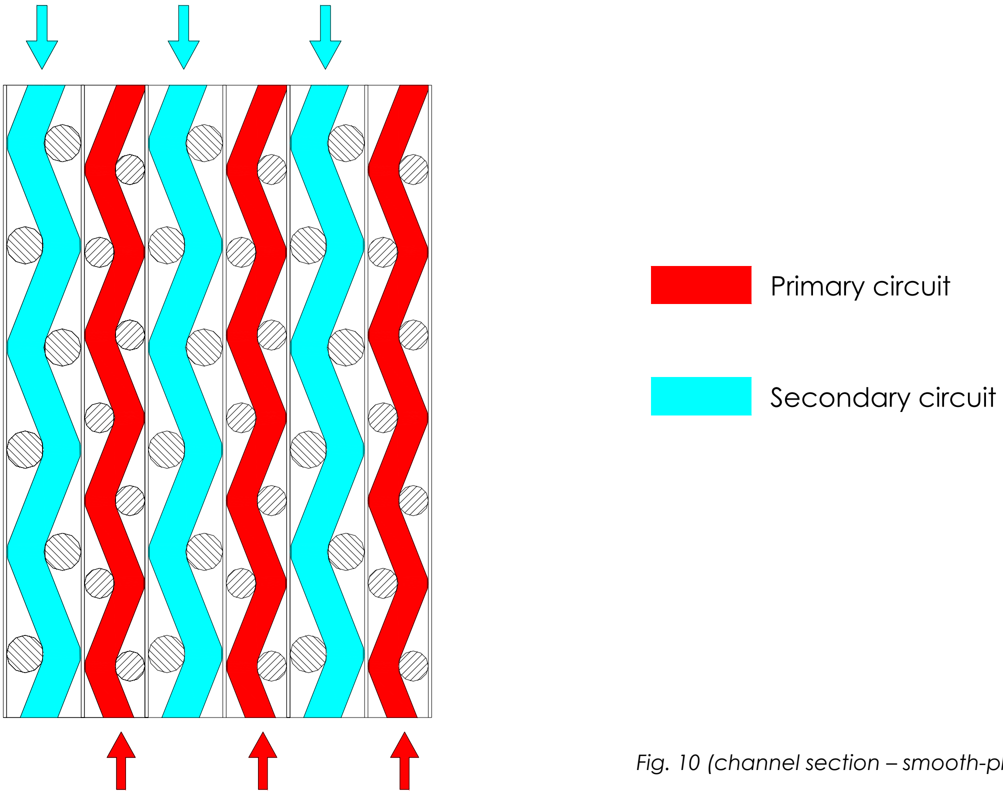


Fig. 10 (channel section – smooth-plate exchangers)

C) PRESSURE DROPS

The loss of pressure in the heat exchanger between inlet and outlet (also called pressure drop) is simply the result of the resistance encountered by the fluid as it flows through the device. To overcome high resistance it will be necessary to institute pumping, an operation that will be more costly the higher the pressure drop for a given flow rate. This explains why, when dimensioning a heat exchanger, it is extremely important to determine the maximum tolerated pressure drops. Obviously, the higher the admissible pressure drop, the smaller and more economical the exchanger - but this saving will be offset by higher pumping cost. The determination of reasonable pressure drop values takes into account the process, the cost of materials, and pumping costs. The usual approach when designing a heat exchanger is to keep pressure drops to a minimum without unduly sacrificing the heat transfer coefficients; that is, to seek to obtain the highest possible efficiency in heat transfer. In the case of inexpensive materials, this approach is certainly justified. The TECHNO SYSTEM plate heat exchangers, as we have already mentioned, offer the possibility of selecting from among a vast range of geometries (surface patterns). This permits approximating the ideal solution very closely and exploiting to the maximum the permissible pressure drops in both circuits even when dealing with very different flow rates and/or fluids - and doing so better than any other type of plate heat exchanger. In light of the above, one useful parameter for correct dimensioning of a heat exchanger is the Jensen number (Je), which indicates the specific pressure drop:

$$Je = \frac{\Delta P}{NTUp}$$

(mWG) (bar) (kPa)

For water/water heat transfer, the optimal values for this parameter (from the point of view of total device and operating costs) fall in a range of 2 to 10 mWG, according to construction material. For example, with stainless steel, the Je should be about 2 mWG. Higher values will result with more costly materials. For fluids different from water, the optimal Jensen number values are generally considerably higher.

D) FOULING

One very important factor, to be attentively evaluated, is the tendency of any fluid (with rare exceptions) to deposit on the exchange surfaces films of dirt and incrustations that eventually cause obstruction. The quality factors that most influence the speed at which fouling occurs in an exchanger are the velocity of the fluids and the condition and geometry of the heat transfer surfaces. The velocity inside any heat exchanger varies continually as to direction and magnitude from point to point and even at the same point, due to the uneven flow path the fluid is forced to follow. This greatly influences the tendency to fouling since it is directly responsible for the turbulence and the erosive force of the current and determines how long the fluid will remain in contact with the surface and the laminar layer thickness.
In light of the above, we may say that in relation to fouling the critical areas of an exchanger are those in which the velocity is lowest; in certain areas, we may even have “stagnant” areas in which the velocity is practically nil.
This does not normally occur in the plate heat exchangers, since the flow distribution conditions are always optimal. (see Fig. 11). Good flow distribution must be assured inside the single channels but also between parallel channels. In many applications, the TECHNO SYSTEM heat exchangers have proved to possess optimal qualities from this point of view. In practical application with fluids of all types, the TECHNO SYSTEM heat exchangers have yielded excellent results as regards fouling and scaling. The perfectly smooth surfaces of the plates, with no recesses or projecting parts to which impurities may attach, impede formation of the film of dirt or scale. What is more, the wire net turbulators, which are in continual movement due to thermal dilatation and contraction, have a marked tendency to disgregate hard scale and thus may be said to be “self-cleaning” in this respect. On the other hand, plate exchangers are not suitable for use with excessively dirty liquids or better, with liquids containing large particles (on the order of 1 mm) in suspension. In this regard, the only plate exchangers that have yielded satisfactory results are the TECHNO SYSTEM corrugated plates, thanks to their unique surface pattern. Liquids containing fibers are in any case much more damaging and almost always cause obstructions. In this case it is advisable to use spiral exchangers or exchangers with very wide passages and, if possible, featuring easy maintenance, since obstruction is practically inevitable.

SMOOTH PLATE WITH TURBULATOR *CORRUGATED PLATE*

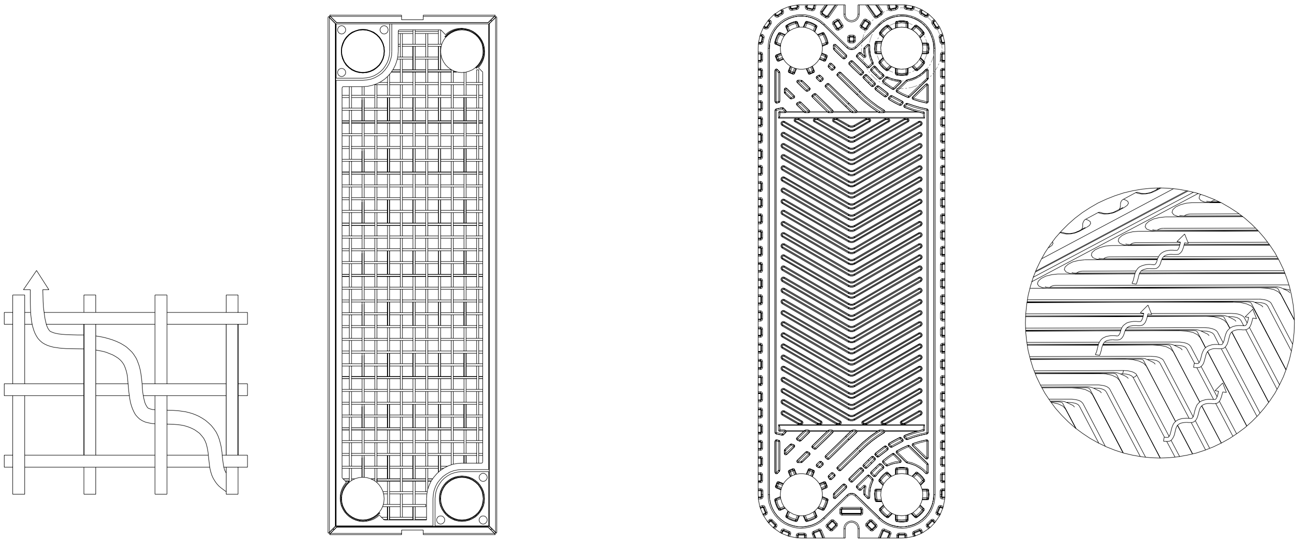


Fig. 11 (Flow distribution and turbolence)

When dimensioning a heat exchanger, special attention must be paid to careful evaluation of the tendency to fouling of the liquids to be used, and to correspondingly increasing the heat transfer surfaces. This is necessary in order to offset the considerable increase in resistance to heat transmission in the case of dirty liquids, which leave deposits of dirt and/or cause scaling. In shell and tube heat exchangers, there is real difficulty as regards obtaining good flow distribution and there are also stagnant areas (or in any case, areas of low velocity). Consequently, fouling factors of up to ten times those commonly adopted for plate exchangers must be used in calculation (see table below) of the requirements for the same duty.

Fouling factors (indicative values):

FLUID	PHE	THE
Pure water	0.00001	0.00005
Hard water	0.00003	0.00015
Cooling tower water	0.00005	0.00025
Industrial water	0.00006	0.00030
Dirty water	0.00010	0.00050

($m^2h°C/Kcal$)

PHE = Plate heat exchangers
THE = Shell and tube heat exchangers.

E) SEALS

Each plate is provided with a gasket, which defines the exchange channel, alterning the sealing rings around the left and right holes.
The gaskets of the corrugated plates are not gloed, but mechanically seald to the plates.
Moreover, thanks to their special assembly system (see Fig. 4), the seal gaskets of the TECHNO SYSTEM smooth-plate heat exchangers permit achieving considerably high pressures, since expulsion of the gaskets is practically impossible. Fig. 12 shows how the V-section of the turbulator housing ensures a further seal increment.
For all types of plates the dual seal ring around the holes impedes mixing of the two fluids; if anything, they may drip to the outside.

SMOOTH PLATE WITH TURBULATOR *CORRUGATED PLATE*

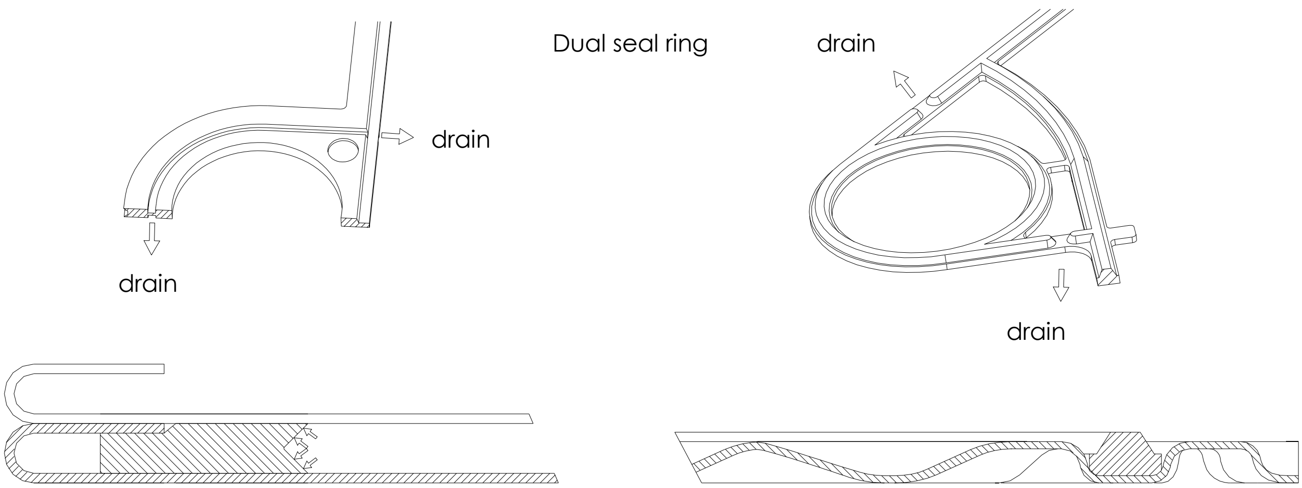


Fig. 12 (Sealing particulars)

F) INSPECTION – CLEANING – EXTENSIBILITY - REPAIRS

From these points of view, the plate heat exchanger is undoubtedly the best solution, since it can be, easily and completely, disassembled for cleaning, inspection, and on-the-spot repairs. With other types of exchangers, these operations are generally difficult to perform or even impossible. In particular and as already mentioned, the gaskets of all the versions of the TECHNO SYSTEM heat exchangers can be replaced easily and rapidly, since they are not glued but rather held in place by a housing. Finally, extensibility is a feature unique to plate heat exchangers.

CRITERIA AND SUGGESTIONS FOR CHOOSING A HEAT EXCHANGER

Compatibly with the temperature and pressure ranges (see graph, Fig. 8), the TECHNO SYSTEM plate heat exchangers are suitable for use, and can offer singular advantages, in the majority of the applications examined below.

A) Liquid-to-liquid heat transfer in all viscosity ranges. Given the high heat transfer coefficients and optimal flow distribution, the TECHNO SYSTEM plate exchangers always require a lesser surface area for the same duty. This is due to the possibility to optimize the geometry of the plates in relation to the viscosity of the fluid and the flow rates. For extremely high viscosity liquids, we recommend using the special corrugated plates type "L".

B) Vapor condensation. Within the limits mentioned above, the TECHNO SYSTEM plate heat exchangers offer excellent results since they permit, once again, to optimize the essential parameters. One limitation to use of plate heat exchangers is represented by the very high flow rates at low pressures, a situation requiring large-diameter nozzles. The dual inlet, with an additional nozzle on the mobile plate, can represent a feasible solution to this problem since it permits dividing the total flow by two. Unfortunately, this is not always practical. Remember that in any case, the embossed plates can help solve the problem, since pressure drops must often be limited.

C) Gas and compressed air. Since they offer excellent seal and great flexibility, the TECHNO SYSTEM heat exchangers can be used successfully in these applications.

D) Dirty fluids without fiber content. The only TECHNO SYSTEM plate exchangers suitable for these applications is the corrugated type.

E) Fluids at high pressures and temperatures. The only devices employed in these cases are specially designed and constructed shell and tube exchangers.

F) Highly corrosive fluids. Special graphite heat exchangers are used in these cases.

*** *** ***

To sum up, we may say that the TECHNO SYSTEM plate heat exchangers are suitable for use in a vast range of applications. With respect to other solutions, they always offer great technical and economic advantages. In addition, all this is possible within a very wide range of temperatures and pressures.
The versatility of the various types of TECHNO SYSTEM heat exchangers makes them your first choice for almost any application.
For applications in which the fluids in the two circuits have very different physical characteristics (above all, different viscosity values) or simply very different flow rates, the TECHNO SYSTEM heat exchangers, as explained at length above, are undoubtedly the best choice for solving the technical problems involved. The admissible pressures and temperatures for the TECHNO SYSTEM plate exchangers are the highest available anywhere. This is made possible by the specially designed gaskets and the system used to secure them to the plates (see Fig. 4). Thus, the TECHNO SYSTEM plate exchangers offer a much wider range of application with respect to other plate exchangers.

FORMULAS AND METHODS FOR THERMAL CALCULATION

The basic formulas for dimensioning plate heat exchangers are:

(1) $$Q = K\,S\,\Delta Tml$$

(2) $$Q = c\,G\,\Delta t$$

(*) $$\Delta Tml = \frac{(Ti-to)-(To-ti)}{\ln \frac{(Ti-to)}{(To-ti)}}$$

where:
- DTml = Logarithmic mean temperature difference
- Dt = Circuit's temperature difference
- K = Overall heat transfer coefficient
- S = Heating surface
- c = Specific heat
- G = Mass flow rate
- Ti,To = Primary input and output temperature
- ti,to = Secondary input and output temperature

Obviously, the quantities of heat (1) and (2) must be equal, where (1) expresses the calories transferred through the heat transfer surface and (2) the calories given up or absorbed by one of the fluids.

From $KS\Delta Tml = cG\Delta t$ comes

(3) $$\frac{KS}{cG} = \frac{\Delta t}{\Delta Tml}$$

The first term of expression (3) is the thermal length of the exchanger or of the plate (S and G may express, respectively, the total surface area and flow rate or only the surface area and flow rate for one channel); the second is the process thermal length. In practice, however, the first term will always be greater than the second, since a certain degree of over-dimensioning is the norm in these cases. To calculate the heat transfer surface using expression (1) or (3) we need to know K, which is given by:

(4) $$K = \frac{1}{\frac{1}{\alpha_1} + \frac{1}{\alpha_2} + \frac{s}{\lambda} + f}$$

where:
- a1 = Film coefficient of heat transfer 1
- a2 = Film coefficient of heat transfer 2
- s = Plate thickness
- l = Plate conductivity
- f = Fouling factor

In order to calculate K with (4), we need to know a1 and a2. The other terms are already known. The coefficients a1 and a2 are normally calculated by formulas like:

(5) $$\alpha = \frac{Nu\,\lambda_f}{De}$$

where:
- Nu = Nusselt's number
- lf = Fluid conductivity
- De = Hydraulic diameter (**)

Nussel's dimensionless number is calculated according to the formula:

(6) $Nu = A\, Re^{a} Pr^{b} Vi^{c}$

where :

A,a,b,c	=	Experimental constants
Re	=	Reynolds' number
Pr	=	Prandtl's number
Vi	=	Ratio between mass and film viscosity

The Reynolds' and Prandtl's numbers are given by:

(7) $$Re = \frac{\rho\, V\, De}{\mu}$$

(8) $$Pr = \frac{\mu\ c}{\lambda_f}$$

Dove:

r	=	density
V	=	velocity
m	=	Dynamic viscosity
c	=	Specific heat

Since we know the experimental constants A, a, b, and c, we can calculate the Nussel number and with it α1, α2, and then K. Although all these calculations, while simple in theory, they are iterative calculations and require some time; they are normally performed by a computer. Nevertheless, in the most common cases and with known fluids (using suitable correction coefficients when conditions deviate from standard) it is possible to formulate preliminary dimensions using the graph calculation method, of which an example is given below. The experimental constants A, a, b, and c for the TECHNO SYSTEM exchangers, with different turbulator and plate geometries, have the values:

A	=	0.15	÷	0.45
a	=	0.63	÷	0.90
b	=	0.30	÷	0.45
c	=	0.06	÷	0.21

Formula (6) is only valid for turbulent flow. As we know, the passage from turbulent flow to laminar flow occurs due to movement in pipes or channels with the Reynolds' number value is about 2100, while, for example, in the TECHNO SYSTEM plate heat exchangers we may have turbulent flow at Re values of 10 or less. With laminar flow, the Nusselt's number is expressed as:

(9) $$Nu = A \cdot Re^{a} \cdot Pr^{a} \left(\frac{De}{L}\right)^{a} \cdot Vi^{c}$$

with:

A	=	1.80 - 4.50
a	=	0.24 - 0.39 (in media 0.33)
c	=	0.10 - 0.18

PRESSURE DROPS

The pressure drops in a plate heat exchanger may be calculated according to the formula:

(10) $$\Delta P = 4f\ \frac{\rho V^{2} L}{2\ De}$$

L = plate length

(11) $$F\,f = \frac{M}{Re^{n}}$$

M and n experimental constants

The symbols used in (10) and (11) are all known to the exception of f, which is the so-called coefficient of friction.

To obtain the total loss in the exchanger, we must add to these loses the pressure drops in the nozzles, which are given by:

(12) $$\Delta P = m \frac{\rho V^2}{2}$$ normally m=1

Depending on the geometries of the plates, the experimental values for M and n for the TECHNO SYSTEM exchangers are:

M = 0.90 ÷ 4.80
n = 0.12 ÷ 0.39

In laminar conditions, (11) becomes (13) $$f = \frac{M}{Re}$$ with M = 38

Like for dimensioning, a graphic calculation can be used to obtain a rough yet satisfactory determination of the pressure drops (see example below).

(**) $$De = \frac{4S}{P}$$

Dove: S = Channel section
P = Wet perimeter

We may conclude, leaving graphs and examples for the annexes, by reporting some indicative values of the overall heat transfer coefficients obtainable with TECHNO SYSTEM exchangers. The values in the table below refer to cases with pressure drops of between 3 and 6 mWG and fouling coefficients in a normal range. With different fouling factors, K may be considerably lower.

FLUIDS		K
Primary	Secondary	(Kcal/m²h°C)
water	water	3000 - 6300
Et. alcool	water	1000 - 3000
sae 10 oil	water	450 - 1200
solvents	water	1000 - 3000
solution	water	900 - 2400
brine	water	1800 - 3900
compr. air	water	150 - 600
steam	water	2700 - 6300
steam	oil	450 - 1200
steam	solvents	900 - 3000
steam	solutions	750 - 2400
condens. NH3	water	2500 - 5400
freon	water	1500 - 3000

STEAM AND OTHER CONDENSING VAPOURS

A rough graphic calculation is not advisable in the presence of steam and condensing vapours as they imply a phase change. It is impossible to display clearly in a graph all variables.
In these cases the computer is indispensable, and we therefore advise you to contact our technical department.

COMPARISON BETWEEN TECHNO SYSTEM SMOOTH PLATE HEAT EXCHANGERS AND CORRUGATED PLATE HEAT EXCHANGERS

PLATES	Smooth with turbulator (corrugated for special applications).	Corrugated.
GASKETS	Not glued: mechanically secured under the entire plate perimeter.	Glued or spot-fixed.
GASKET AGING	Very slow. The edge of the plate holding the gasket protects it from agents that can cause deterioration; e.g. ultraviolet rays, ozone, etc.	Quite rapid, especially when the gaskets are not glued and therefore essentially unprotected.
AVERAGE GASKET LIFE	More than five years, even after many maintenance operations.	Generally less.
GASKET REPLACEMENT	Since the gaskets are not glued, on-site replacement creates no particular problems.	Unglued gaskets are very easy to replace.
THERMAL LENGTH	Either of the circuits can be built to the desired length by inserting a turbulator of the correct geometry; it is thus possible to optimize efficiency and pressure drops.	The corrugation of the plates excludes the possibility of having different geometries (surface patterns) on the two circuits; independent optimization of the circuits is therefore impossible.
PRESSURE CONSIDERATIONS	The TS heat exchanger guarantees seal even with absolute and differential pressures of up to 40 bar.	The maximum non-differential pressure obtainable is 25 bar.
MAINTENANCE	To be done with particular shrewdnesses. Follow strictly the instructions given in the instruction and maintenance manual.	Ordinary maintenance for corrugated plates is generally easier than for smooth-plate exchangers.
HANDLING	Delicate, especially for big-sized models.	Generally easy.

NECESSARY DATA FOR THERMAL CALCULATION	1	2	3	4
Nature of the fluids (density, viscosity, conductivity, specific heat)	☐	☐	☐	☐
Maximum operating temperature	☐	☐	☐	☐
Maximum operating pressure	☐	☐	☐	☐
Fouling factors	☐	☐	☐	☐
Allowable pressure drop in the primary circuit	☐	☐	☐	☐
Allowable pressure drop in the secondary circuit	☐	☐	☐	☐
Input temperature of the primary circuit	☐	☐	☐	☐
Output temperature of the primary circuit	☐		☐	
Flow rate of primary circuit	☐	☐		☐
Input temperature of the secondary circuit	☐	☐	☐	☐
Output temperature of the secondary circuit	☐	☐	☐	☐
Flow rate of secondary circuit		☐		☐
Heat load			☐	☐

N.B. Data of one column are enough for calculation.

CONVERTION TABLE

1 kcal	4.185	kJ	Heat quantity
1 kJ	0.239	kcal	
1 kcal/h	1.163	W	Capacity
1 W	0.860	kcal/h	
1 CV	633	kcal/h	
1 mca	9.81	kPa	Pressure drops
1 kPa	0.102	mWG	
1 bar	100	kPa	
1 kPa	0.01	bar	
1 kcal/Kg°C	4.185	kJ/kg°C	Specific heat
1 kJ/kg°C	0.239	kcal/kg°C	
1 kcal/mh°C	1.163	W/m°C	Conducitivity
1 W/m°C	0.860	kcal/hm°C	
1 cP	0.001	Ns/ m^2	Viscosity
1 Ns/m^2	1000	cP	
1 mPa s	0.001	Ns/m^2	
1 kg/m^3	0.001	gr/cm^3	Specific weight
1 gr/cm^3	1000	kg/m^3	
1 kcal/m^2h°C	1.163	W/ m^2°C	Transfer coefficient
1 W/ m^2°C	0.860	kcal/m^2h°C	
1 m^2h°C/Kcal	0.860	m^2 °C/W	Fouling factor
1 m^2 °C/W	1.163	m^2h°C/kcal	

NOTES:

NOTES:

NOTES:

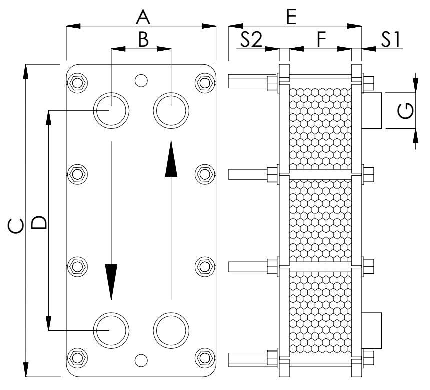
APPLICATIONS	Heating, Cooling, Steam applications
MAX. FLOWRATE	15 m³/h (with water)
MAX. NUMBER OF PLATES	75
FRAME	PN10, PN16 (standard PN10)

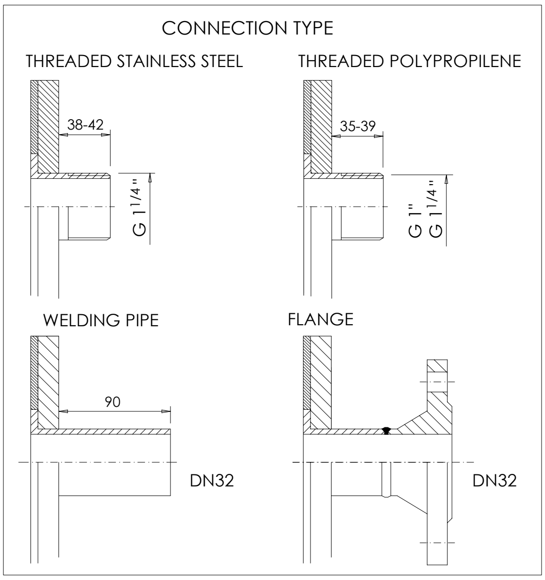
MATERIALS	**FRAME**	Painted carbon steel Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Carbon steel, stainless steel, Polypropilene, PTFE (Teflon)

DIMENSIONS		
NOMINAL PRESSURE	**PN10**	**PN16**
A	204	214
B	86	86
C	490	490
D	381	381
F	N° of plates x 2,65	N° of plates x 2,65
G	1 ¼"	1 ¼"
S1 / S2	14 / 12	18 / 14
unit. surface (m^2)	0,048	0,048
Channel Vol. (l)	0,102	0,102
Plate weight (Kg)	0,29	0,29
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	25	31
Boltings	N°8 M12	N°8 M16

N°OF PLATES	**13**	**21**	**27**	**39**	**51**	**61**
E	91	116	141	191	241	291

DIMENSIONS





are available the support legs too

APPLICATIONS	Heating, Cooling, Steam applications
MAX. FLOWRATE	15 m³/h (with water)
MAX. NUMBER OF PLATES	159
FRAME	PN10, PN16 (standard PN10)

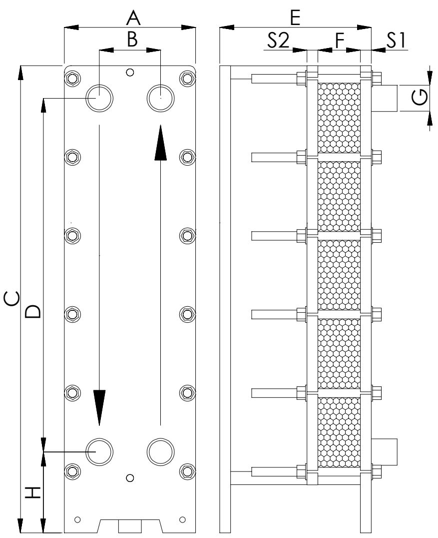
MATERIALS	**FRAME**	Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Carbon steel, stainless steel, Polypropilene, PTFE (Teflon)

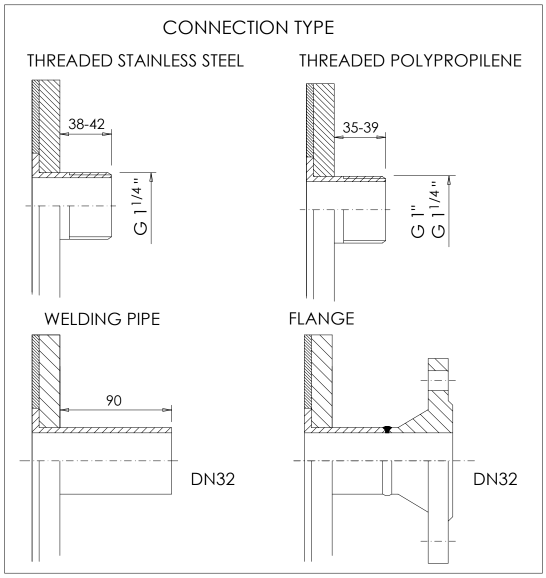
DIMENSIONS

NOMINAL PRESSURE	PN10	PN16
A	204	218
B	86	86
C	840	840
D	657	657
F	N° of plates x 2,65	N° of plates x 2,65
G	1 ¼"	1 ¼"
H	128,5	128,5
S1 / S2	14 / 12	18 / 14
unit. surface (m²)	0,091	0,091
Channel Vol. (l)	0,168	0,168
Plate weight (Kg)	0,49	0,49
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	42	60
Boltings	N°12 M12	N°12 M16

N°OF PLATES	13	25	37	49	61	85	107	131
E	234	284	334	384	434	534	634	734

DIMENSIONS





APPLICATIONS	Heating, Cooling, Steam applications
MAX. FLOWRATE	50 m³/h (with water)
MAX. NUMBER OF PLATES	187
FRAME	PN10, PN16 (standard PN10) on request PN25

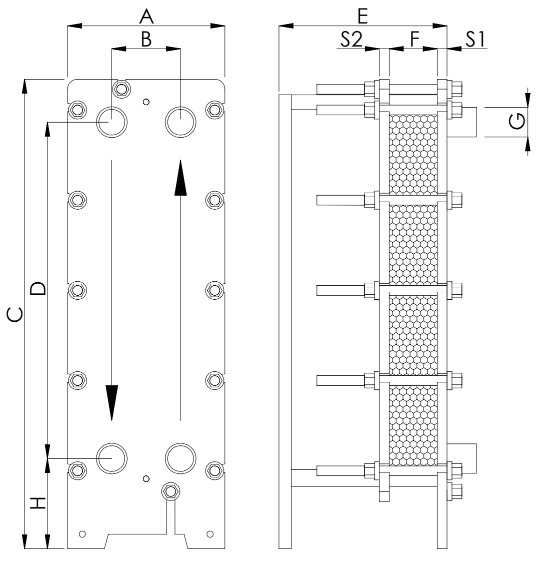
MATERIALS	**FRAME**	Painted carbon steel Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Carbon steel, stainless steel, Polypropilene, PTFE (Teflon)

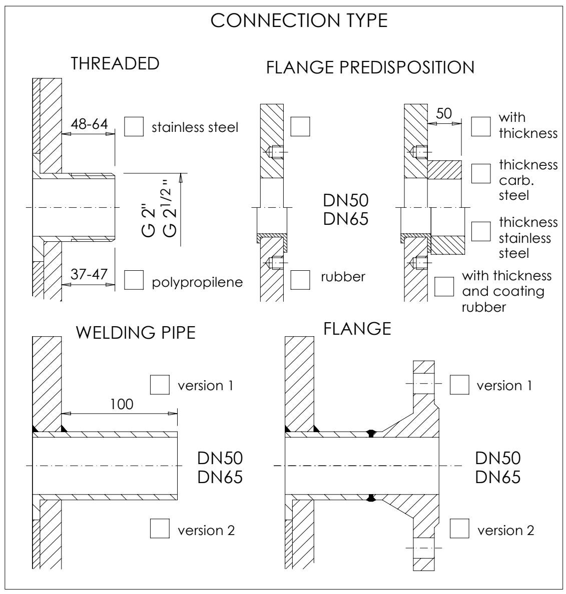
DIMENSIONS

NOMINAL PRESSURE	**PN10**	**PN16**
A	312	320
B	140	140
C	963 / 1003	963 / 1003
D	690	690
F	N° of plates x 3,50	N° of plates x 3,50
G	DN50 (65)	DN50 (65)
H	185	185
S1 / S2	20 / 20 (25 / 20)	25 / 25 (30 / 25)
unit. surface (m^2)	0,169	0,169
Channel Vol. (l)	0,425	0,425
Plate weight (Kg)	0,8	0,8
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	135	170
Boltings	N°12 M16	N°12 (14) M20

N°OF PLATES	**65**	**105**	**129**	**157**
E	447	667	807	957

DIMENSIONS





APPLICATIONS	Heating, Cooling, Steam applications
MAX. FLOWRATE	50 m³/h (with water)
MAX. NUMBER OF PLATES	209
FRAME	PN10, PN16 (standard PN10) on request PN25

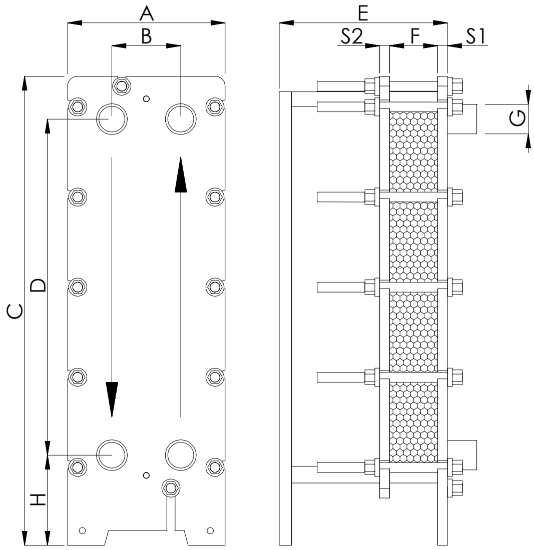
MATERIALS	**FRAME**	Painted carbon steel Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Carbon steel, stainless steel, Polypropilene, PTFE (Teflon)

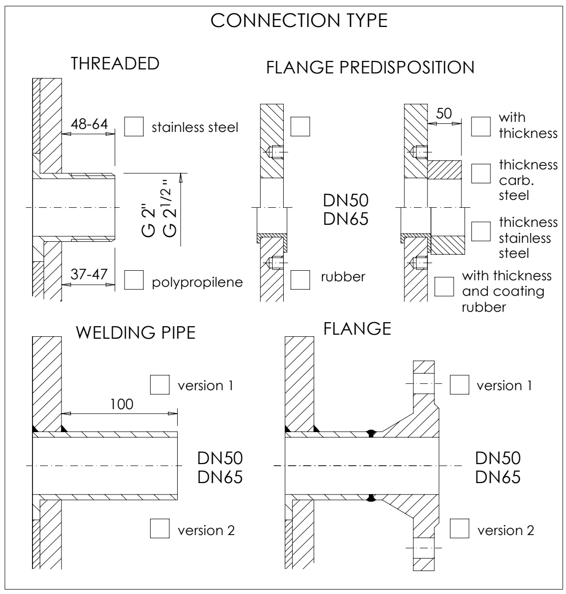
DIMENSIONS

NOMINAL PRESSURE	**PN10**	**PN16**
A	312	320
B	140	140
C	963 / 1003	963 / 1003
D	690	690
F	N° of plates x 2,95	N° of plates x 2,95
G	DN50 (65)	DN50 (65)
H	185	185
S1 / S2	20 / 20 (25 / 20)	25 / 25 (30 / 25)
unit. surface (m^2)	0,169	0,169
Channel Vol. (l)	0,36	0,36
Plate weight (Kg)	0,8	0,8
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	135	170
Boltings	N°12 M16	N°12 (14) M20

N°OF PLATES	**73**	**117**	**145**	**175**
E	447	667	807	957

DIMENSIONS





APPLICATIONS	Heating, Cooling, Steam applications
MAX. FLOWRATE	50 m³/h (with water)
MAX. NUMBER OF PLATES	209
FRAME	PN10, PN16 (standard PN10) on request PN25

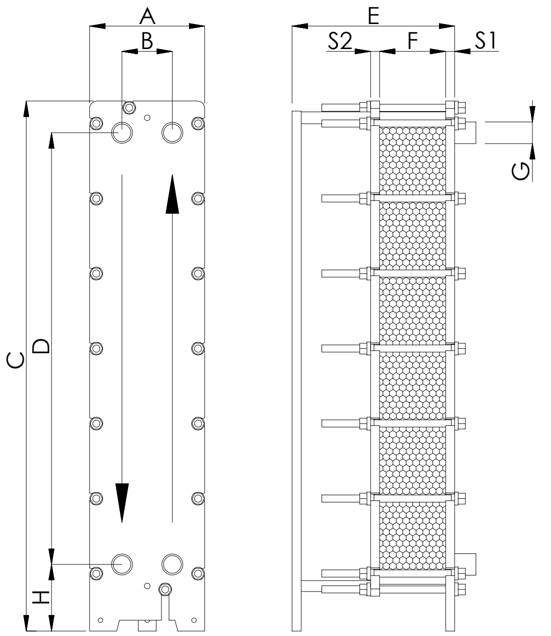
MATERIALS	**FRAME**	Painted carbon steel Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Carbon steel, stainless steel, Polypropilene, PTFE (Teflon)

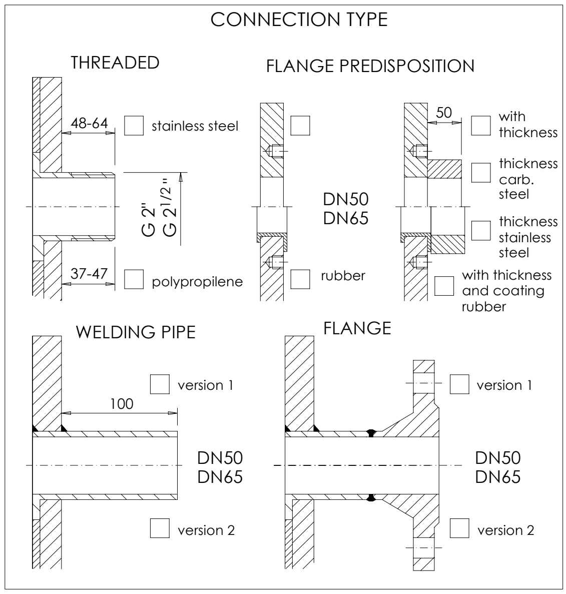
DIMENSIONS

NOMINAL PRESSURE	**PN10**	**PN16**
A	312	320
B	140	140
C	1473 / 1513	1473 / 1513
D	1200	1200
F	N° of plates x 2,95	N° of plates x 2,95
G	DN50 (65)	DN50 (65)
H	185	185
S1 / S2	25 / 20	30 / 25
unit. surface (m²)	0,304	0,304
Channel Vol. (l)	0,63	0,63
Plate weight (Kg)	1,4	1,4
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	175	210
Boltings	N°16 M16	N°16 (18) M20

N°OF PLATES	**73**	**117**	**145**	**175**
E	452	672	812	962

DIMENSIONS





APPLICATIONS	Heating, Cooling, Steam applications
MAX. FLOWRATE	150 m³/h (with water)
MAX. NUMBER OF PLATES	403
FRAME	PN10, PN16 (standard PN16) on request PN25

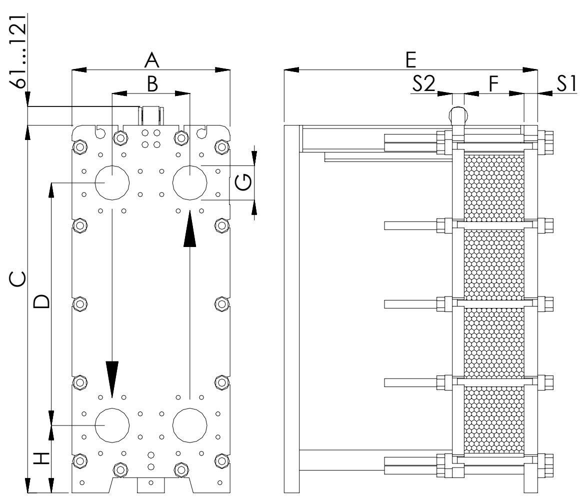
MATERIALS	**FRAME**	Painted carbon steel Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Carbon steel, stainless steel

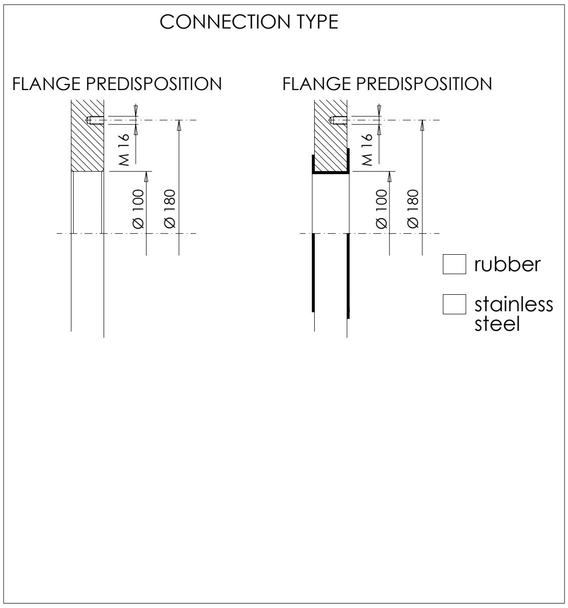
DIMENSIONS

NOMINAL PRESSURE	**PN10**	**PN16**
A	455	468
B	230	230
C	1091	1091
D	720	720
F	N° of plates x 3,10	N° of plates x 3,10
G	DN100	DN100
H	200	200
S1 / S2	30 / 30	40 / 35
unit. surface (m2)	0,224	0,224
Channel Vol. (l)	0,583	0,583
Plate weight (Kg)	1,35	1,35
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	285	360
Boltings	N°10 M20 + N°4 M20	N°10 M24 + N°4 M20

N°OF PLATES	**105**	**151**	**197**	**243**	**289**	**337**
E	750	1000	1250	1500	1750	2000

DIMENSIONS





APPLICATIONS	Heating, Cooling, Steam applications
MAX. FLOWRATE	150 m³/h (with water)
MAX. NUMBER OF PLATES	403
FRAME	PN10, PN16 (standard PN16) on request PN25

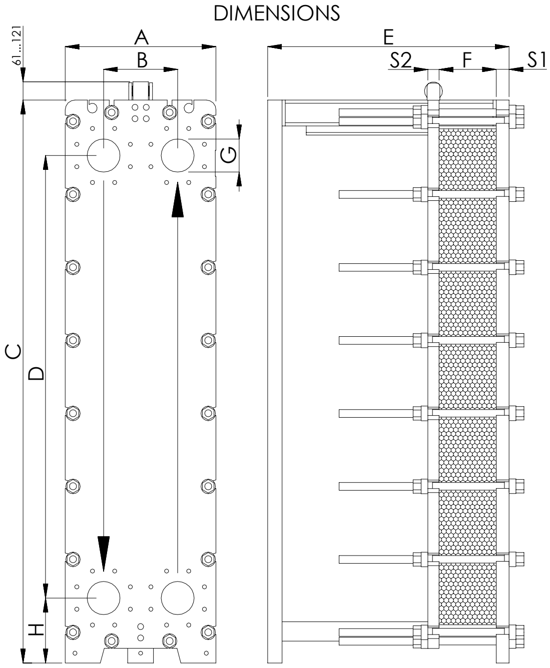
MATERIALS	**FRAME**	Painted carbon steel Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Carbon steel, stainless steel

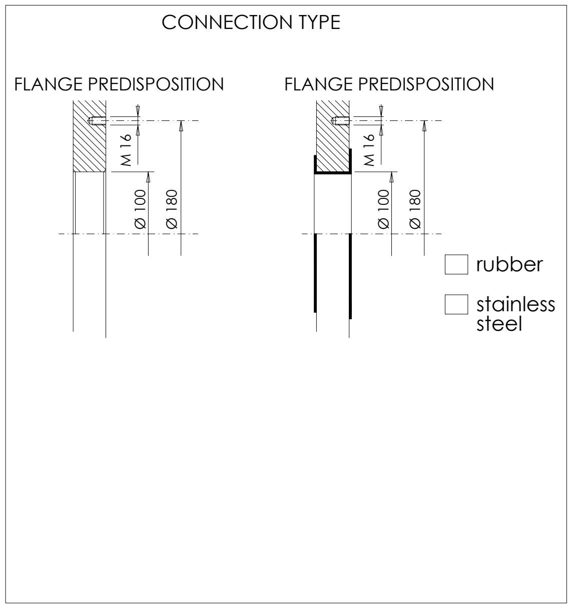
DIMENSIONS

NOMINAL PRESSURE	**PN10**	**PN16**
A	455	468
B	230	230
C	1735	1735
D	1364	1364
F	N° of plates x 3,10	N° of plates x 3,10
G	DN100	DN100
H	200	200
S1 / S2	30 / 30	40 / 35
unit. surface (m2)	0,4871	0,4871
Channel Vol. (l)	1,11	1,11
Plate weight (Kg)	2,4	2,4
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	475	565
Boltings	N°16 M20 + N°4 M20	N°16 M24 + N°4 M20

N°OF PLATES	**105**	**151**	**197**	**243**	**289**	**337**
E	750	1000	1250	1500	1750	2000

DIMENSIONS





TSC 4810

The plate heat exchangers are made according to the PED 97/23/CE

APPLICATIONS	Heating, Cooling, Steam applications
MAX. FLOWRATE	330 m³/h (with water)
MAX. NUMBER OF PLATES	399
FRAME	PN10, PN16 (standard PN16) on request PN25

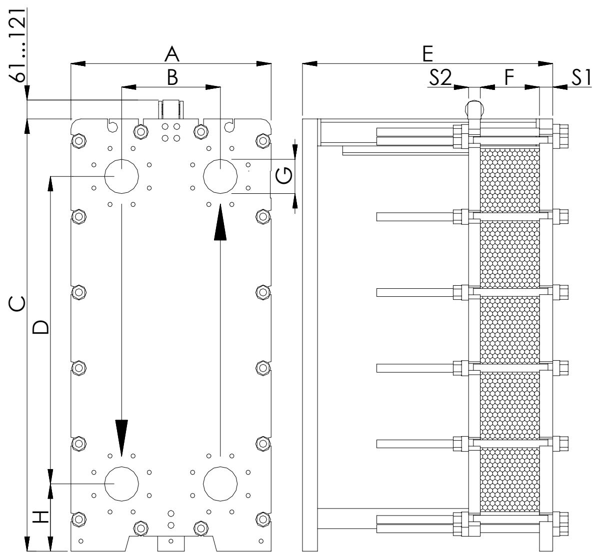
MATERIALS	**FRAME**	Painted carbon steel Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Carbon steel, stainless steel

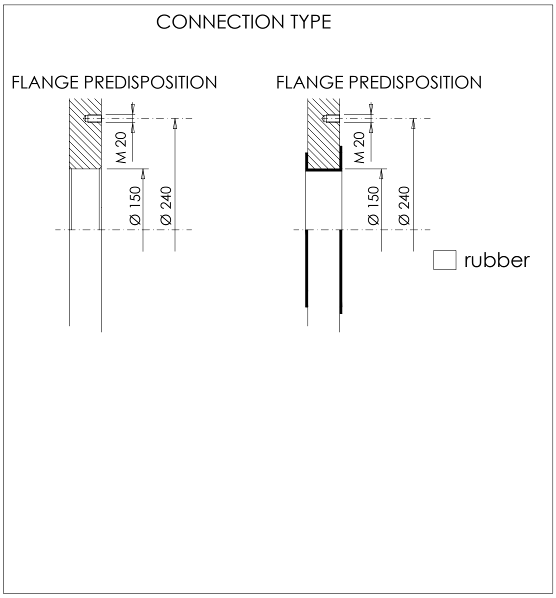
DIMENSIONS

NOMINAL PRESSURE	PN10	PN16
A	582	600
B	296	296
C	1394	1394
D	973	973
F	N° of plates x 3,10	N° of plates x 3,10
G	DN150	DN150
H	225	225
S1 / S2	40 / 35	50 / 45
unit. surface (m2)	0,425	0,425
Channel Vol. (l)	1,09	1,09
Plate weight (Kg)	2,4	2,4
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	540	700
Boltings	N°12 M24 + N°4 M24	N°12 M30 + N°4 M24

N°OF PLATES	105	151	197	243	289	337
E	760	1010	1260	1510	1760	2010

DIMENSIONS





APPLICATIONS	Heating, Cooling, Steam applications
MAX. FLOWRATE	330 m³/h (with water)
MAX. NUMBER OF PLATES	399
FRAME	PN10, PN16 (standard PN16) on request PN25

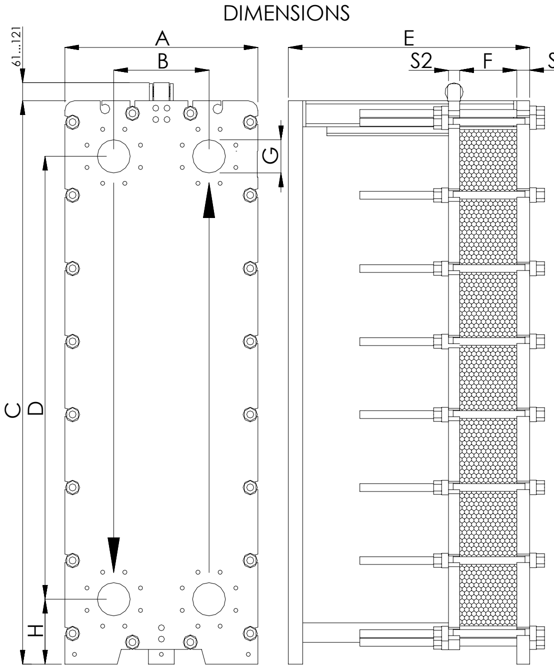
MATERIALS	**FRAME**	Painted carbon steel Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Carbon steel, stainless steel

DIMENSIONS

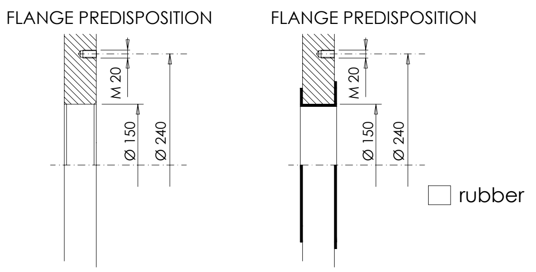
NOMINAL PRESSURE	PN10	PN16
A	582	600
B	296	296
C	1994	1994
D	1573	1573
F	N° of plates x 3,10	N° of plates x 3,10
G	DN150	DN150
H	225	225
S1 / S2	40 / 35	50 / 45
unit. surface (m2)	0,756	0,756
Channel Vol. (l)	1,746	1,746
Plate weight (Kg)	3,6	3,6
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	765	1000
Boltings	N°16 M24 + N°4 M24	N°16 M30 + N°4 M24

N°OF PLATES	105	151	197	243	289	337
E	760	1010	1260	1510	1760	2010

DIMENSIONS



CONNECTION TYPE



APPLICATIONS	Heating, Cooling, Steam applications
MAX. FLOWRATE	600 m³/h (with water)
MAX. NUMBER OF PLATES	389
FRAME	PN10, PN16 (standard PN16) on request PN25

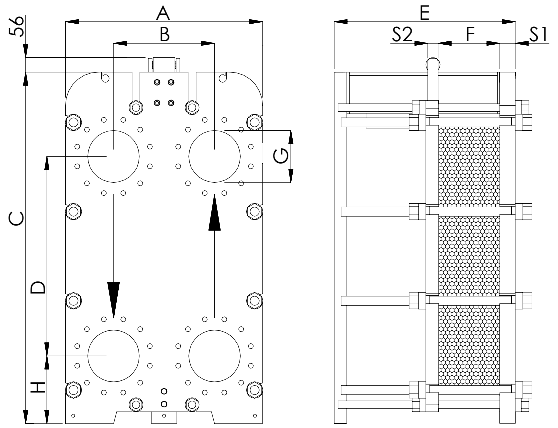
MATERIALS	**FRAME**	Painted carbon steel Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Carbon steel, stainless steel

DIMENSIONS

NOMINAL PRESSURE	**PN10**	**PN16**
A	763	773
B	396	396
C	1367	1367
D	776	776
F	N° of plates x 3,10	N° of plates x 3,10
G	DN200	DN200
H	262,5	262,5
S1 / S2	45 / 40	60 / 50
unit. surface (m2)	0,4025	0,4025
Channel Vol. (l)	1,274	1,274
Plate weight (Kg)	2,4	2,4
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	730	930
Boltings	N°8 M30 + N°4 M30	N°8 M36x3 + N°4 M30

N°OF PLATES	**93**	**139**	**185**	**231**	**277**	**325**
E	710	960	1210	1460	1710	1960

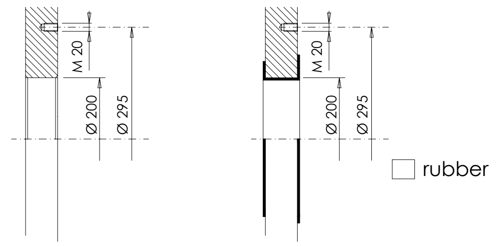
DIMENSIONS



CONNECTION TYPE

FLANGE PREDISPOSITION

FLANGE PREDISPOSITION



APPLICATIONS	Heating, Cooling, Steam applications
MAX. FLOWRATE	600 m³/h (with water)
MAX. NUMBER OF PLATES	389
FRAME	PN10, PN16 (standard PN16) on request PN25

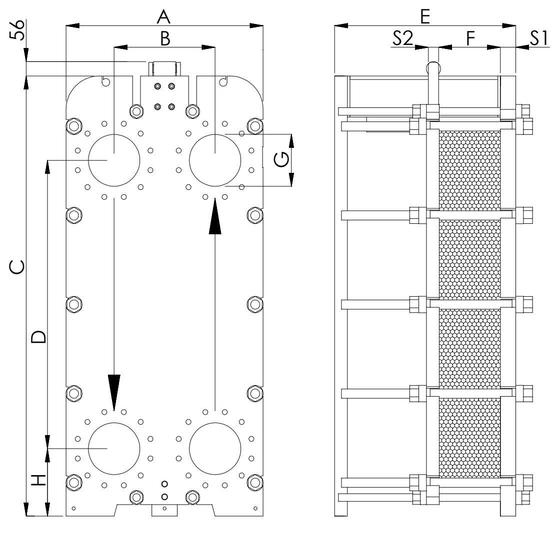
MATERIALS	**FRAME**	Painted carbon steel Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Carbon steel, stainless steel

DIMENSIONS

NOMINAL PRESSURE	**PN10**	**PN16**
A	763	773
B	396	396
C	1737	1737
D	1146	1146
F	N° of plates x 3,10	N° of plates x 3,10
G	DN200	DN200
H	262,5	262,5
S1 / S2	50 / 45	65 / 55
unit. surface (m2)	0,67	0,67
Channel Vol. (l)	1,82	1,82
Plate weight (Kg)	3,4	3,4
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	1030	1300
Boltings	N°10 M30 + N°4 M30	N°10 M36x3 + N°4 M30

N°OF PLATES	**93**	**139**	**185**	**231**	**277**	**323**
E	715	965	1215	1465	1715	1965

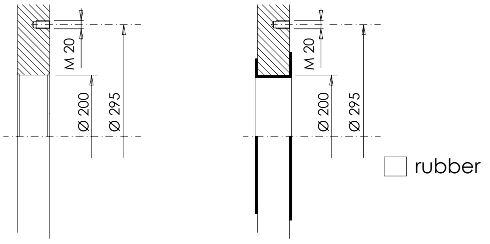
DIMENSIONS



CONNECTION TYPE

FLANGE PREDISPOSITION

FLANGE PREDISPOSITION



APPLICATIONS	Heating, Cooling, Steam applications
MAX. FLOWRATE	600 m³/h (with water)
MAX. NUMBER OF PLATES	389
FRAME	PN10, PN16 (standard PN16) on request PN25

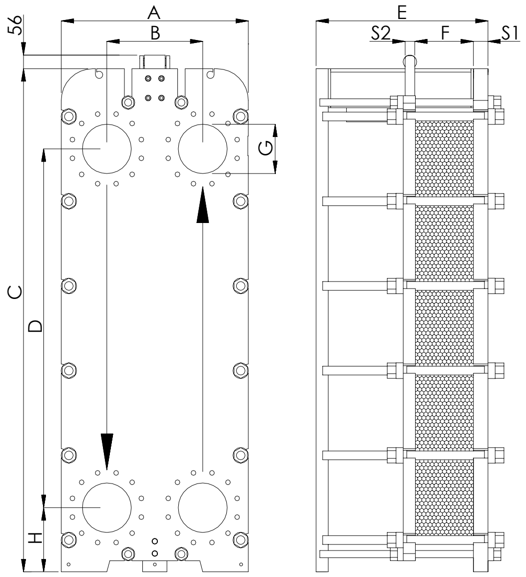
MATERIALS	**FRAME**	Painted carbon steel Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Carbon steel, stainless steel

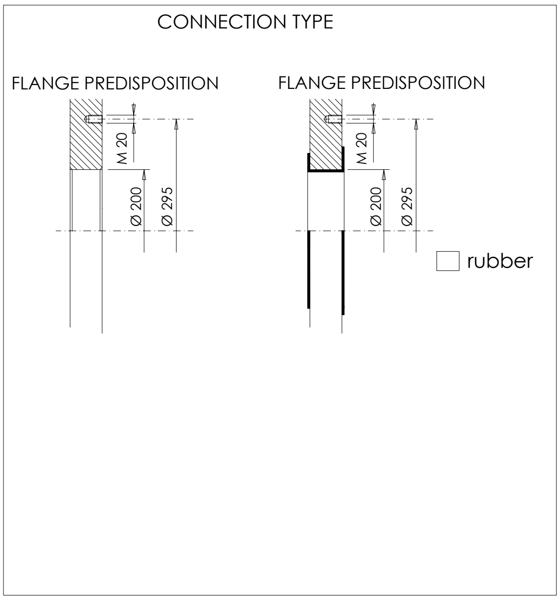
DIMENSIONS

NOMINAL PRESSURE	**PN10**	**PN16**
A	763	773
B	396	396
C	2127	2127
D	1536	1536
F	N° of plates x 3,10	N° of plates x 3,10
G	DN200	DN200
H	262,5	262,5
S1 / S2	50 / 45	65 / 55
unit. surface (m2)	0,963	0,963
Channel Vol. (l)	2,4	2,4
Plate weight (Kg)	4,5	4,5
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	1330	1720
Boltings	N°12 M30 + N°4 M30	N°12 M36x3 + N°4 M30

N°OF PLATES	**93**	**139**	**185**	**231**	**277**	**323**
E	715	965	1215	1465	1715	1965

DIMENSIONS





APPLICATIONS	Food, pharmaceutical, chemical applications
MAX. FLOWRATE	15 m³/h (with water)
MAX. NUMBER OF PLATES	73
FRAME	PN6, PN10 (standard PN6) on request PN16

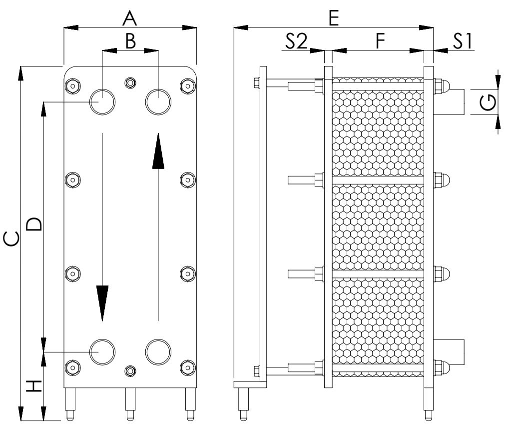
MATERIALS	**FRAME**	Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Stainless steel, Polypropilene, PTFE (Teflon)

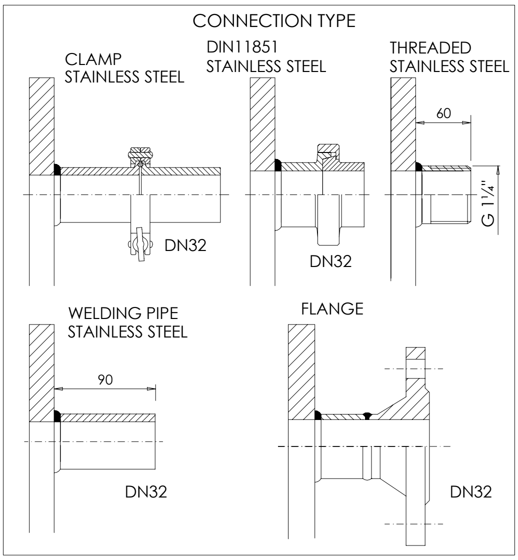
DIMENSIONS

NOMINAL PRESSURE	PN6	PN10
A	204	210
B	86	86
C	540	540
D	381	381
F	N° of plates x 2,65	N° of plates x 2,65
G	DN32	DN32
H	104,5	104,5
S1 / S2	15 / 12	18 / 15
unit. surface (m²)	0,048	0,048
Channel Vol. (l)	0,102	0,102
Plate weight (Kg)	0,29	0,29
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	27	35
Boltings	N°8 M12	N°8 M14

N°OF PLATES	13	25	37	49	61
E	265	315	365	415	465

DIMENSIONS





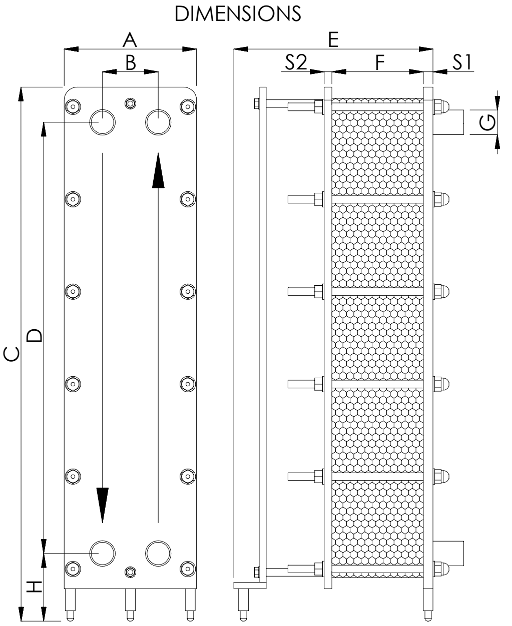
APPLICATIONS	Food, pharmaceutical, chemical applications
MAX. FLOWRATE	15 m^3/h (with water)
MAX. NUMBER OF PLATES	159
FRAME	PN6, PN10 (standard PN6) on request PN16

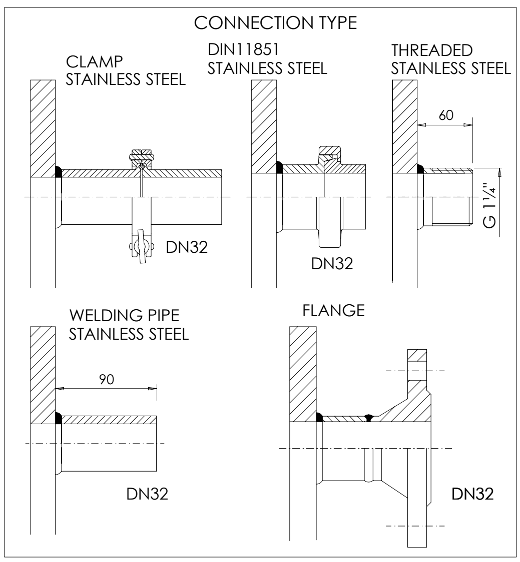
MATERIALS	**FRAME**	Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Stainless steel, Polypropilene, PTFE (Teflon)

DIMENSIONS

NOMINAL PRESSURE	**PN6**	**PN10**
A	204	210
B	86	86
C	816	816
D	657	657
F	N° of plates x 2,65	N° of plates x 2,65
G	DN32	DN32
H	104,5	104,5
S1 / S2	15 / 12	18 / 15
unit. surface (m^2)	0,091	0,091
Channel Vol. (l)	0,168	0,168
Plate weight (Kg)	0,49	0,49
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	50	60
Boltings	N°12 M12	N°12 M14

N°OF PLATES	**13**	**25**	**37**	**49**	**61**	**85**	**107**	**131**
E	265	315	365	415	465	565	665	765





APPLICATIONS	Food, pharmaceutical, chemical applications
MAX. FLOWRATE	50 m³/h (with water)
MAX. NUMBER OF PLATES	187
FRAME	PN6, PN10 (standard PN6) on request PN16

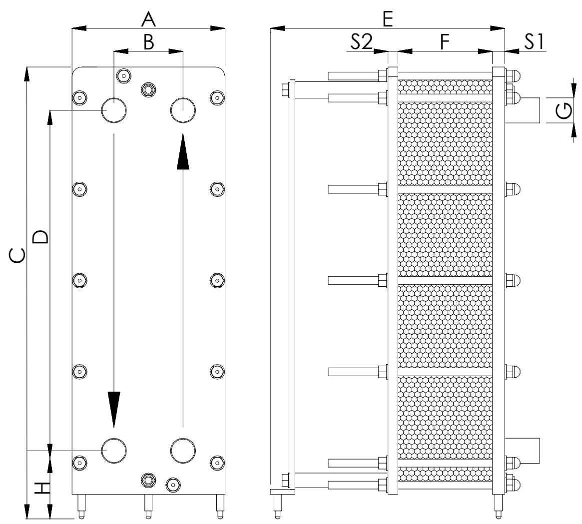
MATERIALS	**FRAME**	Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Stainless steel, Polypropilene, PTFE (Teflon)

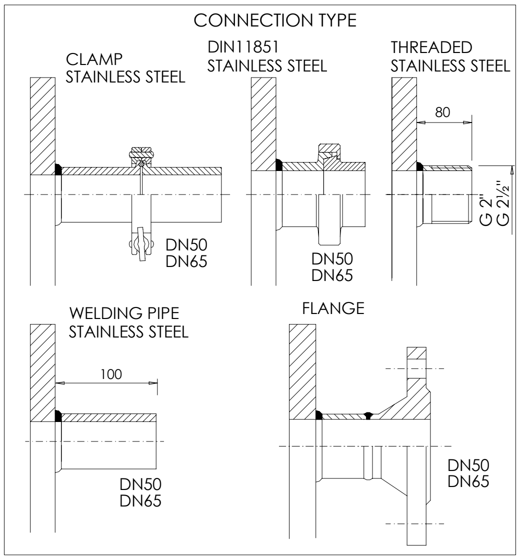
DIMENSIONS

NOMINAL PRESSURE	PN6	PN10
A	310	317
B	140	140
C	916	916
D	690	690
F	N° of plates x 3,50	N° of plates x 3,50
G	DN50 (65)	DN50 (65)
H	138	138
S1 / S2	25 / 20	30 / 25
unit. surface (m²)	0,169	0,169
Channel Vol. (l)	0,425	0,425
Plate weight (Kg)	0,8	0,8
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	125	165
Boltings	N°12 M16	N°12 M20

N°OF PLATES	65	105	129	157
E	475	695	835	985

DIMENSIONS





APPLICATIONS	Food, pharmaceutical, chemical applications
MAX. FLOWRATE	50 m³/h (with water)
MAX. NUMBER OF PLATES	209
FRAME	PN6, PN10 (standard PN6) on request PN16

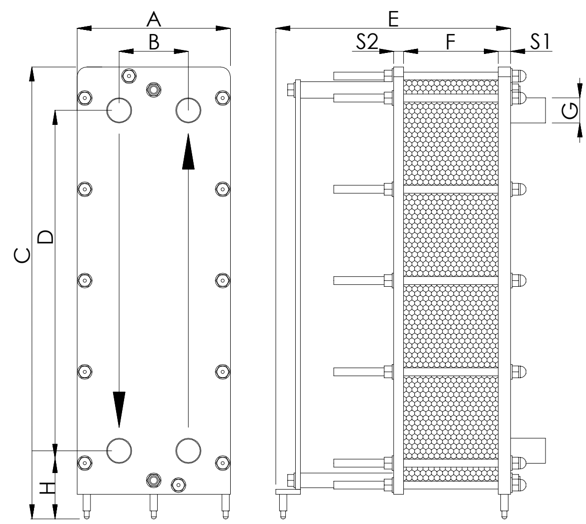
MATERIALS	**FRAME**	Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Stainless steel, Polypropilene, PTFE (Teflon)

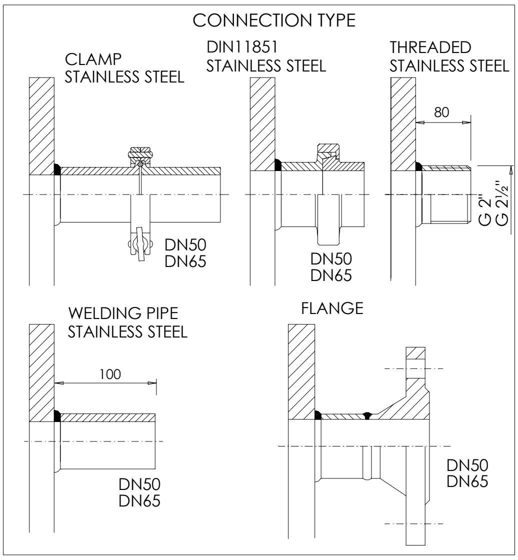
DIMENSIONS

NOMINAL PRESSURE	PN6	PN10
A	310	317
B	140	140
C	916	916
D	690	690
F	N° of plates x 2,95	N° of plates x 2,95
G	DN50 (65)	DN50 (65)
H	138	138
S1 / S2	25 / 20	30 / 25
unit. surface (m²)	0,169	0,169
Channel Vol. (l)	0,36	0,36
Plate weight (Kg)	0,8	0,8
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	125	165
Boltings	N°12 M16	N°12 M20

N°OF PLATES	73	117	145	175
E	475	695	835	985

DIMENSIONS





APPLICATIONS	Food, pharmaceutical, chemical applications
MAX. FLOWRATE	50 m³/h (with water)
MAX. NUMBER OF PLATES	209
FRAME	PN6, PN10 (standard PN6) on request PN16

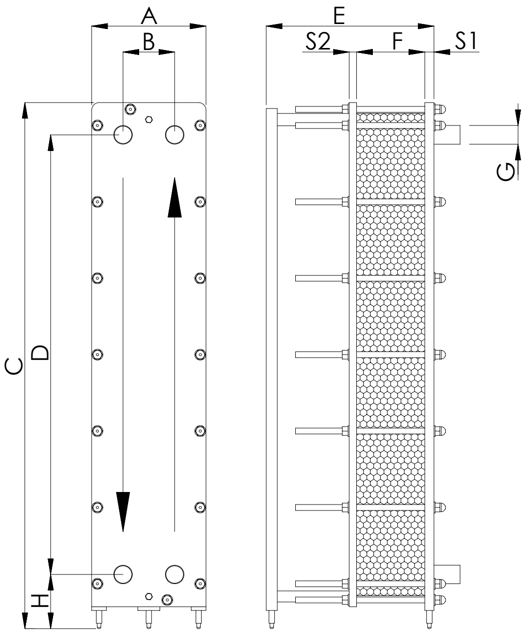
MATERIALS	**FRAME**	Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Stainless steel, Polypropilene, PTFE (Teflon)

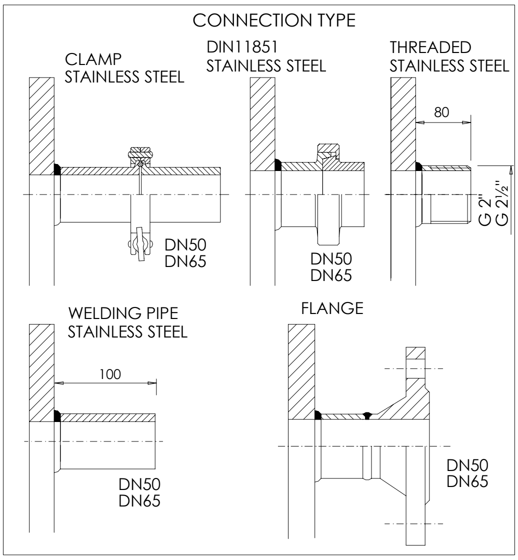
DIMENSIONS

NOMINAL PRESSURE	**PN6**	**PN10**
A	310	317
B	140	140
C	1438	1438
D	1200	1200
F	N° of plates x 2,95	N° of plates x 2,95
G	DN50 (65)	DN50 (65)
H	150	150
S1 / S2	25 / 20	30 / 25
unit. surface (m^2)	0,304	0,304
Channel Vol. (l)	0,63	0,63
Plate weight (Kg)	1,4	1,4
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	170	210
Boltings	N°16 M16	N°16 M20

N°OF PLATES	**73**	**117**	**145**	**175**
E	455	675	815	965

DIMENSIONS





APPLICATIONS	Food, pharmaceutical, chemical applications
MAX. FLOWRATE	150 m^3/h (with water)
MAX. NUMBER OF PLATES	403
FRAME	PN6, PN10 (standard PN6) on request PN16

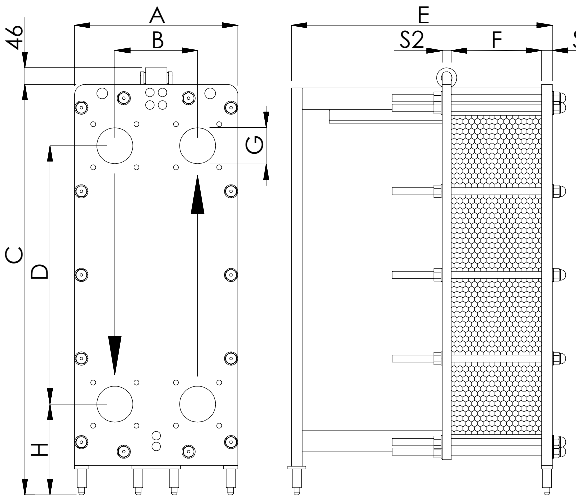
MATERIALS	**FRAME**	Stainless steel AISI 304 – AISI 316
	PLATES	Stainless steel AISI 304 – AISI 316 titanium, incoloy, monel, hastelloy
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Stainless steel, Polypropilene, PTFE (Teflon)

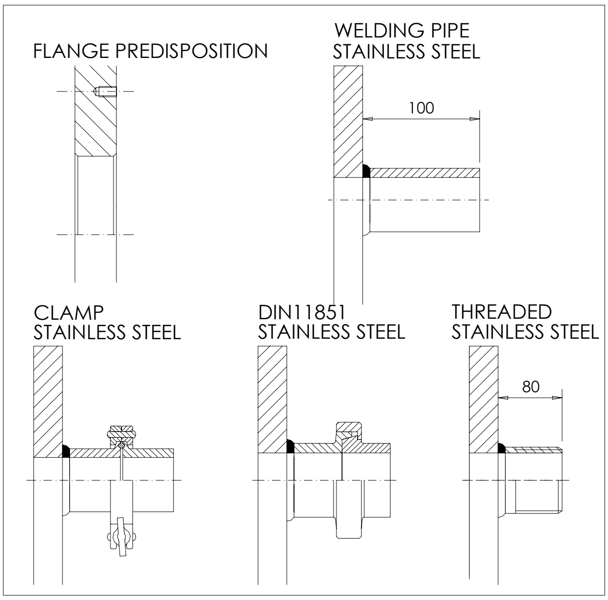
DIMENSIONS

NOMINAL PRESSURE	PN6	PN10
A	454	465
B	230	230
C	1146	1146
D	720	720
F	N° of plates x 3,10	N° of plates x 3,10
G	DN100	DN100
H	255	255
S1 / S2	30 / 25	40 / 35
unit. surface (m^2)	0,224	0,224
Channel Vol. (l)	0,583	0,583
Plate weight (Kg)	1,35	1,35
Plate thickness (mm)	0,5	0,5
Frame weight (Kg)	260	350
Boltings	N°10 M20 + N°4 M20	N°10 M24 + N°4 M20

N°OF PLATES	105	151	197	243	289	337
E	735	985	1235	1485	1735	1985

DIMENSIONS





APPLICATIONS	Heating, Cooling, Steam applications
MAX. FLOW RATE	15 m^3/h (with water)
MAX. NUMBER OF PLATES	75
FRAME	PN10, PN16, PN25 (standard PN10)

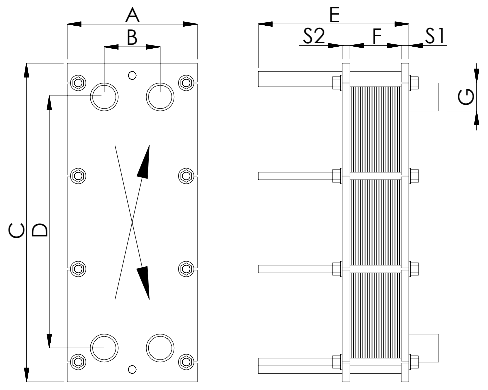
MATERIALS	**FRAME**	Painted carbon steel AISI 304 – 316 Stainless steel
	PLATES	AISI 304 – 316 Stainless steel titanium, incoloy, monel, hastelloy, copper
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Carbon steel, stainless steel

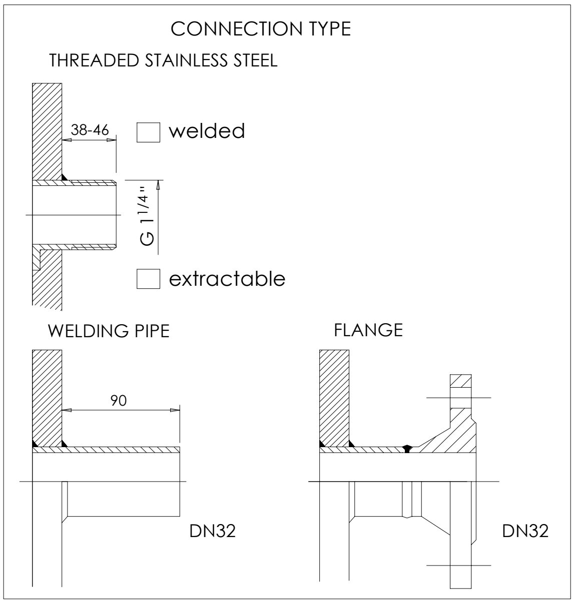
DIMENSIONS

NOMINAL PRESSURE	PN10	PN16	PN25
A	200	200	200
B	86	86	86
C	490	490	490
D	385	385	385
F	N° of plates x 2,5	N° of plates x 2,5	N° of plates x 2,5
G	1 ¼"	1 ¼"	1 ¼"
S1 / S2	12 / 12	15 / 15	20 / 20
Plate surface (m^2)	0,05	0,05	0,05
Vol. of channel (l)	0,085	0,085	0,085
Weight of plate (Kg)	0,4	0,4	0,4
Plate thickness (mm)	0,5	0,5	0,5
Weight of frame (Kg)	22	27	35
Clamping bolts	N°8 M12	N°8 M16	N°8 M16

N°OF PLATES	15	21	27	39	51	63
E	90	115	140	190	240	290

DIMENSIONS





are available the support legs too

APPLICATIONS	Heating, Cooling, Steam applications
MAX. FLOW RATE	50 m³/h (with water)
MAX. NUMBER OF PLATES	187
FRAME	PN16, PN25 (standard PN16)

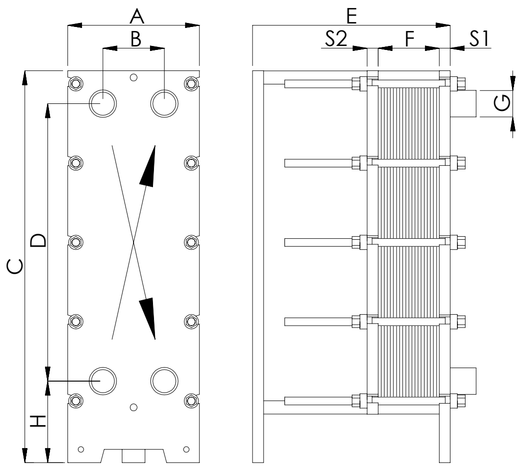
MATERIALS	**FRAME**	Painted carbon steel AISI 304 – 316 Stainless steel
	PLATES	AISI 304 – 316 Stainless steel titanium, incoloy, monel, hastelloy, copper
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Carbon steel, stainless steel

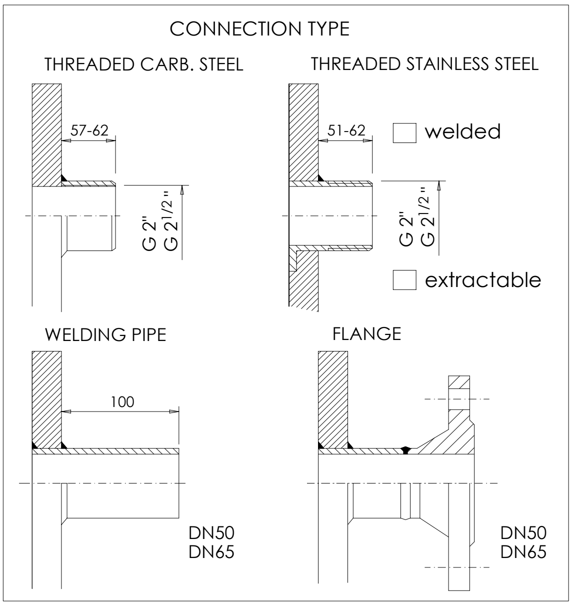
DIMENSIONS

NOMINAL PRESSURE	**PN16**	**PN25**
A	300	311
B	140	140
C	890	890
D	630	630
F	N° of plates x 3,75	N° of plates x 3,75
G	2" - 2 ½"	2" - 2 ½"
H	185	185
S1 / S2	25 / 25	30 / 30
Plate surface (m²)	0,135	0,135
Vol. of channel (l)	0,35	0,35
Weight of plate (Kg)	1,3	1,3
Plate thickness (mm)	0,6	0,6
Weight of frame (Kg)	115	140
Clamping bolts	N°10 M20	N°10 M24

N°OF PLATES	**39**	**71**	**93**	**115**	**137**
E	450	670	810	960	1100

DIMENSIONS





APPLICATIONS	Heating, Cooling, Steam applications
MAX. FLOW RATE	150 m^3/h (with water)
MAX. NUMBER OF PLATES	335
FRAME	PN10, PN16, PN25 (standard PN16)

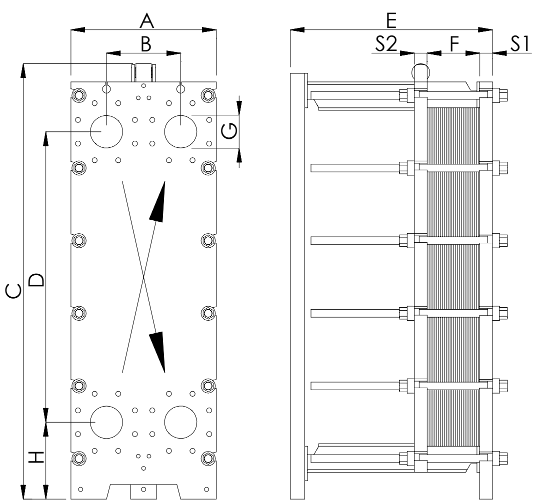
MATERIALS	**FRAME**	Painted carbon steel AISI 304 – 316 Stainless steel
	PLATES	AISI 304 – 316 Stainless steel titanium, incoloy, monel, hastelloy, copper
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Carbon steel, stainless steel

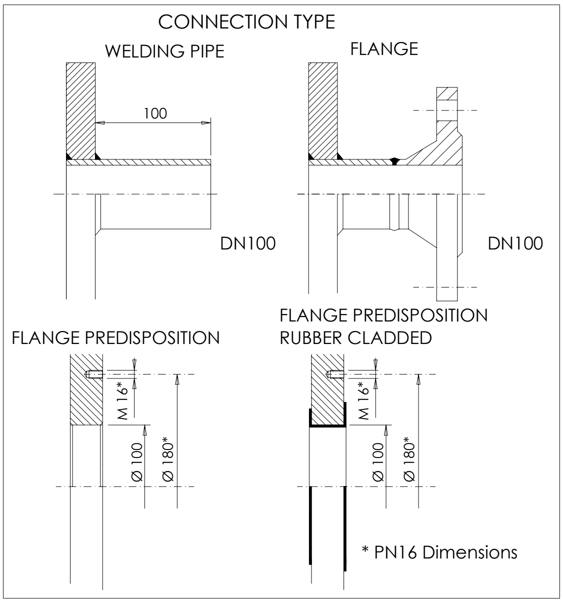
DIMENSIONS

NOMINAL PRESSURE	**PN10**	**PN16**	**PN25**
A	450	450	474
B	230	230	230
C	1343	1343	1343
D	896	896	896
F	N° of plates x 3,75	N° of plates x 3,75	N° of plates x 3,75
G	DN100	DN100	DN100
H	237	237	237
S1 / S2	30 / 30	40 / 35	50 / 45
Plate surface (m^2)	0,3	0,3	0,3
Vol. of channel (l)	0,8	0,8	0,8
Weight of plate (Kg)	2,7	2,7	2,7
Plate thickness (mm)	0,6	0,6	0,6
Weight of frame (Kg)	300	360	450
Clamping bolts	N°12 M20	N°12 M24	N°12 M30

N°OF PLATES	**89**	**127**	**165**	**203**	**241**	**279**
E	750	1000	1250	1500	1750	2000

DIMENSIONS





APPLICATIONS	Heating, Cooling, Steam applications
MAX. FLOW RATE	330 m³/h (with water)
MAX. NUMBER OF PLATES	335
FRAME	PN10, PN16, PN25 (standard PN10)

MATERIALS	**FRAME**	Painted carbon steel AISI 304 – 316 Stainless steel
	PLATES	AISI 304 – 316 Stainless steel titanium, incoloy, monel, hastelloy, copper
	GASKETS	NBR, EPDM, EPM, FKM, Silicone
	CONNECTIONS	Carbon steel, stainless steel

DIMENSIONS

NOMINAL PRESSURE	**PN10**	**PN16**	**PN25**
A	605	620	640
B	320	320	320
C	1536	1536	1536
D	960	960	960
F	N° of plates x 3,75	N° of plates x 3,75	N° of plates x 3,75
G	DN150	DN150	DN150
H	299	299	299
S1 / S2	40 / 35	50 / 45	65 / 55
Plate surface (m²)	0,4365	0,4365	0,4365
Vol. of channel (l)	1,2	1,2	1,2
Weight of plate (Kg)	4,0	4,0	4,0
Plate thickness (mm)	0,6	0,6	0,6
Weight of frame (Kg)	540	720	870
Clamping bolts	N°12 M24	N°12 M30	N°12 M36

N°OF PLATES	**89**	**127**	**165**	**203**	**241**	**279**
E	750	1000	1250	1500	1750	2000

DIMENSIONS