

SCHIMBATOARE DE CALDURA

cu suprafete extinse

NECESITATEA UTILIZARII

- o Cand coeficientii individuali de transfer termic ai celor doua fluide au valori mult diferite:
 - abur in condensare: $5000 - 21000 \text{ W.m}^{-2}.\text{K}^{-1}$;
 - aer care se incalzeste: $3 - 150 \text{ W.m}^{-2}.\text{K}^{-1}$;
 - un schimbator de caldura obisnuit asigura un coeficient global de transfer K:

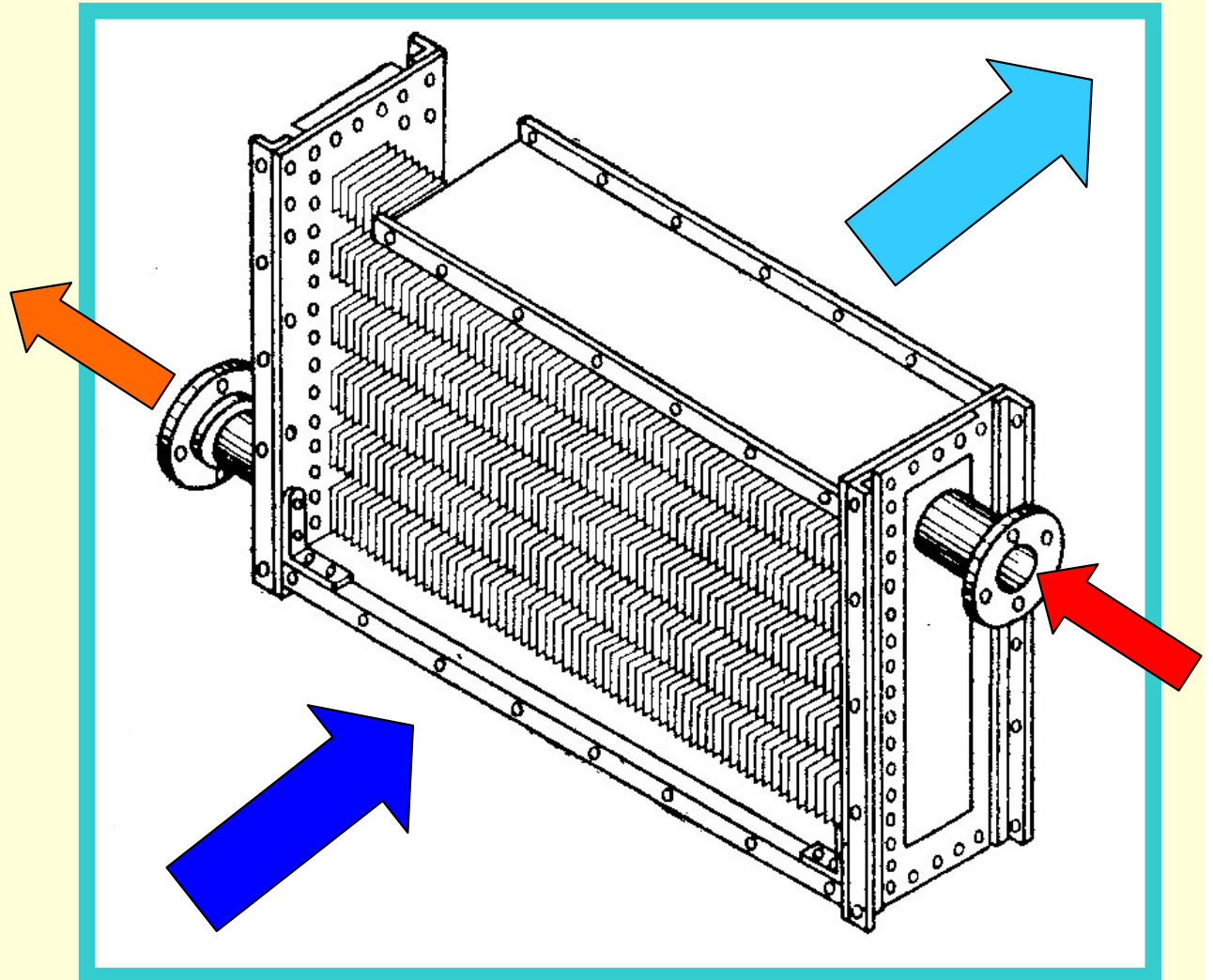
$$K = \frac{1}{\frac{1}{\alpha_1} + \sum \frac{\delta}{\lambda} + \frac{1}{\alpha_2}} = \frac{1}{\frac{1}{21000} + \frac{2 \cdot 10^{-3}}{47,5} + \frac{1}{150}} = 148 \text{ W}/(\text{m}^2 \cdot \text{K})$$

APLICATII

- o Industria criogenica;
- o Racirea echipamentelor de calcul;
- o Racirea motoarelor autovehiculelor;
- o Racirea motoarelor vehiculelor spatiale;
- o Instalatii de climatizare;
- o Ingineria nucleara;
- o Incalzirea/racirea sangelui (chirurgie);
- o Incalzirea/racirea fluidelor viscoase (industria alimentara).

SCHIMBATOARE DE CALDURA CU ARIPIOARE

- o Intrare agent termic;
- o Iesire agent termic;
- o Intrare fluid de incalzit;
- o Iesire fluid de incalzit.



SCHIMBATOARE DE CALDURA CU ARIPIOARE

Aripioarele se monteaza de partea agentului cu α mai mic, astfel incat:

$$\alpha_1 \cdot A \cong \alpha_2 \cdot A_2$$

- α_1 - coeficientul de transfer de la fluidul din tevi la peretele neted al tevii;
- α_2 - coeficientul de transfer de la suprafata cu aripioare la fluidul dintre tevi;
- A - suprafata interioara a tevilor;
- A_2 - suprafata exterioara a tevilor cu aripioare.

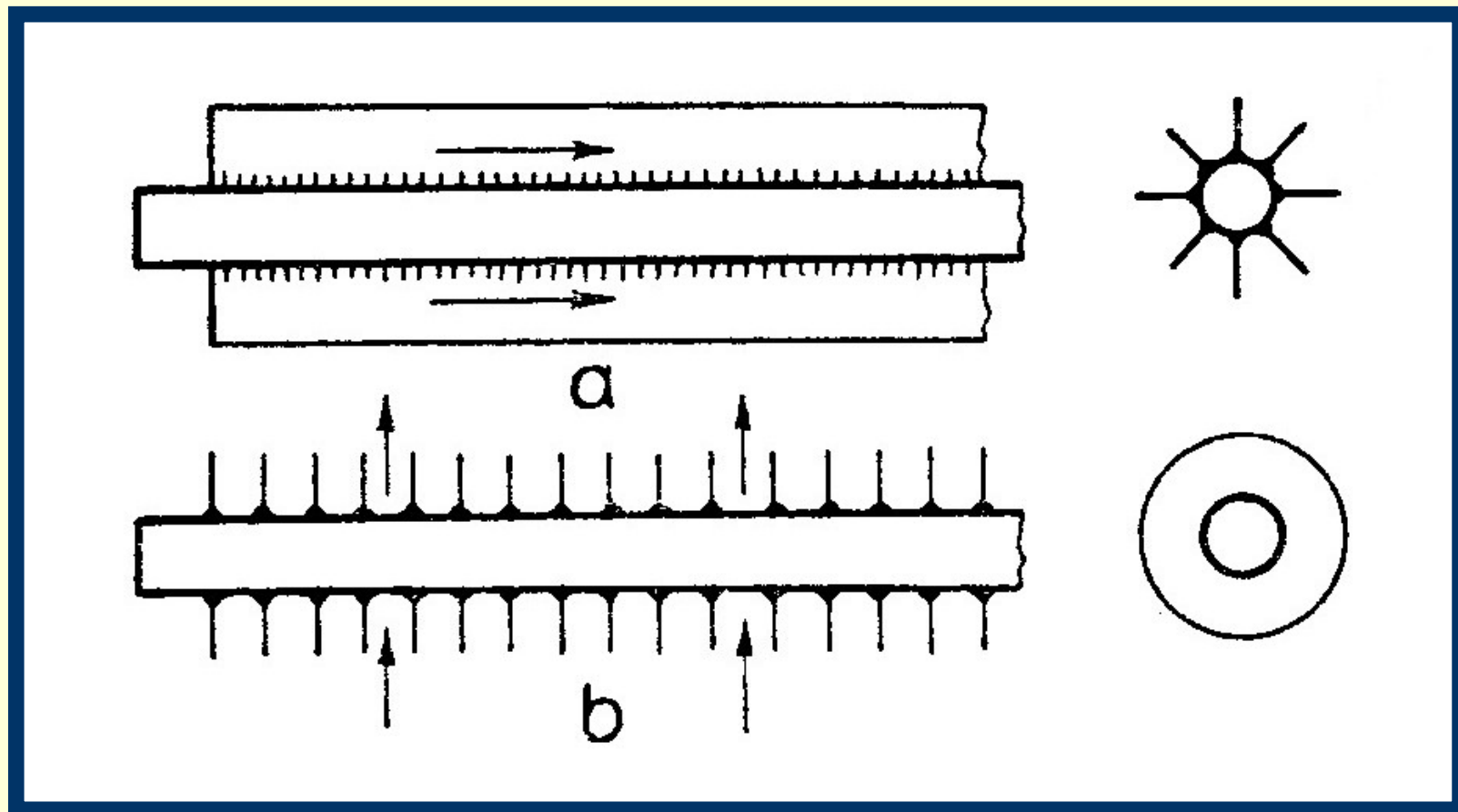
SCHIMBATOARE DE CALDURA CU ARIPIOARE

Ecuatia generala a transferului termic devine:

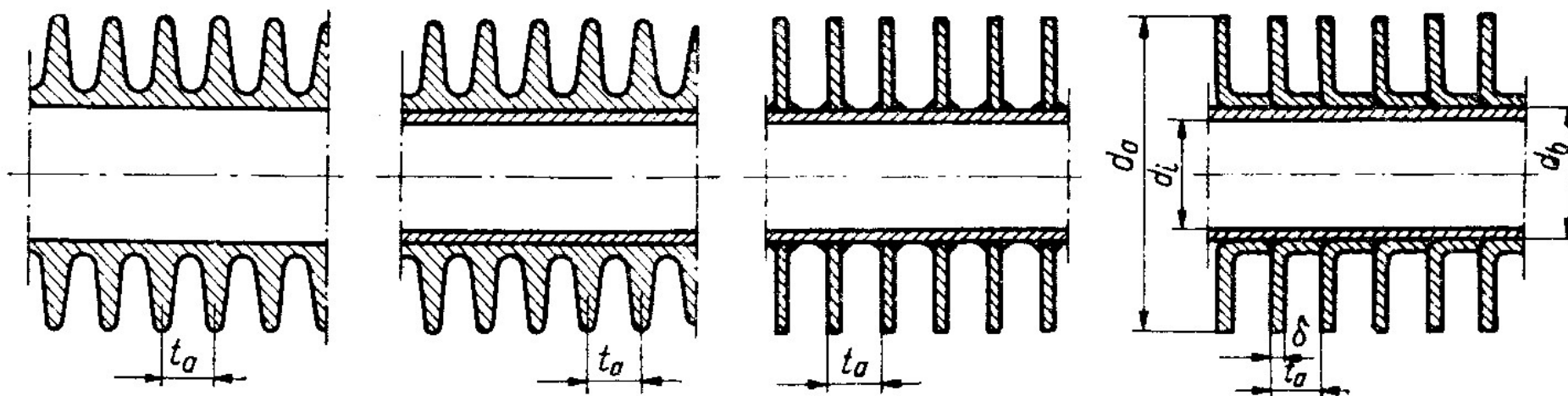
$$Q = K \cdot A \cdot \Delta T_{\text{med}} = \frac{A \cdot \Delta T_{\text{med}}}{\frac{1}{\alpha_1} + \sum \frac{\delta}{\lambda} + \frac{1}{\alpha_2} \cdot \frac{A}{A_2}}$$

SCHIMBATOARE DE CALDURA CU ARIPIOARE

- a) Aripioare longitudinale;
- b) Aripioare transversale.

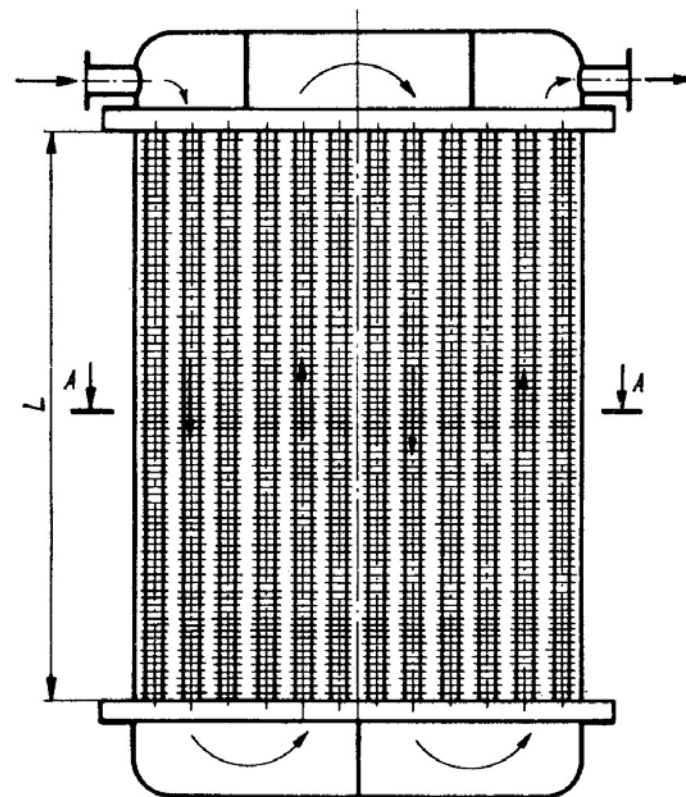


SCHIMBATOARE DE CALDURA CU ARIPIOARE

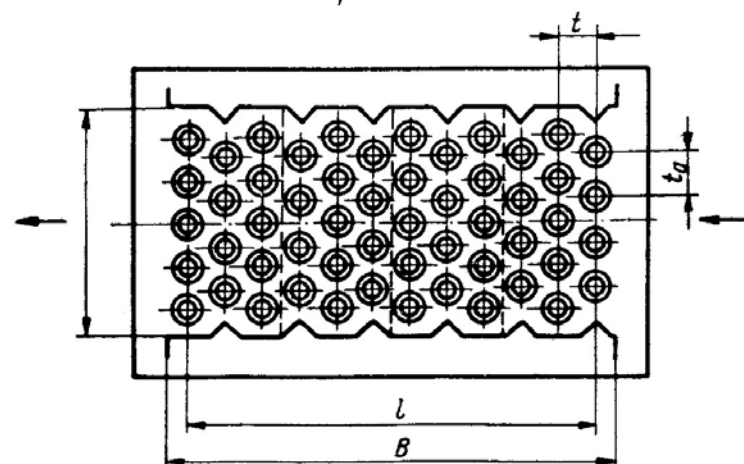


Forme de țevi cu aripioare.

SCHIMBATOARE DE CALDURA CU ARIPIOARE

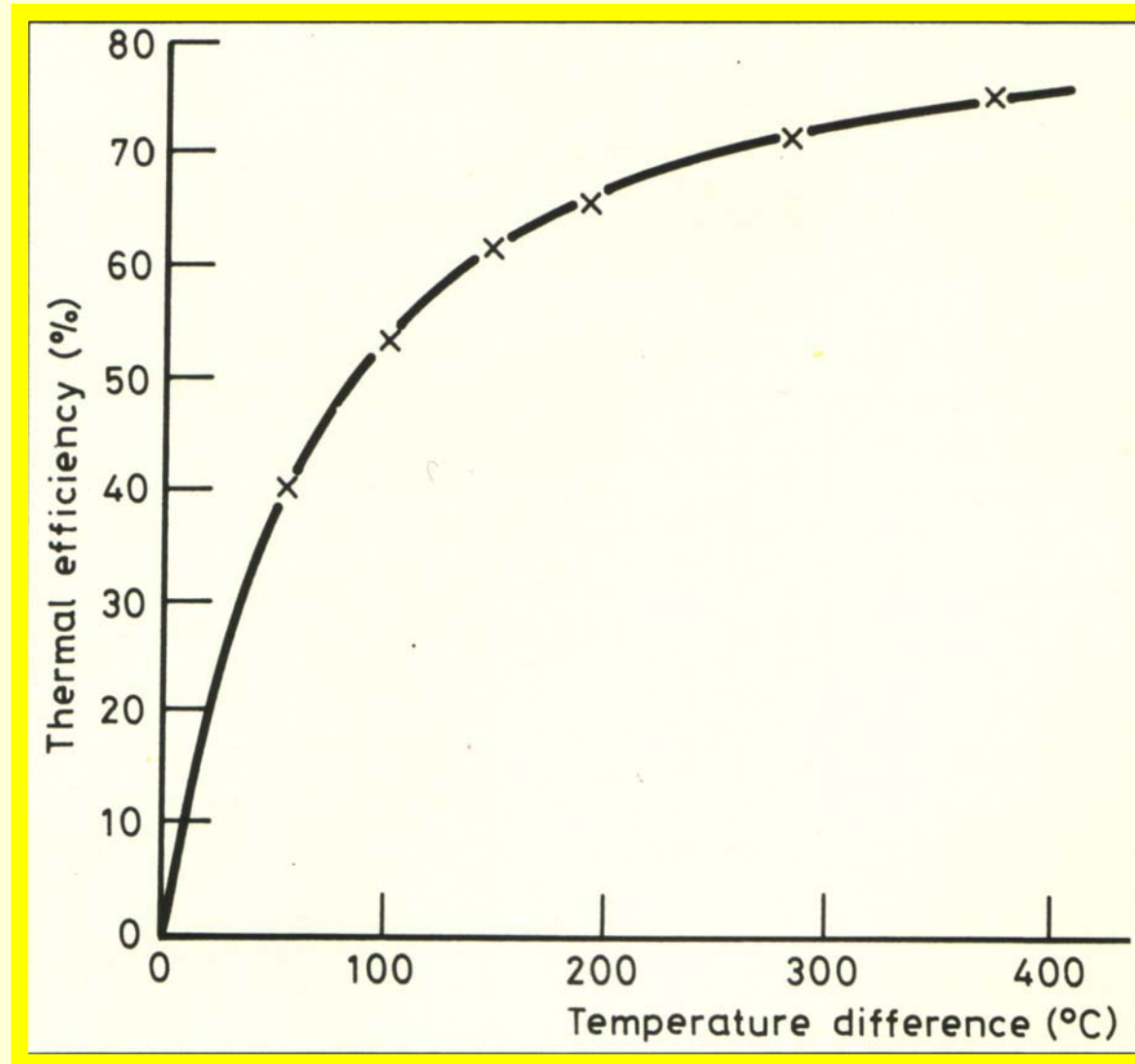


Secțiunea A-A



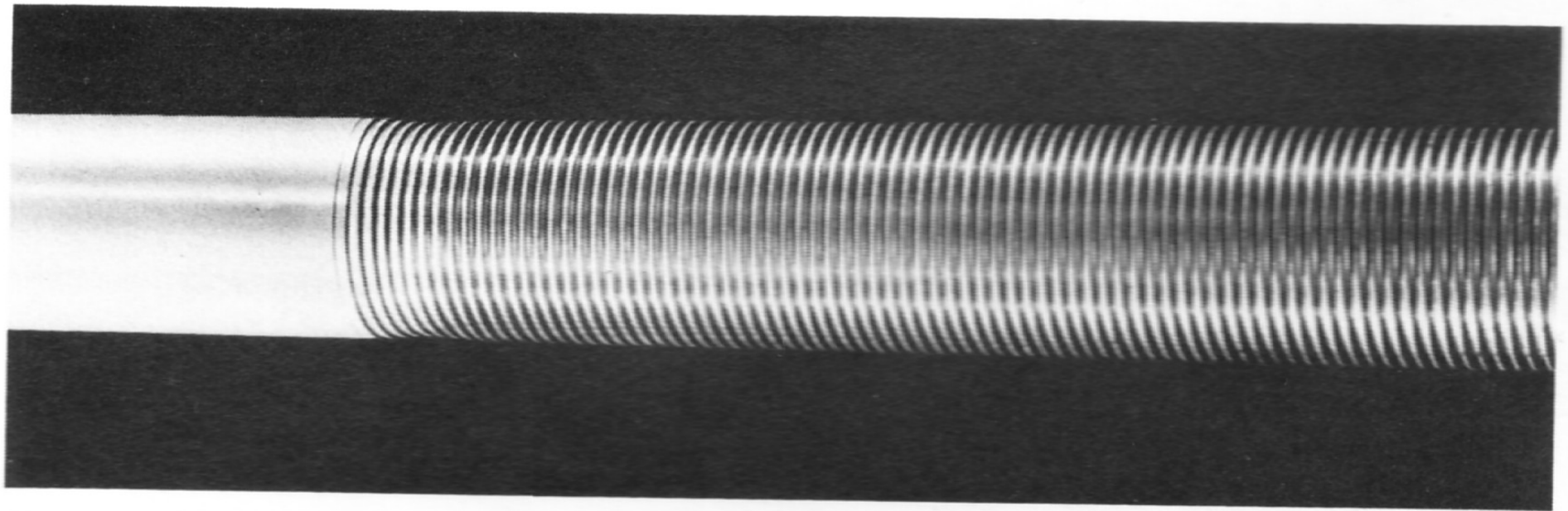
Schimbător de căldură cu țevi cu aripioare

SCHIMBATOARE DE CALDURA CU ARIPIOARE

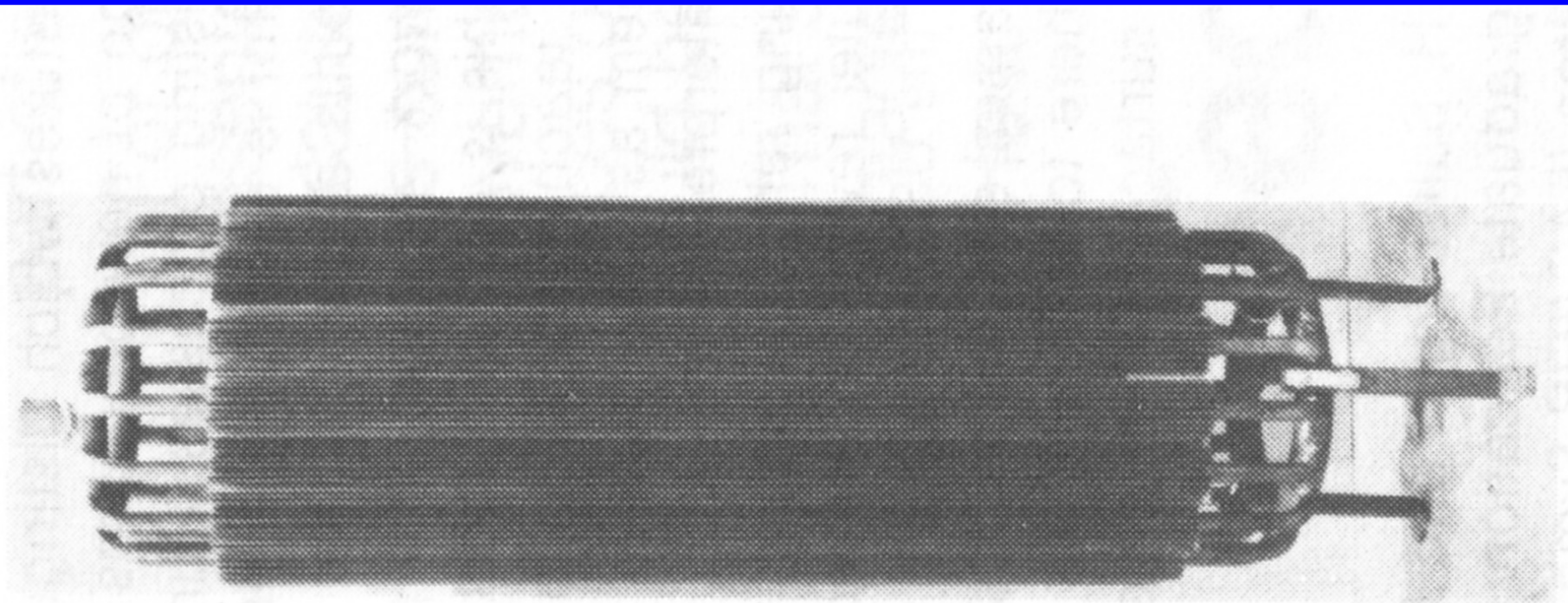


SCHIMBATOARE DE CALDURA CU TEVI STRIATE

Tevi cu suprafețe exterioare extinse obținute
prin prelucrarea mecanică a tevii
- tevi striate (nervurate)



SCHIMBATOARE DE CALDURA CU TEVI STRIATE



SCHIMBATOARE DE CALDURA COAXIALE CU TEVI CU SUPRAFETE EXTINSE

TEVI ONDULATE

Ondulatiile tevilor conduc la:

1. marirea **turbulentei**;
2. Cresterea valorii **coeficientilor de transfer termic**;
3. Cresterea **suprafetei de transfer de caldura**.



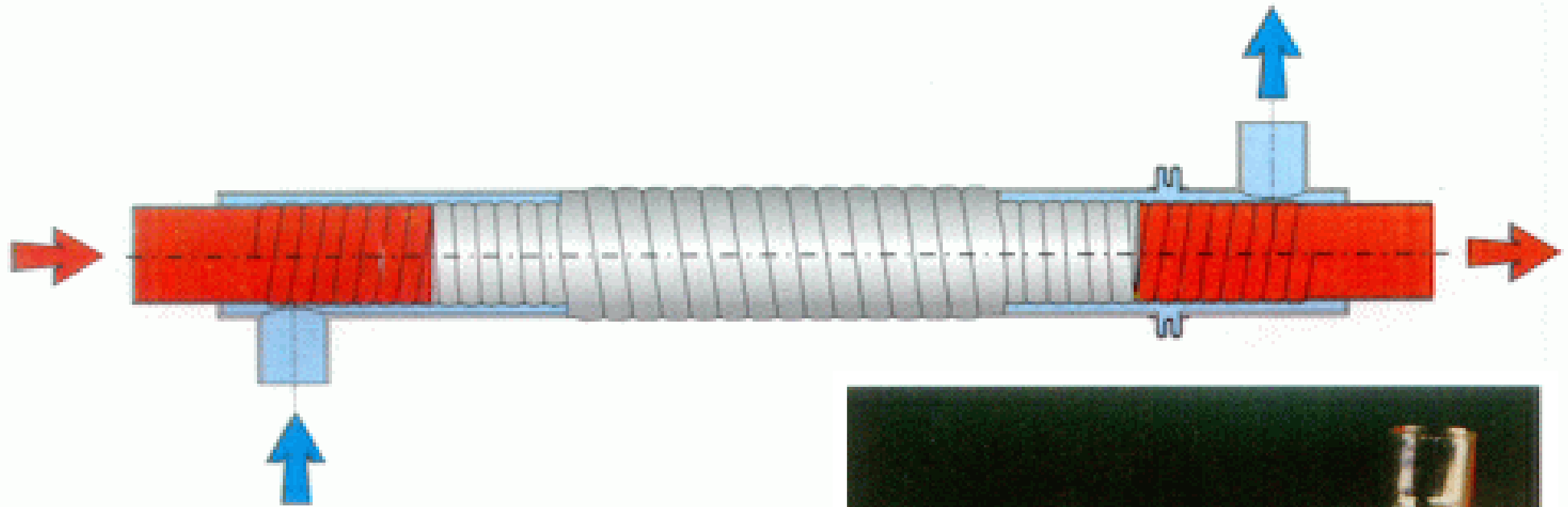
AVANTAJE COMPARATIV CU SCFT SI SCP

- o Unitati compacte;
- o Distributie uniforma a temperaturilor;
- o Timp de stationare scurt;
- o Retentie minima de produs;
- o Posibilitati de curatire in flux (CIP);
- o Flexibilitate in dimensionarea spatiului inelar;
- o Gama diversificata de materiale de constructie;
- o SC tip MONOTUB pot procesa particule de pana la 50 mm.

APLICATII

- o Fluide cu viscozitate ridicata;
- o Fluide cu fibre in suspensie;
- o Fluide cu particule solide mari (pana la 50 mm).
- o Glicoli si alcool;
- o Uleiuri vegetale si minerale;
- o Extracte de cafea, ceai;
- o Siropuri de zahar;
- o Produse lactate;
- o Pulpe si sucuri de fructe;
- o Extract de malt;
- o Sosuri si siropuri;
- o Paste si piureuri de tomate;
- o Bucati de fructe;
- o Alte produse alimentare.

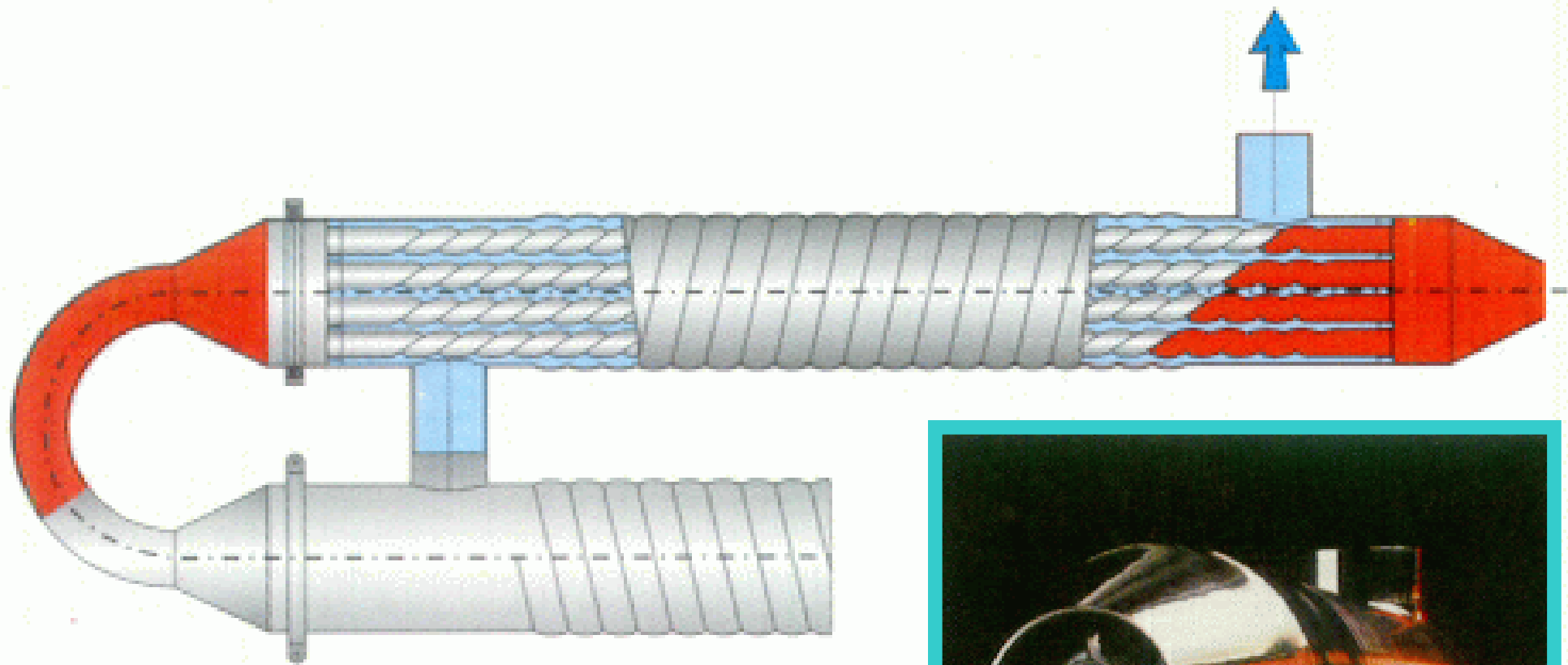
CONSTRUCTIE MONOTUB



Typical Monotube construction



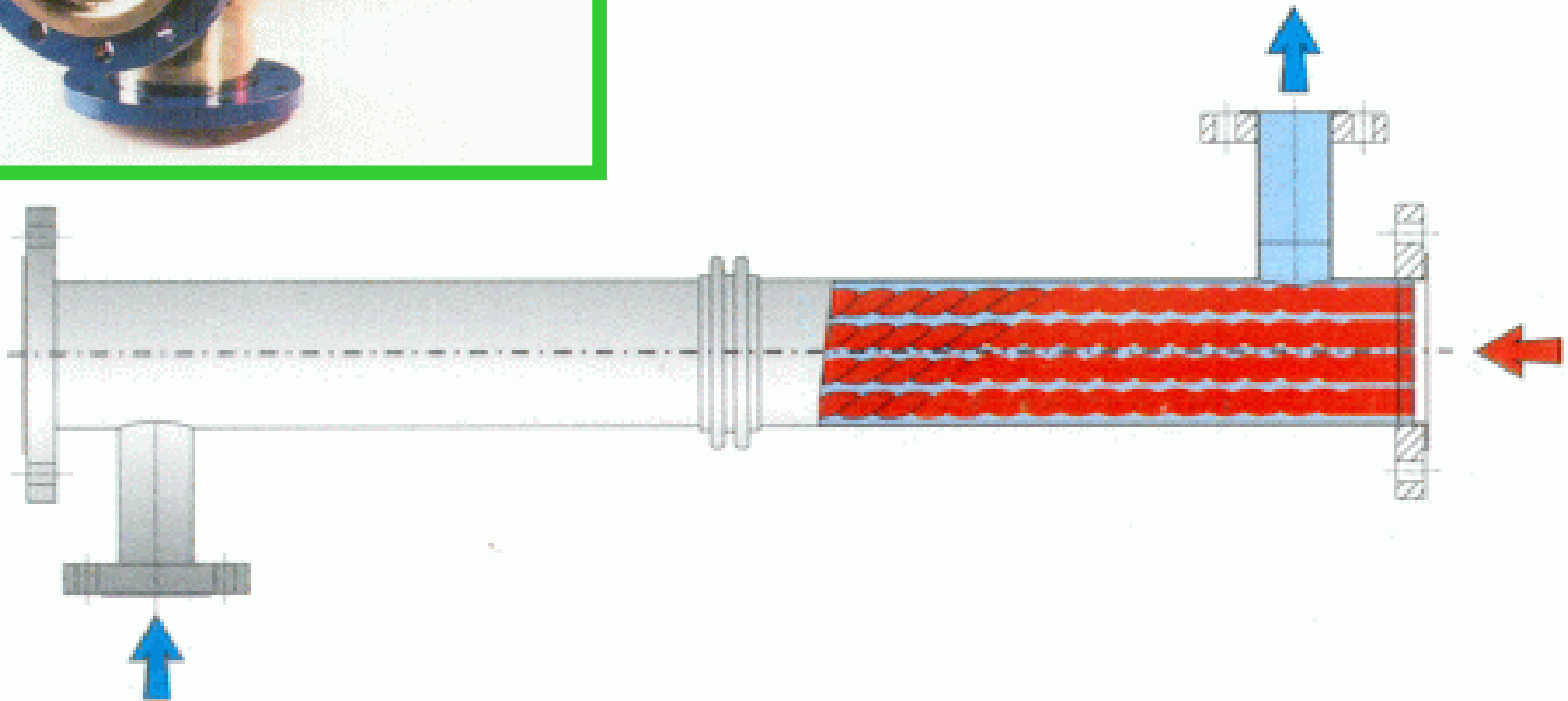
CONSTRUCTIE MULTITUB



Typical Multitube construction

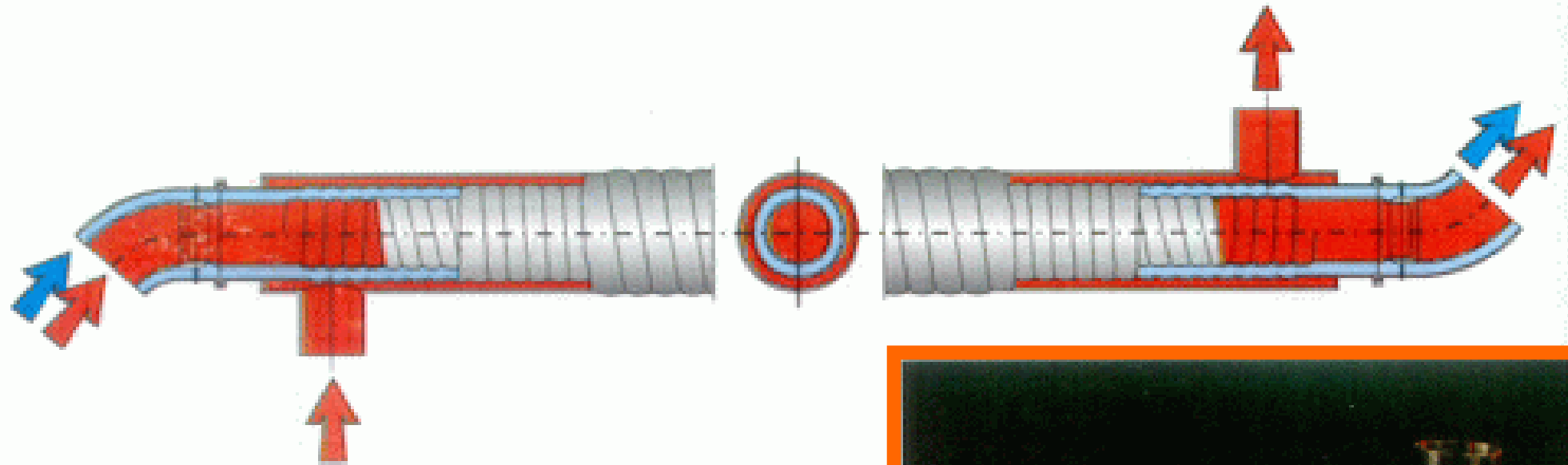


CONSTRUCTIE TIP "SCFT"



Typical 'K' series construction

CONSTRUCTIE INELARA



Typical Annular space construction



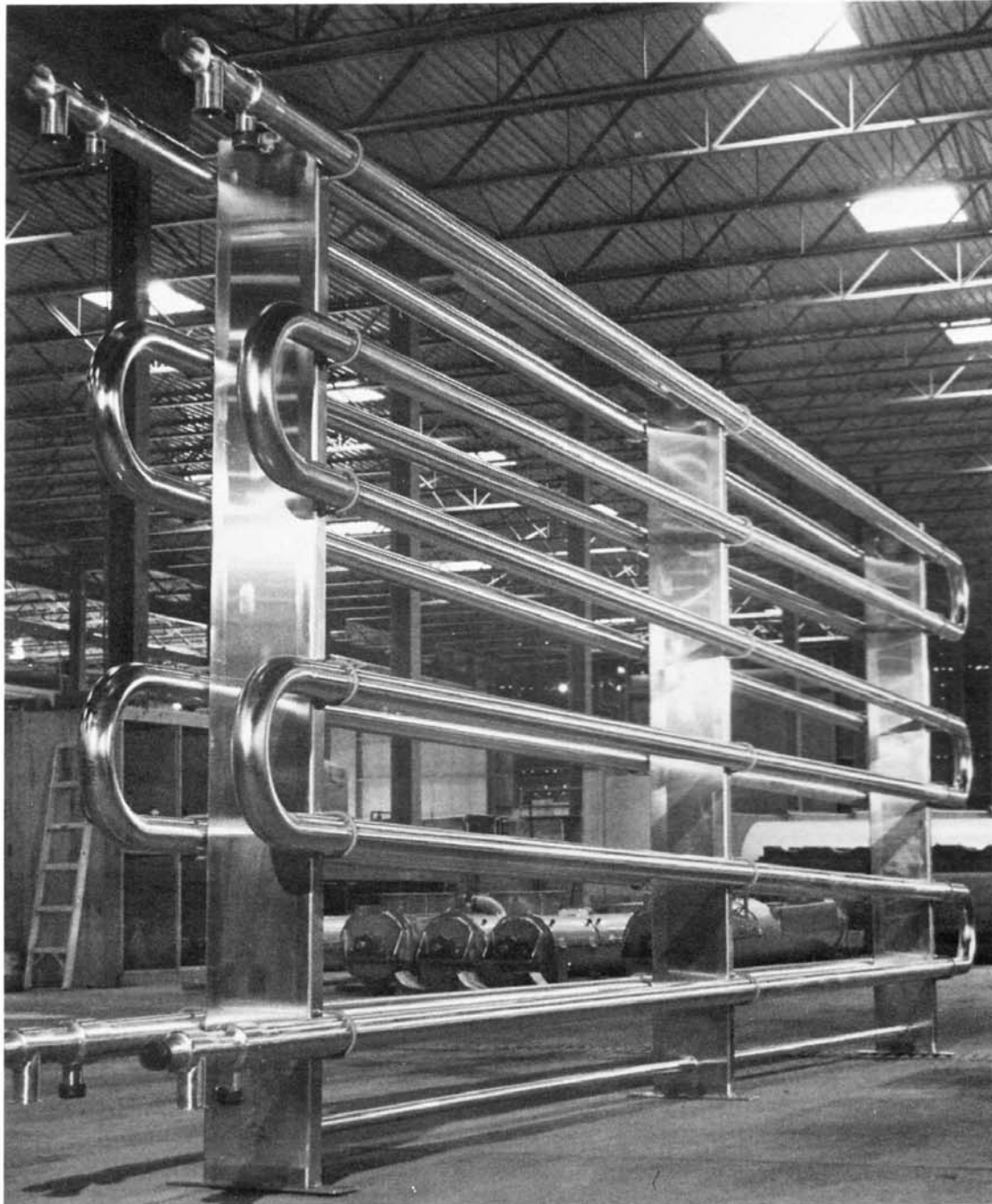


Figure 28
Paul Mueller Company

APLICATII

- o Incalzire/racire;
- o Pasteurizare;
- o Sterilizare.



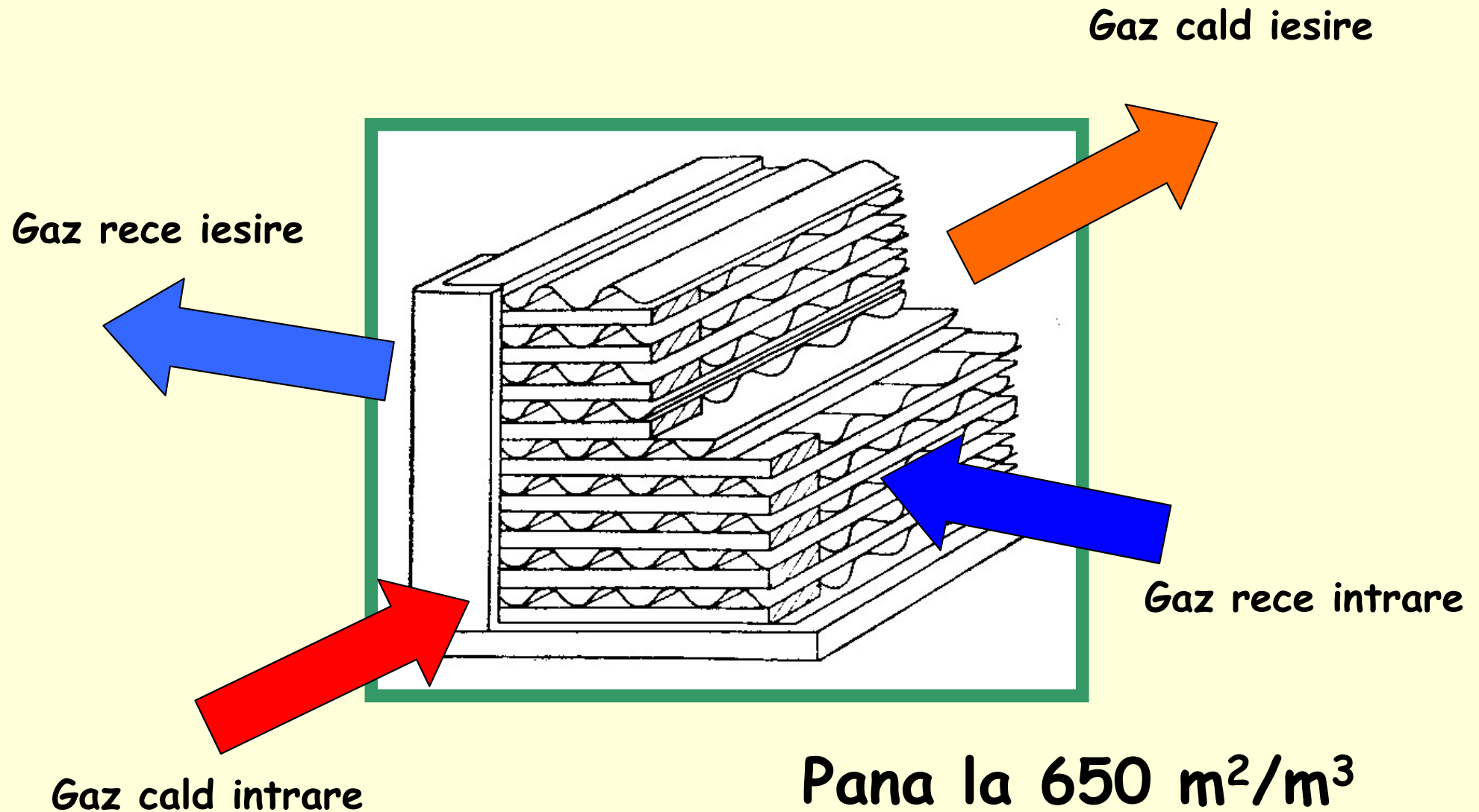
- o Lactate;
- o Bere;
- o Sucuri de fructe;
- o S.a.m.d.

SCHIMBATOARE DE CALDURA GAZ - GAZ

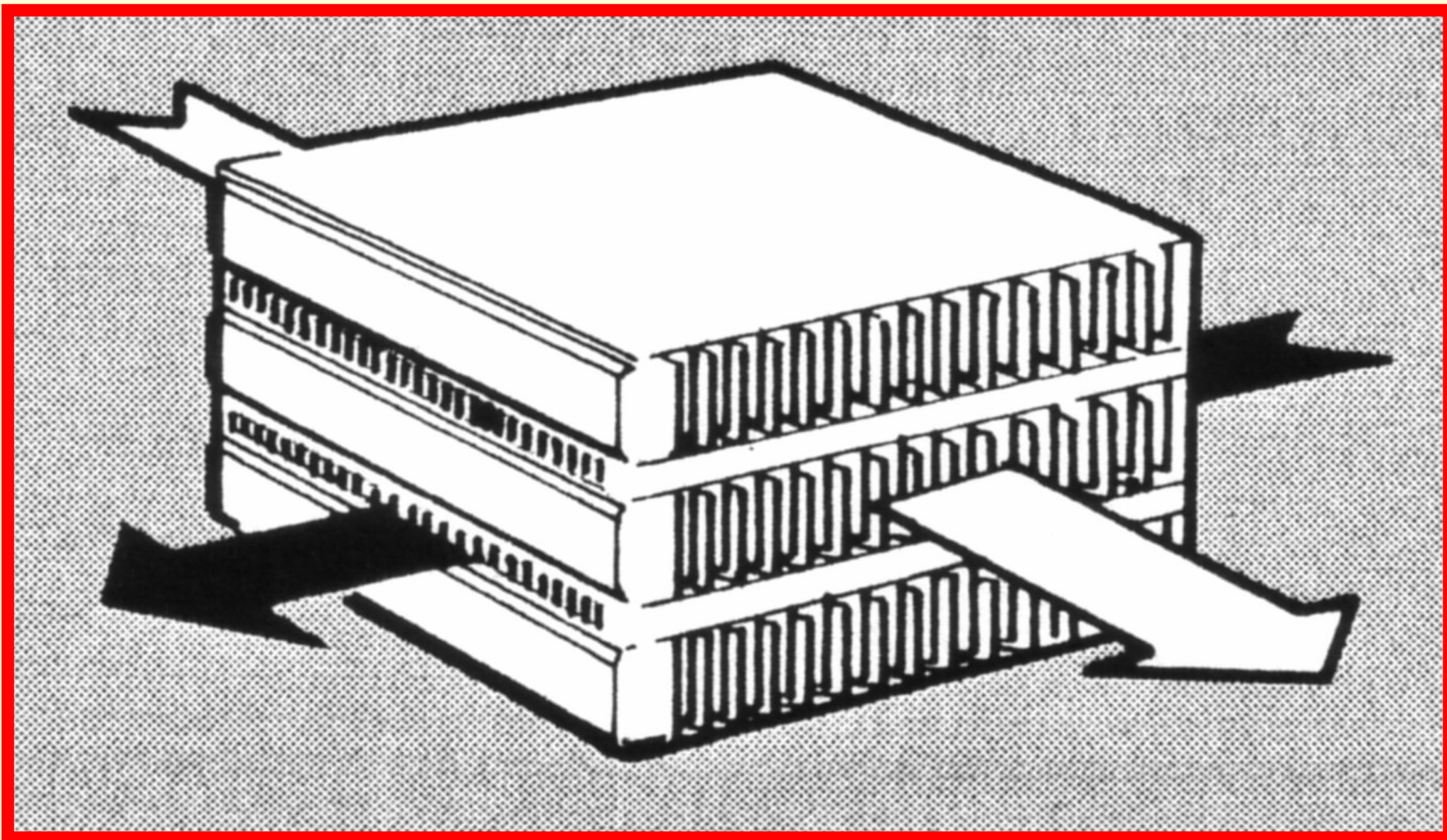
DOMENII DE UTILIZARE

- o Transferul termic intre doua medii gazoase:
 - Preincalzitoare de aer in CT;
 - Instalatii de conditionare a aerului.

SCHIMBATOARE DE CALDURA CU PLACI ONDULATE INCRUCISATE

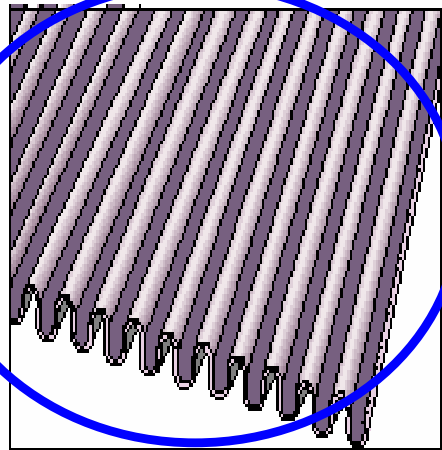


SCHIMBATOARE DE CALDURA CU PLACI ONDULATE INCRUCISATE



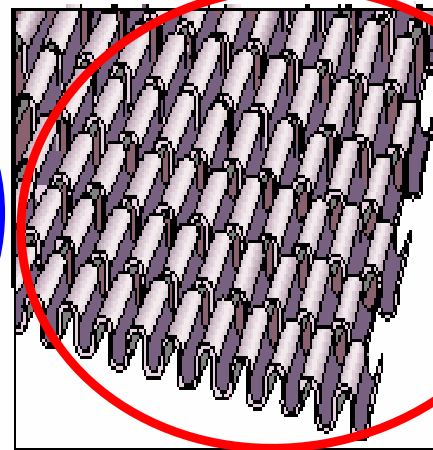
TIPURI DE NERVURI

Plane

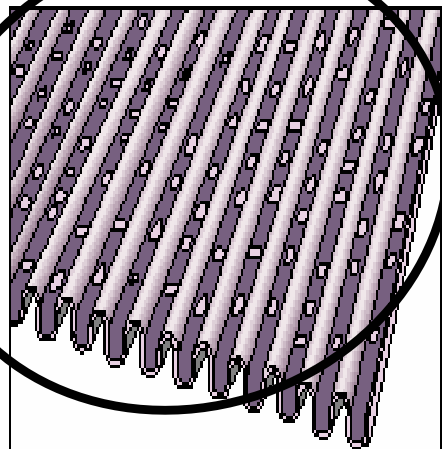


Plain Fins

Intrrupte

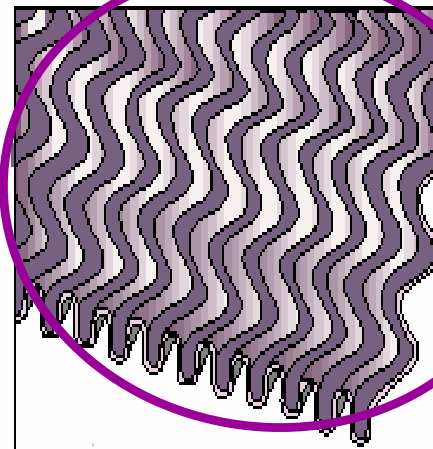


Serrated (Offset) Fins



Perforated Fins

Perforate



Wavy (Herringbone) Fins

In valuri

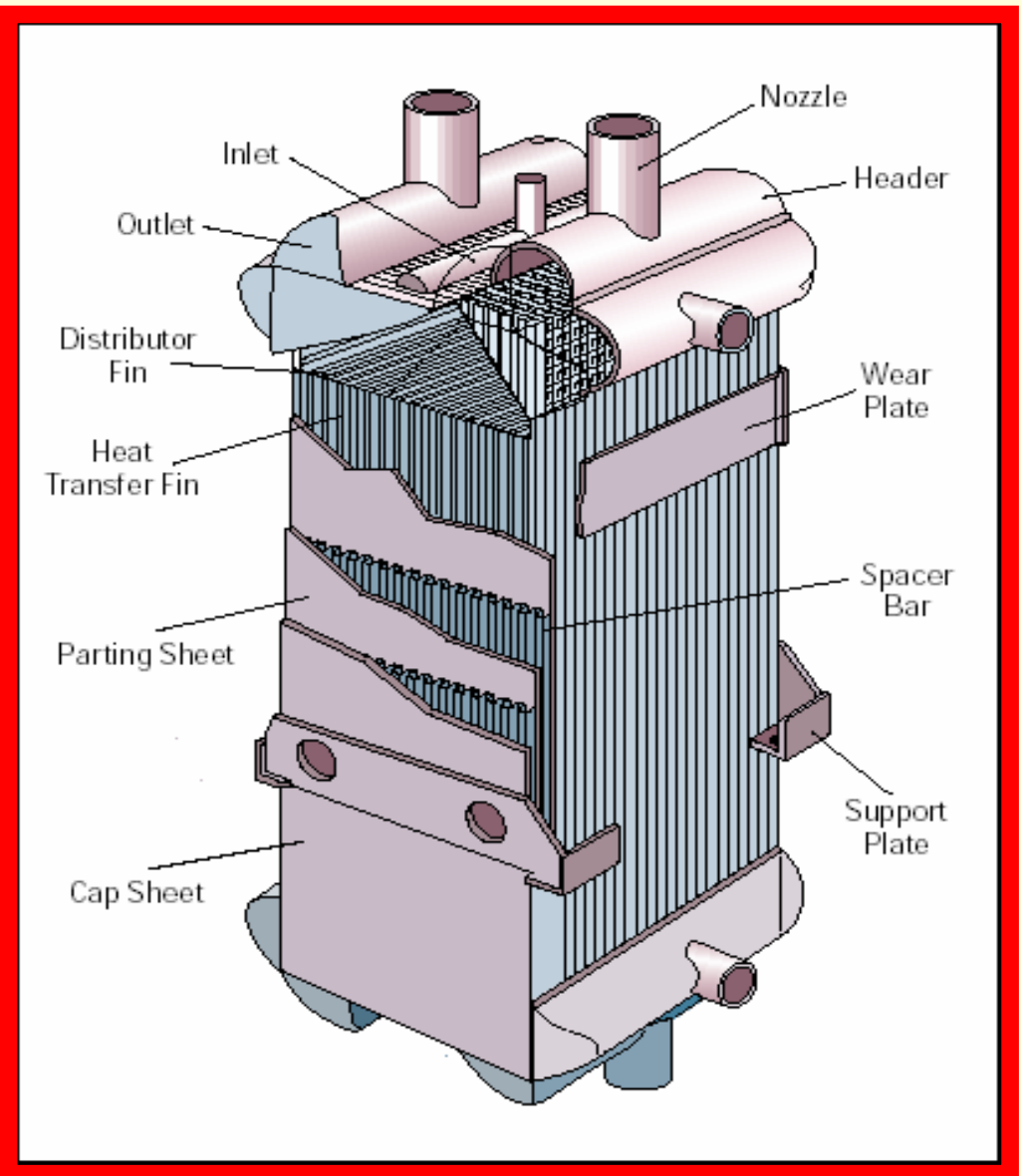
SCHIMBATOARE DE CALDURA CU PLACI ONDULATE INCRUCISATE

o Materiale utilizate:

- Oteluri inox;
- Cupru;
- Nichel;
- Aluminiu;

o Grad mare de compactizare:

800 - 1500 m²/m³;



Hydraulic Diameter, mm

60

10

1

0.1

Plamani umani



Speciale

Placi nervurate

Placi

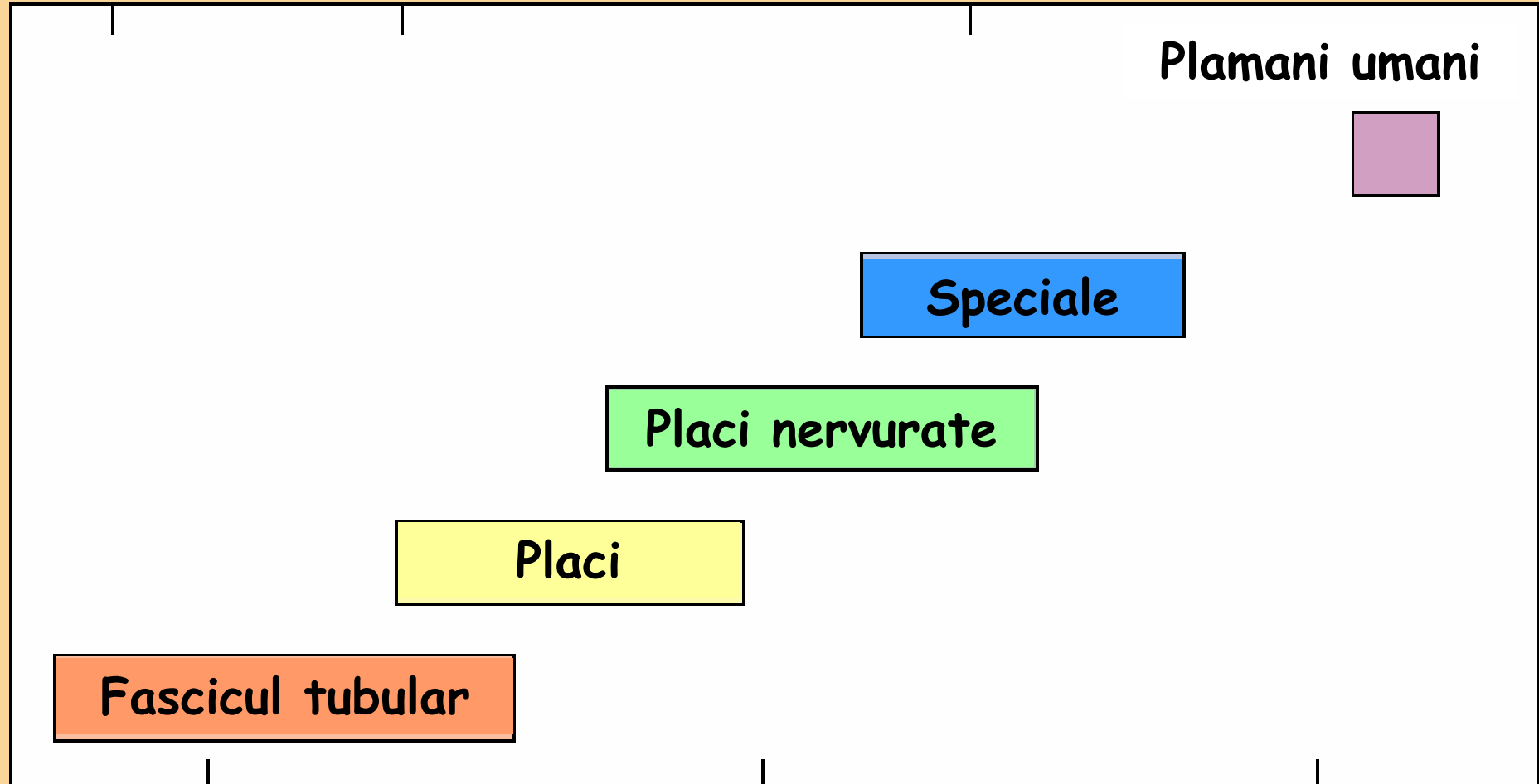
Fascicul tubular

100

1,000

10,000

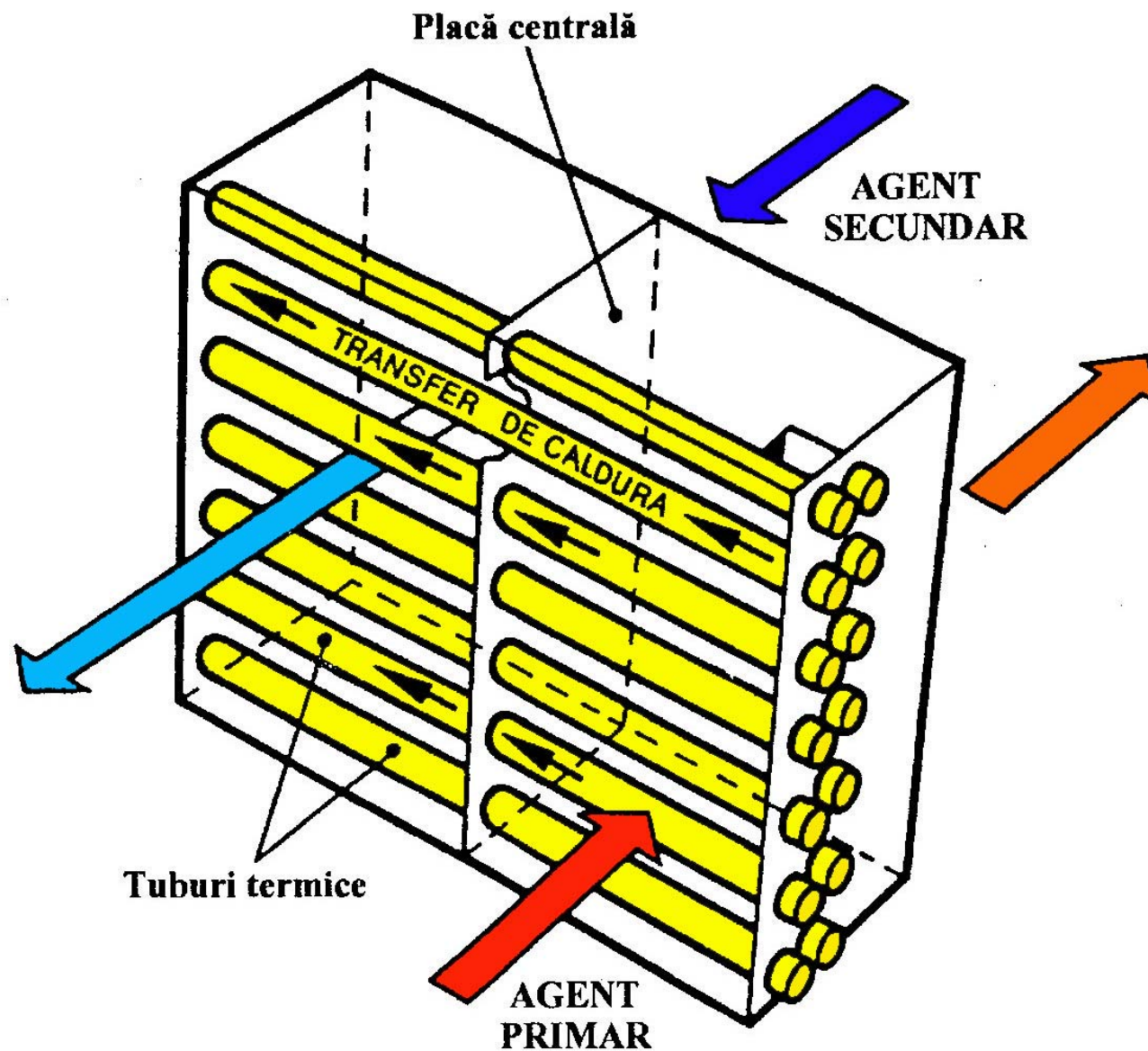
Area Density, m^2/m^3



**SCHIMBATOARE DE
CALDURA DE
CONSTRUCTIE
SPECIALA SI MIXTE**

**SCHIMBATOARE DE
CALDURA
CU TUBURI TERMICE**

SCHIMBATOARE DE CALDURA CU TUBURI TERMICE



TUBURI TERMICE

- o Incinta etansa (tub) care contine un lichid aflat in echilibru cu vaporii sai;
- o 1942 Gangler, USA;
- o 1964 Grover, Cotter & Erickson;
- o λ cu 2 sau 3 ordine de marime mai mare decat a metalului.

TUB TERMIC
GRAVITATIONAL
(TERMOSIFON)

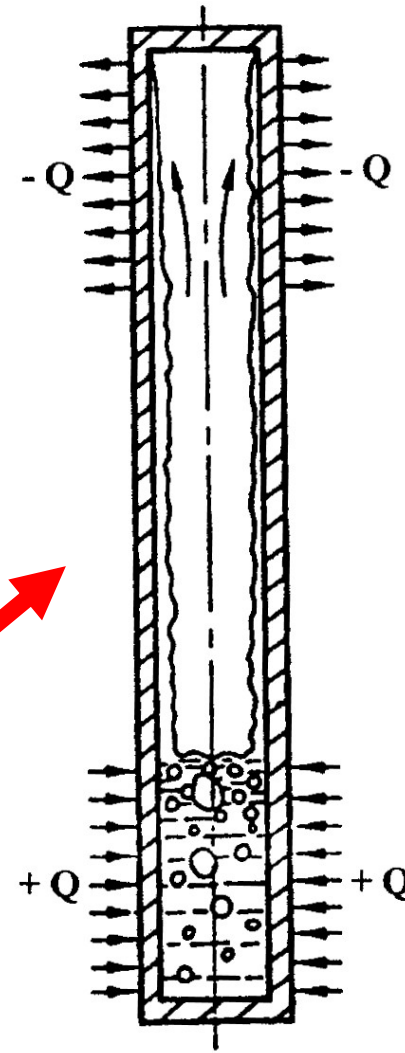


Fig. 6.2. Tub termic gravitațional (termosifon)

TUB TERMIC CU UMPLUTURA

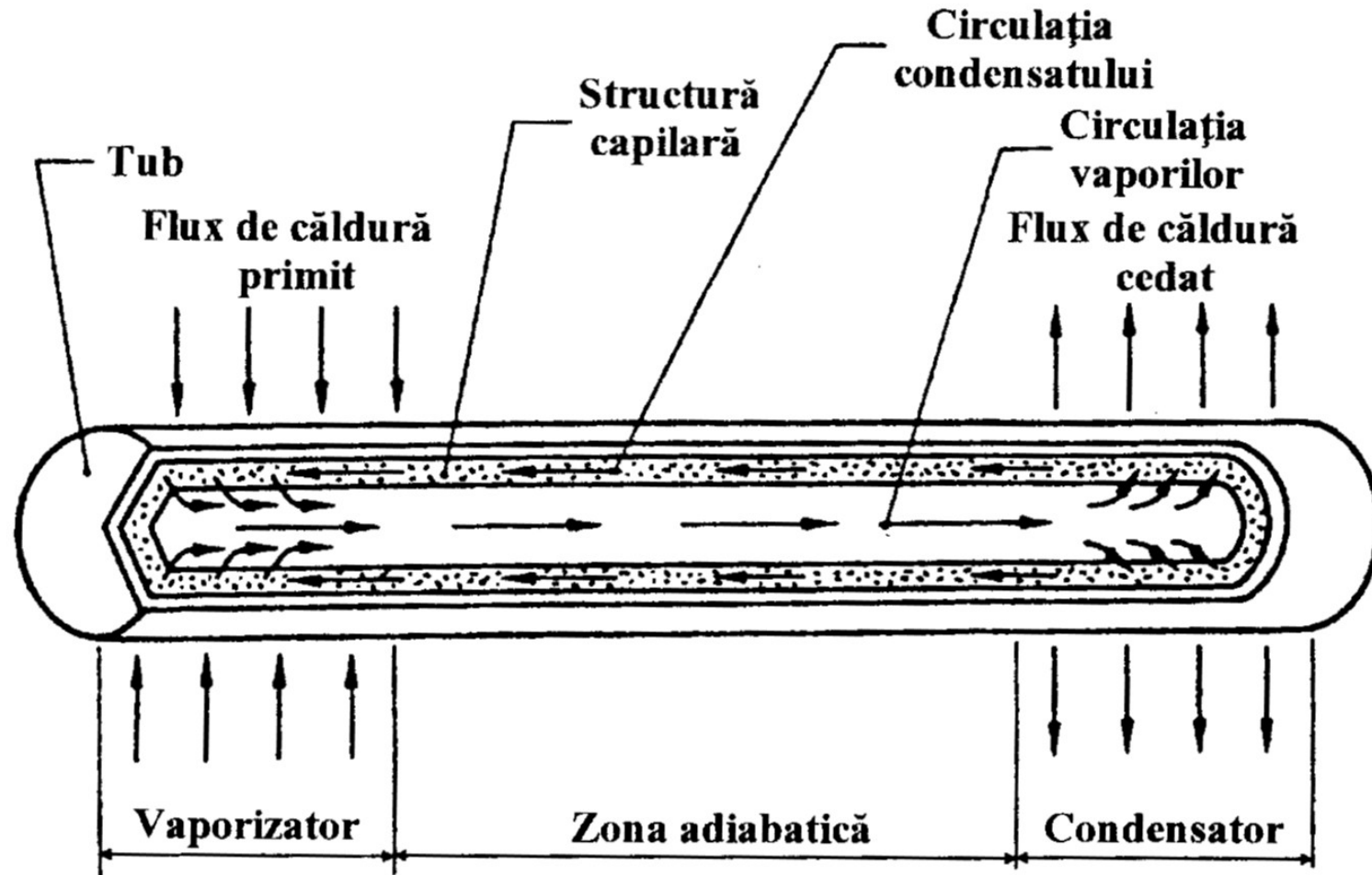
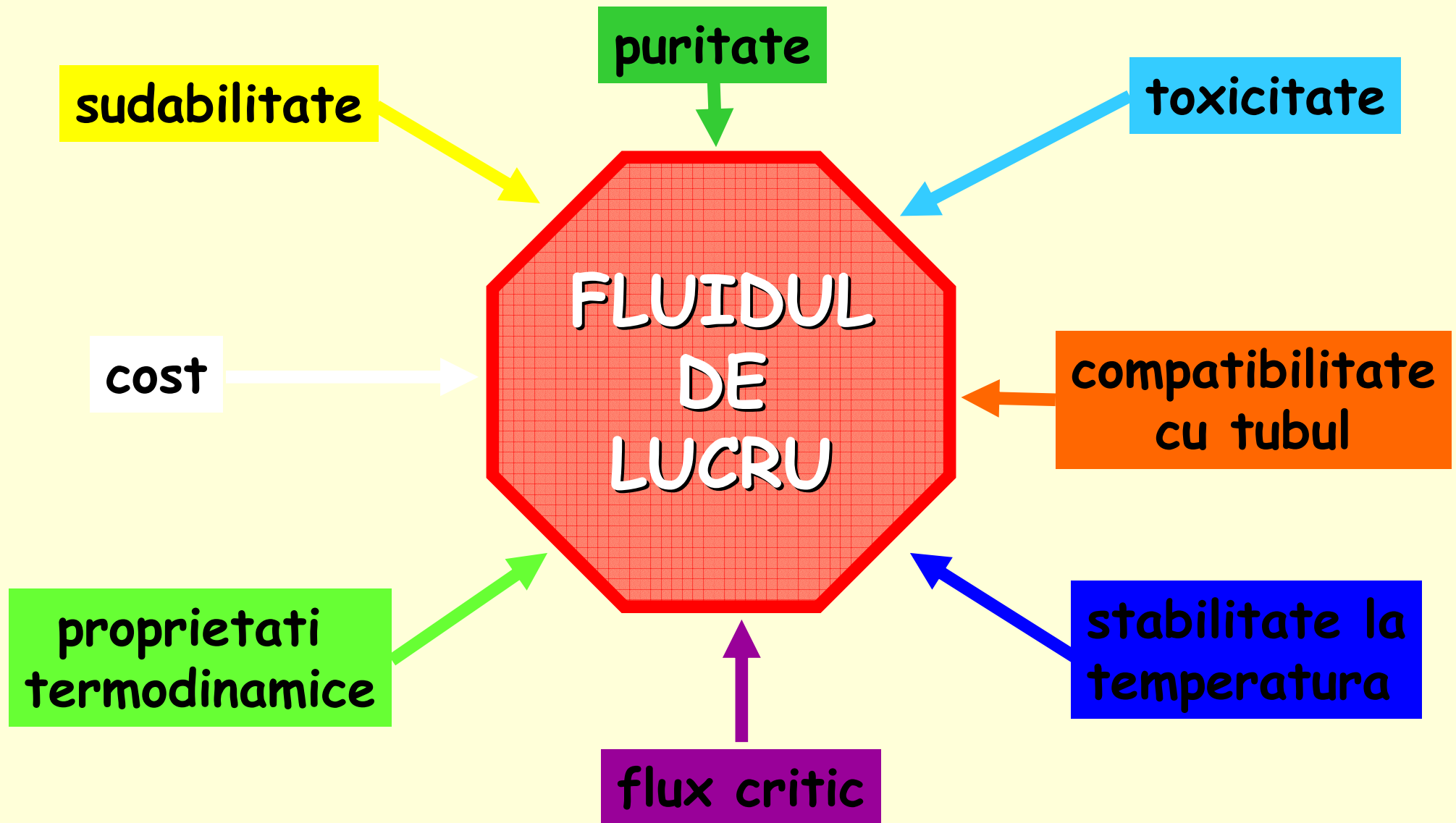


Fig. 6.1. Tub termic cu umplură

ALEGEREA FLUIDULUI DE LUCRU



MATERIALE UTILIZATE

Fluidul de lucru	Materialul tubului
Amoniac	Aluminiu, otel inox
Freon	Aluminiu, cupru
Acetona	Cupru
Metanol, etanol	Cupru
Apa	Cupru
Toluen	Otel, otel inox
Dowtherm A	Otel, otel inox
Mercur	Otel low C, otel inox
Potasiu	Otel inox 316, nichel
Sodiu	Otel inox 316, nichel, molibden
Litiu	Wolfram, molibden

Joasa temperatura:
-20 ... +60 °C

Medie temperatura:
60 ... 250 °C

Inalta temperatura:
250 ... 400 °C

Foarte inalta temperatura:
> 400 °C

AVANTAJE ALE SCHIMBATOARELOR DE CALDURA CU TUBURI TERMICE

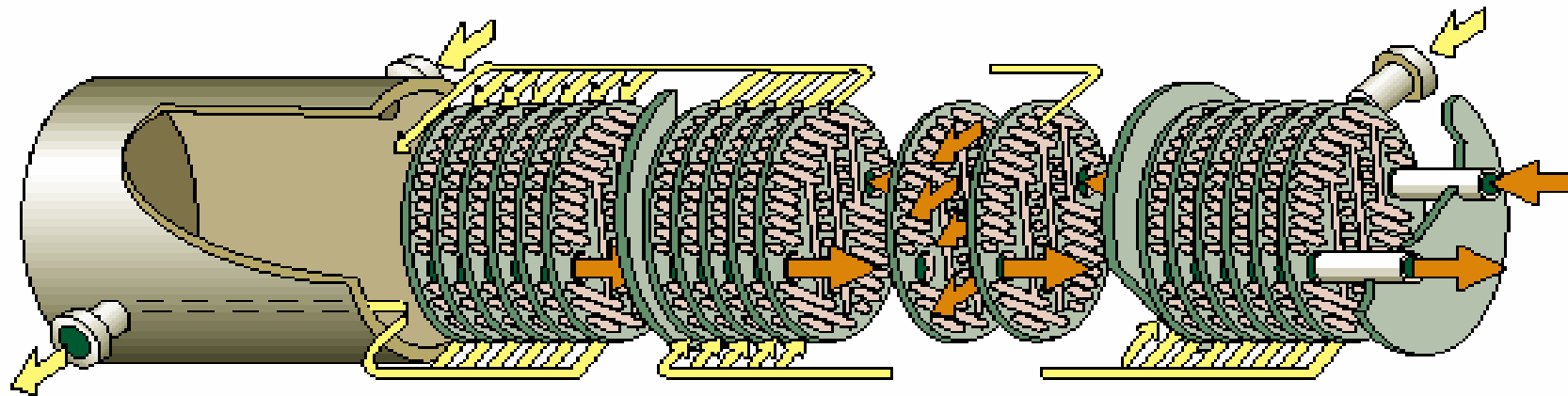
- o **ETANSEITATE** foarte buna intre cele doua fluide;
- o **FIABILITATE** ridicata a schimbatorului;
- o Comportare foarte buna la **DILATARE**;
- o **SUPLETE IN CONCEPTIE** - tuburile sunt independente;
- o **EFICIENTA** ridicata - valori α mari;
- o **PIERDERI DE PRESIUNE** reduse.

APLICATII ALE SCHIMBATOARELOR DE CALDURA CU TUBURI TERMICE

- o RECUPERAREA CALDURII - preincalzirea cu gaze de ardere a aerului la cuptoarele industriale;
- o INSTALATII DE CLIMATIZARE;
- o INDUSTRIA CHIMICA;
- o ENERGETICA NUCLEARA.

SCHIMBATOARE DE CALDURA CU PLACI IN MANTA

SCHIMBATOARE DE CALDURA CU PLACI IN MANTA (LAMELARE)

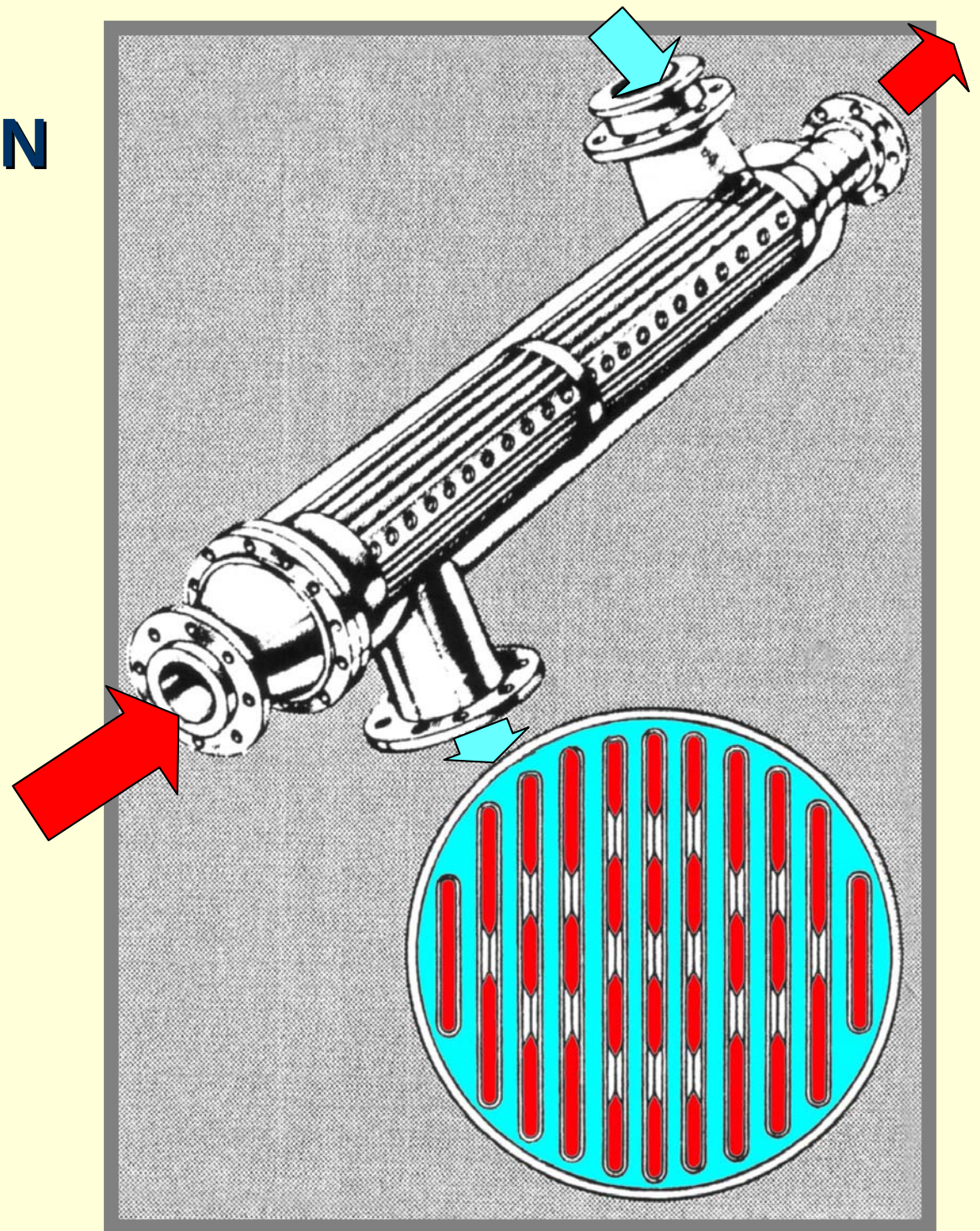


- o $D = 200 \div 1000 \text{ mm}$;
- o $A = 0,5 \div 500 \text{ m}^2$;
- o $T = -200 \div 600 \text{ }^{\circ}\text{C}$;
- o $P = \text{max. } 4 \text{ MPa}$.



SCHIMBATOARE DE CALDURA CU PLACI IN MANTA (LAMELARE)

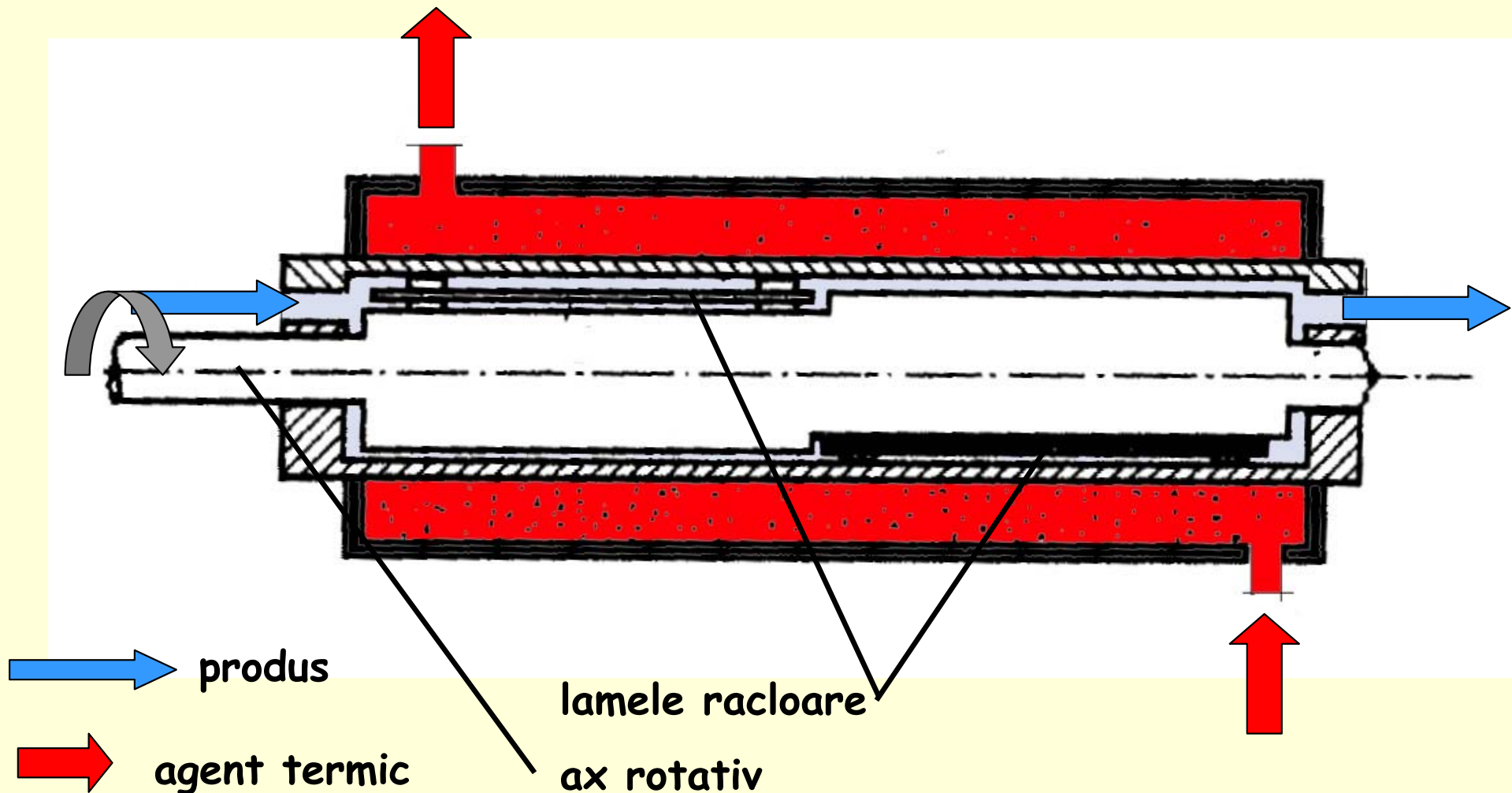
- o Mai scumpe decat SCP cu garnituri;
- o Intervalul de lucru (P,T) mai mare decat al SCP;
- o Alternativa la SCFT confectionate din alte materiale decat OL;
- o Posibilitati limitate de curatire.



**SCHIMBATOARE DE
CALDURA
CU SUPRAFETE RACLATE**

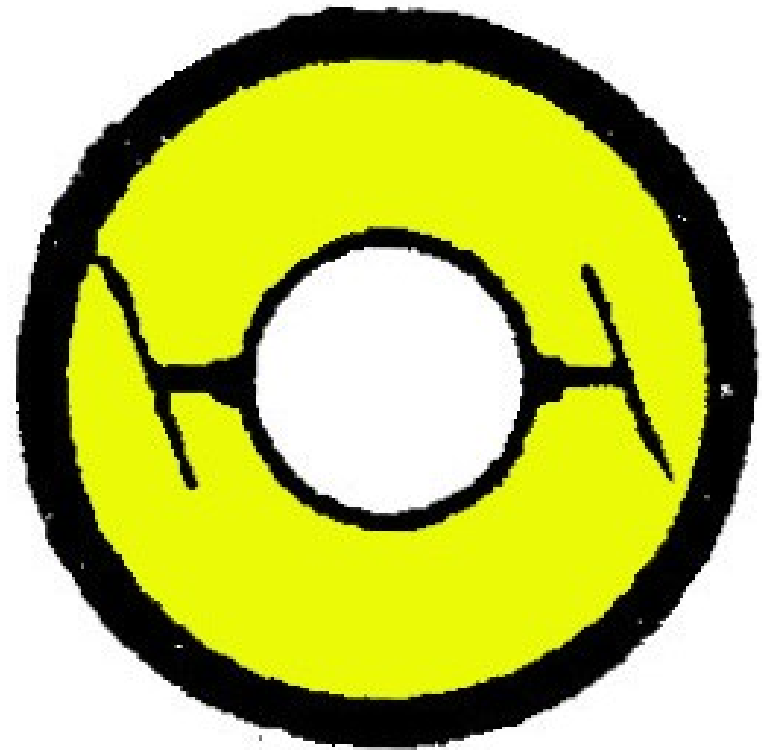
SCHIMBATOARE DE CALDURA CU SUPRAFAȚA RACLATĂ

o Scraped Surface Heat Exchangers (SSHE)



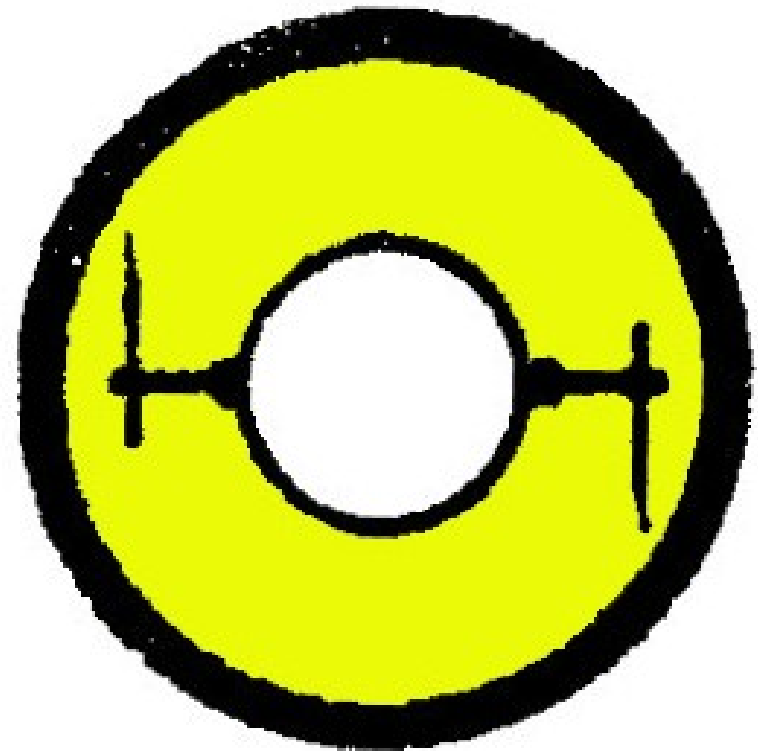
SCHIMBATOARE DE CALDURA CU SUPRAFATA RACLATA

- o Tipuri de raclete:
**Cutite concentrice
suspendate**



SCHIMBATOARE DE CALDURA CU SUPRAFATA RACLATA

- o Tipuri de raclete:
**Cutite concentrice
fixe**



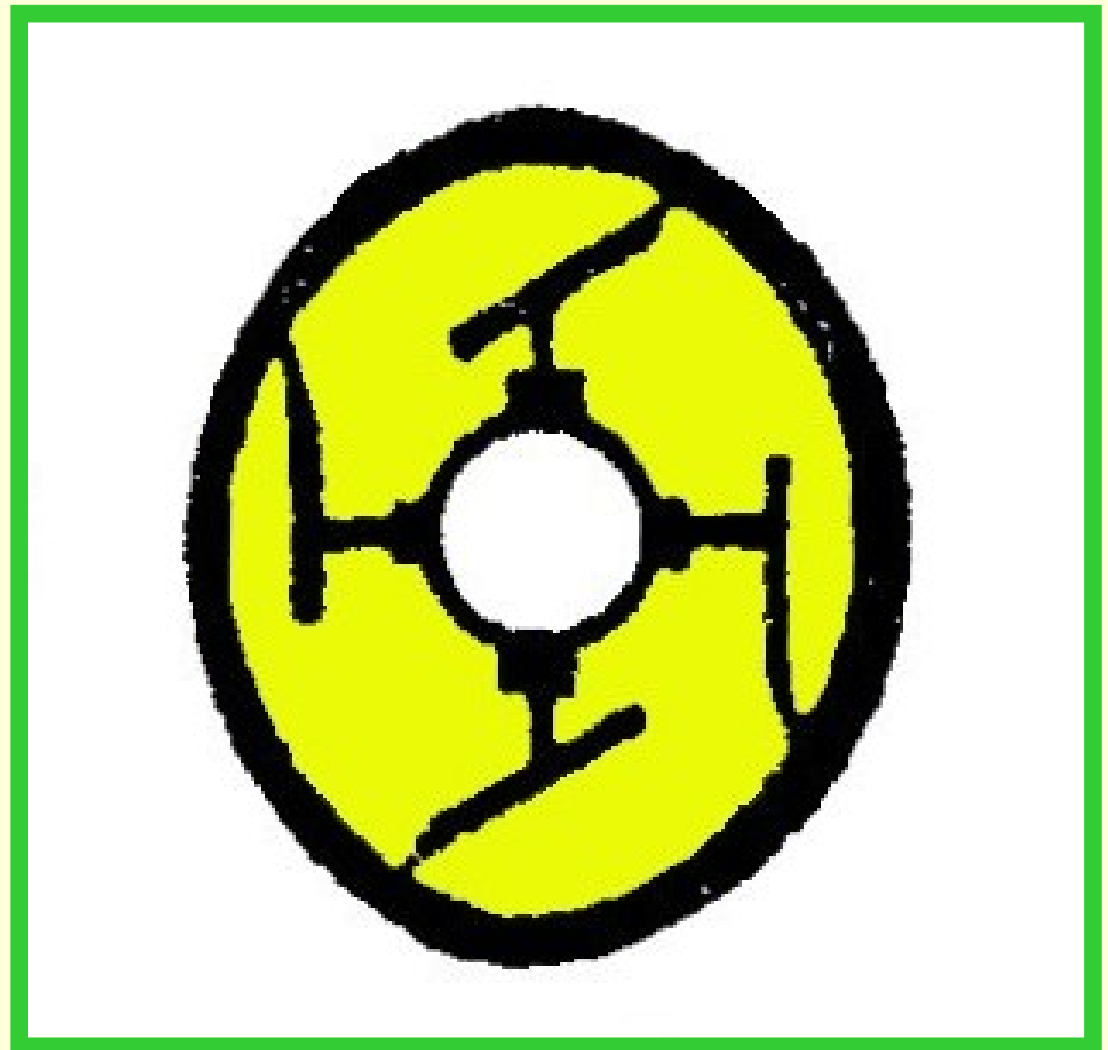
SCHIMBATOARE DE CALDURA CU SUPRAFATA RACLATA

- o Tipuri de raclete:
**Cutite excentrice
suspendate**



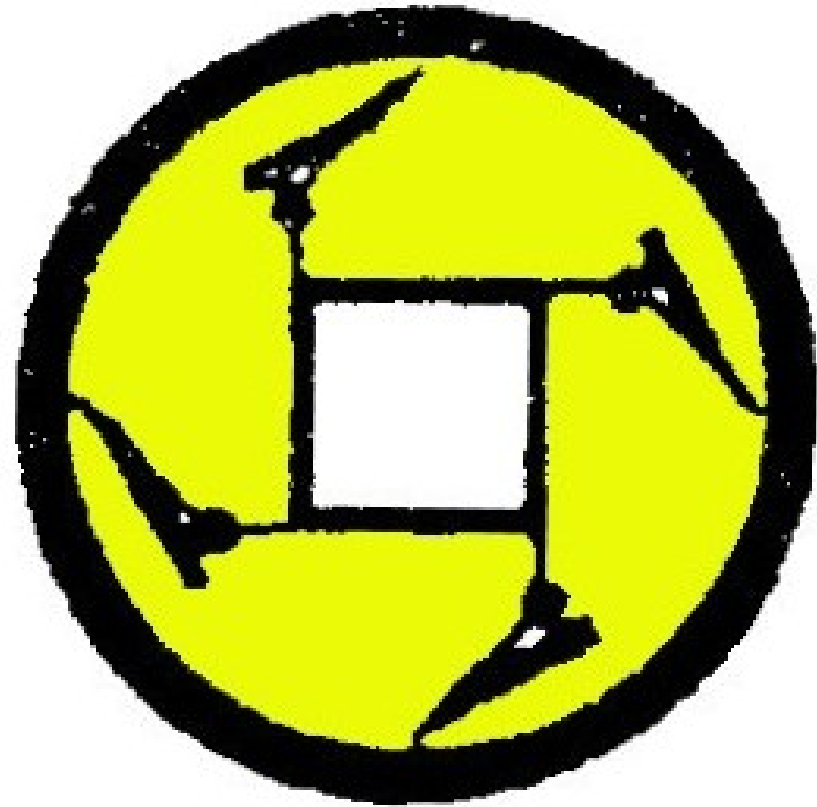
SCHIMBATOARE DE CALDURA CU SUPRAFATA RACLATA

- o Tipuri de raclete:
**Cutite suspendate
in teava de forma
avala**



SCHIMBATOARE DE CALDURA CU SUPRAFATA RACLATA

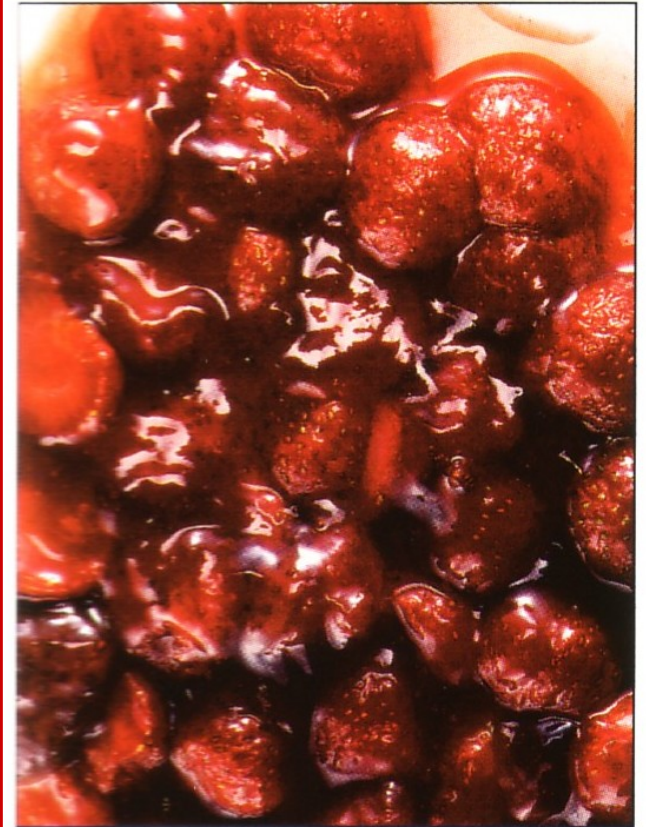
- o Tipuri de raclete:
**Cutite concentrice
flexibile**



SCHIMBATOARE DE CALDURA CU SUPRAFATA RACLATA

o FLUIDE CU PARTICULE SOLIDE:

- Bucati de pui;
- Peste;
- Mancare pentru animale de casa;
- Budinca de orez;
- Iaurturi cu fructe.



Particulate

Chicken pieces, fish meal, jams and preserves, pet food, rice pudding, yogurt fruit.

SCHIMBATOARE DE CALDURA CU SUPRAFATA RACLATA

o FLUIDE LIPICIOASE:

- Caramel;
- Sosuri cu branza;
- Lecitina;
- Branza topita;
- Amidon;
- Produse zaharoase.



Sticky

*Caramel, cheese sauces,
lecithin, process cheese,
confectionery and starch.*

SCHIMBATOARE DE CALDURA CU SUPRAFATA RACLATA

o FLUIDE VISCOASE:

- Ketchup;
- Maioneze;
- Umpluturi din fructe;
- Ciocolata;
- Sosuri;
- Unt de arahide;
- Dressing pentru salate;
- Carne dezosata mecanic (MDM);
- Alimente pentru copii.



Viscous

Ketchup, mayonnaise, chocolate, fruit pie filling, gravy and sauces, peanut butter, pizza sauce, pudding, salad dressing, salsa and taco fillings, sandwich spreads, deboned chicken (MDM), gelatin, scrambled eggs, baby food, ointment, lotions, mascara and candle gels.

SCHIMBATOARE DE CALDURA CU SUPRAFATA RACLATA

o FLUIDE CARE CRISTALIZEAZA:

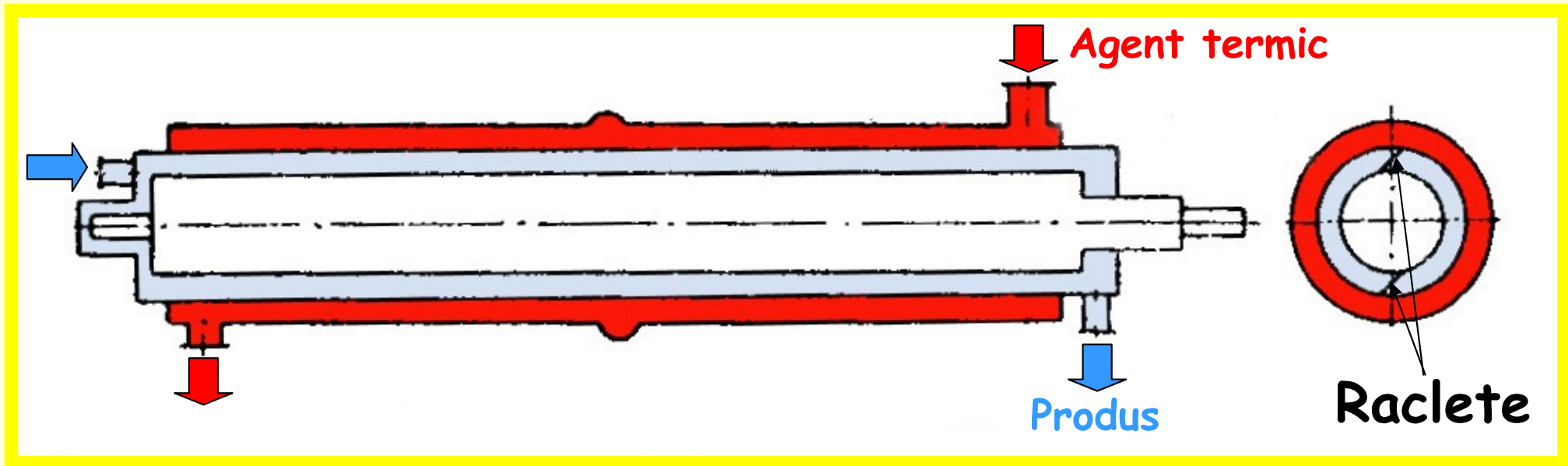
- Extracte de ceai/cafea;
- Creme de prajituri;
- Concentrate de zahar;
- Margarina;
- Sroturi;
- Topping pentru prajituri;
- Glazuri;
- Bere si vin.



Crystallizing/ Phase Change

Coffee/tea extracts, cookie cream, confectionery topping, lard, sugar concentrates, margarine, shortening, spreads, beer and wine.

SCSR TIP "VOTATOR"



- o Suprafata de transfer termic: $0,1 - 5,5 \text{ m}^2$;
- o Pentru suprafete mai mari se leaga in serie, paralel sau mixt (serie/paralel) mai multe aparate identice;
- o Coeficienti de transfer $K = 3000 \div 6500 \text{ W.m}^{-2}.\text{K}^{-1}$.

SCSR TIP “VOTATOR”

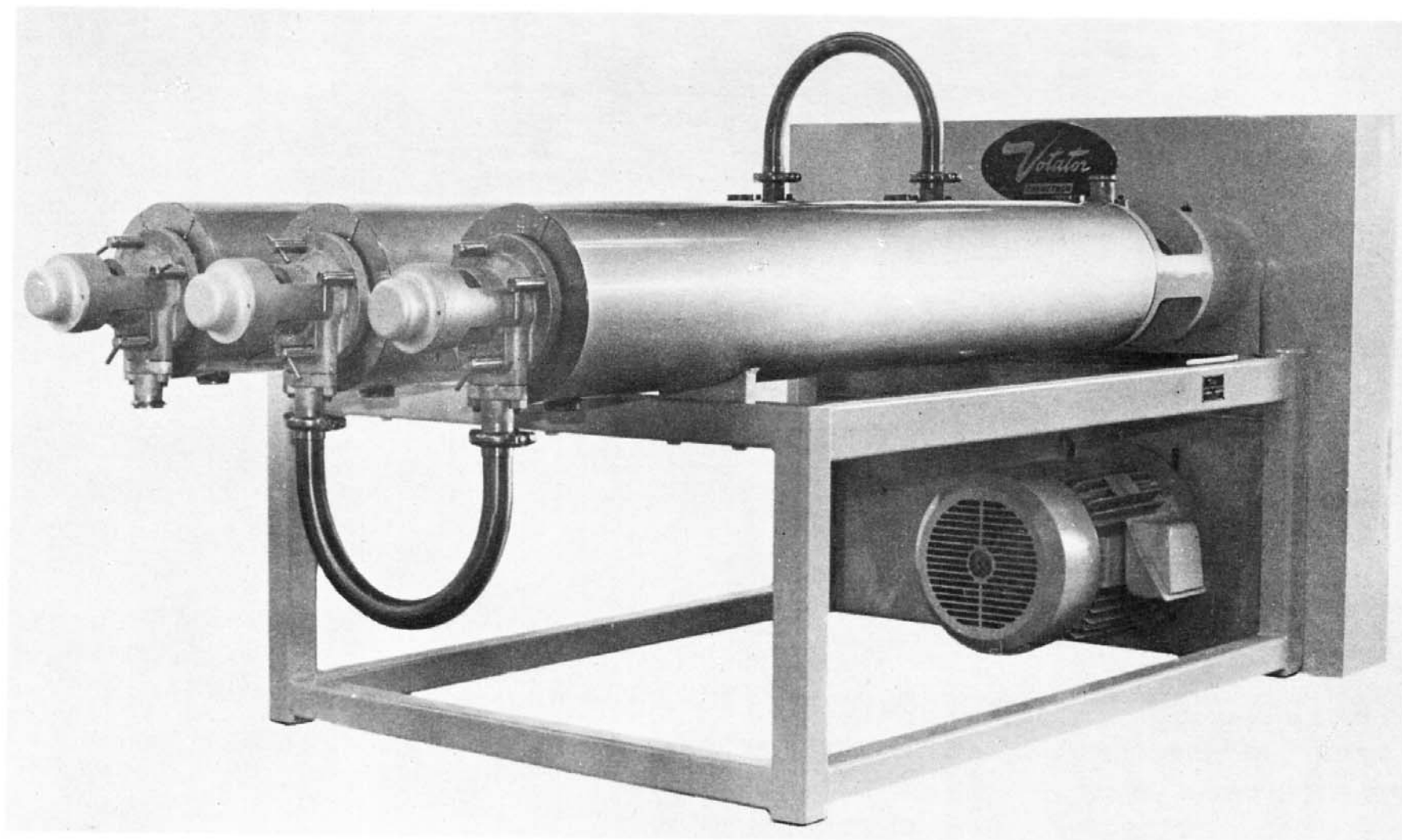
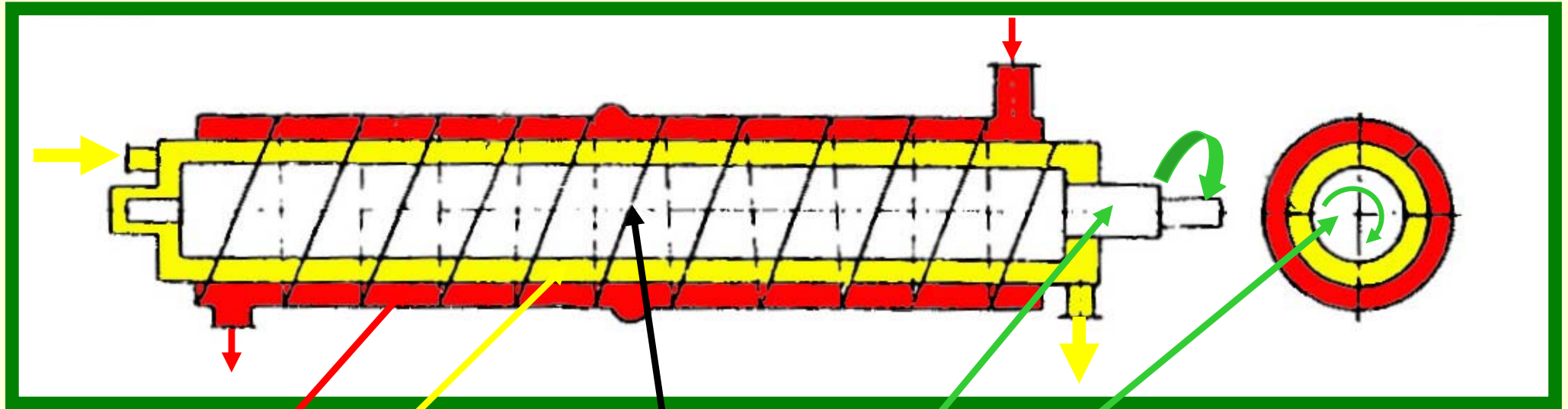


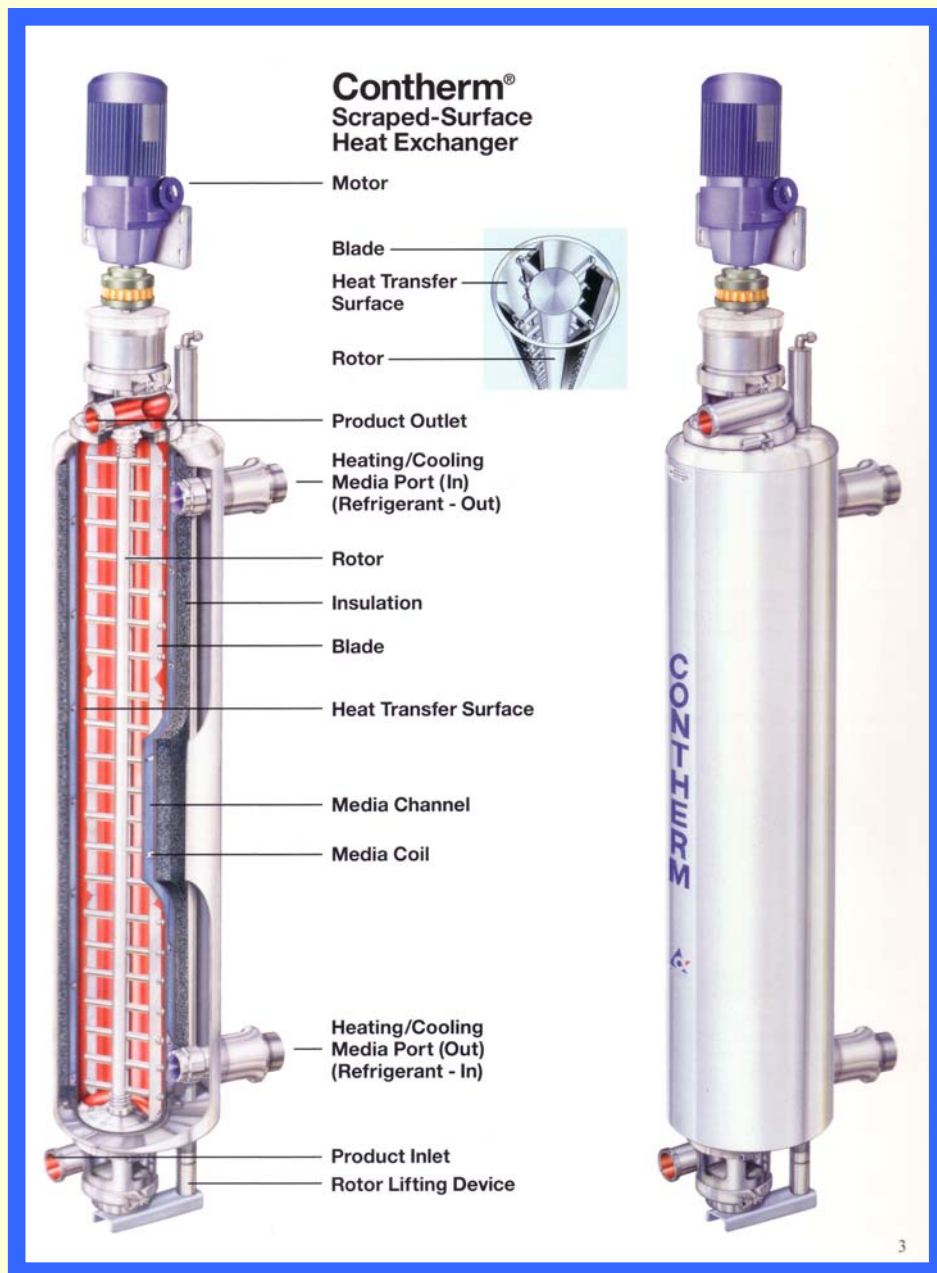
Figure 35
Votator Division, Chemetron Corporation

SCSR TIP "CHERY-BURRELL"



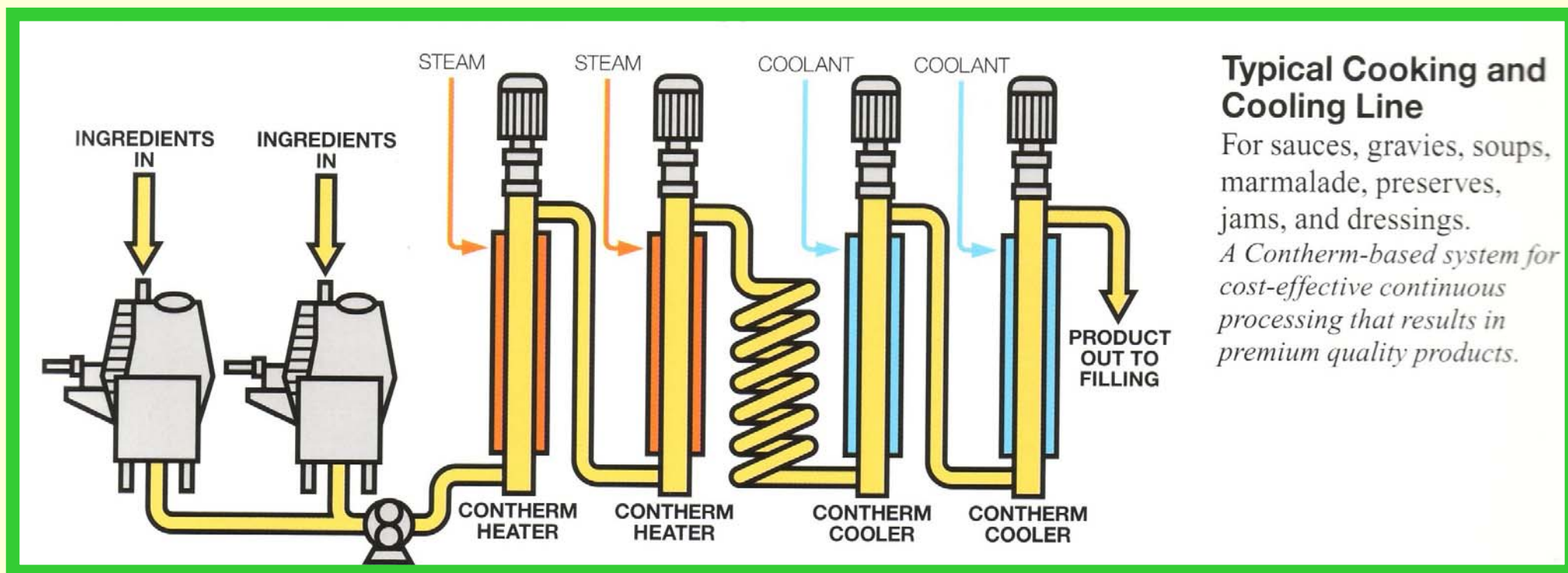
- o Spirala pentru dirijarea fluxului de agent termic;
- o Agent termic;
- o Produs;
- o Rotor cu raclete.

SCSR TIP "CONTHERM"



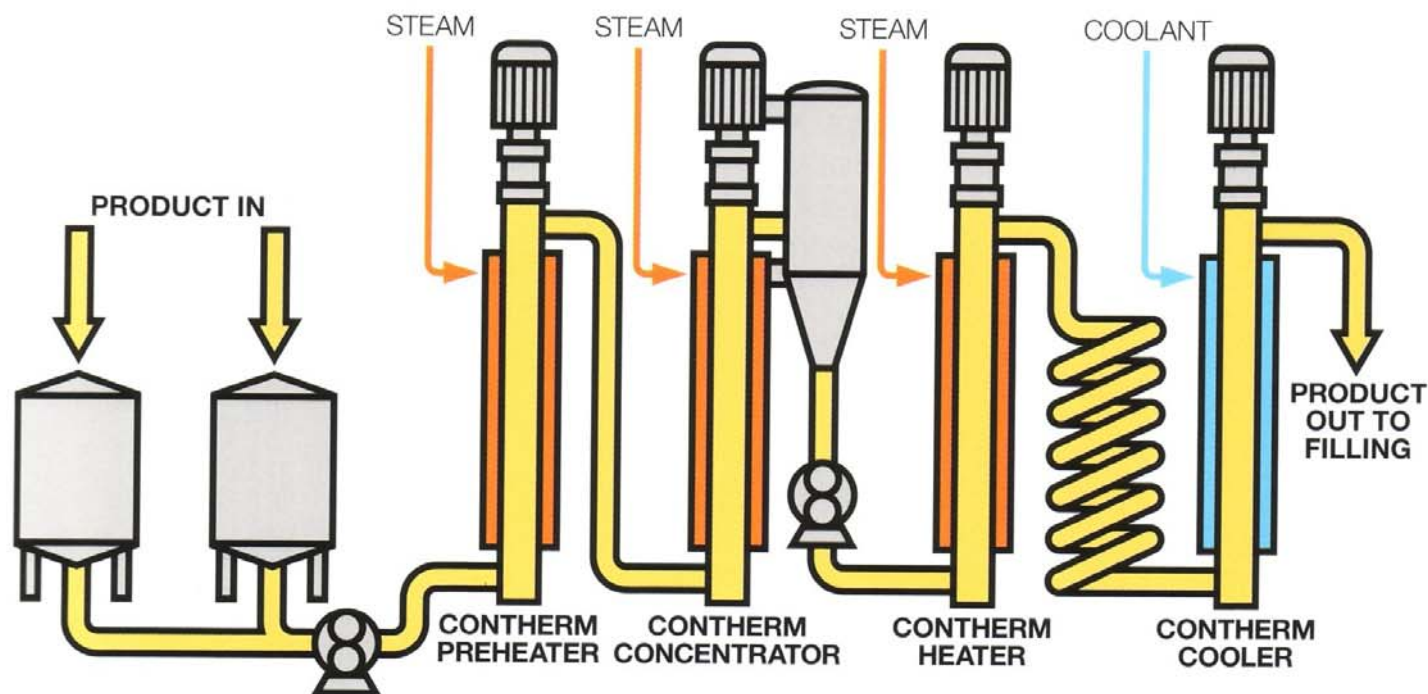
**Incalzitor CONTHERM
pentru procesarea termica
a pestelui**

SCSR TIP “CONTHERM”



Linie tipica pentru FIERBERE - RACIRE

SCSR TIP “CONTHERM”

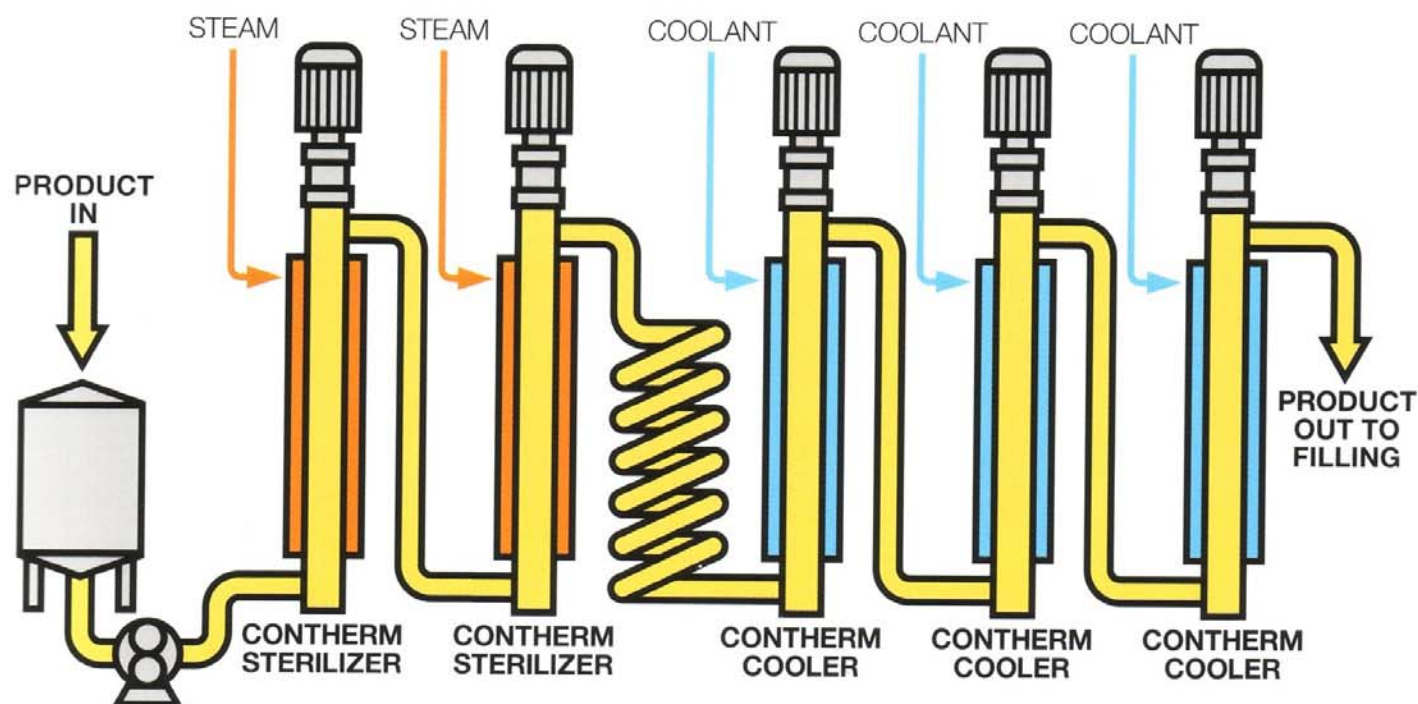


Fruit and Vegetable Processing

For purées, mashes, pulps, concentrates, and pastes. *The integrity of fruit and vegetable products is retained better in a Contherm system than in traditional heat exchangers because they are exposed to heat for shorter periods.*

Linie pentru prelucrarea termica
a legumelor si fructelor

SCSR TIP “CONTHERM”



Aseptic Processing

For soups, sauces, jams, yogurt fruit, purées, and juices.

Aseptic processing preserves product taste, color and texture, and prolongs shelf life. A Tetra Laval aseptic packaging system can be integrated to complete this type of processing line.

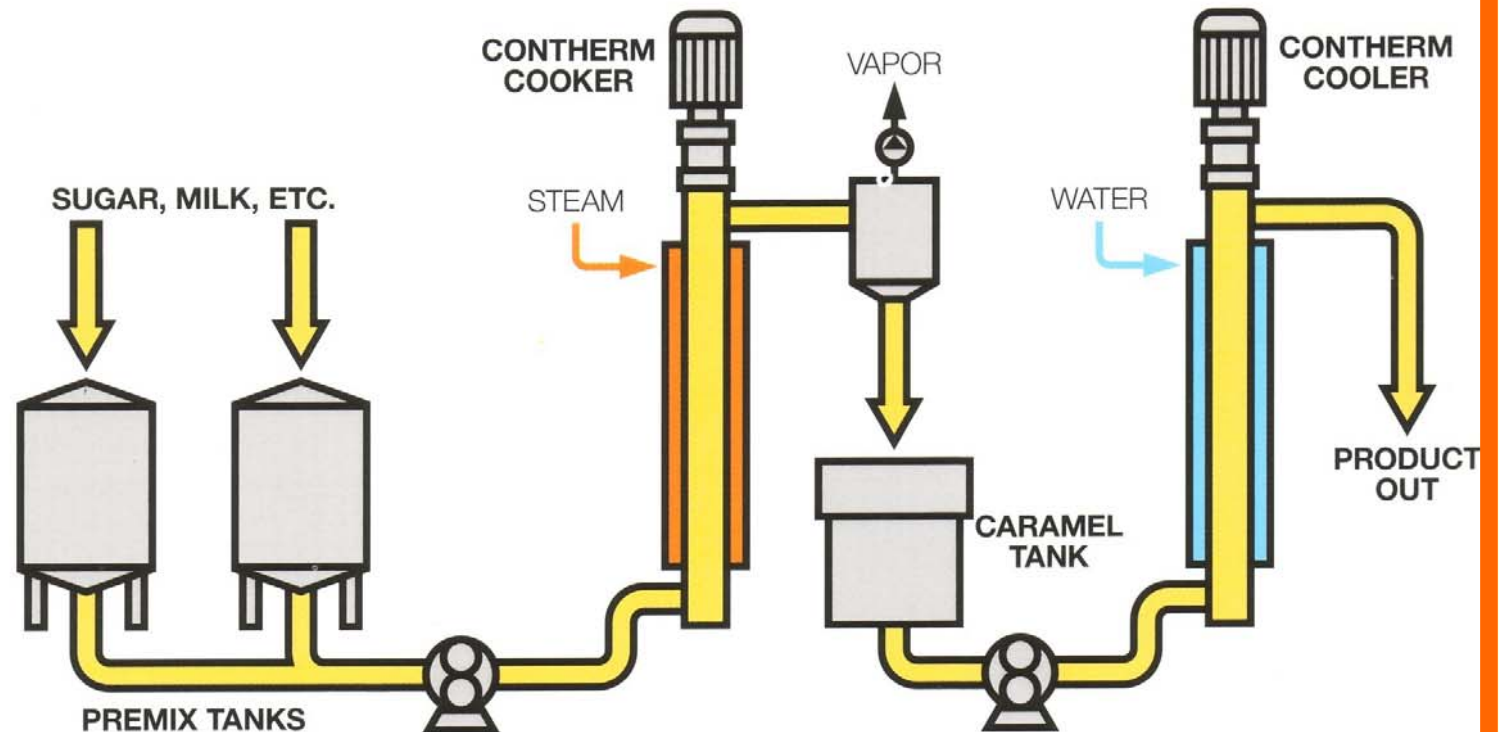
Linie pentru prelucrarea aseptica

SCSR TIP “CONTHERM”



Caramel Processing

The caramel mixture (condensed milk, corn syrup, HFCS, caramel, sugar and flavoring) is heated and agitated in a process vessel and then pumped to a Contherm to further heat the product. It is then flashed into a caramel tank for color development. The mixture is then pumped to a Contherm for final cooling, as temperature control is critical to the production of a consistent product.



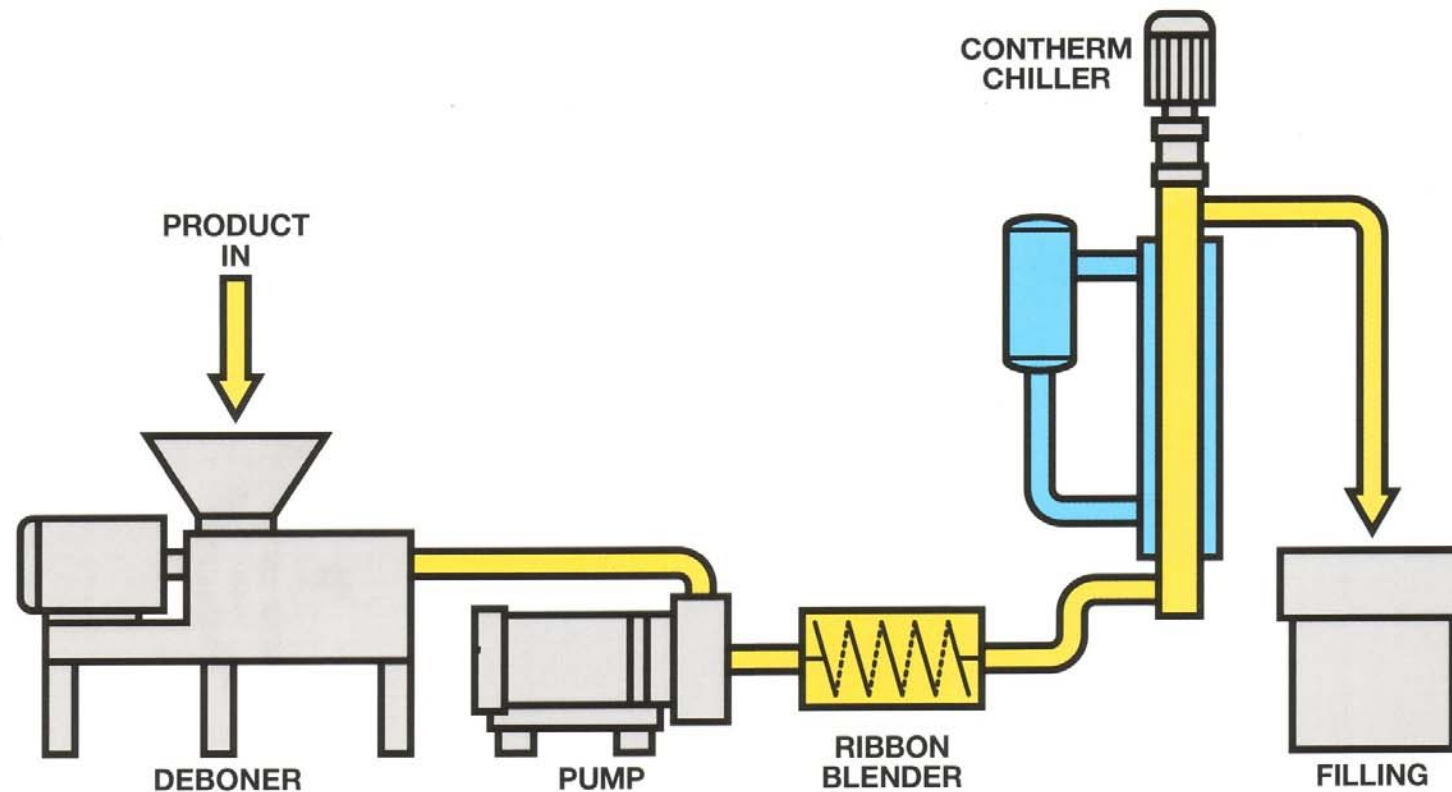
Linie pentru prelucrarea caramelului

SCSR TIP “CONTHERM”



MDM Cooling Line

The Contherm scraped surface heat exchanger is used for batch or continuous cooling of mechanically deboned meat (MDM). The Contherm system improves product quality compared to other methods of cooling.



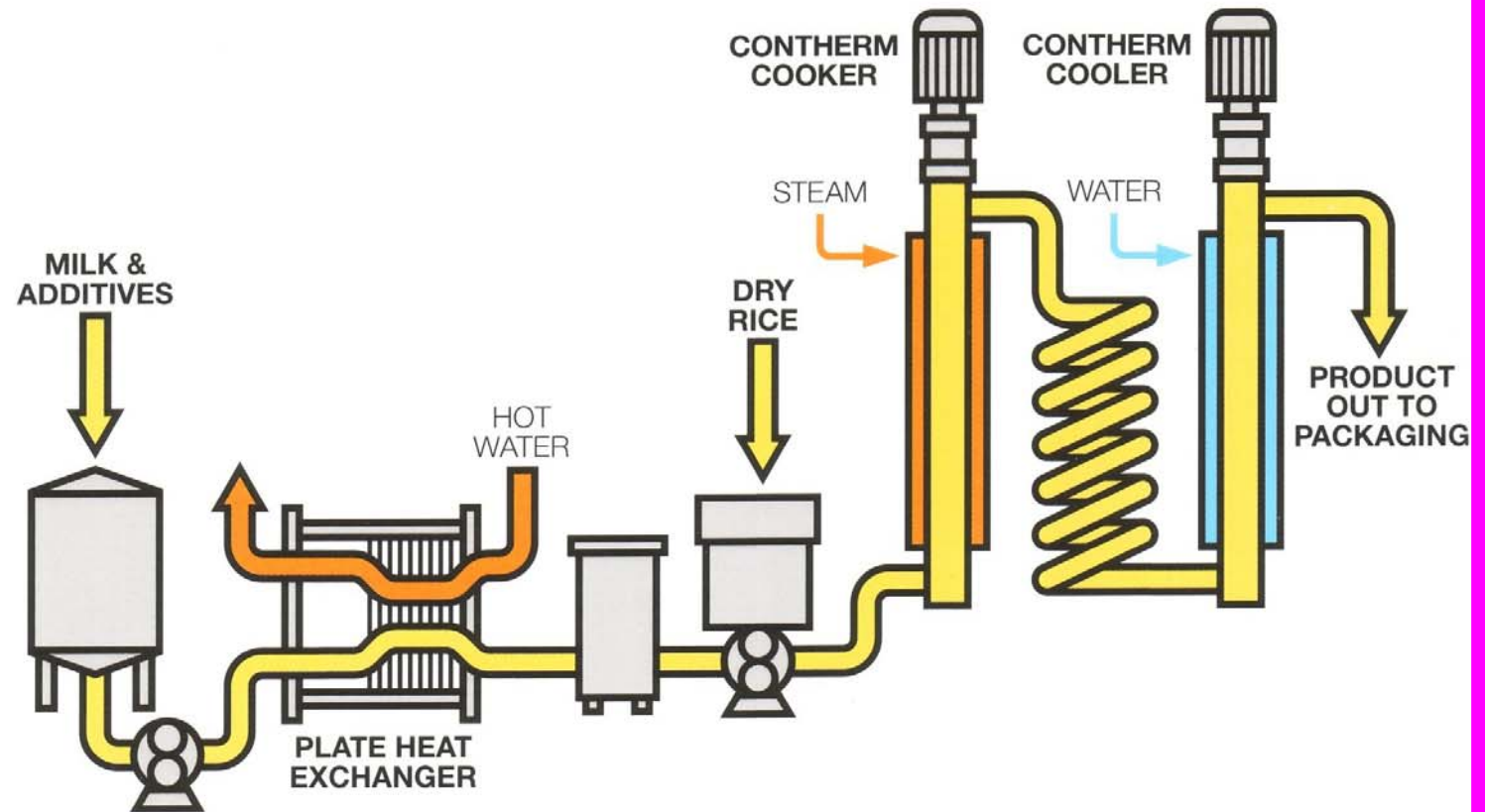
Linie pentru racirea carni dezosate mecanic (MDM)

SCSR TIP “CONTHERM”



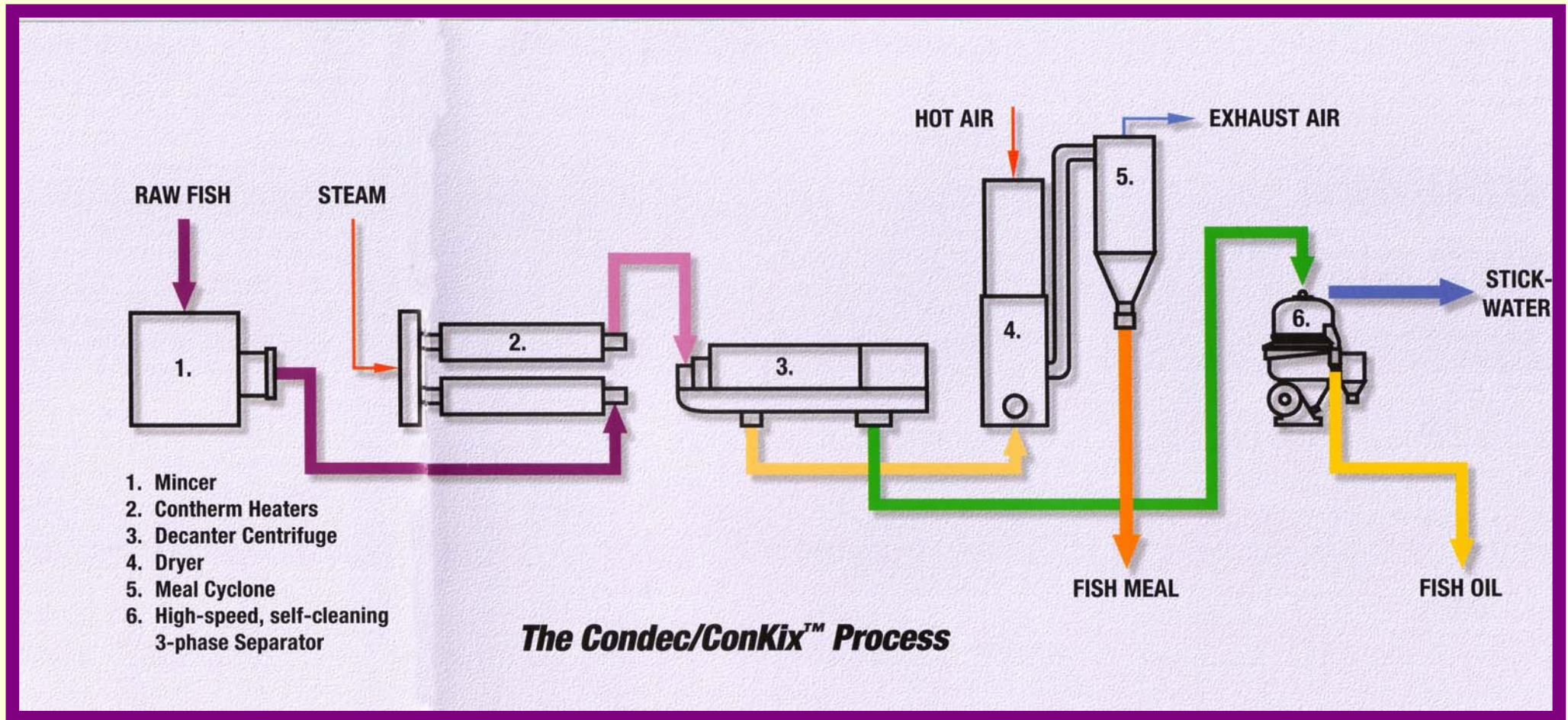
Continuous Rice Pudding Production

The pudding ingredients (milk, salt, sugar and thickener) are mixed and preheated before dry rice or grain is metered into the mixture. The mixture is then pumped to a Contherm scraped surface heat exchanger for heating (scalding). It then resides in a holding cell before being cooled in a Contherm to the required filling temperature, which determines the consistency of the end product.



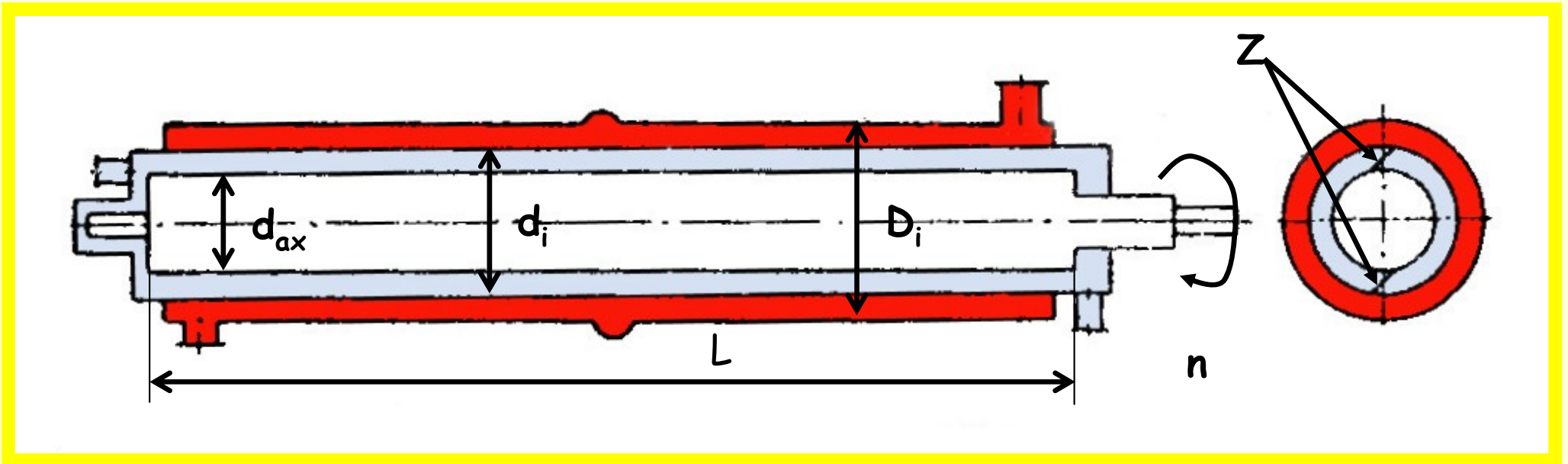
Linie pentru fabricarea continua a budincii de orez

SCSR TIP “CONTHERM”



Linie pentru prelucrarea pestelui

DIMENSIONAREA SCHIMBATOARELOR DE CALDURA CU SUPRAFATA RACLATA



D_i - diametrul interior al spatiului agentului termic;

d_i - diametrul interior al spatiului fluidului procesat;

d_{ax} - diametrul axului rotorului;

n - turatia axului rotorului;

L - lungimea axului rotorului;

Z - numarul de raclete;

DIMENSIONAREA SCHIMBATOARELOR DE CALDURA CU SUPRAFATA RACLATA

o DATE CUNOSCUTE:

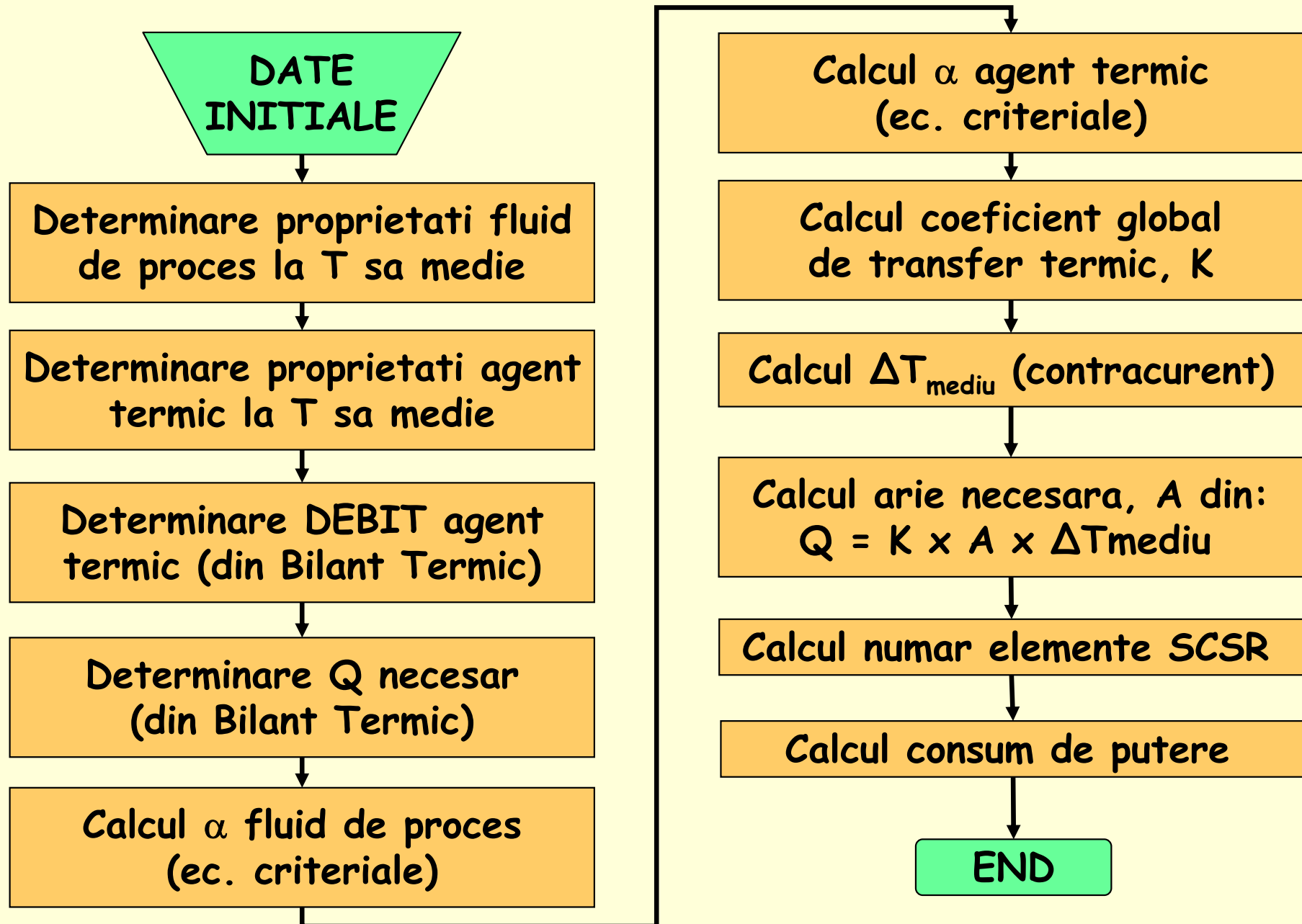
- Debitul de fluid procesat si natura acestuia;
- Temperaturile de intrare-iesire ale fluidului procesat;
- Temperaturile de intrare-iesire ale agentului termic;
- Caracteristicile unui element de SCSR: d_i ; D_i ; d_{ax} ; L ; n ; Z .

DIMENSIONAREA SCHIMBATOARELOR DE CALDURA CU SUPRAFATA RACLATA

o NECUNOSCUTE DE DETERMINAT:

- Debitul necesar de agent termic, M_{AT} ;
- Numarul elementelor de SCSR, n_E ;
- Puterea consumata, P .

DIMENSIONAREA SCHIMBATOARELOR DE CALDURA CU SUPRAFATA RACLATA



DIMENSIONAREA SCHIMBATOARELOR DE CALDURA CU SUPRAFATA RACLATA

o Calculul coeficientului individual de transfer termic al fluidului de proces, α_1 :

$$Nu = \frac{\alpha_1 \cdot d_i}{\lambda} = a \cdot \left(\frac{c_p \cdot \mu}{\lambda} \right)^b \cdot \left(\frac{(d_i - d_{ax}) \cdot v \cdot \rho}{\mu} \right)^{1,0} \cdot \left(\frac{d_i \cdot n}{v} \right)^{0,62} \cdot \left(\frac{d_{ax}}{d_i} \right)^{0,55} \cdot Z^{0,53}$$

o $a = 0,014$; $b = 0,96$ - lichide viscoase;

o $a = 0,039$; $b = 0,70$ - lichide neviscoase.

In literatura exista si alte ec. criteriale de corelare pt. α .

DIMENSIONAREA SCHIMBATOARELOR DE CALDURA CU SUPRAFATA RACLATA

o Coeficientul global de transfer termic, K:

$$K = \frac{1}{\frac{1}{\alpha_1} \cdot \frac{d_e}{d_i} + \frac{\delta_{\text{perete}}}{\lambda_{\text{perete}}} \cdot \frac{d_e}{d_m} + R_{\text{depuneri}} + \frac{1}{\alpha_2}} \left[\frac{W}{m^2 \cdot K} \right]$$

o Numarul de elemente de SCSR:

$$n_E = \frac{A}{\pi \cdot d_e \cdot L}$$

o Consumul de putere:

$$P = A \cdot n^B \cdot \mu^C + D \cdot n \text{ [W]}$$

DIMENSIONAREA SCHIMBATOARELOR DE CALDURA CU SUPRAFATA RACLATA

$$P = A \cdot n^B \cdot \mu^C + D \cdot n \text{ [W]}$$

Valorile coeficientilor $A \div D$ din ecuatia puterii
(datele mai multor autori)

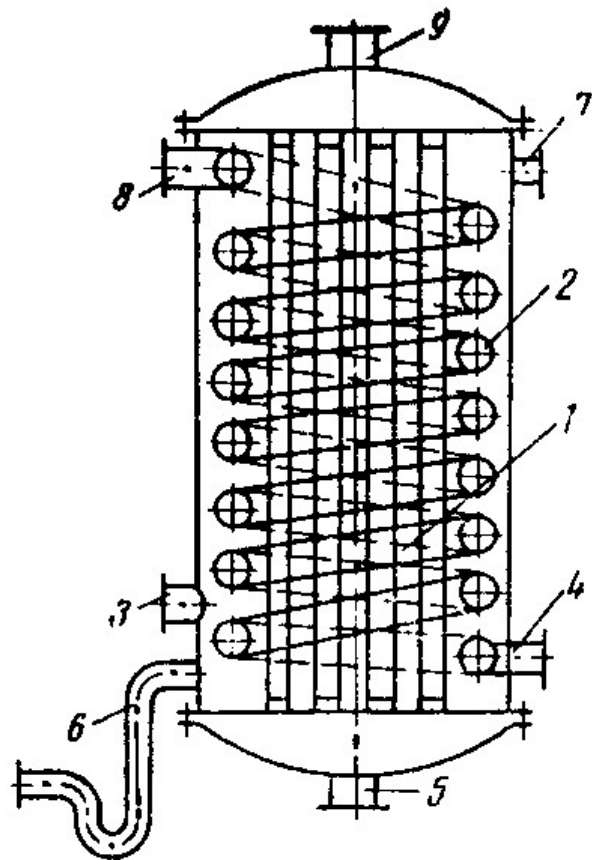
A	B	C	D
34,44	1,93	0,61	34,88
29,05	2,00	0,66	43,96
53,40	1,79	0,68	40,41
39,31	2,00	1,00	79,60
104,5	1,73	1,27	99,21

SCHIMBATOARE DE CALDURA MULTITUBULARE COMBinate CU SERPENTINA

APLICATII & SCOP

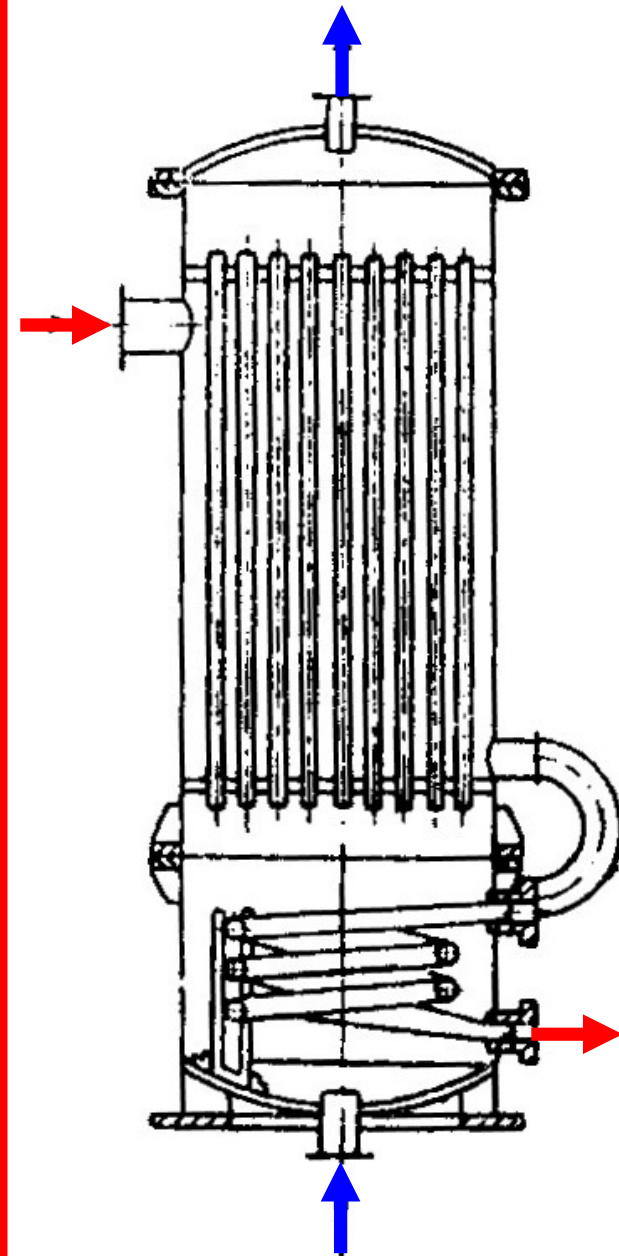
- o Instalatiile de rectificare din industria spirtului;
- o Pot utiliza 2 agenti termici pt. racirea vaporilor in condensare (**DEFLEGMATOR**);
- o Pot realiza procesul in doua etape:
 - I - condensarea vaporilor
 - II - racirea vaporilor (**CONDENSATOR**).

TIPURI CONSTRUCTIVE



Schimbător de căldură
mixt-multitubular cu serpentină
în jurul țevelor:

1 – element multitubular; 2 – serpentină; 3 – racord intrare vapori;
4, 5 – racord intrare agenți schimb de căldură; 6 – evacuare condensat;
7 – evacuare vapori necondensați;
8, 9 – racord evacuare agenți de schimb de căldură.

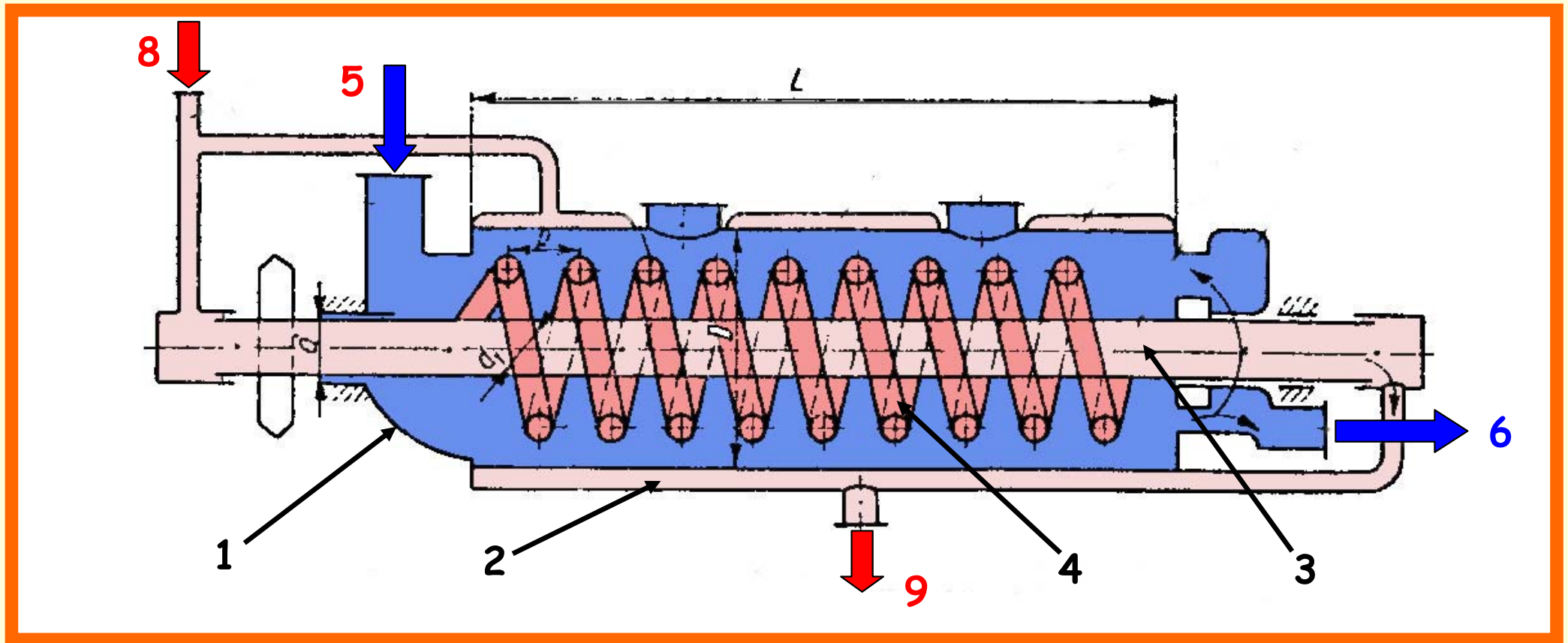


SCHIMBATOARE DE CALDURA CU SERPENTINA ROTATIVA SI MANTA

UTILIZARI

- o Preincalzirea aproape instantanee a lichidelor la o anumita temperatura (80 - 90 °C) si mentinerea lor la aceasta temperatura (3 - 6 min) pentru:
 - Oprirea actiunilor enzimaticice;
 - Solubilizarea anumitor componentii;
- o Agentul termic: abur 0,2 - 0,3 MPa.

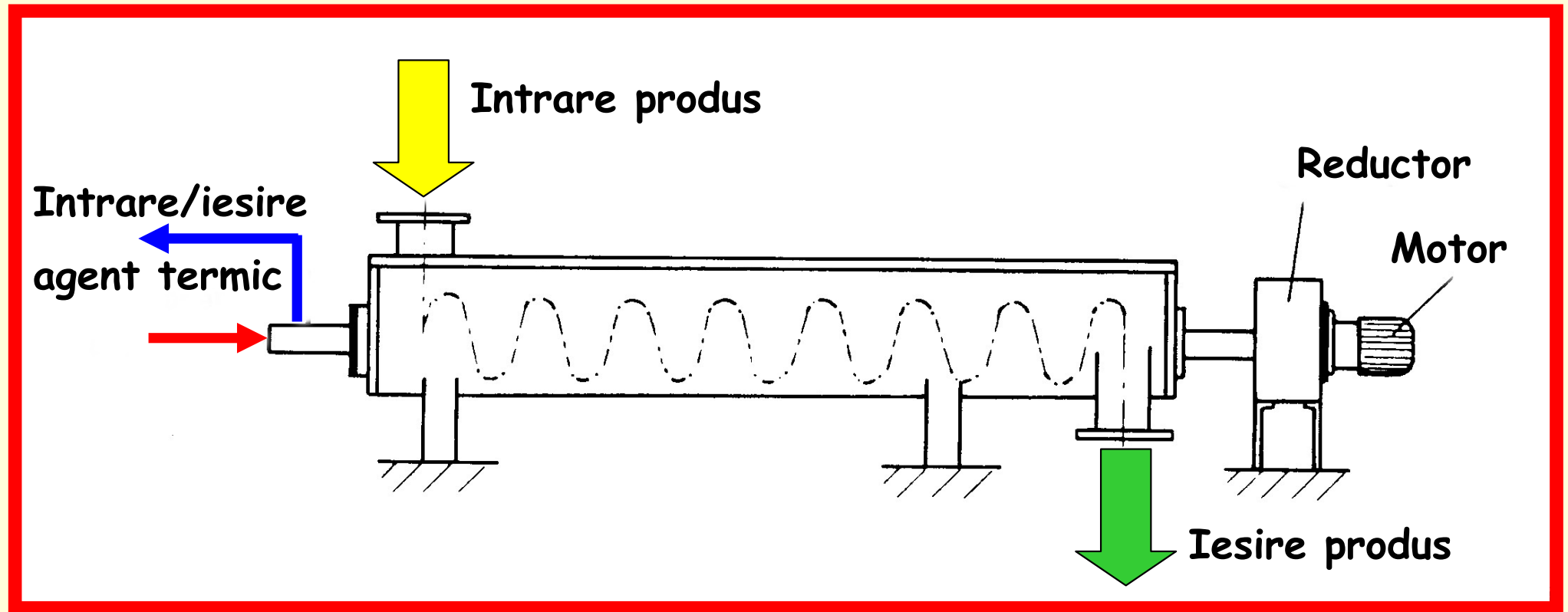
PRINCIPIUL CONSTRUCTIV SI FUNCTIONAL



1 - cilindru; 2 - manta de incalzire; 3 - arbore inelar rotativ;
4 - spirala; 5 - alimentare produs; 6 - evacuare produs;
7 - recirculare produs; 8 - alimentare abur; 9 - evacuare condensat.

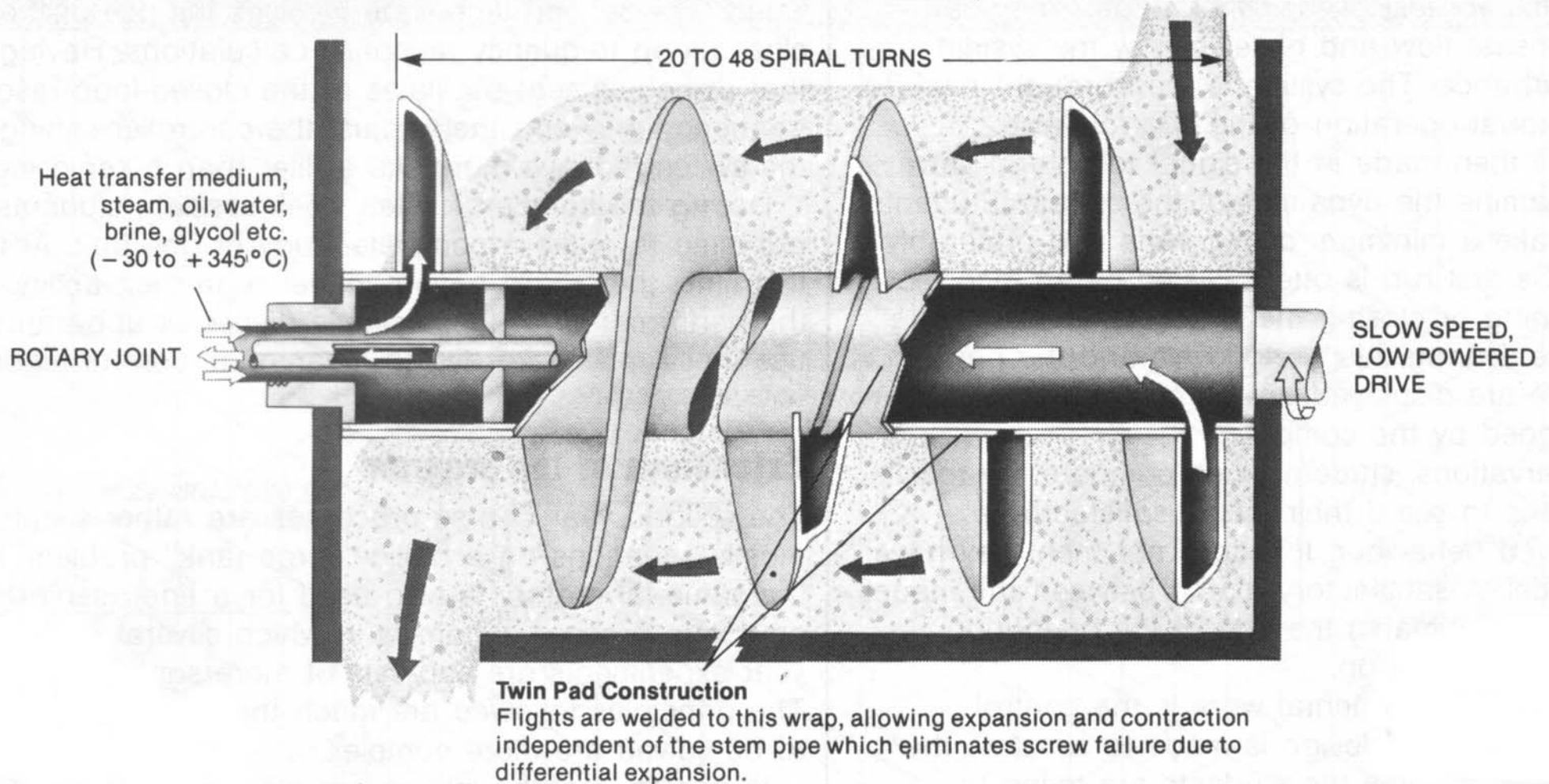
SCHIMBATOARE DE CALDURA
TIP
TRANSPORTOR ELICOIDAL

PRINCIPIU DE FUNCTIONARE



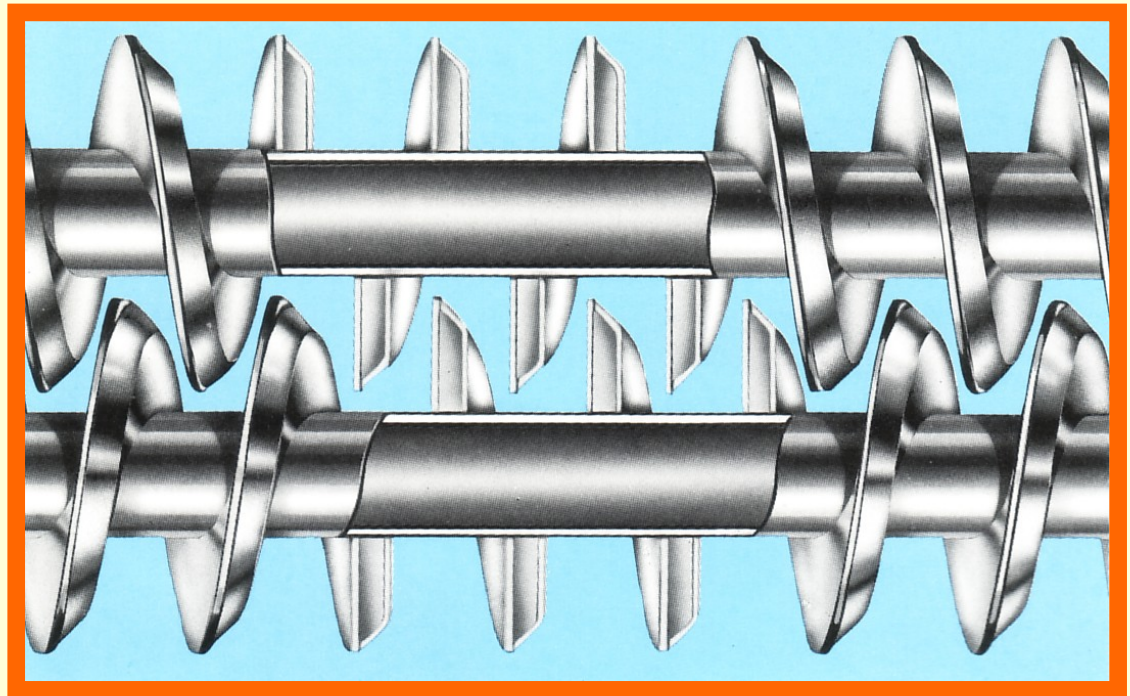
Cristalizare; Evaporare;
Desublimare; Topire; Uscare;
Incalzire; Racire.

PRINCIPIU DE FUNCTIONARE



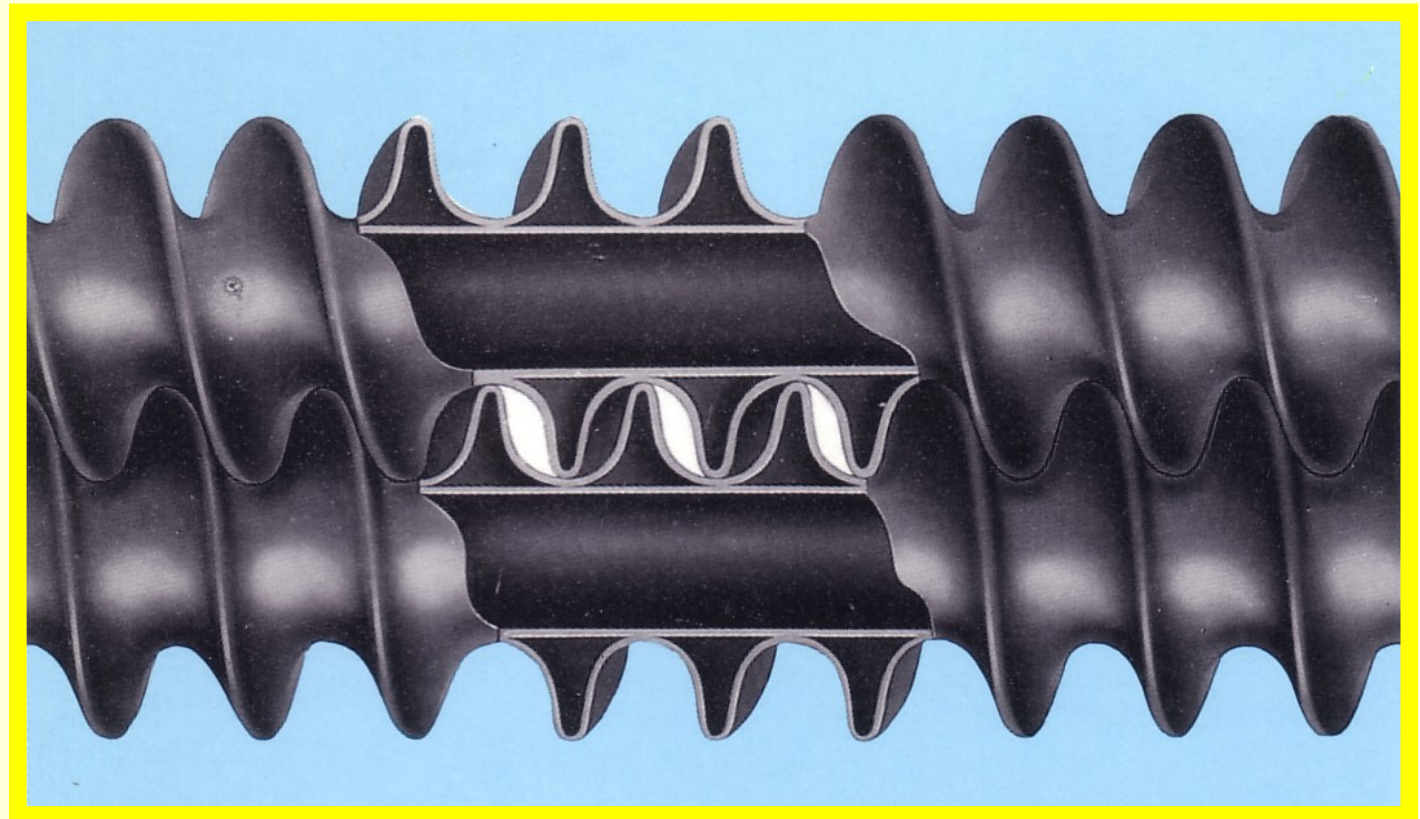
TIPURI DE TRANSPORTOR MELCAT

- o Pentru produse neaderente si neincrustante;
- o Materiale cu granule mari;
- o Pulberi fine;
- o Paste cu viscozitate medie si ridicata.



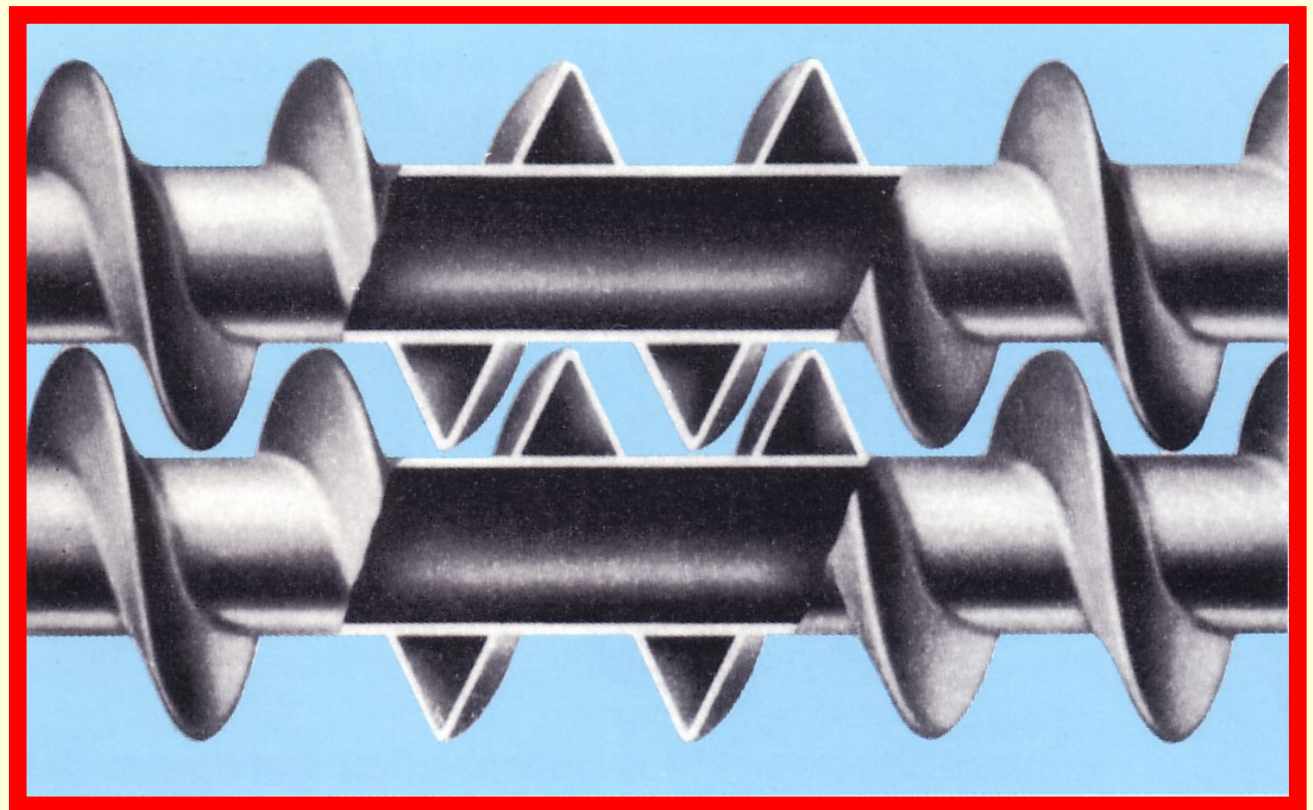
TIPURI DE TRANSPORTOR MELCAT

- o Pentru produse aderente si incrustante;
- o Pentru namoluri si suspensii concentrate;
- o Pentru pulberi cu granule fine.



TIPURI DE TRANSPORTOR MELCAT

- o Pentru produse aderente si incrustante;
- o Paste cu viscozitate medie spre ridicata;
- o Pentru materiale granulare superfine.



TIPURI CONSTRUCTIVE

- o Tratarea termica a intermediarilor din industria farmaceutica;
- o Preevaporatoare (constructie etansa);
- o Cristalizatoare.

Variocleaner 2V 410-24

For thermal treatment of pharmaceutical intermediate products.
Gas-tight design with jacket, suitable for use as pre-evaporators arranged in series, as re-evaporators and crystallization units.



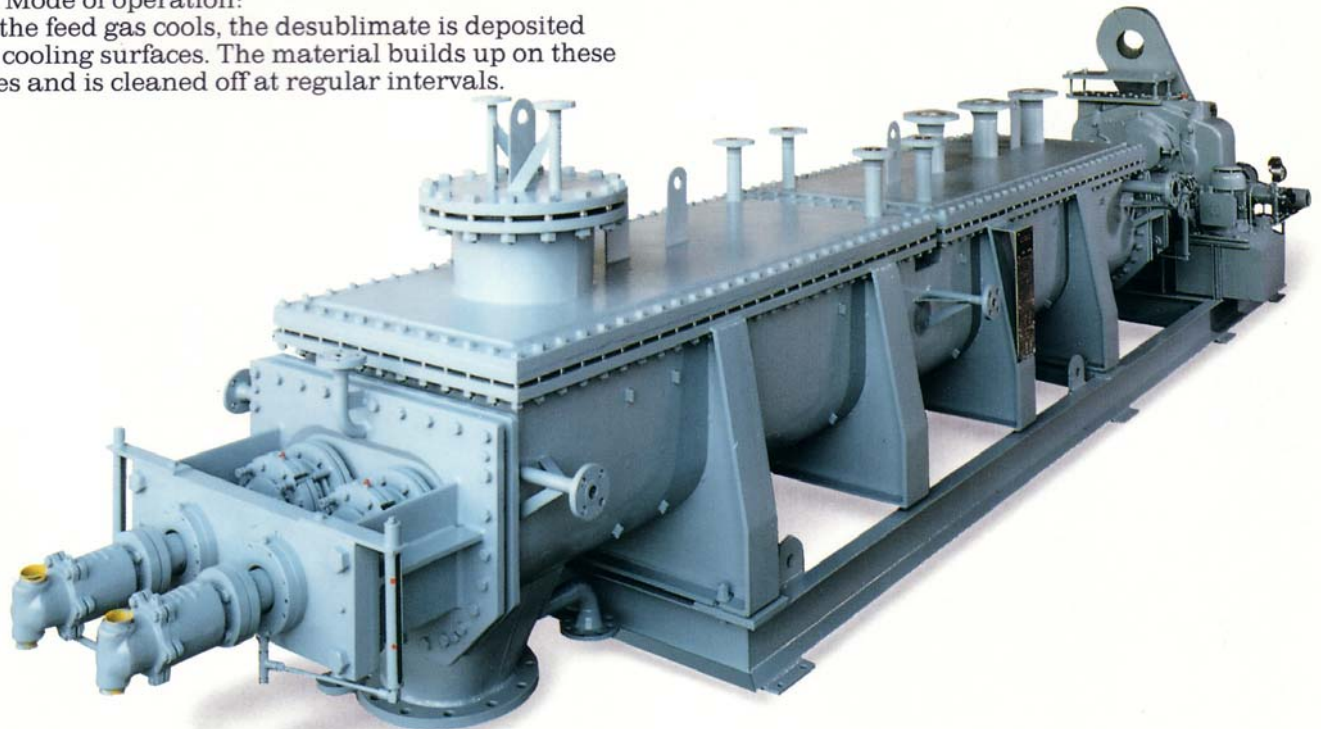
TIPURI CONSTRUCTIVE

- o Recomandat pentru desublimare;
- o Constructie etansa, prevazut si cu manta.

Variocleaner 2V 410-45

Suitable for desublimation. Gas-tight design with jacket. Mode of operation:

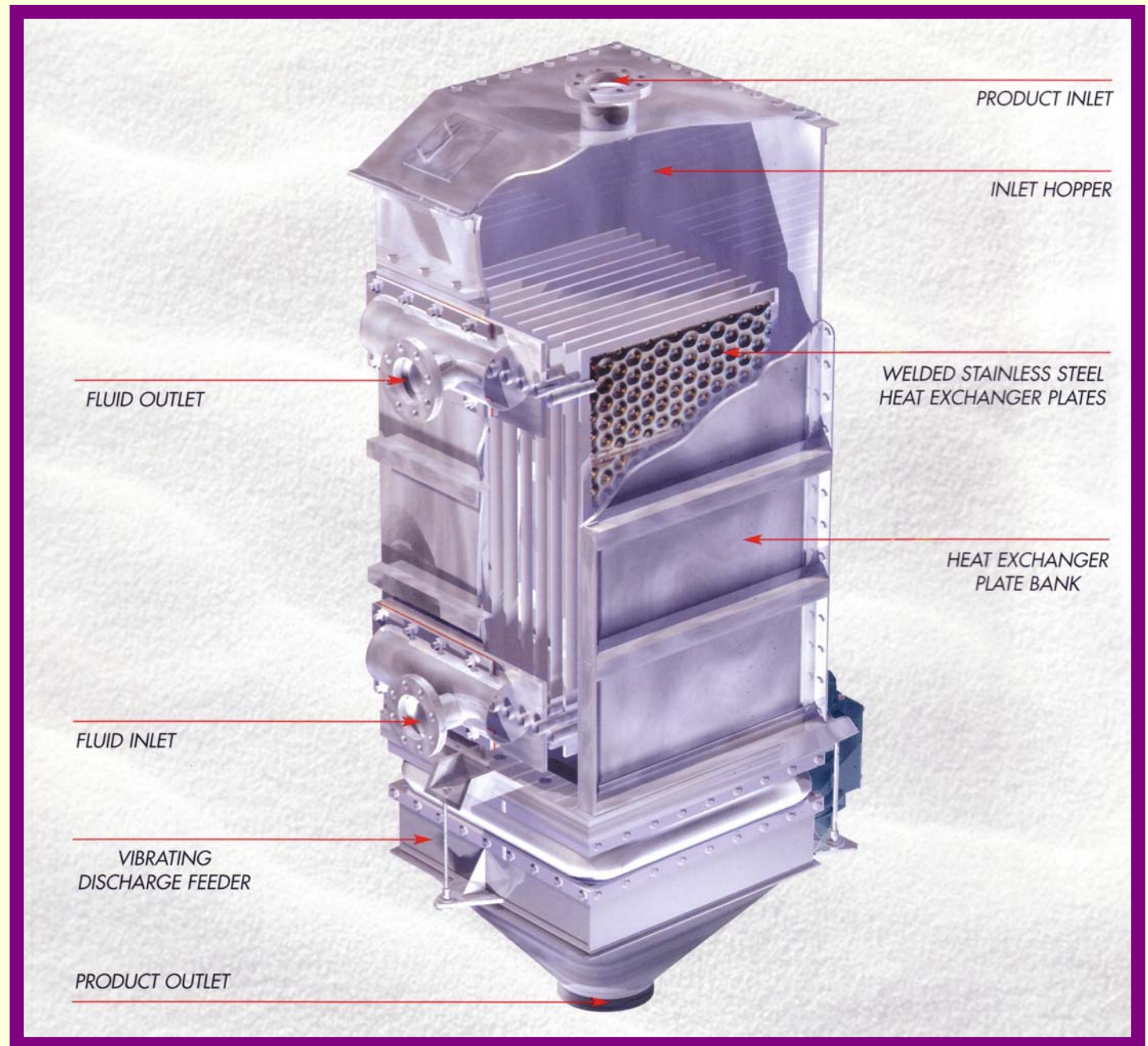
While the feed gas cools, the desublimate is deposited on the cooling surfaces. The material builds up on these surfaces and is cleaned off at regular intervals.



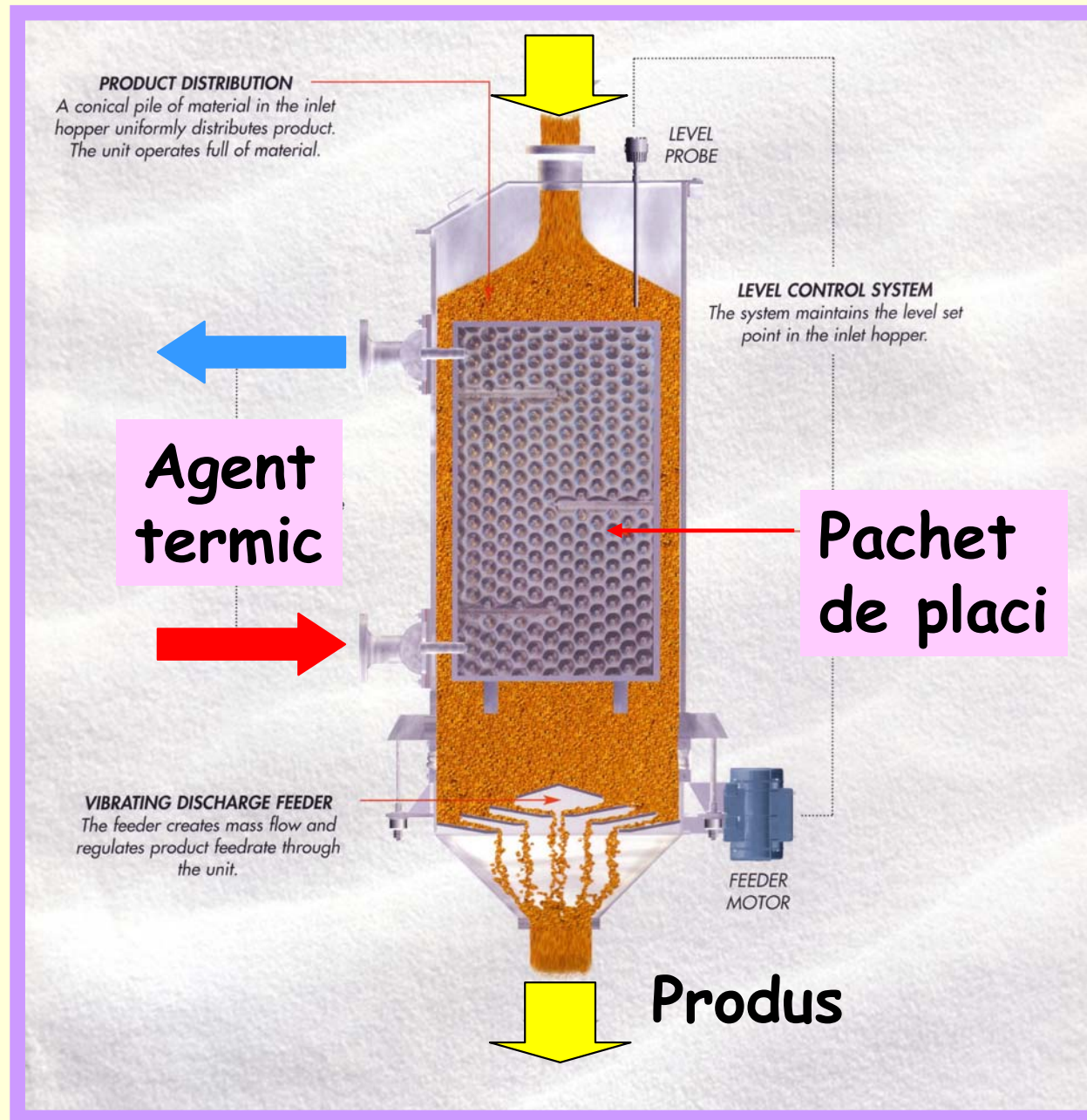
SCHIMBATOARE DE CALDURA PENTRU MATERIALE SOLIDE

BULKFLOW

- o INCALZIRE
- o RACIRE
- o USCARE
- o DOZARE

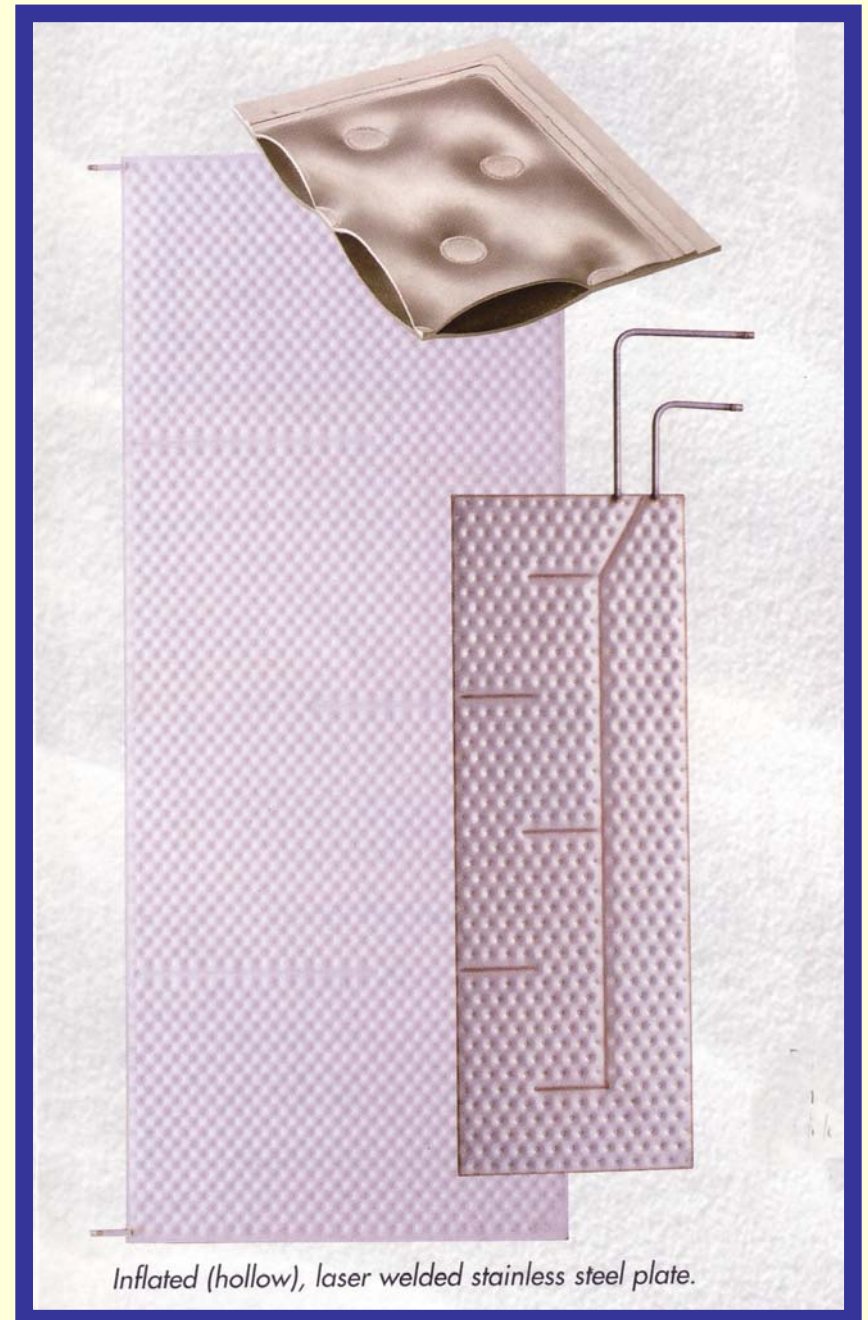


PRINCIPIU DE FUNCTIONARE

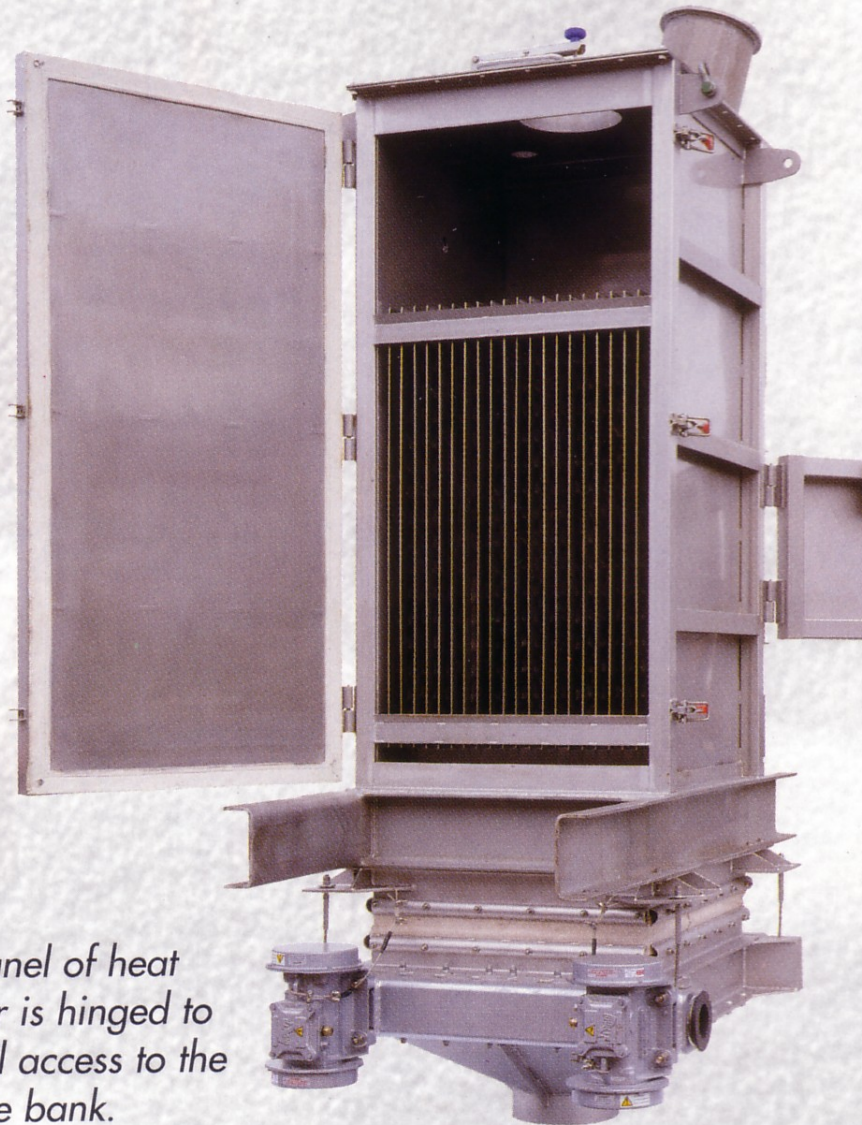


DETALIU PLACI

- o Placi duble sudate laser;
- o Fara garnituri;
- o Material standard: 316L;

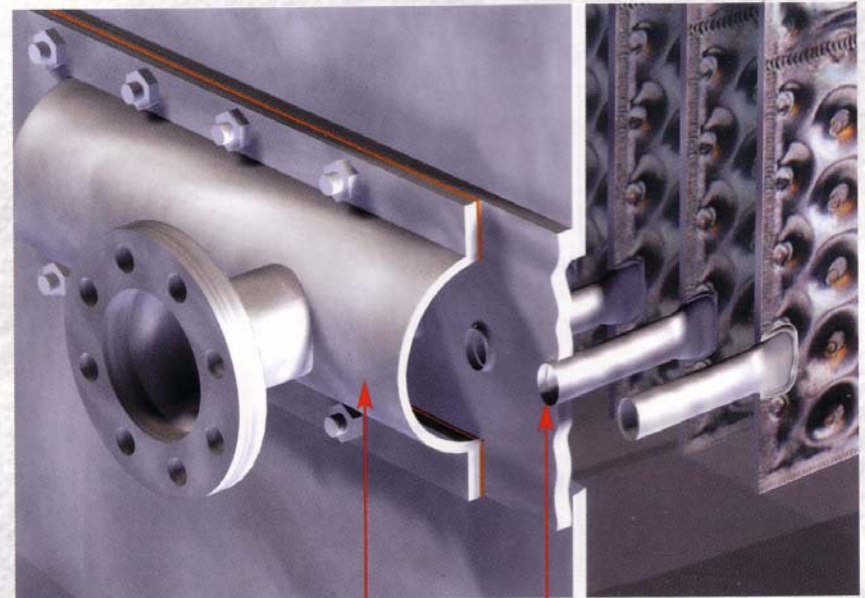


MONTARE PACHET DE PLACI



Back panel of heat exchanger is hinged to provide full access to the plate bank.

MANIFOLD DESIGN

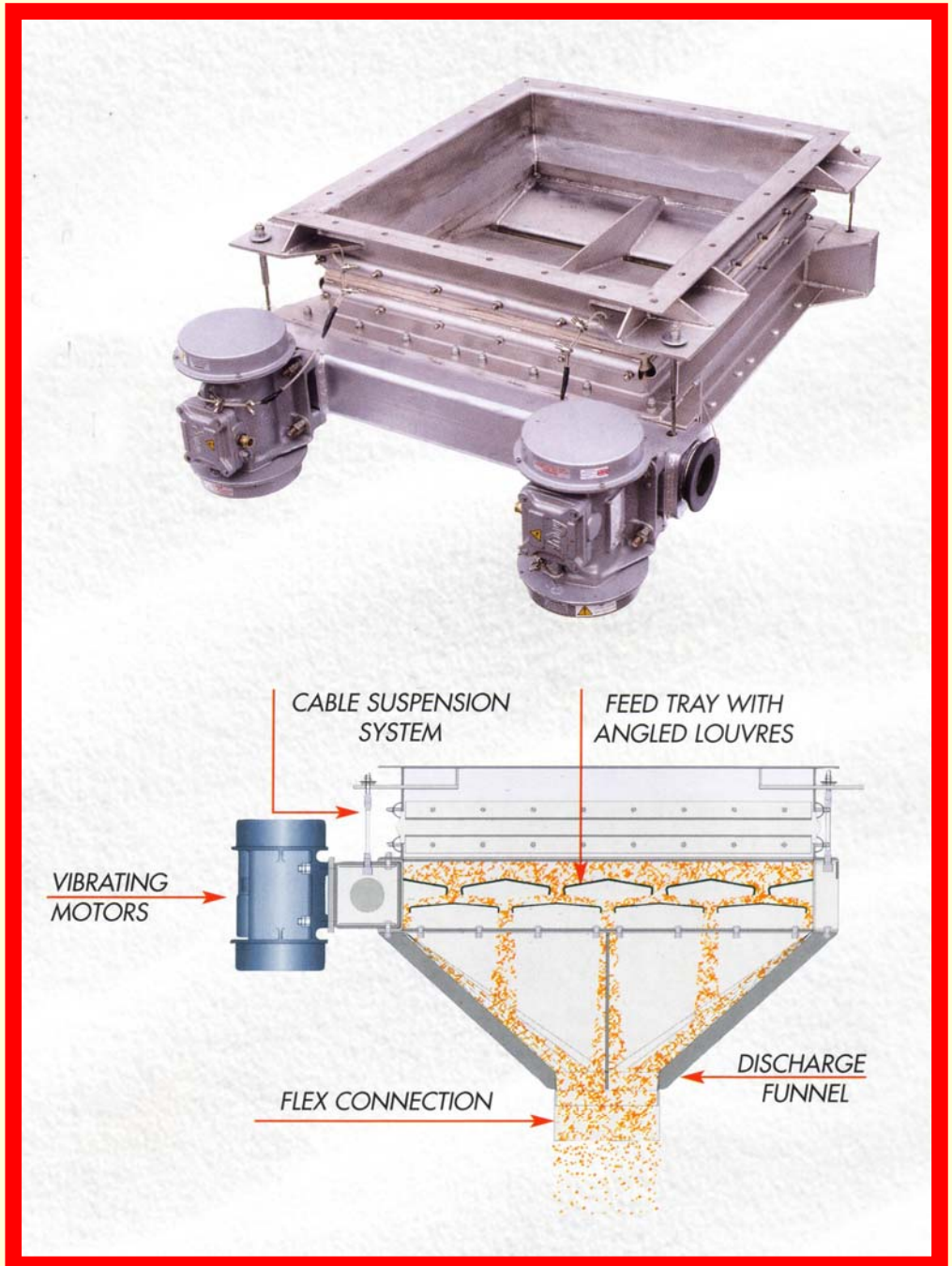


MANIFOLD COVER IS REMOVABLE

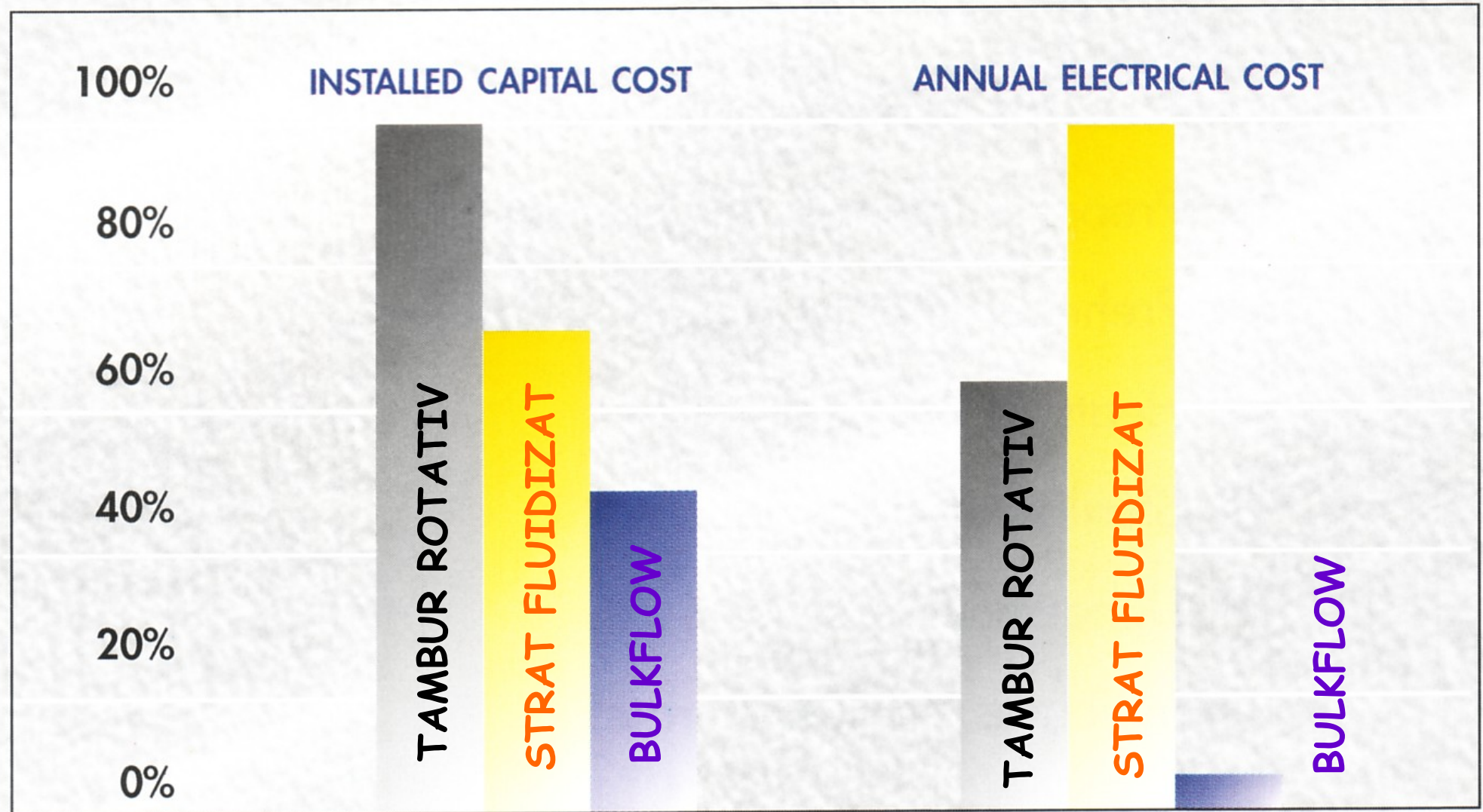
TUBES ARE WELDED TO MANIFOLD

SISTEMUL DE GOLIRE SOLIDE

- o Descarcare prin vibrare;
- o Debit uniform;
- o Fara pericol de infundare.



COST COMPARISON



Source: Jacobs Engineering Study ©1995

APLICATII

- o Rasini si mase plastice;
- o Chimicale;
- o Ingrasaminte;
- o Nisip si minerale;
- o Cosmetice;
- o Detergenti;
- o **Produse alimentare:**



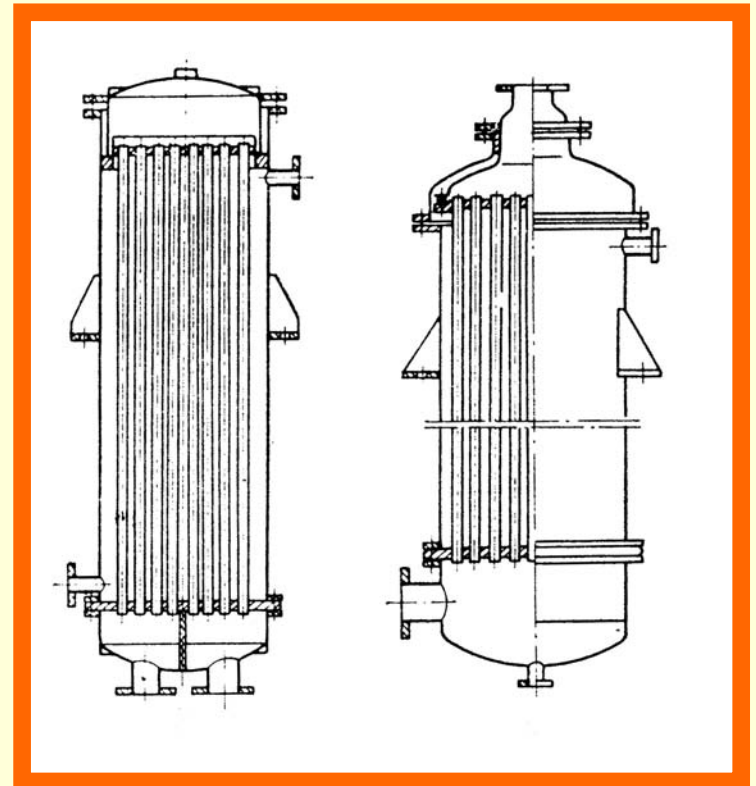
- o Praf de ciocolata;
- o Nuci sfaramate;
- o Nuci intregi;
- o Tablete de sare;
- o Cristale de zahar;
- o Seminte si graunte;
- o Sare de bucatarie.

ALEGEREA TIPULUI DE SCHIMBATOR DE CALDURA

- o Trebuie asigurat **Regimul Termic Optim**:
 - ✓ Se satisfac **toate** cerintele procesului tehnologic
 - ✓ Consumul energetic este **minim**
- o Factori de influenta:
 - Fluxul termic schimbat;
 - Conditiiile de temperatura ale transferului termic;
 - Rezistenta hidraulica a aparatului;
 - Materialul de constructie + protectia anticoroziva;
 - Posibilitati de indepartare a depunerilor;
 - Posibilitati de spalare, sterilizare, dezinfectare (CIP, SIP).

ALEGEREA TIPULUI DE SCHIMBATOR DE CALDURA

- o SC multitubulare cu mai multe treceri:
- Transfer termic vapor - lichid;
- Flux termic transferat foarte mare;
- Transfer termic L-L sau G-G.



ALEGEREA TIPULUI DE SCHIMBATOR DE CALDURA

o SC cu suprafete extinse:

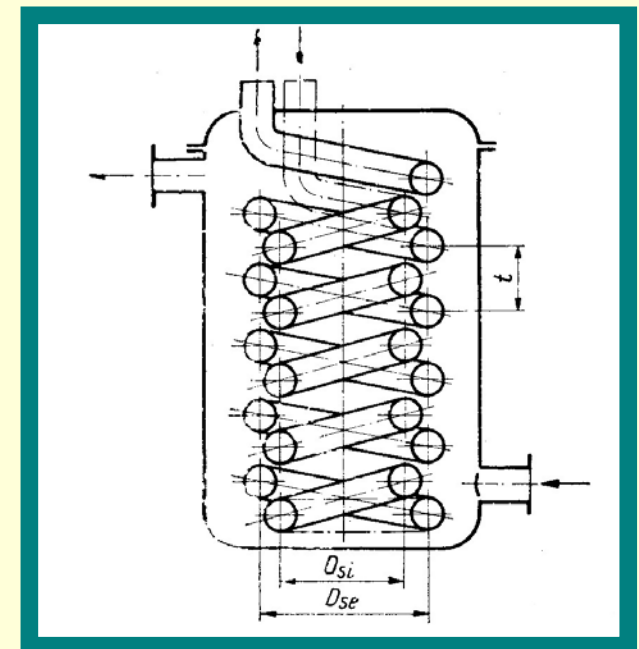
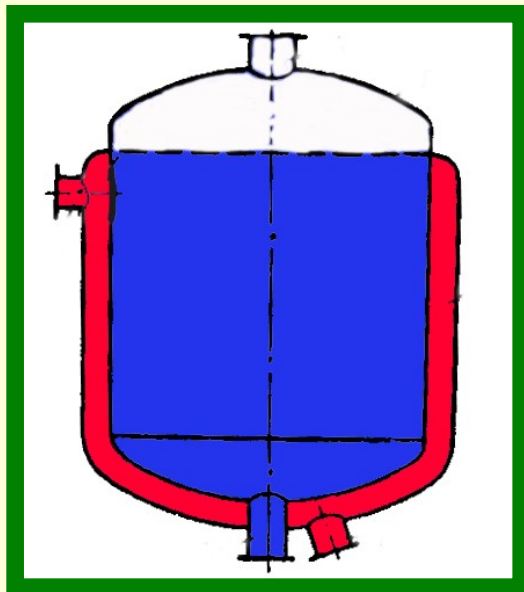
- Transfer termic intre:
vapori in condensare - gaz;
- Transfer termic lichid - gaz,
cand $\alpha_{\text{lichid}} \gg \alpha_{\text{gaz}}$;



ALEGEREA TIPULUI DE SCHIMBATOR DE CALDURA

o SC cu manta, SC cu serpentina:

- Fluxuri tehnologice reduse;
- Transferul termic reprezinta un scop secundar;
- Procesul decurge discontinuu.



ALEGEREA TIPULUI DE SCHIMBATOR DE CALDURA

o SC cu tevi coaxiale (teava in teava):

- Debite mici de flux termic;
- La fluxuri termice mari:
 - mai multe elemente inseriate;
 - tevi ondulate sau nervurate.



ALEGEREA TIPULUI DE SCHIMBATOR DE CALDURA

o SC spirale:

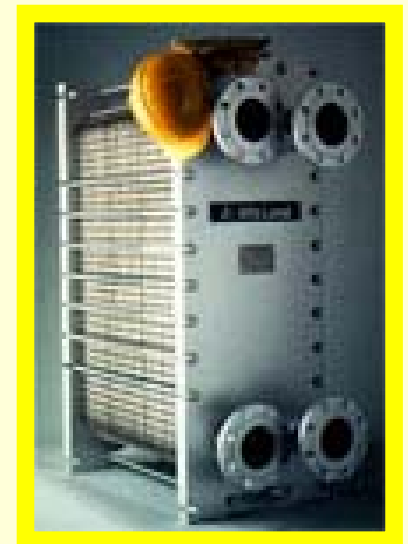
- Fluxuri termice mari;
- Cand sunt necesare unitati compacte;
- Cand P fluidelor nu sunt prea mari.



ALEGEREA TIPULUI DE SCHIMBATOR DE CALDURA

o SC cu placi:

- Sunt necesare unitati foarte compacte;
- Gradul de recuperare a caldurii trebuie sa fie ridicat;
- Sunt necesare conditii speciale de igiena;
- Suprafata de transfer trebuie modificata frecvent;
- P si T fluidelor nu sunt prea mari.



ALEGEREA TIPULUI DE SCHIMBATOR DE CALDURA

o SC cu suprafete raclate:

- Fluidele prelucrate sunt foarte viscoase, aderente, cu particule solide sau fibre in suspensie, usor termodegradabile.

