



## Low Charge, Energy Efficient Ammonia Evaporator with Separator Vessel

Rolf Christensen, June 2014





# — a global company



- 3500 M€ order intake 2013
- >16300 employees
- 34 Production units\*
- 106 Service centres
- Sales companies in 55 countries
- Other sales representation in 45 countries

\* Plus a number of minor production and assembling units



# – a global company



June 18-19, 2014 - San Francisco

Alfa Laval aims at creating better everyday conditions for people by providing highly efficient and environmentally responsible solutions for water supply, energy production and food.

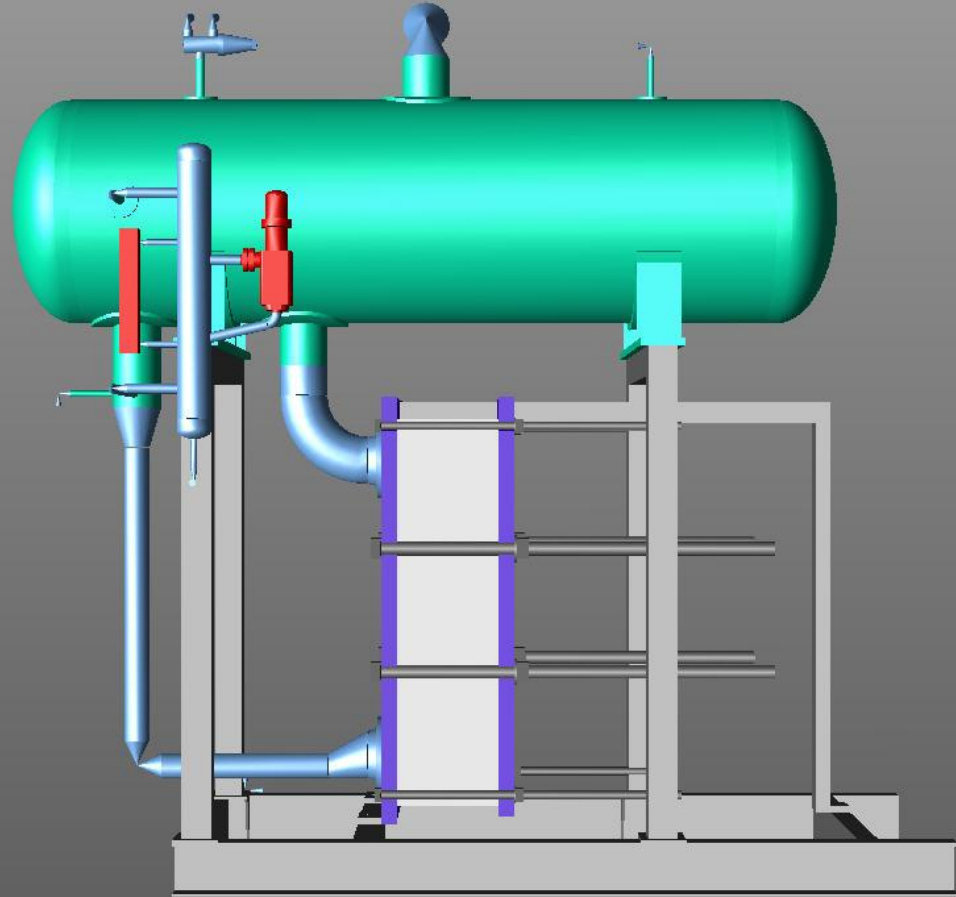
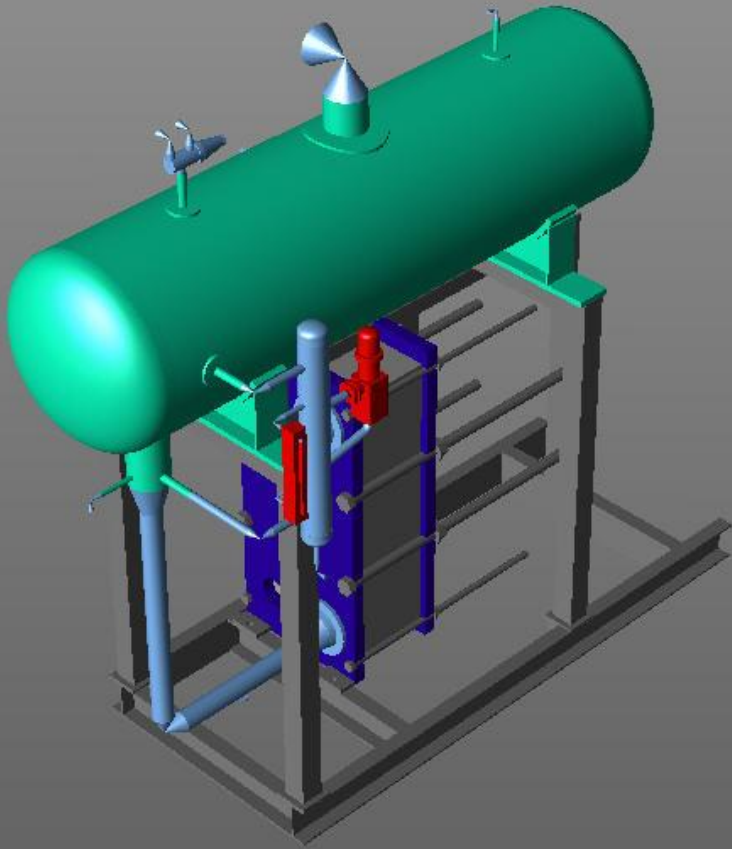


## Focus in refrigeration

- Energy efficiency
- Heat recovery
- Heat pumps
- Natural refrigerants
  - CO<sub>2</sub>, NH<sub>3</sub> and HC
- Complete product range



# Traditional separator design



# Liquid separator function

- To accommodate surplus liquid during load variations
- To separate liquid droplets and make sure oil is returned to the compressor
- To obtain (close to) saturated gas at suction nozzle
- To provide a static head for the circulation

Additionally:

- For forced circulation systems; to obtain sufficient liquid column ( $NPSH_{PUMP}$ ) to avoid pump cavitation

# Introducing the U Turn

”energy efficient”

”compact”

”high COP”

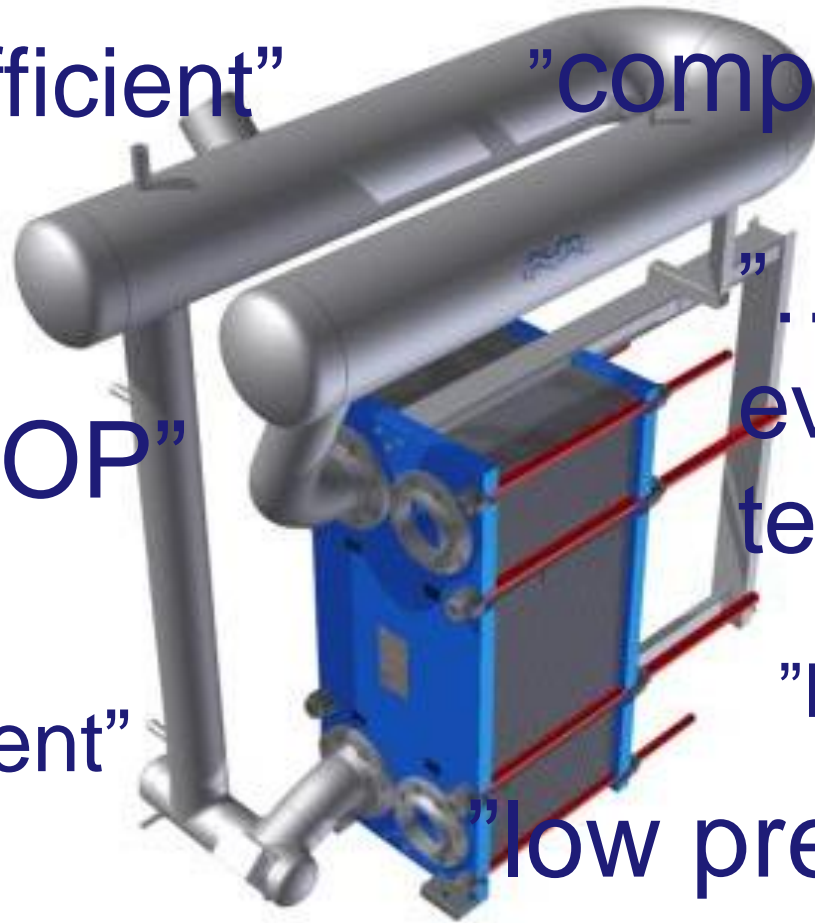
”...higher  
evaporating  
temperature”

”cost efficient”

”Easy to install”

”low pressure drop”

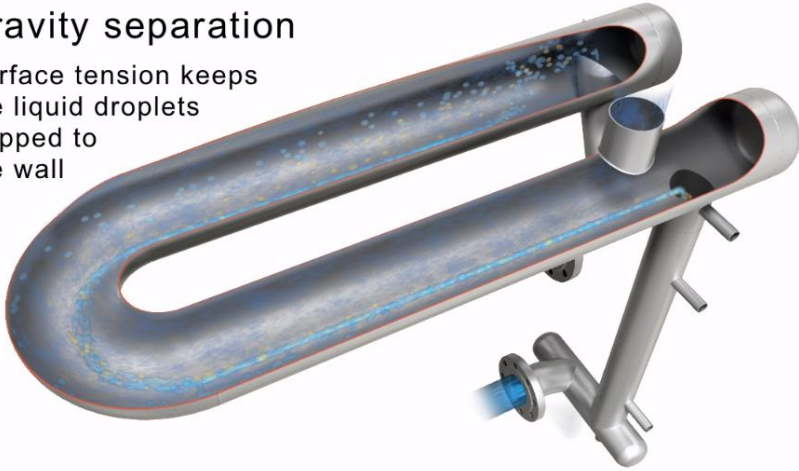
”low charge”



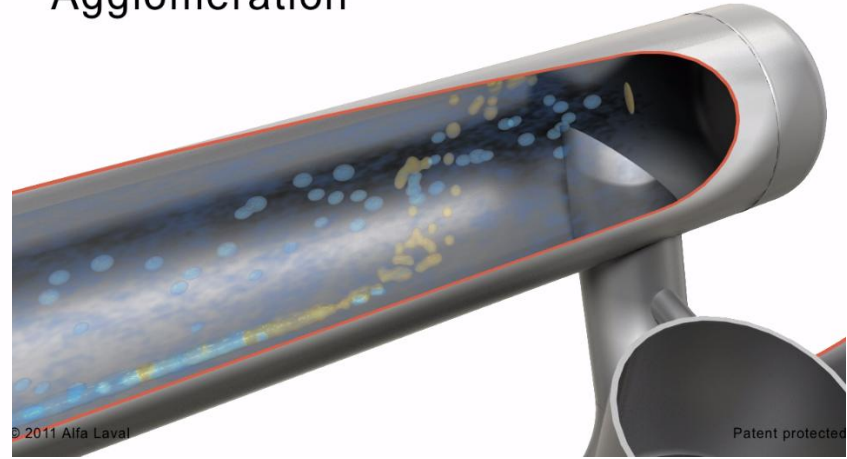
# U-Turn Working Principle

## Gravity separation

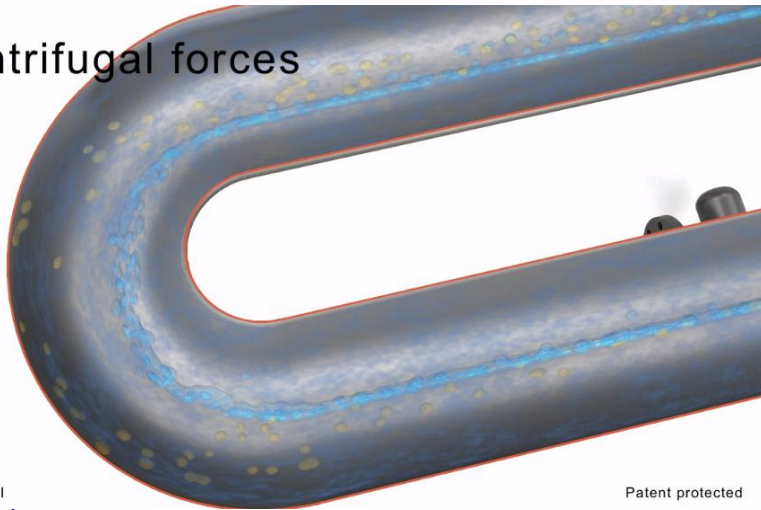
Surface tension keeps the liquid droplets trapped to the wall



## Agglomeration

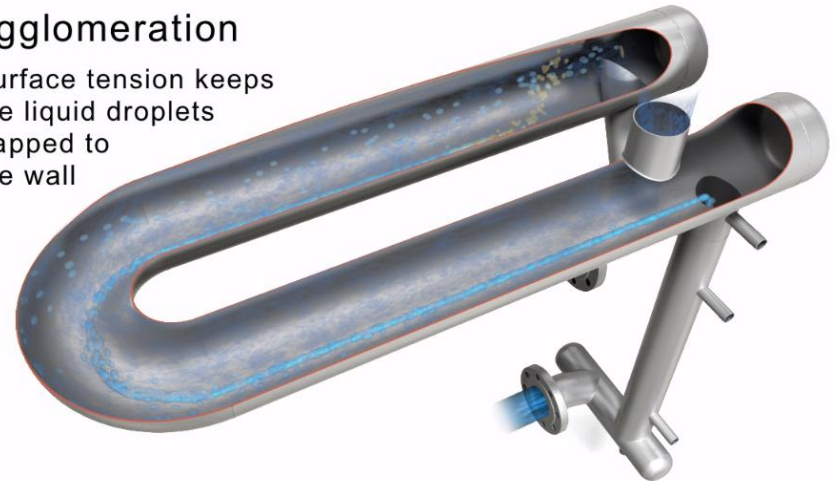


## Centrifugal forces



## Agglomeration

Surface tension keeps the liquid droplets trapped to the wall



© 2011 Alfa Laval

Patent protected

© 2011 Alfa Laval

Patent protected

© 2011 Alfa Laval

Patent protected

© 2011 Alfa Laval

Patent protected

# U-Turn separator design

Liquid injection with  
“ejector function” to  
reduce wet return  
dP

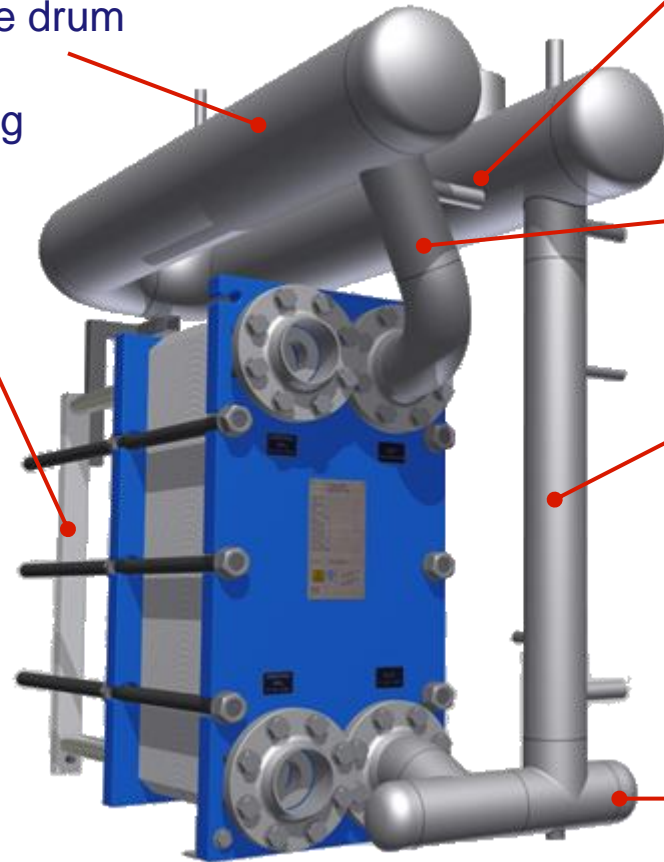
Small diameter  
surge drum

Self-supporting  
construction

Wet Return – Low  
Pressure Drop

Drop leg:  
Integrated piping  
for liquid level  
sensors and high  
level shut-off  
devices

Standard oil-pot  
included



## Advantages:

- High separation efficiency
- Low weight
- Compact

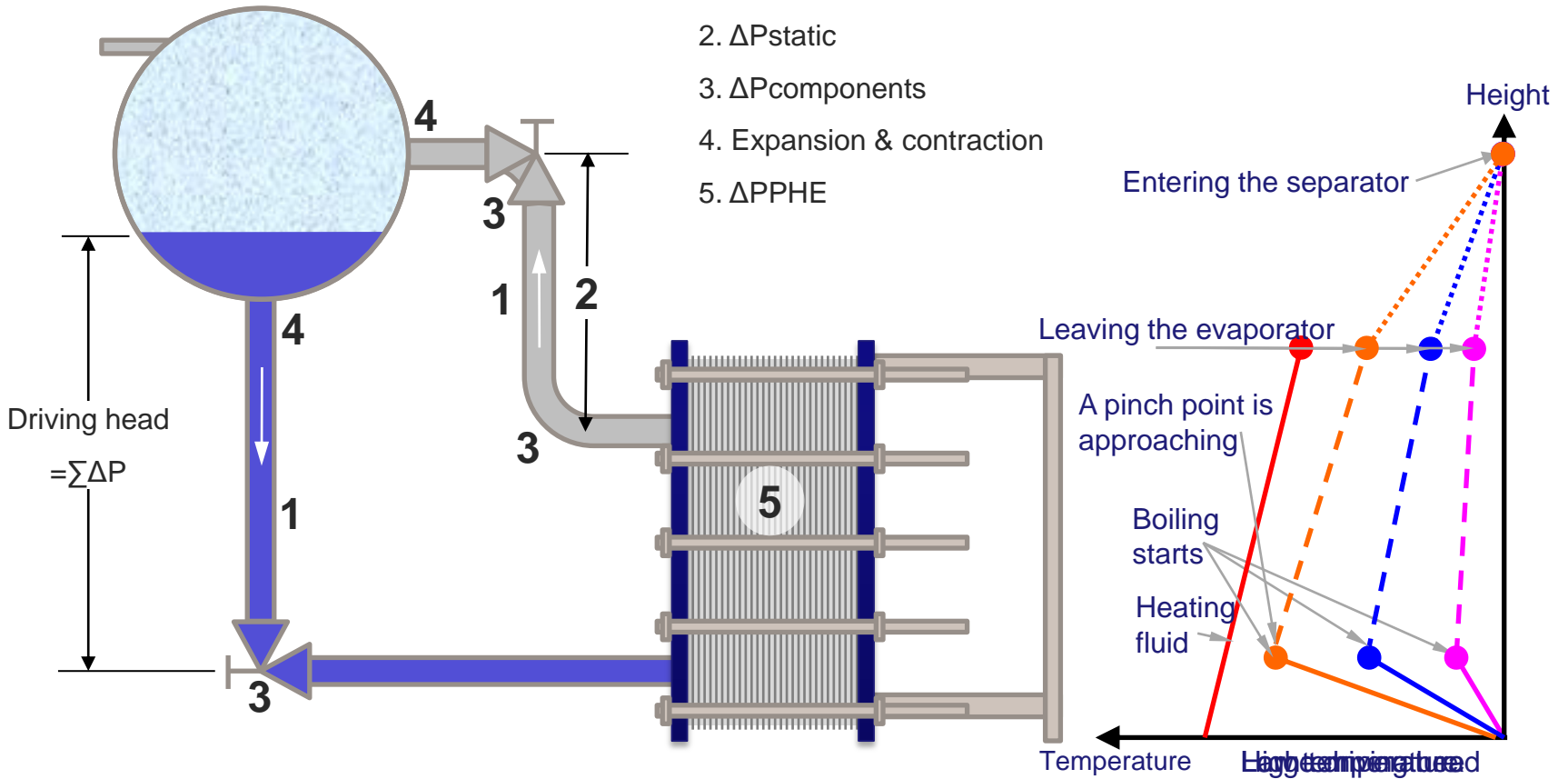
## Disadvantages:

- Very small volume for liquid hold up

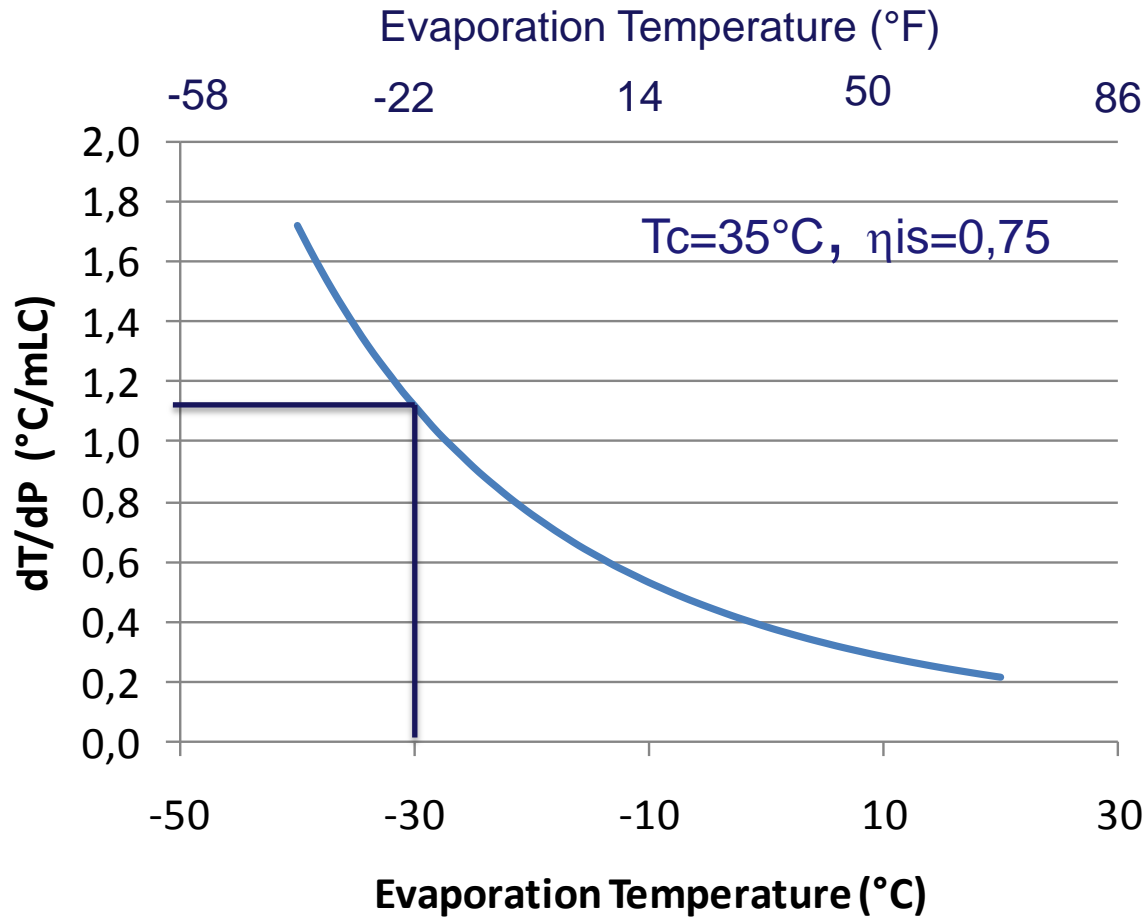


# The flooded evaporator Thermosyphon system

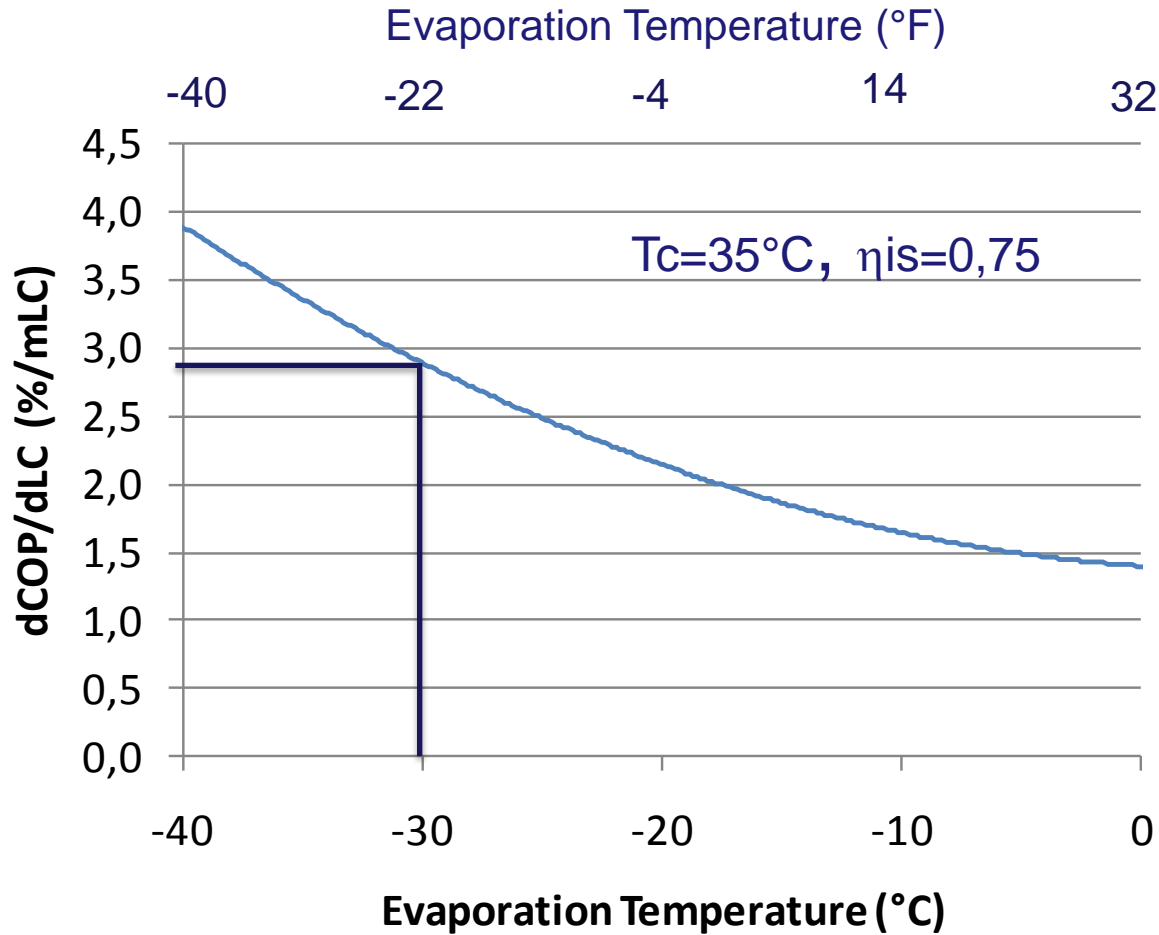
1.  $\Delta P_{\text{friction}}$
2.  $\Delta P_{\text{static}}$
3.  $\Delta P_{\text{components}}$
4. Expansion & contraction
5.  $\Delta P_{\text{PHE}}$



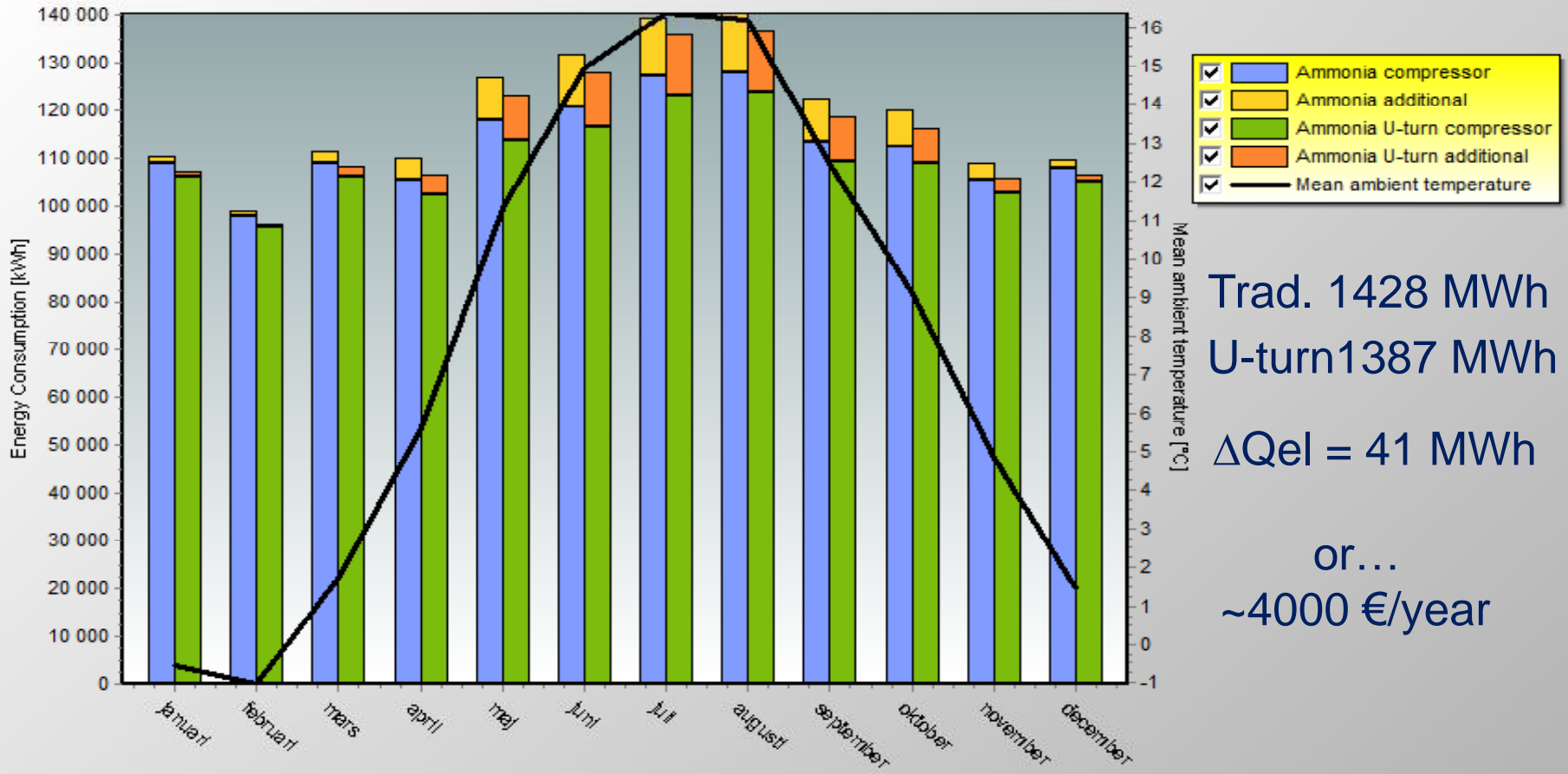
# Change in temperature per meter (3 ft) Liquid Column pressure drop



# Change in efficiency (COP) per meter (3 ft) Liquid Column pressure drop



# Energy consumption for a 500kW (142TR) single stage system operating in Copenhagen

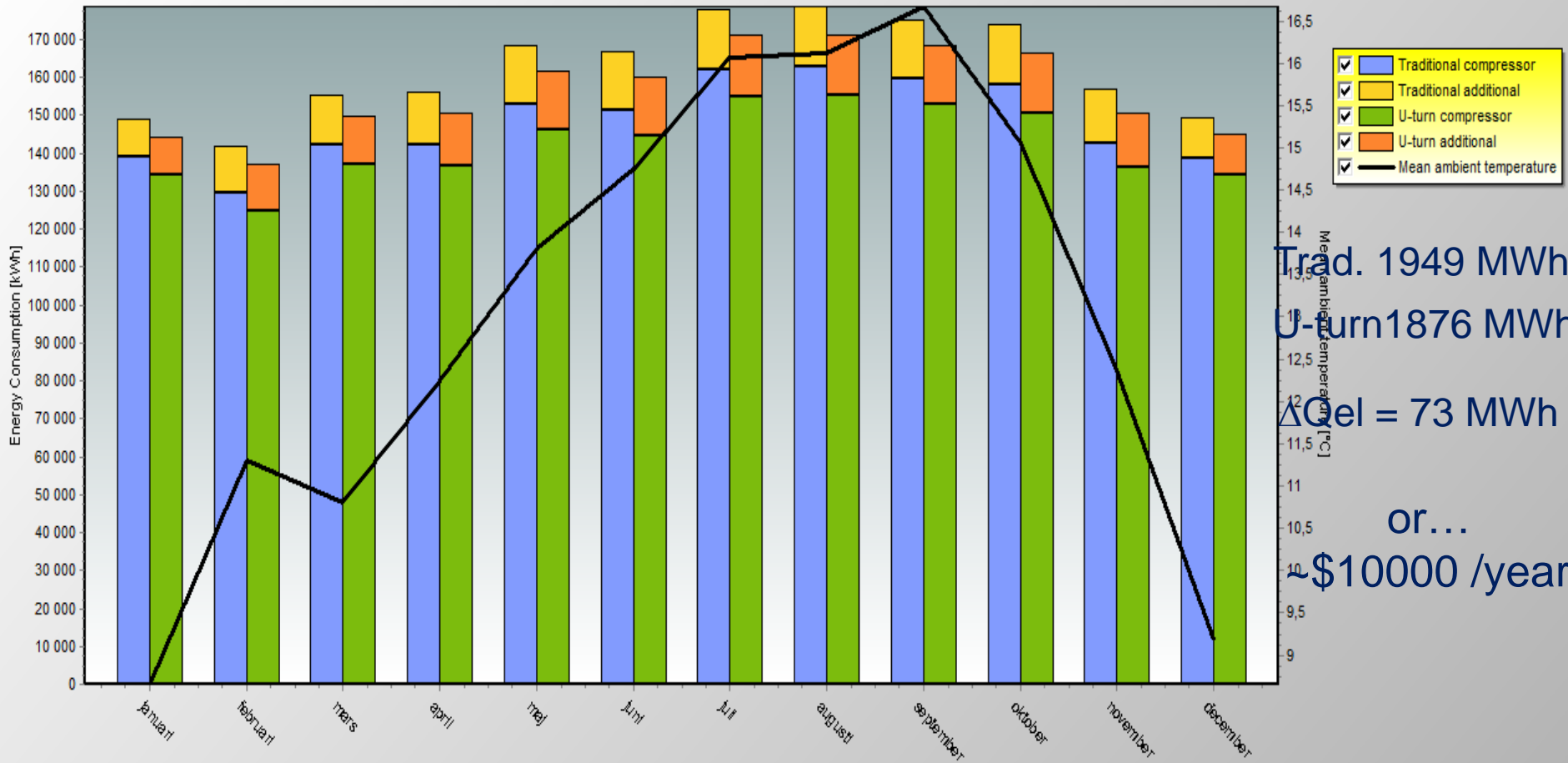


Trad. 1428 MWh  
U-turn 1387 MWh  
 $\Delta Q_{el} = 41 \text{ MWh}$

or...  
~4000 €/year

# Energy consumption for a 500kW (142TR) single stage system operating in San Francisco

June 18-19, 2014 - San Francisco



Trad. 1949 MWh

U-turn 1876 MWh

$\Delta$ CO<sub>2</sub>e = 73 MWh

or...

~\$10000 /year

# British Columbia installations in Richmond, Nanaimo, Comox & Fort. St. John

June 18-19, 2014 - San Francisco



# Ice Rink in Montreal City

June 18-19, 2014 - San Francisco



AlfaNova plate condenser  
U-turn evaporator 71 TR  
Charge :168 lbs, or  
2,4 lbs/TR

# Homerton University Hospital



Existing R22 System was upgraded from 340 to 500 kW  
(97 to 142 TR)  
Charge dropped from 250 kg (550 lbs) of R22 in the old  
system to 50 kg (110 lbs) of NH3 in the new system  
Result – Increase in capacity by 50%, charge reduced from  
0.74 to 0.1 kg/kW ( 5.7 to 0.77 lbs/TR)



# Ammonia Heat Pump at Alfa Laval manufacturing site in Lund, Sweden

M10BW-FT condenser  
Evaporator MK15 with U-turn  
Cooling capacity 707kW/202 TR  
Heating capacity: 827kW/236TR  
Charge : 40 kg / 88 lbs, or  
0.048 kg/kW / 0.37 lbs/TR

Environment: Reducing the CO<sub>2</sub>  
emission with 140 MT / year  
Energy cost: reduced with >160  
kEUR / year



# Conclusion

- Combination of different separation techniques make the U-Turn compact, low charge and efficient liquid separator
- Premounted, approved ...Easy to install
- Low pressure drop in wet return line ensures high energy efficiency
- Small footprint- easy access to plant room
- Very Low Charge,  $< 0.05 \text{ kg/kW}$  or  $0,39 \text{ lbs/TR}$ , is possible.



**ATMO**  
**sphere**

business case

---

**natural refrigerants**

---

June 18-19, 2014 - San Francisco

---

Thank you very much!