Energy efficiency & Maintenance aspects of Heat exchanger – Dairy Industry

Alfa Laval Team

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Topics

- Introduction to Alfa Laval
- Alfa Laval- Heat exchangers
- Dairy process – Heat exchanger locations
- Energy saving opportunities –Dairy Industry
- Maintenance Aspects – Heat exchanger
- Question and Answer

Introduction to Alfa Laval

- Alfa Laval is a world leader within the key technology areas of
  Heat transfer,
  Separation and
  Fluid handling.
- Our company was founded on a single brilliant invention, and innovation remains at the heart of everything we do.
- With more than 2,500 patents,
- We provide worldwide solutions
- Globally AL is 130 Years company.
- AL India : 79 Years

Introduction to Alfa Laval

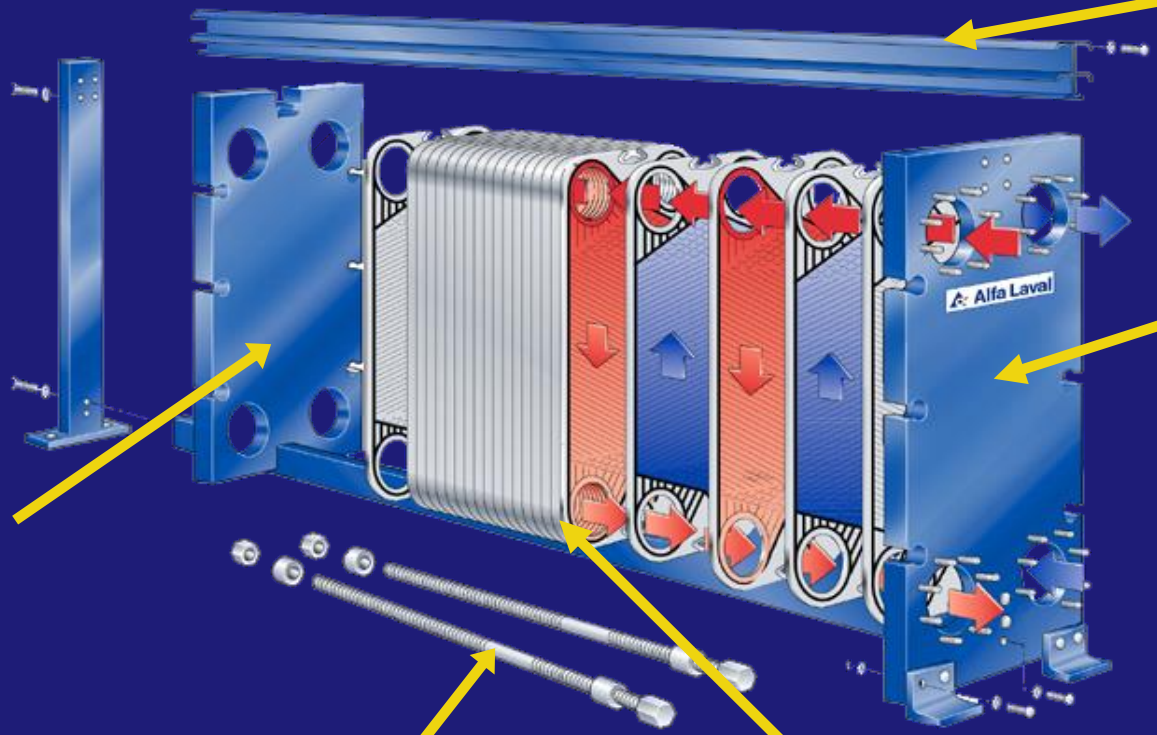
- **Our three Pillars are**
- **CUSTOMERS** = Improve customer interaction
- **PRODUCTS** = Building on our technological strengths
- **SERVICE** = Further grow the service offering
- **Organization**
- Alfa Laval's strategy is based on a Global Sales & Service
- Works close to our customers.
- To gain a clear customer focus, the company is divided into three divisions:

Food & Water Energy Marine

Alfa Laval- Heat exchangers

Compact Heat Exchangers – bright ideas whose time has come

PHE - Main components



Carrying bar

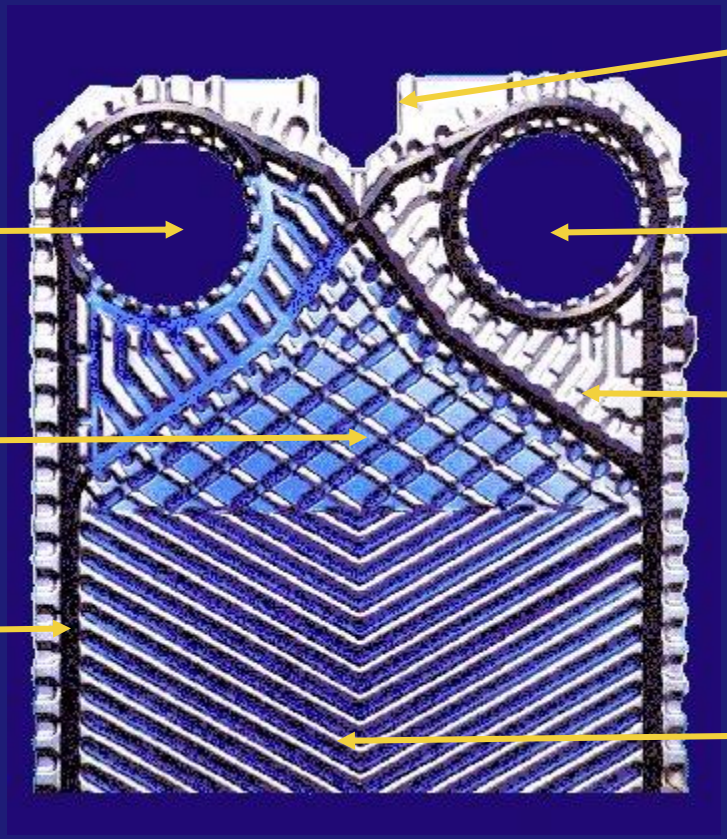
Frame plate

Pressure plate

Tightening bolts

Plate pack

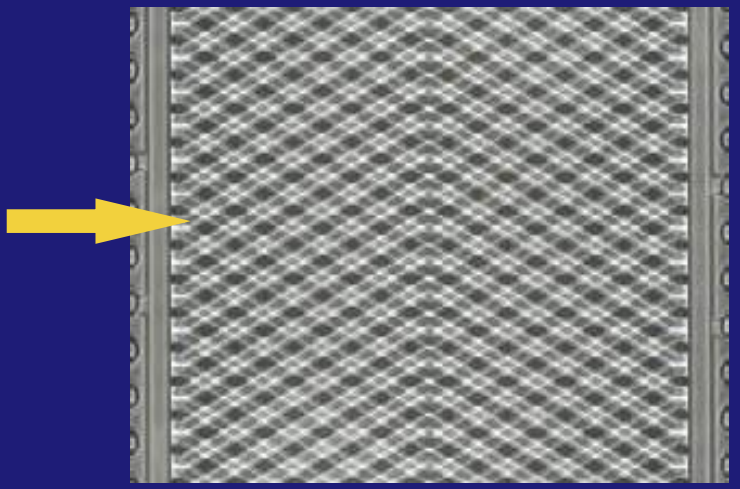
Plate - Main components



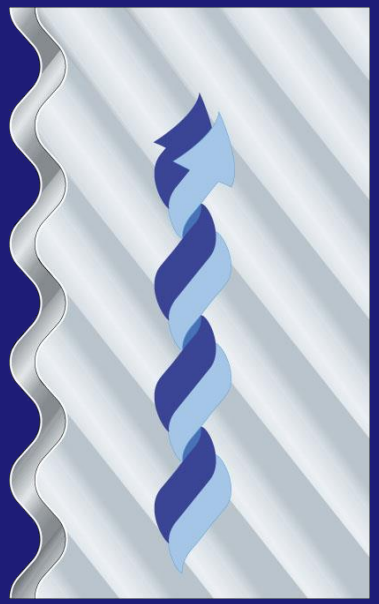
Thin sheet design, cold formed in single step hydraulic pressing (up to 40000 tons)

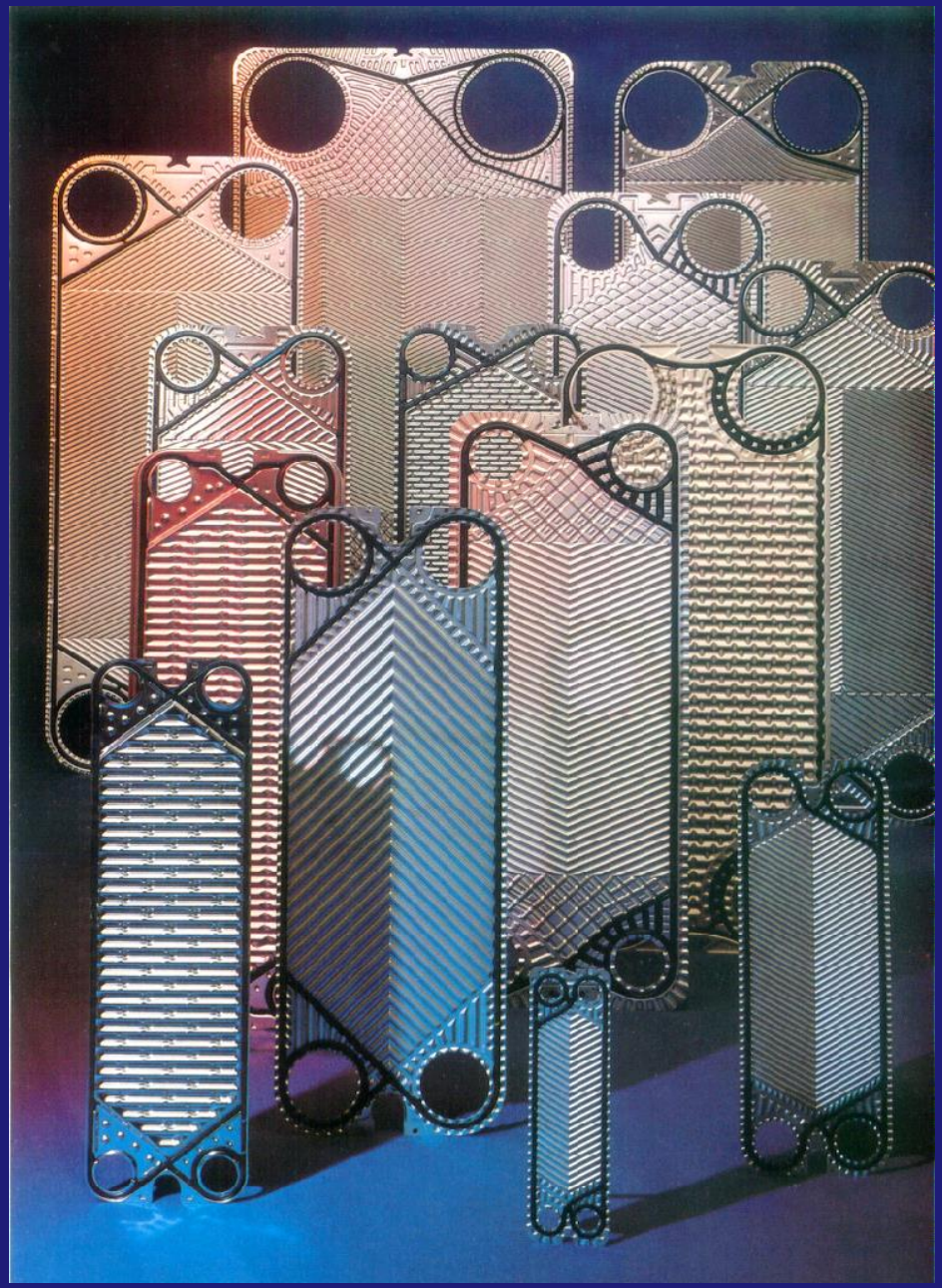
Plate - Corrugation function

- Mechanical
  - Provide support points
  - Allows thin material



- Flow dynamic
  - Creates high turbulence
  - High efficiency
  - Minimize fouling
  - Cork-screw flow





Heat Exchanger Plates

Plate - distribution area

- Chocolate pattern
  - Distributes flow evenly over the plate
  - Same ΔP for distance A and B
  - Uses a minimum of ΔP for distribution
  - Gives more ΔP for efficient heat transfer
  - Allows parallel flow configuration
  - Alfa Laval innovation
    - Patent has expired
    - Competitors has copied us
  - Avoids dead-spots in the far corner
    - Full use of heat transfer area
    - No fouling in stagnant zones

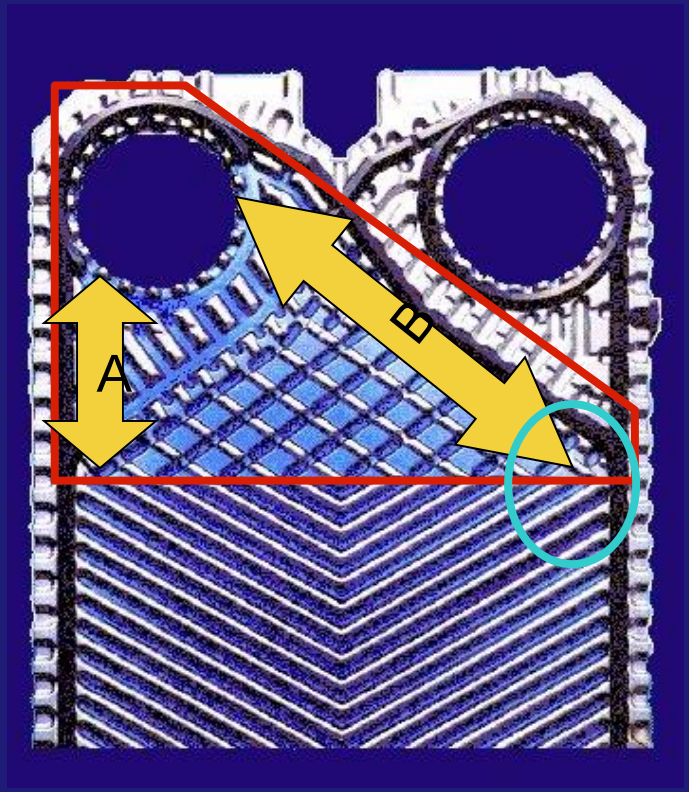


Plate - materials

- Standard materials and thicknesses
  - AISI 304 (stainless steel)
    - Usually 0.4 or 0.5 mm thickness
    - Cheapest possible solution
  - AISI 316 (stainless steel)
    - Always 0.5 and 0.6 mm
    - Some with thicker plates (high-pressure applications)
  - 254 SMO (high-alloy stainless steel)
    - Usually in 0.6 mm to allow stock-keeping
  - Titanium
    - Always 0.5 and 0.6 mm
    - Some with thicker plates (high-pressure applications)
    - Some PHEs with 0.4 mm (low-pressure applications)
  - Alloy C-276 (Nickel alloy)
    - Usually in 0.6 mm to allow stock-keeping

Typical Composition of Metals for Use in Heat Exchanger

	Cr	Ni	Mo	Cu	Others
AISI 304	18	8			
AISI 316	17	12	2		
904 L (W.1.4539)	20	25	4.5	1.5	
AVESTA 254 SMO	20	18	6.1	0.7	Mn 2.0, N 0.20
AVESTA 654 SMO	24	22	7.5	0.5	Mn 2.0, N 0.50
INCOLOY 825 (Nicrofer 4221)	22	42	3	2.5	Fe 30
INCONEL 625 (" 6020 HMO)	22	60	9		
HASTELLOY C 276	15.5	58	16		W 4, Fe 5
HASTELLOY C 2000	23	55	16	1.6	Fe 3, Co 2
HASTELLOY G 30	29.5	46	5	1.7	w 2.5 Fe 15
HASTELLOY C - 22	21	58	13.5		W 3 Fe 2 - 6
HASTELLOY B - 2	1	68	28		Fe 2, Mn 1
HASTELLOY D-205	20	64	2.5	2	Si 5, Fe 6
NICKEL 200		99.2			
TITANIUM					Ti
PD-STAB TITANIUM					Ti + Pd 0.2%
TANTALUM					Ta

Gasket - profile and groove

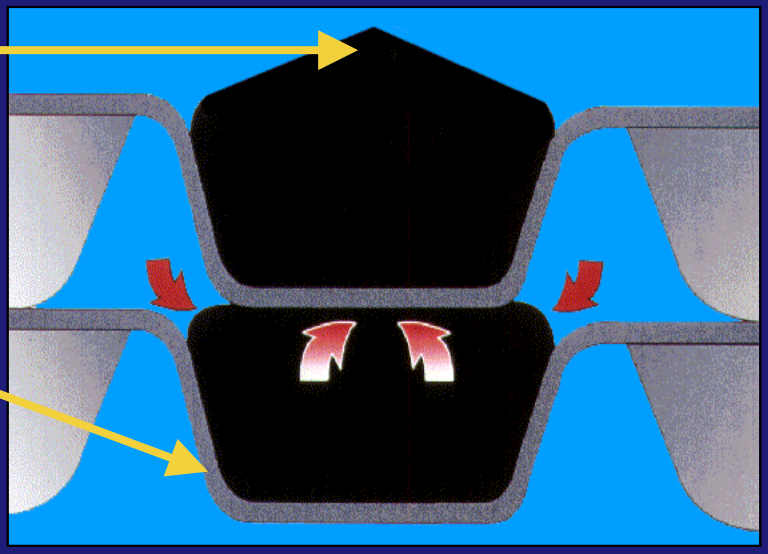
Alfa Laval

Profile

Higher sealing pressure

Groove

Full support to gasket



Gasket - materials

- The choice of rubber material depends on
  - Fluids - chemical attack or not
  - The combination of temperature and pressure
- Rubber materials change properties due to
  - Time - the rubber relaxes
  - Temperature - the rubber deteriorates
  - Hardening by attack of oxidising agents (e.g., oxygen in air)
  - Swelling or softening by absorption of chemicals in the fluids
- Common gasket types
  - Nitrile
  - EPDM
  - FKM

Gasket - materials

- Nitrile
  - Inexpensive standard material up to 130°C
    - NBR P (performance) up to 130°C
    - NBR B (base) inexpensive for lower temperatures
  - Application related NBR qualities
    - NBR HTF - food grade for high temperatures
    - NBR LT - for low temperature in refrigeration applications
    - H NBR (hydrogenated) for duties where normal NBR swells and for higher temperatures, more expensive

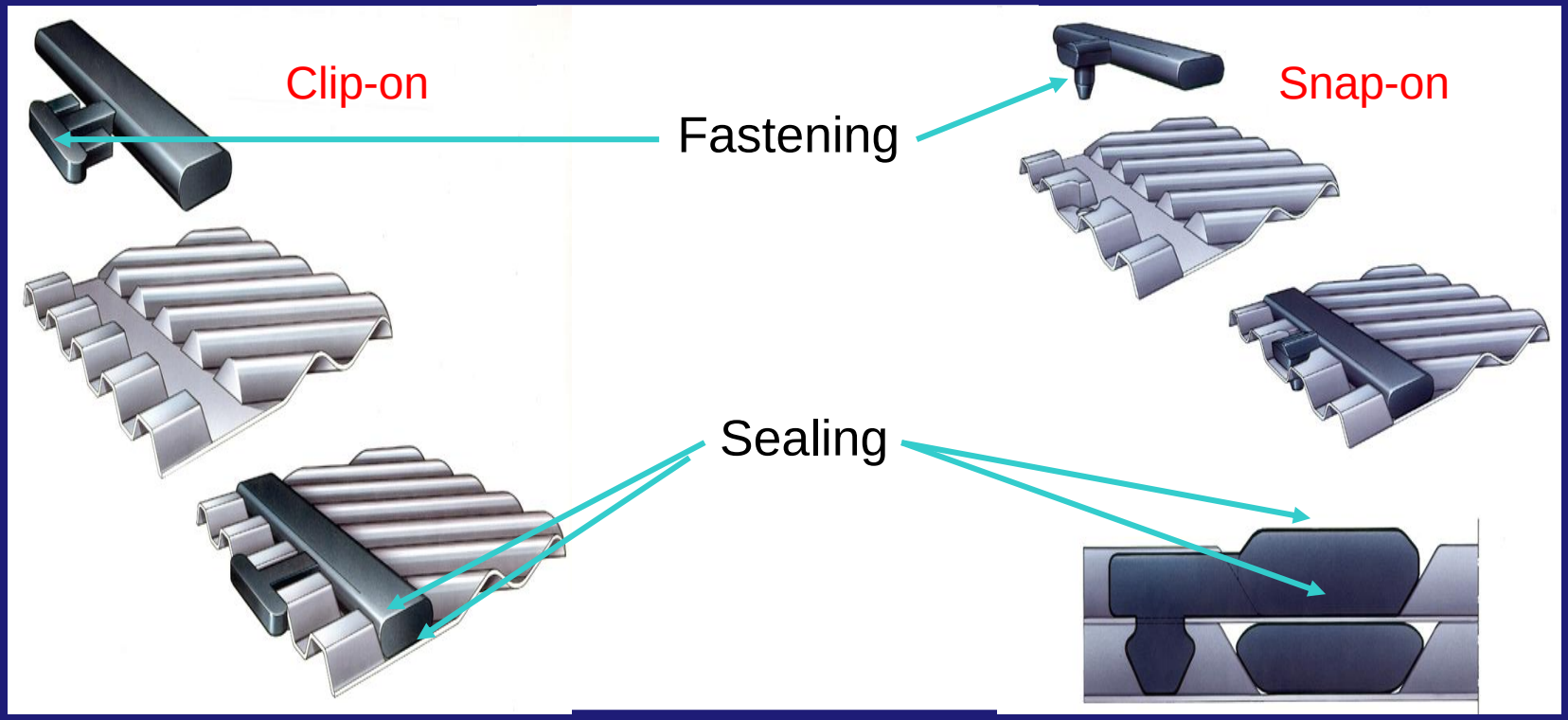
Gasket - materials

- EDPM
  - Standard material up to 160 °C
  - Standard EPDM qualities
    - EPDM for glued gaskets (“Crushing resistant”)
    - EPDMC for clip-on gaskets at high temperature
    - EPDMCT as above but for thin gaskets in models with low pressing depth (1.5-3 mm)
  - **Application related EPDM qualities**
    - **EPDMF - food grade**
    - **EPDM AL for increased pressure resistance in certain chemical duties where normal EPDM swells**

Gasket - materials

- FKM, Fluorocarbon rubber
  - Often called Viton (DuPont trade name)
  - Used for aggressive chemical compounds
    - Sulphuric acid
    - Aromatic organic compounds
    - Chlorinated organic compounds
  - Two different qualities used (GST- FOR TEMP RANGE)
    - FKM G -
    - FKM S
    - T -
- Other types are Neopren, Hypalon, Chloroprene, etc.

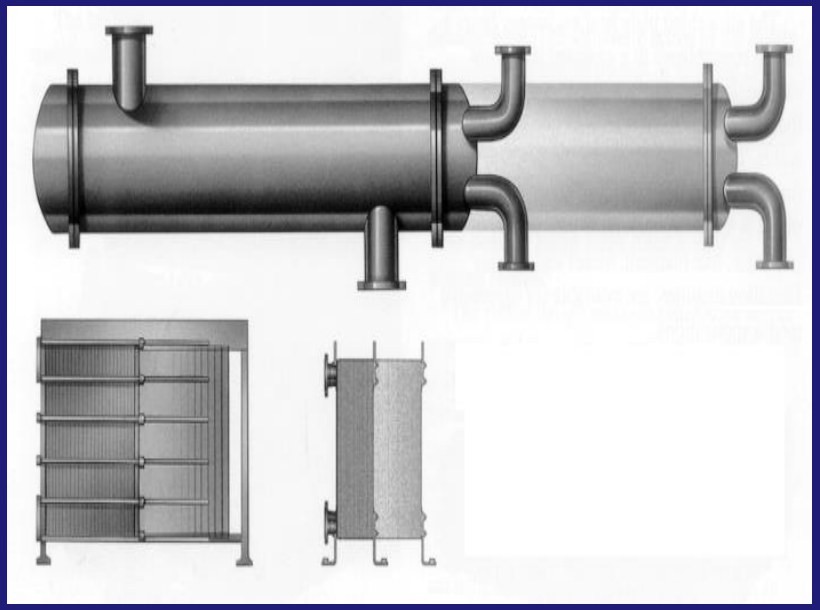
Gasket - glue free fastening



- Fastening and sealing are kept separate
- If the one of the fastener breaks, the gasket still stays sealed
- Clip-on is mostly used (snap-on on a few older models)

Edge over the Shell &Tube HEs

- High thermal efficiency
- High heat transfer coefficient
- Close temp. approach - 1 Deg. C
- True counter current
- Low holder fouling
- Low Fouling
- Flexibility
- Compact dimensions
- Low weight
- Ease in opening & cleaning
- Multi duty in single unit
- No insulation
- Vibration free



	PHE	S&T
Weight ratio	1	6
Space ratio	1	7
Hold-up volume	1	10

Plate heat exchanger

Performance limits

- **Maximum operating pressure** — **Normal - 10 - 16 barg**; **Special - 25 - 30 barg**
- **Maximum temperature** — **Normal - 160 Deg C**; **Special - 180 Deg C**
- **Maximum flow rate(in single PHE)** — **3,600 M3 / Hr**
- **Heat transfer area(in single PHE)** — **2,200 M2**
- **Plate thickness** — **0.4 mm to 1.0 mm**; **Standard - 0.5 to 0.6 mm**
- **Plate gap** — **Normal - 2.5 - 5.0 mm**; **Wide gap- 8.0 -16.0 mm**

Current GPHE range

- We have Four different PHE ranges
  - A-serie PHE
    - Some units remaining from an old serie (1970 and 1980)
  - M-serie PHE
    - The majority of our range , Modern type (1990s)
  - V-series – NOT MFG NOW
    - Came through the Vicarb acquisition
  - T-serie PHE
    - Most Modern types introduced mainly during the 2000s

Plate pack - channel plates

- Channel Plates are the heat transfer plates
- They dominate the plate pack
- Most frequently with 4 holes punched

Plate pack - end plate

- **1st plate at the carbon steel frame plate**
- **In multi-pass, 1st plate in each pass**
- **Prevent the fluids from coming in contact with the painted carbon steel frame plate**
- **All 4 ports sealed off**
- **Transports the fluids**
  - **From the connections in the frame plate**
  - **To the first channel plate**
- **Usually in 0.6 mm with high-theta**

(On older models the End Plate II is at the end of the plate pack)

Plate pack assembly

- Channel Plate
- End Plate II
- End plate I
- Turn Plate
- Transition Plate
- Partition Plate
- Connection Plate

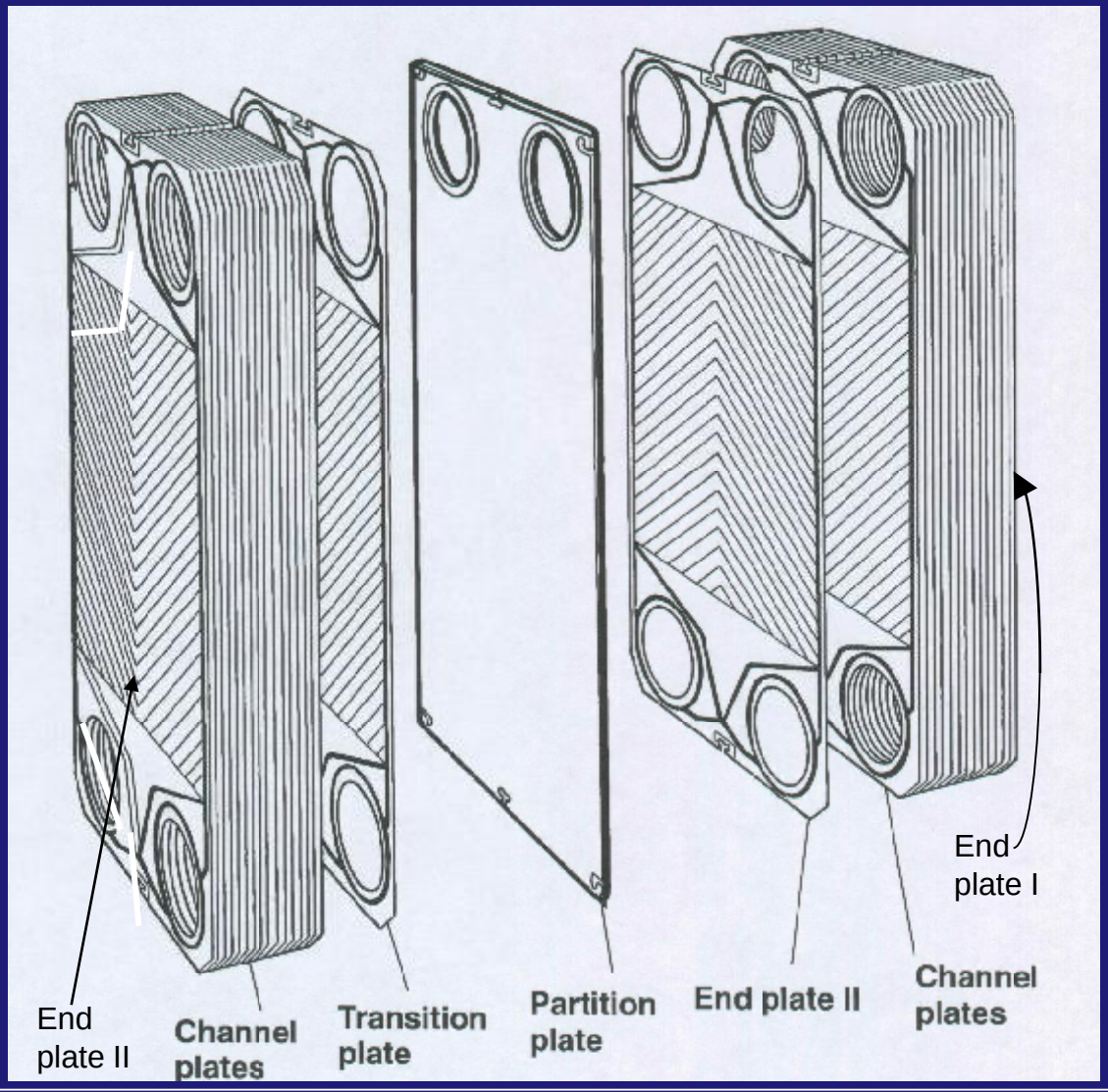
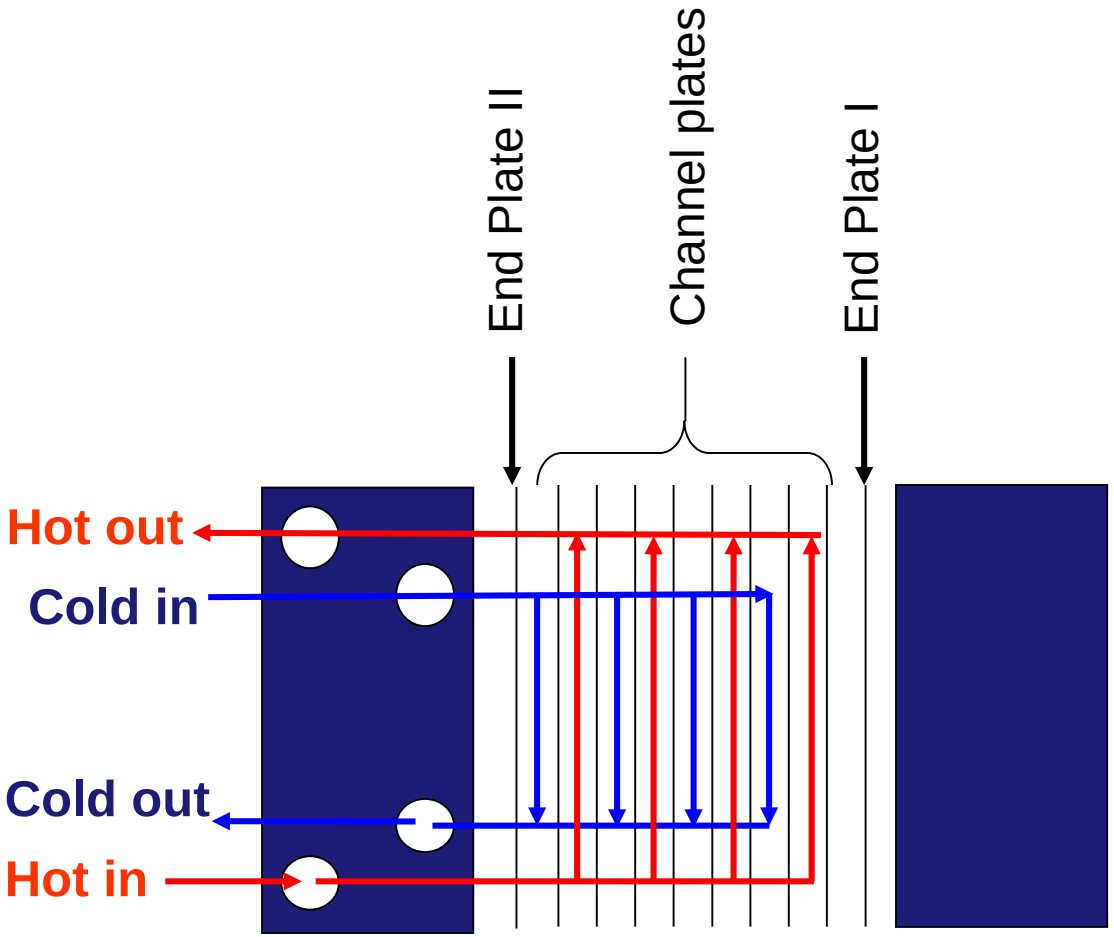
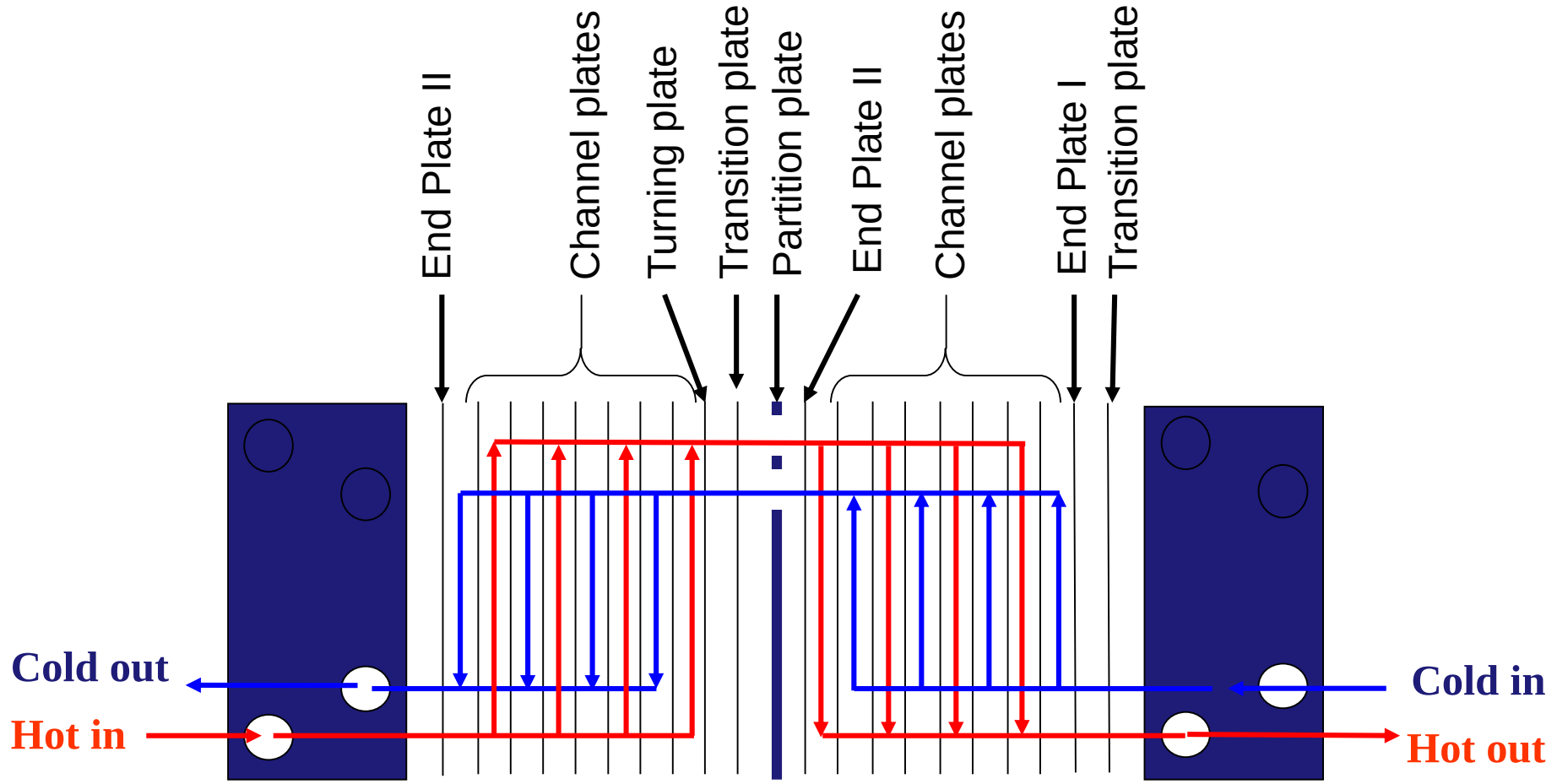


Plate pack - example single pass



Only 2 plates that do not transfer heat - the endplates

Plate pack - example two pass



3 plates in each pass that do not transfer heat

Plate pack - turning plate

- Used in multi-pass
- 1, 2 or 3 port can be unholed
- Change the flow direction of one or both fluids in between the passes
- Normal channel plate gasket

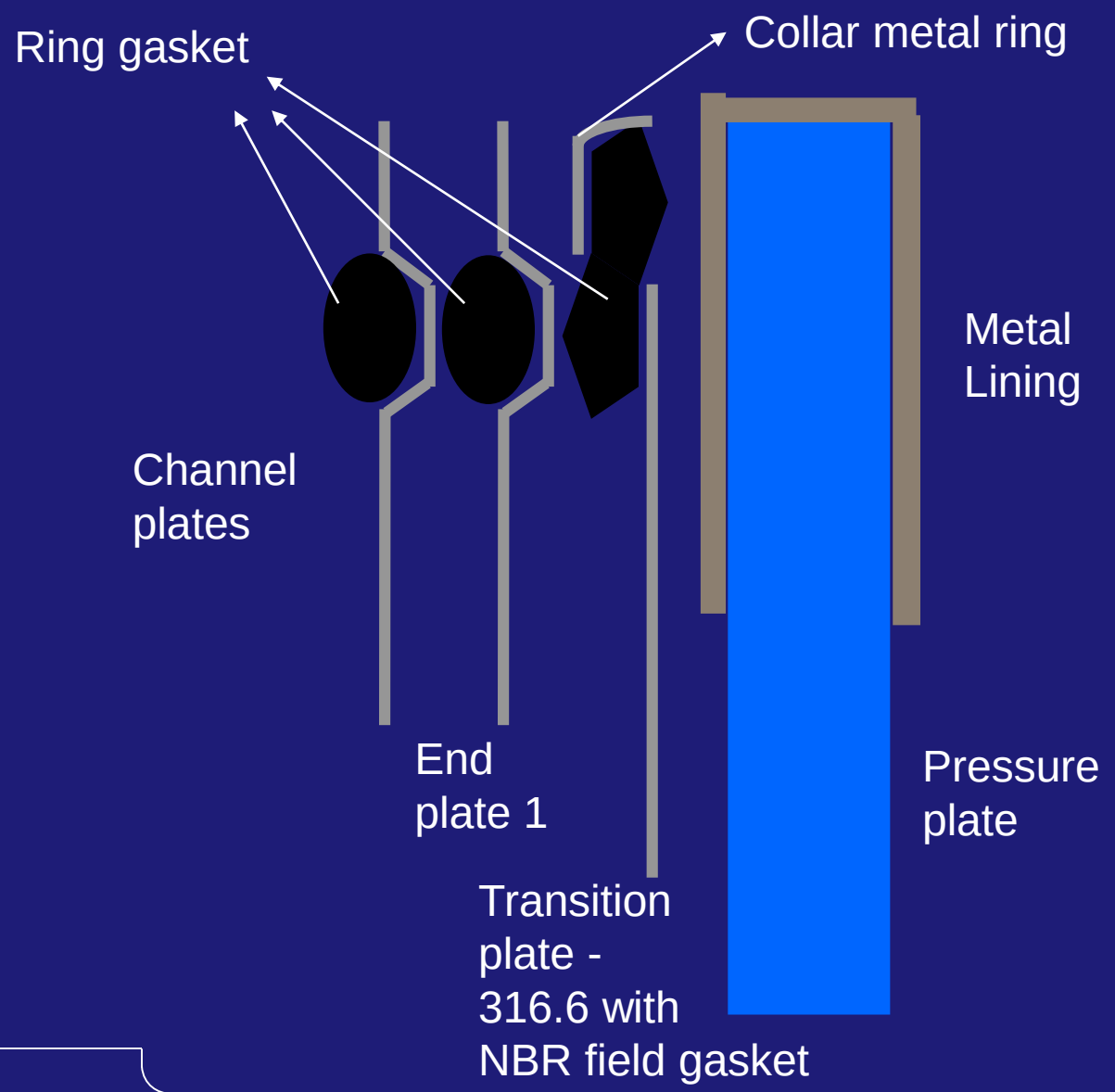
Plate pack - partition plate

- Used in multi-pass
- Solid carbon steel plates (6-12 mm thick)
- Metal ring in same material as the plate pack
- Used behind turning plates to support it from the pressure of the flow in the unholed port

Plate pack - transition plate

- Used in multi-pass
- Last plate in each pass (behind Turning plates and End plate I)
- Prevents the fluids to come in contact with partition plates and the pressure plate
- Special port ring-gaskets
  - Protrude through the plate
  - Allows a seal on both sides of the plate
  - Lined on the inside perimeter with a metal ring
- Always, plate in AISI 316 and field gasket in NBR
- Metal ring in the same material as the plate pack
- Ring gaskets in the same material as the plate pack

Transition plate concept



- Special port ring-gaskets that protrude through the plate
- Allowing the plate to seal on both sides
- Lined on the inside perimeter with a metal ring.

Plate pack – Connecting Plate

- Used in Multisection cladded/Hygenic PHE

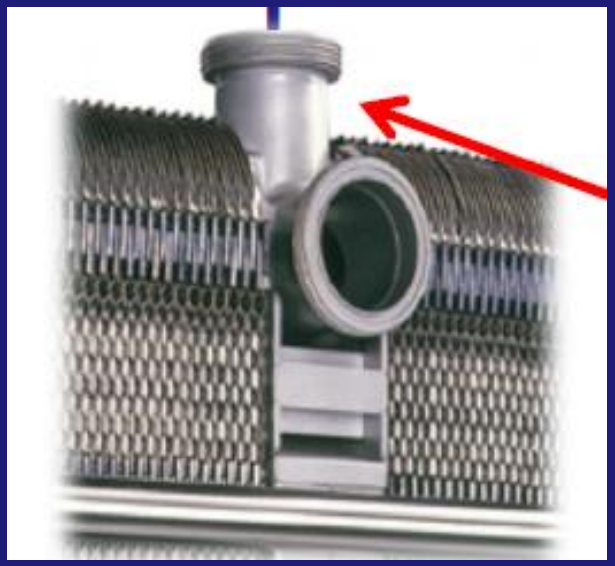
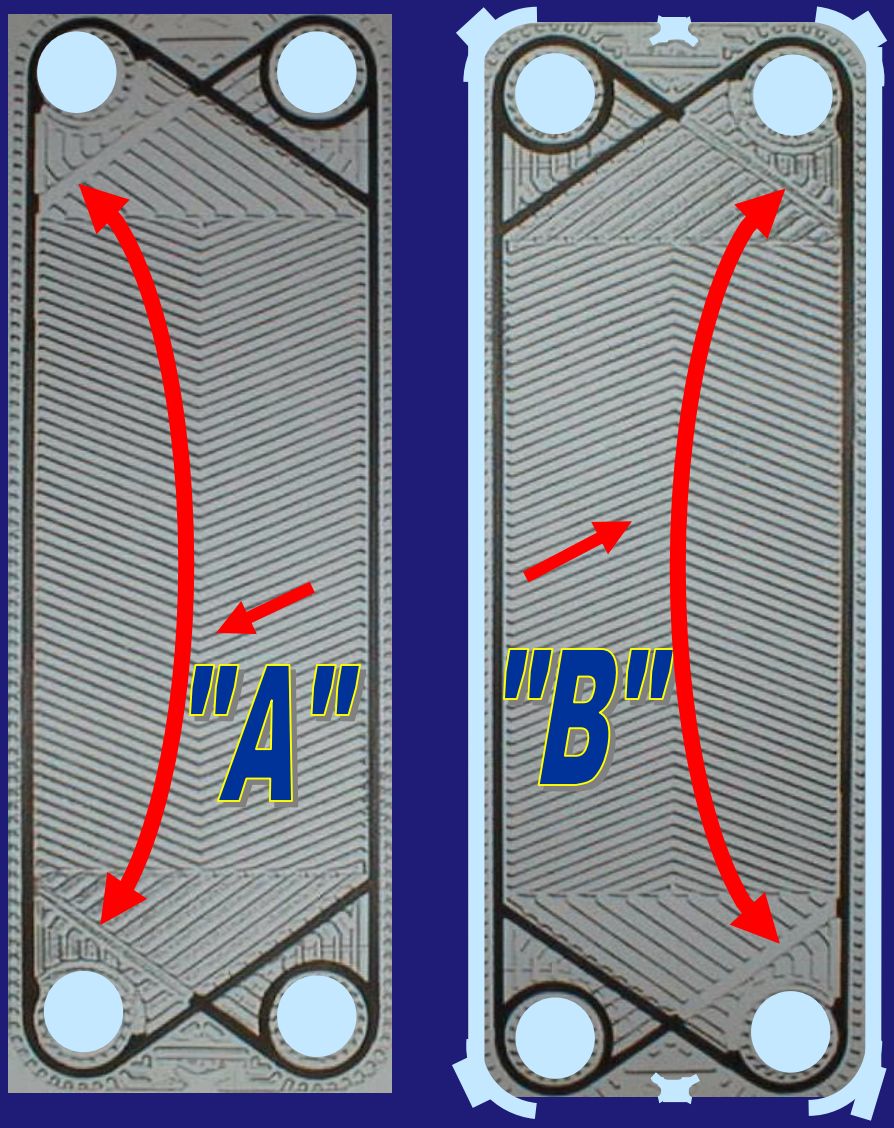


Plate pack – Distance sheet

- Used in Semiwelded PHE, between Frame Plate and End plate -I and If connections are on Pressure plate, between Pressure plate and End plate-II.

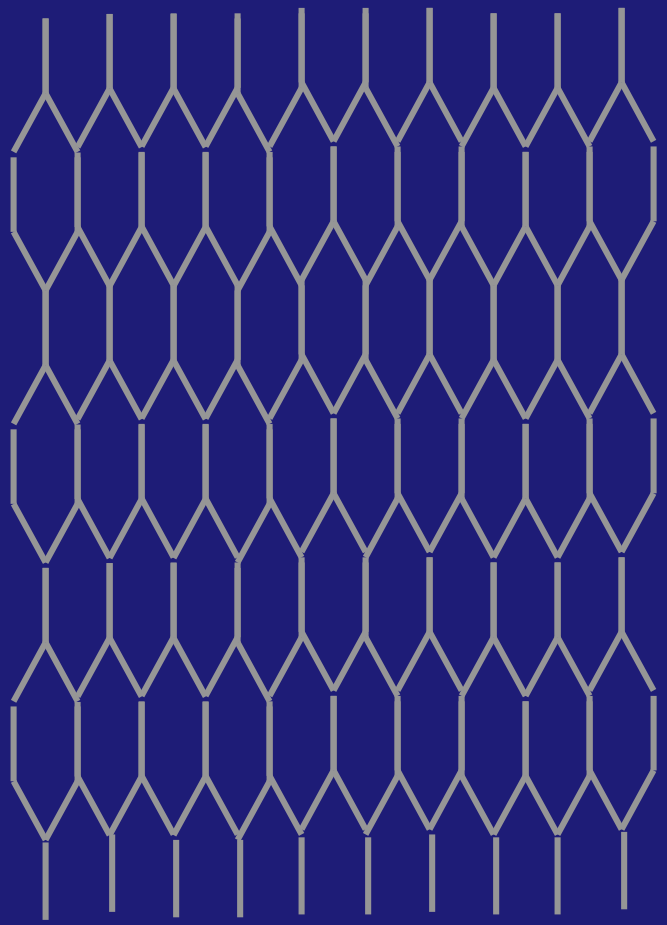
Chevron Direction Parallel Flow

- Upward pointed “Chevron” pattern = B position
- Flow direction from upper left to lower left.
- Opposite = A position
- “A” plate turned upside down becomes a “B” plate



Honeycomb Pattern

- The plate edges are corrugated in such manner that they form a honeycomb pattern. This provides mechanical support and a visual aid that the plates have been correctly hung in the frame.



Honeycomb Pattern

- Improperly hung plates, or those which do not alternate A,B,A,B….. will disrupt the honeycomb pattern.

Alfa Laval- Heat exchangers

Unique Features of Our *PHE!

- Adjustable Feet for easy installation on site without reworking on pipes.
- Higher stability with two point feet on supporting columns
- Carrying bar with hygienic design.
- Key Hole Bolt Opening for ease of maintenance.
- Bearing Boxes & Lock Washer for manpower and energy saving during maintenance.
- Chocolate Distribution Pattern for uniformity and for reducing microbi growth.

Alfa Laval- Heat exchangers

- **Unique Features of Our *PHE!**
- Roof Top/Rib gaskets for uniform pressure and durability
- Elongated Nut for greater ease of opening during maintenance
- Material traceability for the material used for manufacturing the PHE

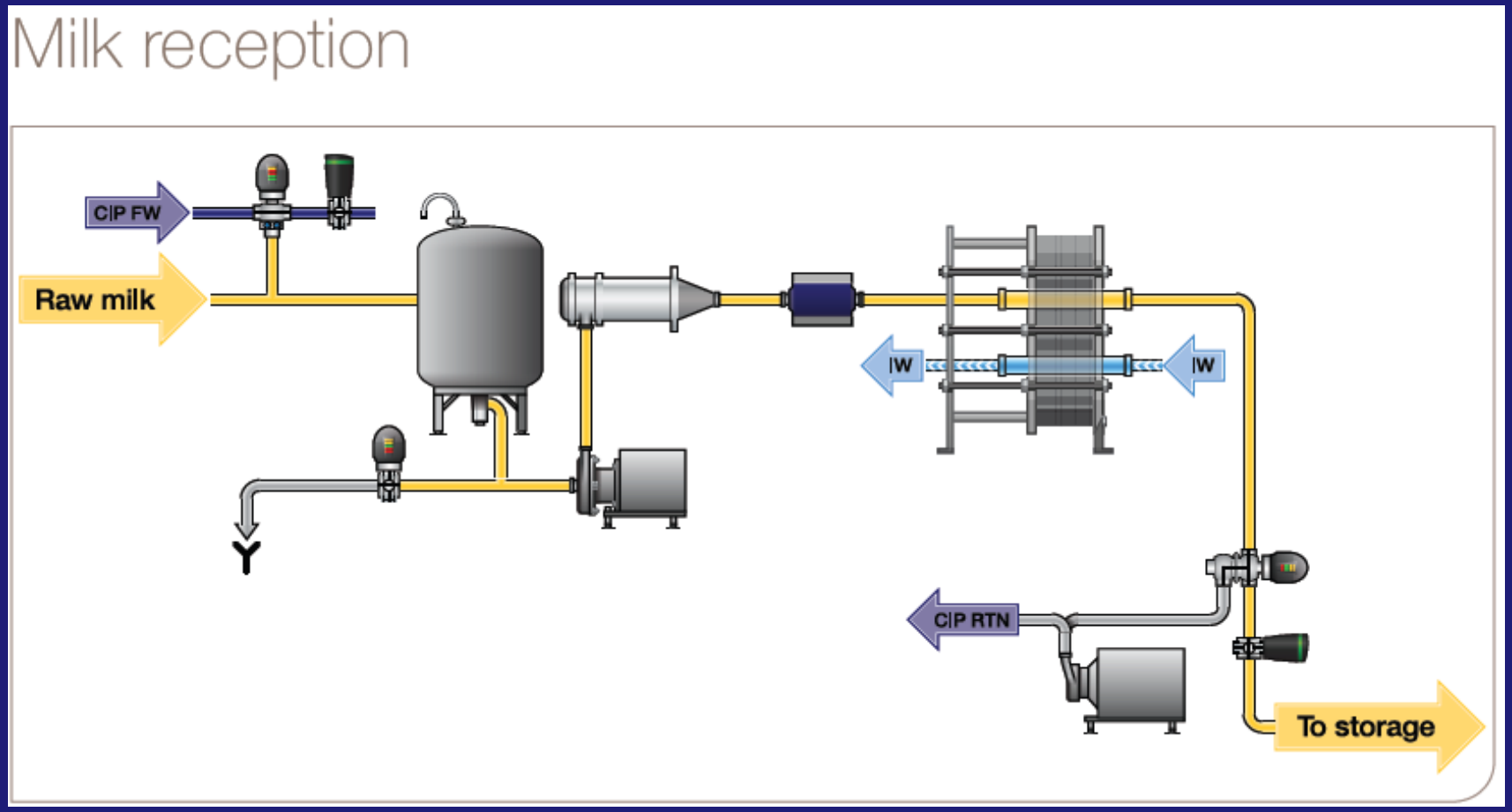
Dairy process – Heat exchanger positions

- Milk Chiller
- Milk Pasteurizer
- Milk Heater
- Cream pasteurizers
- Utility Heat exchangers

Dairy process – Heat exchanger

- Position 1 : Milk Chiller

Dairy process – Milk Chiller

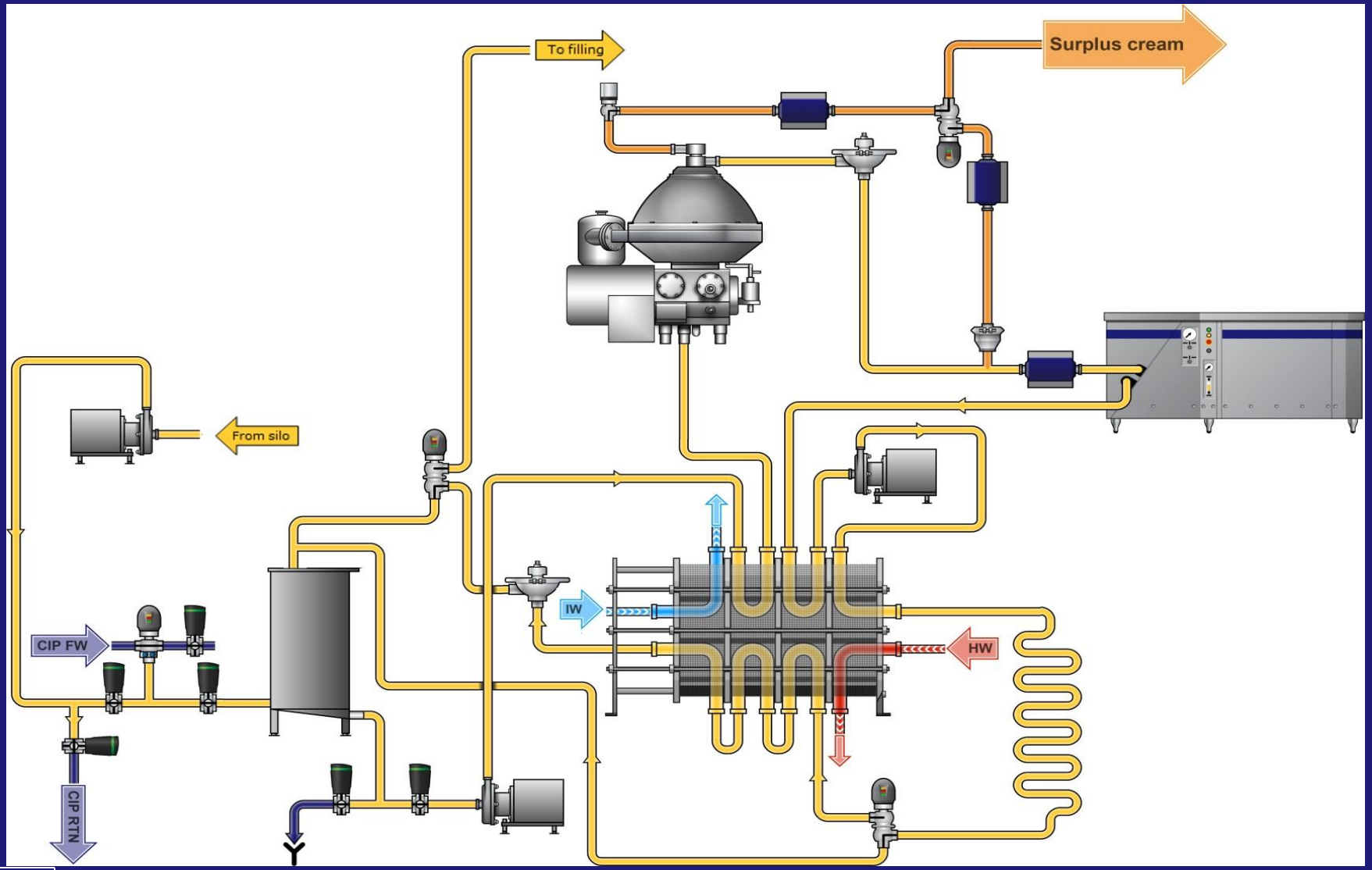


- Milk Duty : 10 °C ----- 4 °C **Or** 35 °C ------- 4 °C
- Utility : 2 °C Chilled Water

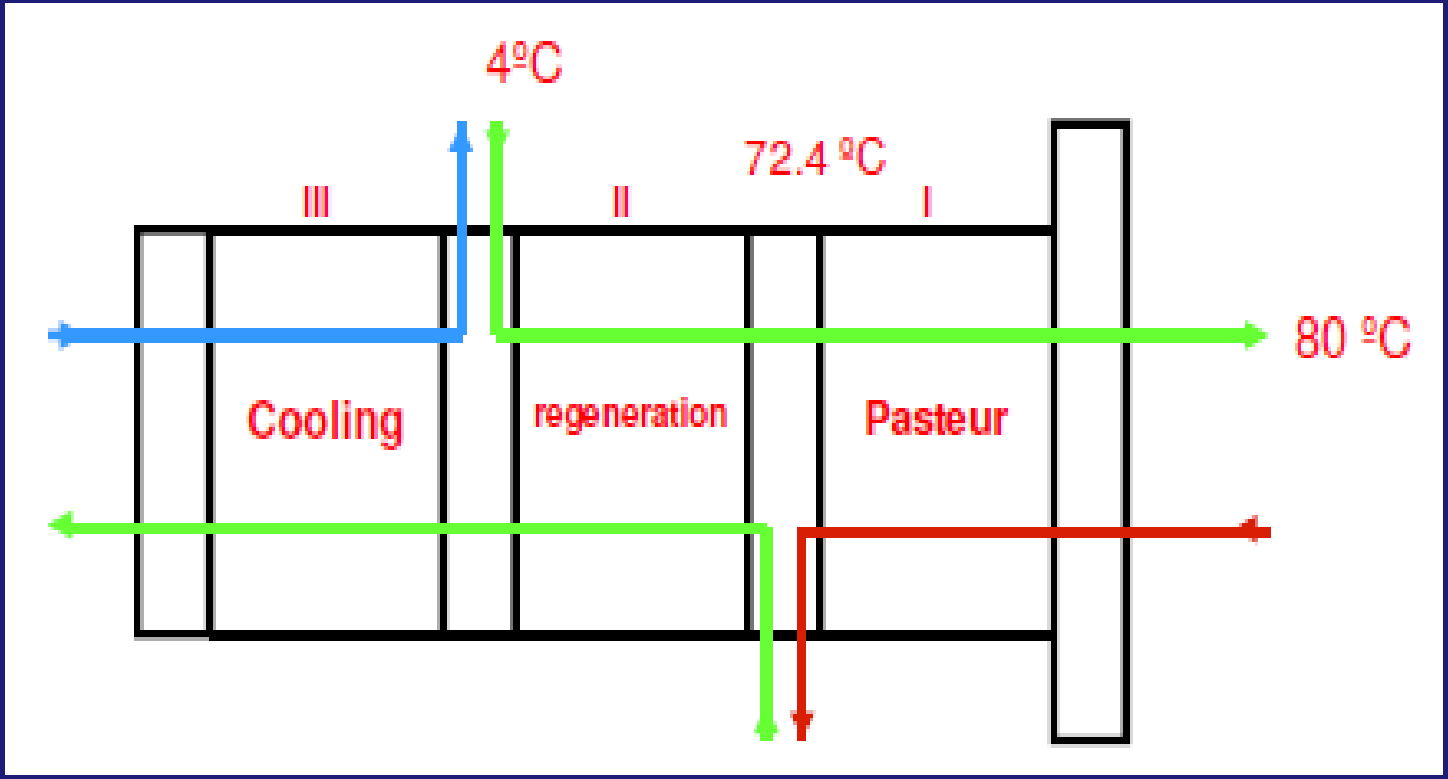
Dairy process – Heat exchanger

- Position 2 : Milk Pasteurizers

Dairy process – Milk Pasteurizers



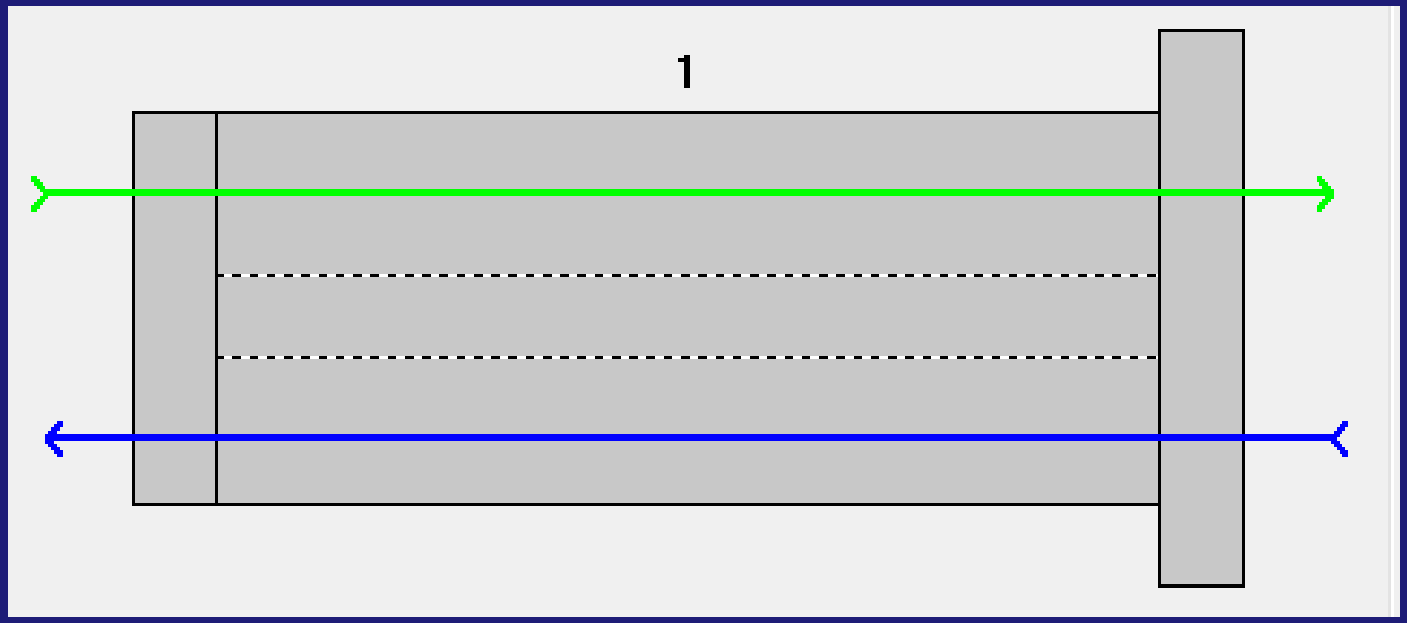
Dairy process – Milk Pasteurizers



Dairy process – continue…..

- Position 3 : Milk Heater

Dairy process – 3 : Milk Heater



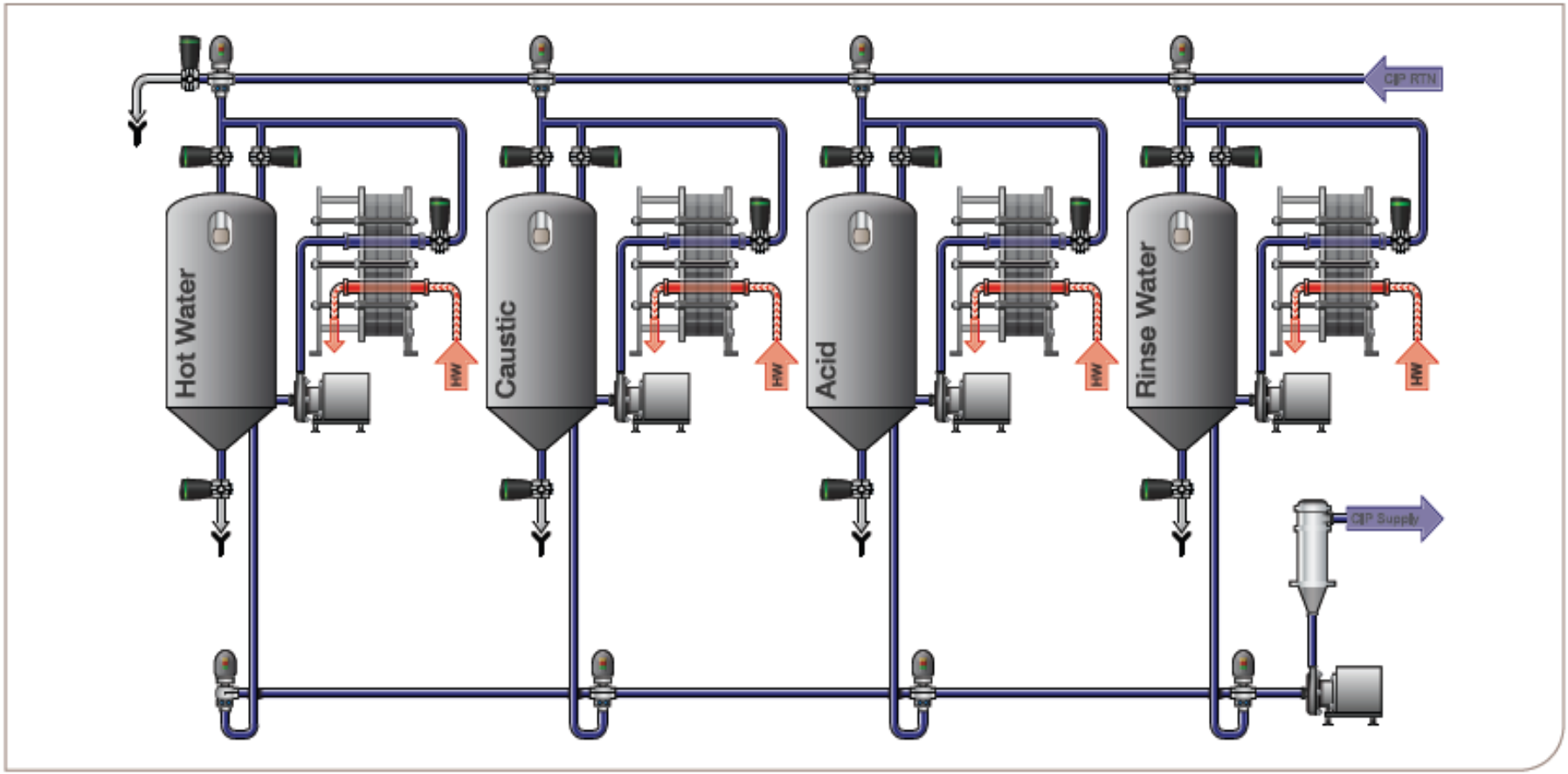
- Heat Milk From 4 °C to 42 °C Using Hot Water,
- Mainly for Curd manufacturing plant before sending it to Inoculation / Fermentation

Dairy process –

- Position 4 : Cream Pasteurizer

Dairy process – : Utility/CIP PHE's

Cleaning-in-Place



Energy saving opportunities –Dairy Industry

- Pasteurizers
- Pumps

Energy saving opportunities –Dairy

Resource Optimization

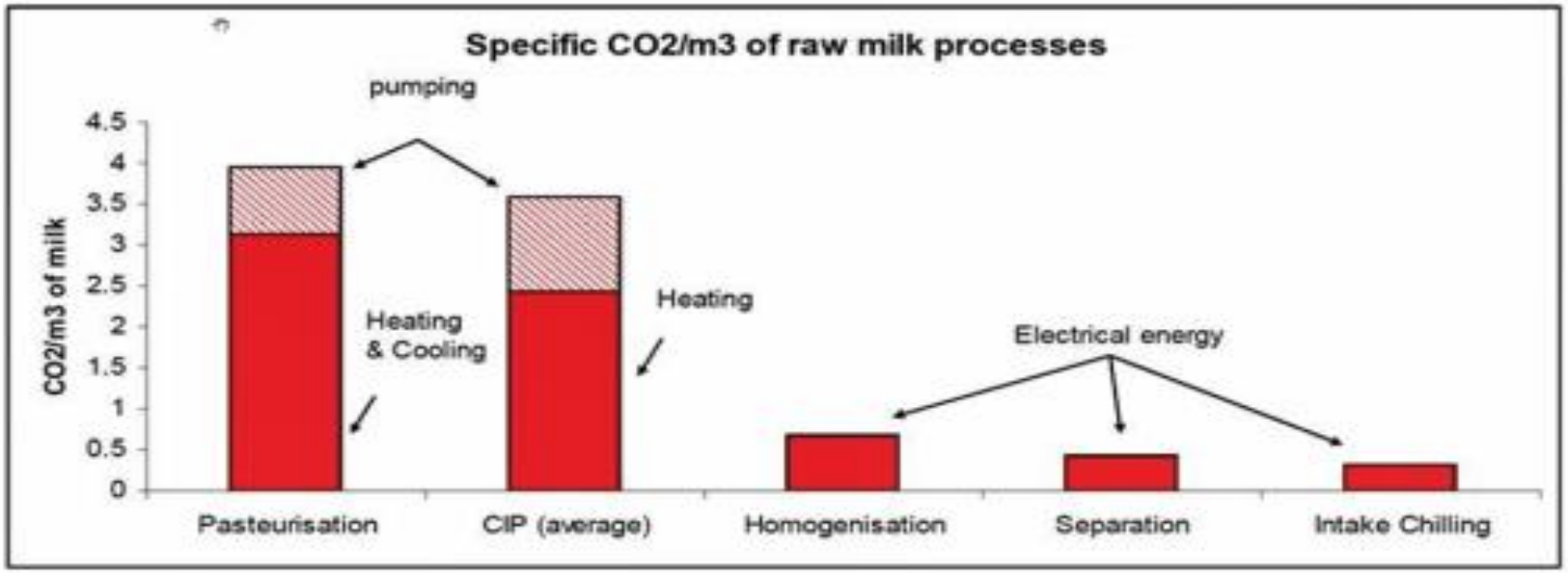


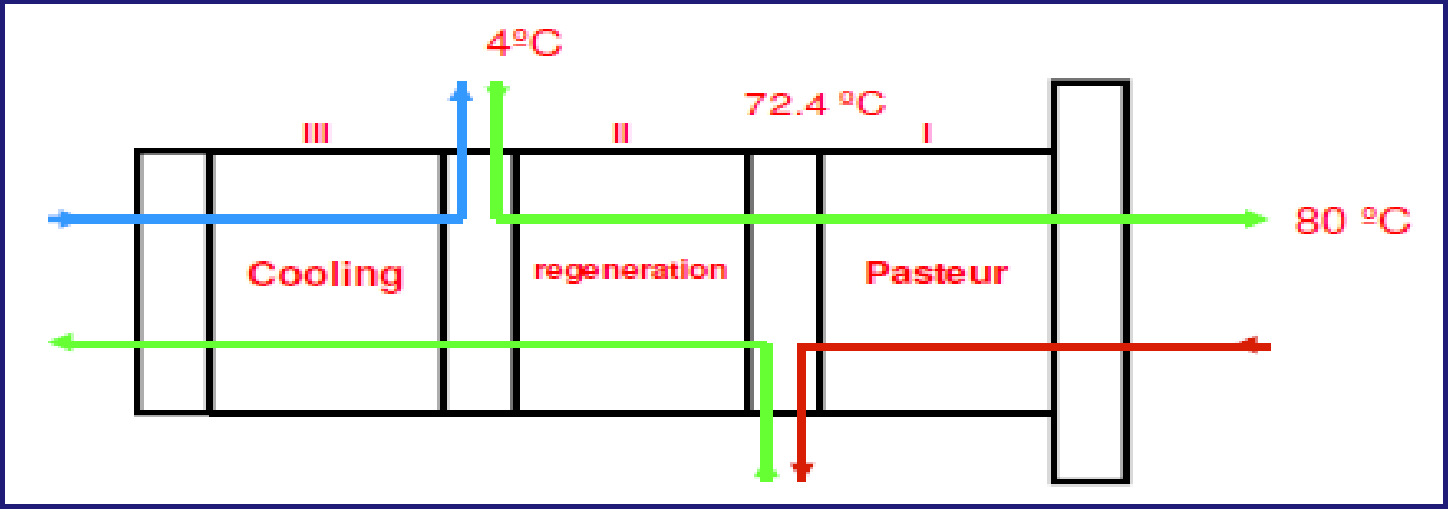
Figure 8: Relative energy intensity of raw milk processes

Energy Saving –Pasteurizer

- **Why Alfa Laval Pasteurizer Is Value for Money.**
- We understand your challenges to run a profitable dairy plant and the pressures to ensure that every rupee invested works for you.
- Therefore we have designed Pasteurizer that is operator friendly, has ease of maintenance that never let you down.
- AL Pasteurizer offers utility savings with 93% regeneration.
- With AL Pasteurizer you get guaranteed heat exchange efficiency, accuracy of temperature control and flow capacity besides flexibility of multiple applications such as Cream, Curd Milk, Ice cream and Juice Pasteurization to help you to get your ROI faster.
-

Energy Saving – Pasteurizer

- That is why our clients trusts our brand for maintaining the superior quality of their products.
- Regeneration Efficiency



- Calculation

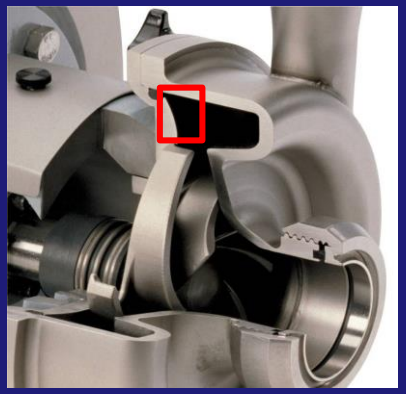
Energy Saving – Alfa Laval Pumps

Alfa Laval Pumps

1. **Always use high efficient pumps such as the Alfa Laval LKH range**
2. Always select pumps as close to their BEP (best efficiency point) as possible.
3. Use a VFD to control pump speed.
4. Select pumps at an early stage in the system design and optimize pump and system using Alfa Laval's CAS selection tool.
5. Over-speed pumps to attain the required flow and head
6. Consider a positive displacement pump for higher viscosities

Alfa Laval high efficiency pumps

Pump efficiency is amongst others determined by....



Close tolerance between impeller and back plate

provides for high pump hydraulic efficiency and low pump NPSHr, due to lower product internal recirculation. Close tolerances require High quality, precision and stronger than average casings. LKH material thickness adds up to 40mm on selected models

Optimising impeller blade geometry

allows for higher pump hydraulic efficiency and lower NPSHr (better suction capabilities means higher efficiency)

SIX ways to reduce pump energy cost

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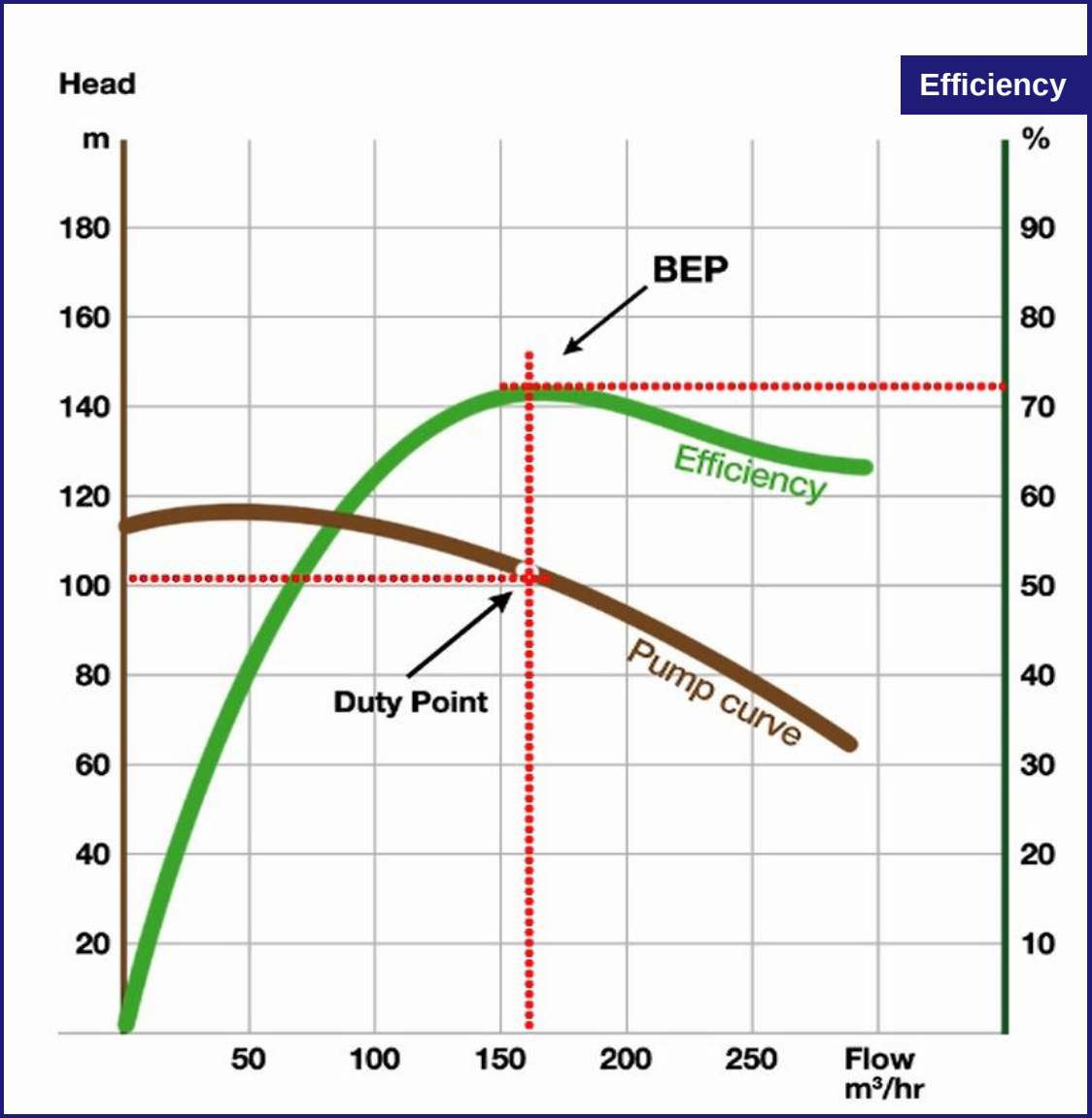
BEP – **B**est **E**fficiency **P**oint



SIX ways to reduce pump energy cost

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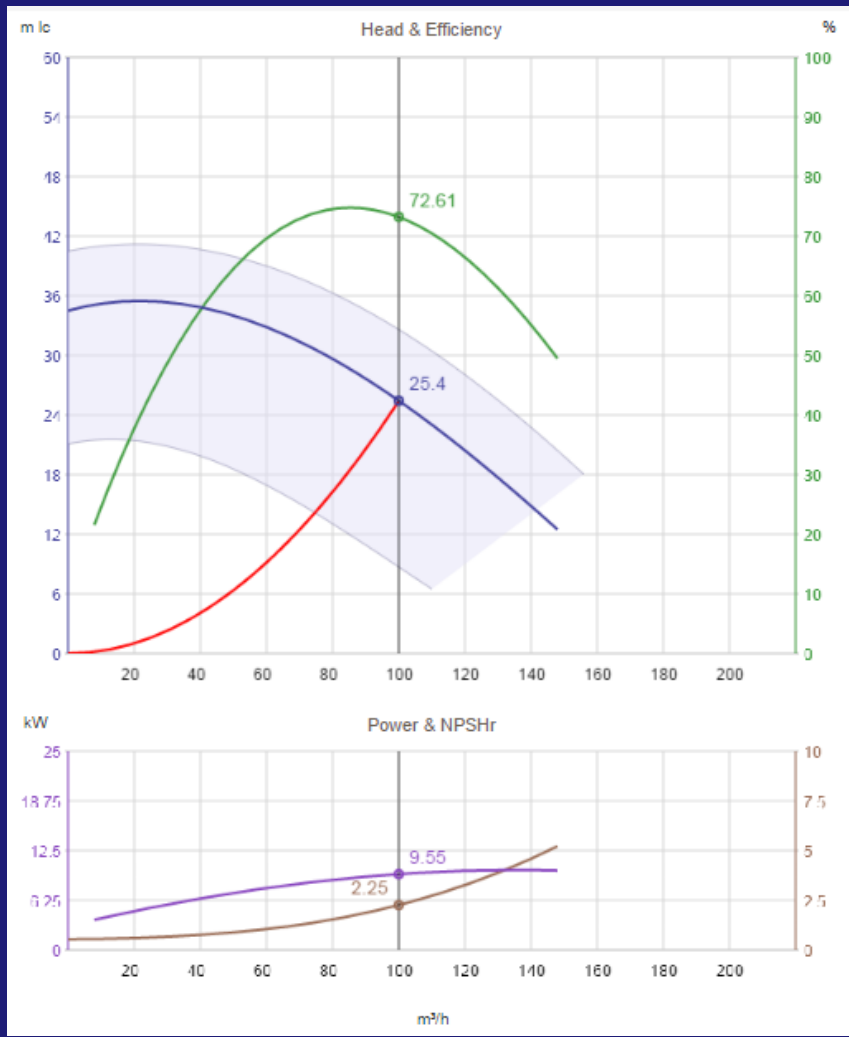
VFD instead of throttling valve

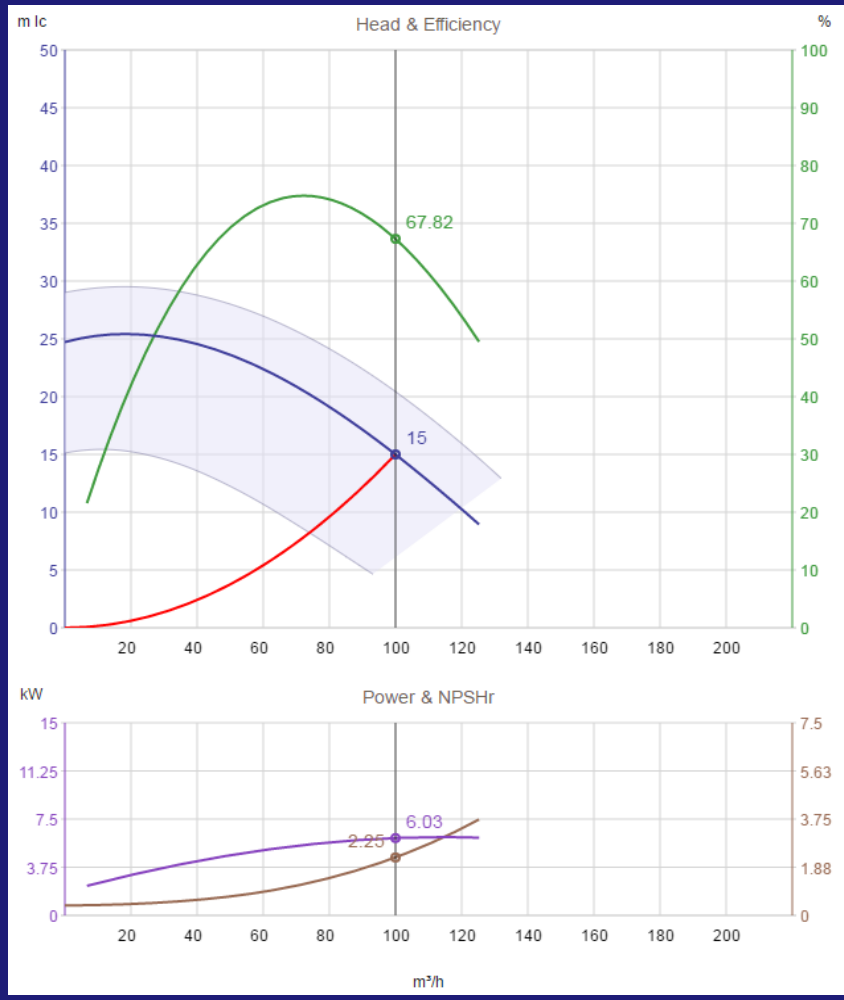
Flow (m3/hr)	% Flow	Throttled systems	VFD systems
70	100%	26 KW	26 KW
56	80%	23 KW	16 KW
42	60%	21 KW	9 KW
35	50%	20 KW	6 KW

VFD instead of throttling valve



Pump Model	LKH-45
Fluid name	Water 5°C
Speed (rpm)	2930
Diameter (mm)	168
Flow (m³/h)	100
Head (m lc)	25.4
Power (kW)	9.55
NPSHr (m lc)	2.25

VFD instead of throttling valve



Pump Model	LKH-45
Fluid name	Water 5°C
Speed (rpm)	2480
Diameter (mm)	168
Flow (m³/h)	100
Head (m lc)	15
Power (kW)	6.03 **37% savings**
NPSHr (m lc)	2.25

SIX ways to reduce pump energy cost

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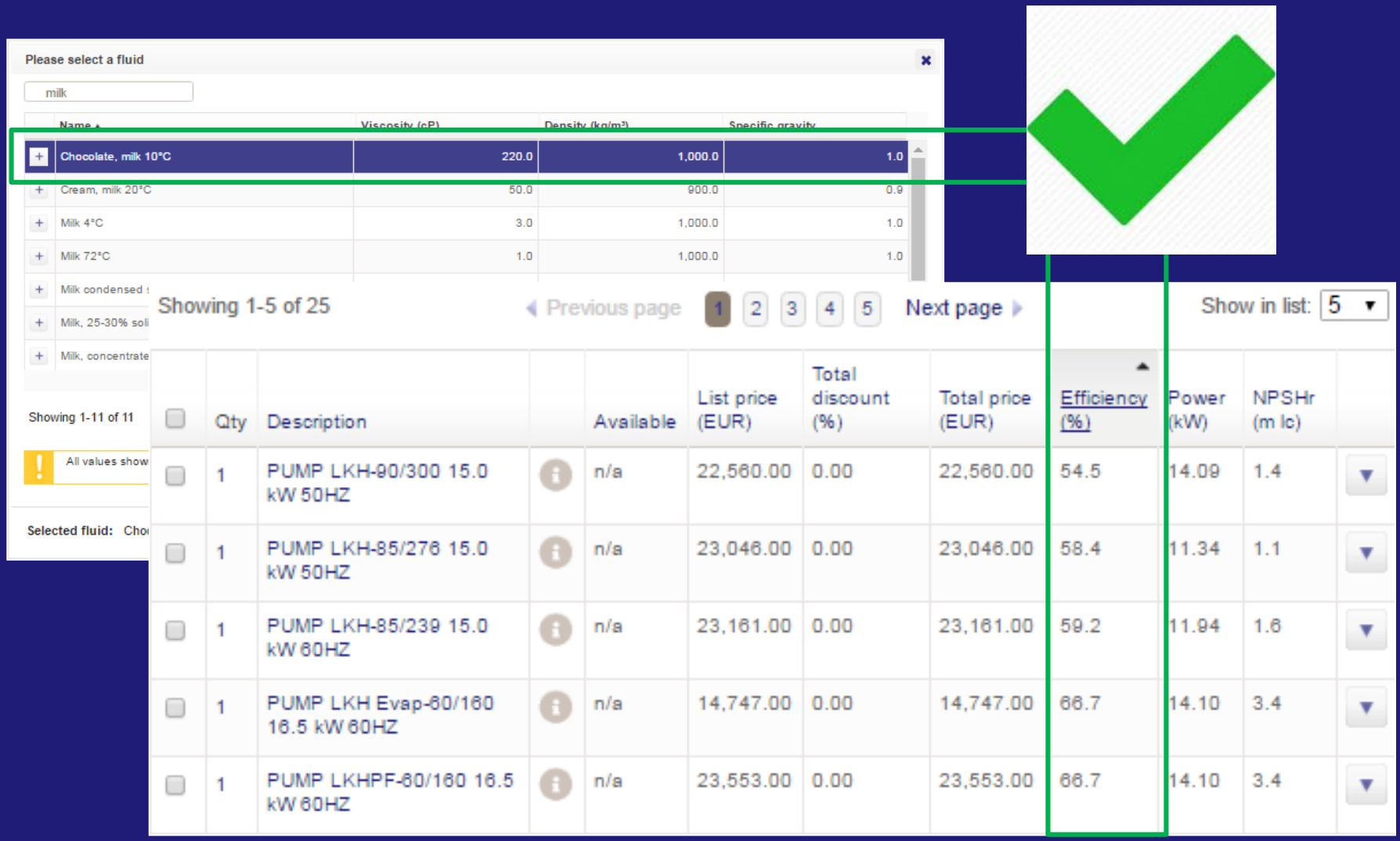
6. Consider a positive displacement pump for higher viscosities

Anytime pump sizing optimization



SIX ways to reduce pump energy cost

1. Always use high efficient pumps such as the Alfa Laval LKH range
2. Always select pumps as close to their BEP (best efficiency point) as possible.
3. Use a VFD to control pump speed.
4. Select pumps at an early stage in the system design and optimize pump and system using Alfa Laval's Anytime selection tool.
5. **Over-speed pumps to attain the required flow and head**
6. Consider a positive displacement pump for higher viscosities

5. Overspeeding pumps

Required flow (m³/h)	70.0
Head (m lc)	70.0

	Qty	Description		Available	List price (EUR)	Total discount (%)	Total price (EUR)	Efficiency (%)	Power (kW)	NPSHr (m lc)	
☑	1	PUMP LKH-70/226 22.0 kW 50HZ		n/a	20,393.00	0.00	20,393.00	64.3	20.57	1.9	

	Qty	Description		Available	List price (EUR)	Total discount (%)	Total price (EUR)	Efficiency (%)	Power (kW)	NPSHr (m lc)	
☑	1	PUMP LKH-25/203 21.0 kW 60HZ		n/a	12,921.00	0.00	12,921.00	68.5	19.46	3.3	

Note - If increase impeller diameter then actual speed will be 58 HZ

SIX ways to reduce pump energy cost

1. Always use high efficient pumps such as the Alfa Laval LKH range
2. Always select pumps as close to their BEP (best efficiency point) as possible.
3. Use a VFD to control pump speed.
4. Select pumps at an early stage in the system design and optimize pump and system using Alfa Laval's CAS selection tool.
5. Over-speed pumps to attain the required flow and head
6. **Consider a positive displacement pump for higher viscosities**

Maintenance :

- Benefits of Alfa Laval PHE’s

- Adjustable Feet for easy installation on site without reworking on pipes.
- Higher stability with two point feet on supporting columns
- Carrying bar with hygienic design.
- Key Hole Bolt Opening for ease of maintenance.
- Bearing Boxes & Lock Washer for manpower and energy saving during maintenance.

Maintenance :

- Benefits of Alfa Laval PHE’s

- Roof Top/Rib gaskets for uniform pressure and durability
- Elongated Nut for greater ease of opening during maintenance
- Well established service network for spares and maintenance

Thank You.

B. R. Khot

S. Lakshmanan

Nilesh Shirke

ALFA LAVAL INDIA