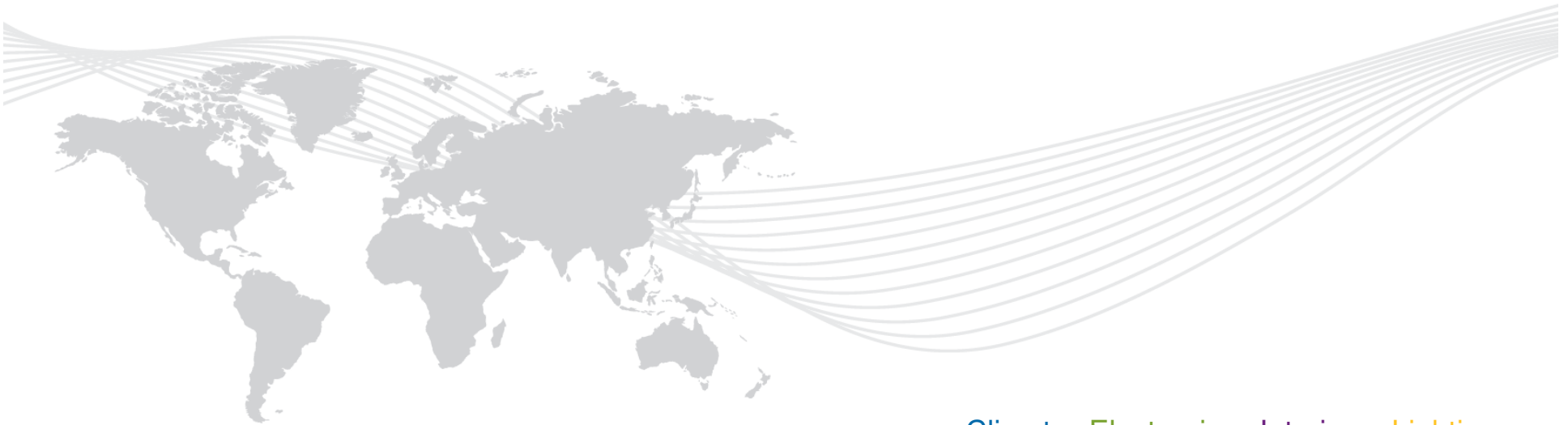




# IHX R1234yf

Marek Pernicky, Nov 10 2010



Climate • Electronics • Interiors • Lighting

# Presentation outline

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- Market trends, drivers
- R1234yf vs. R134a
- Project scope
- Technical assumption
- Results
- Conclusion

# Market trends, drivers

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- EU legislation
  - Fuel economy legislation: CO2 emission
    - Affects 65% of new car registrations in 2012, 75% in 2013, 80% in 2014, 100% in 2015
  - Low GWP refrigerant – Ban of R134a
- US Greenhouse Gas Rules
  - US Environmental Protection Agency rules to reduce greenhouse gases and improve fuel economy for MY2012-2016 passenger cars, light duty trucks, and medium duty passenger vehicles
  - Includes credits for A/C system efficiency improvements and low leakage systems, including the use of a low GWP refrigerant
  - Internal Heat Exchanger specifically called out and provides 1.1 g/mi of CO2 credit

- Consumer & Customer demands
  - Lower fuel consumption
  - Lower cost
  - Less leakage & higher reliability
  - Reduced NVH
  - Reduce component weight (less kg to accelerate, less fuel consumption, less CO2 emissions)
  - Reduced package size
  - Fast response to late design changes

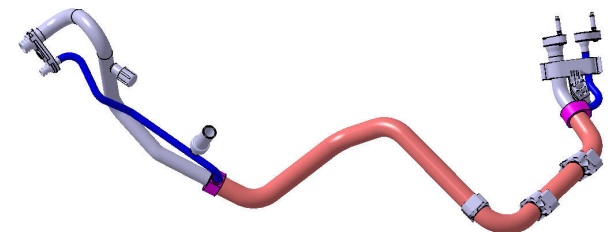
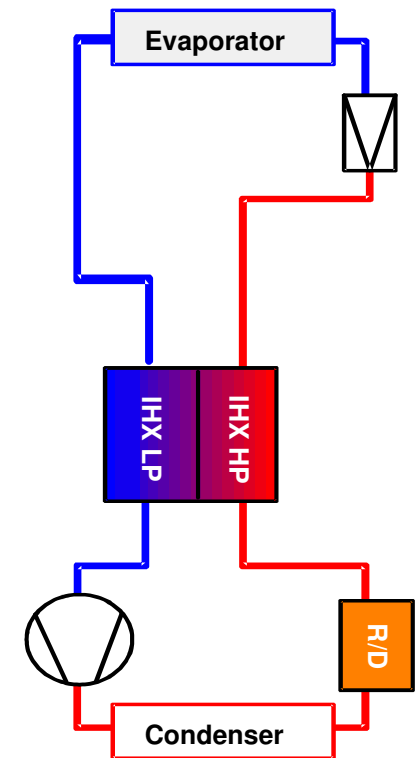
A decorative graphic consisting of multiple thin, grey, wavy lines that create a sense of motion and depth, positioned behind the text.

**Eco friendly products and technologies**

# Visteon response



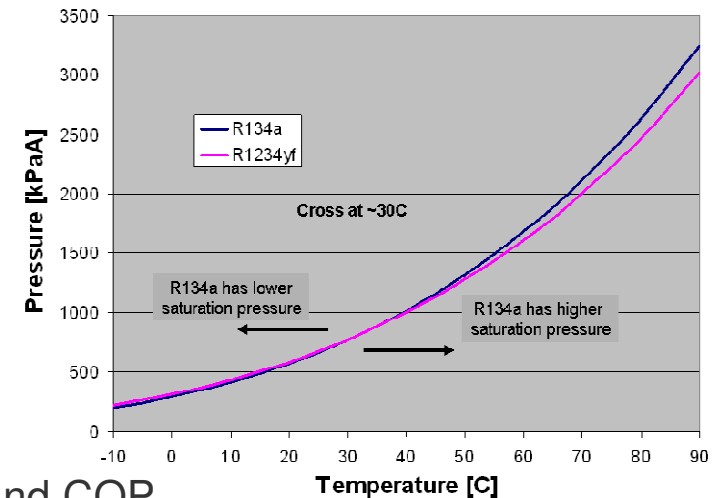
- Environmentally friendly products and technologies aligned to recent world trend. One of the technologies for emission improvement include IHX.
- In order to follow EU and US legislation requirements calling for improved and environmentally friendly systems, Visteon has developed IHX for R134a and R1234yf.
- Internal Heat Exchanger with innovative coaxial tube design integrated in the refrigerant circuit for enhanced system performance (cooling capacity) and efficiency.
- Replaces a part of the suction and liquid refrigerant lines to exchange energy in a counter-flow arrangement.



# R1234yf vs R134a



- Thermodynamic properties of R1234yf near to R134a
  - Pressure range nearly equal
  - Pressure ratio ↓ (discharge/suction)
  - Evaporation enthalpy ↓
  - Density of gas at suction side ↑
- Test results show a drop of 0 to 10 % in cooling capacity and COP in these “near drop in” systems
- Lower compressor outlet temperature requires higher efficiency of IHX



## Energetic Analysis

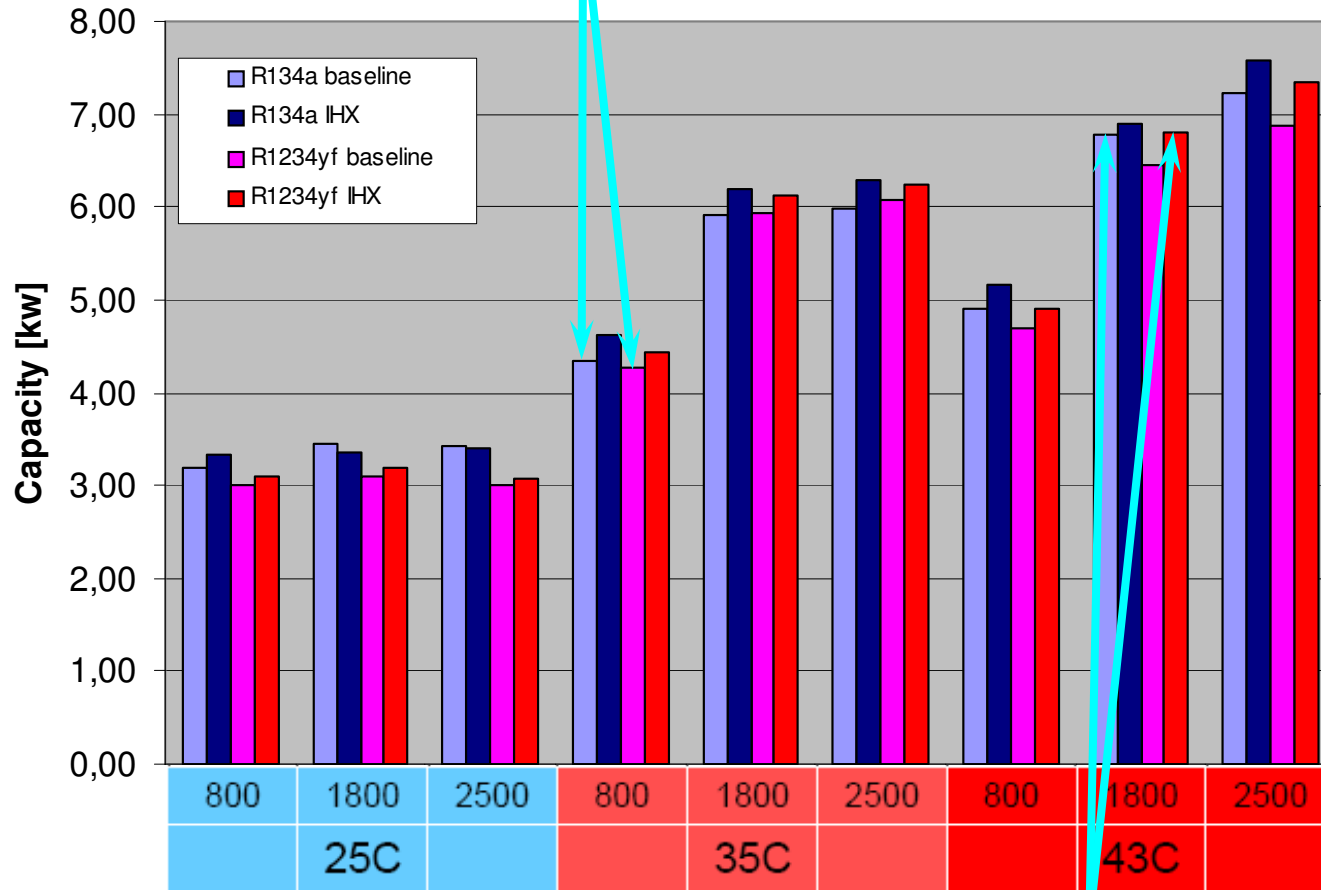
	$t_2$ / °C	$Q_0$ / kW	Potential /%	COP /-	Potential /%
R134a	84,0	8,6	100	2,38	100
R1234yf	72,2	7,7	89,5	2,23	93,7

**Internal heat exchanger may reduce lack of capacity**

# R1234yf Drop in evaluation – capacity (current IHX design)



Capacity of R1234yf is ~5% lower than R134a

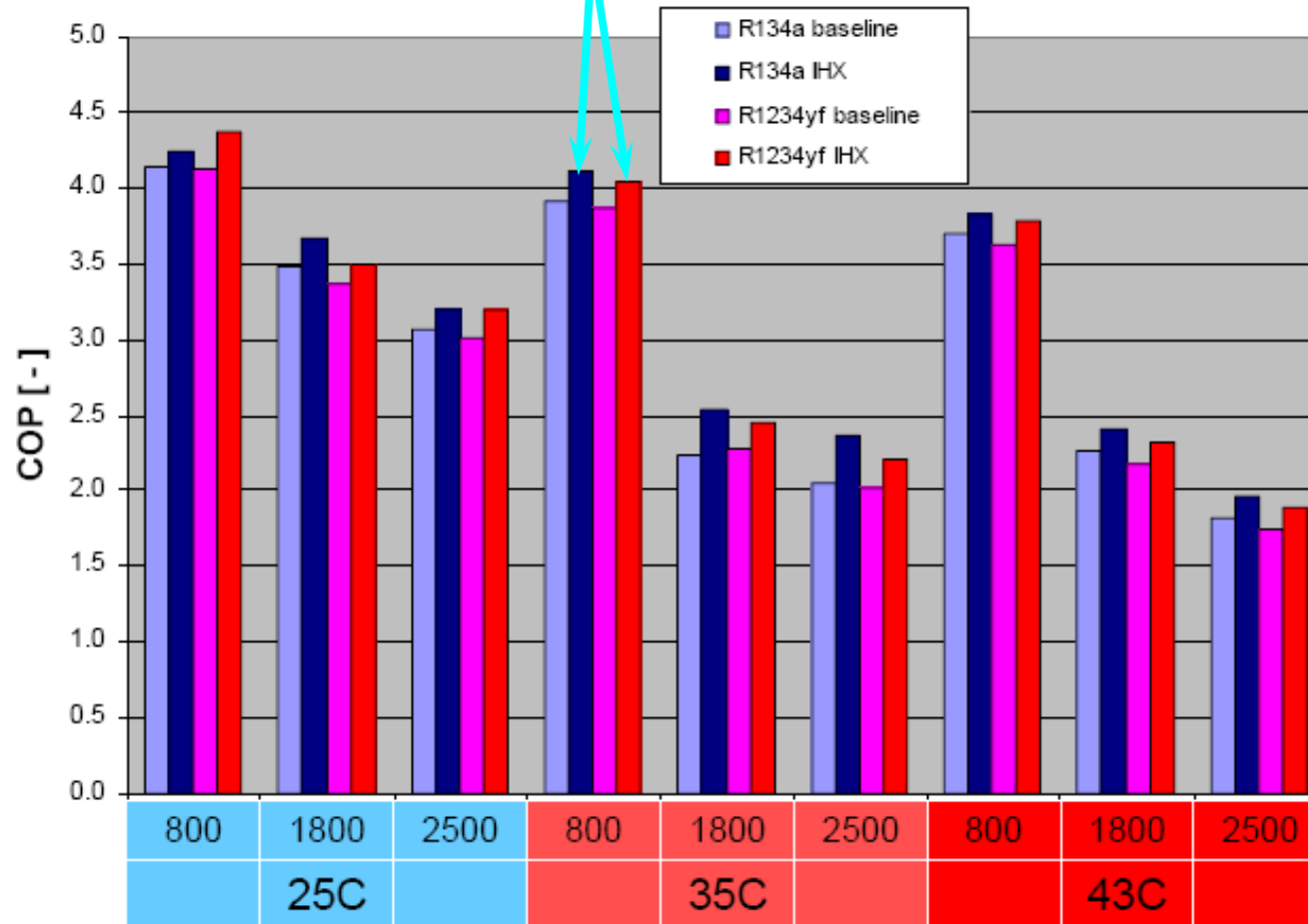


Lower capacity can be compensated for with an IHX

# R1234yf Drop in evaluation – COP (current IHX design)



Impact on COP is similar to cooling power



Lower COP R1234yf can be compensated with an IHX

# Project goals & scope

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- Scope:
  - Improve system capacity and COP for R1234yf refrigerant compared to an R134a system with IHX
  
- Goals & objectives:
  - Develop internal heat exchanger for R1234yf refrigerant
  - Consider already known requirements
  - Review various concepts and perform trade-offs
  - Proceed with most “effective” concept (performance vs. cost)
    - Improved design of IHX having equivalent performance of R134a system with current IHX design for full compensation of lower cooling power
    - high efficiency IHX – coax tube or stand alone IHX

**Solution to close a performance gap**

# Technical assumption

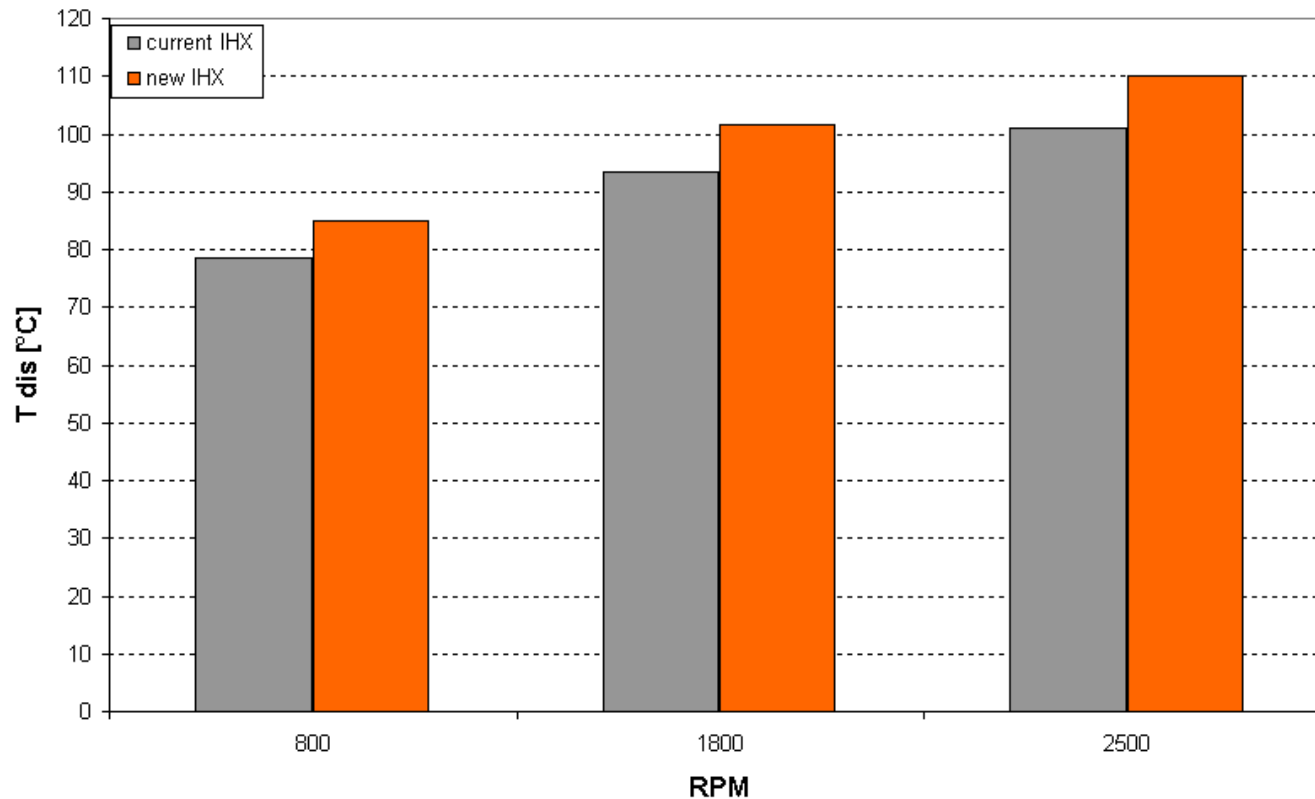
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- Size
  - Use maximum allowable length & outer diameter in existing vehicle space
- Geometry
  - Increase IHX performance to offset lower performance of R1234yf (when base is R134a with IHX)
  - Increase IHX performance due to lower compressor discharge temperature with minimal additional pressure loss
- Manufacturing feasibility
- Refrigerant properties - R1234yf
  - Discharge temperature with stronger IHX to be cooler than R134a
  - ~70%-120% increase of  $q_{IHx}$  required
  - Additional pressure loss may reduce potential contribution of IHX

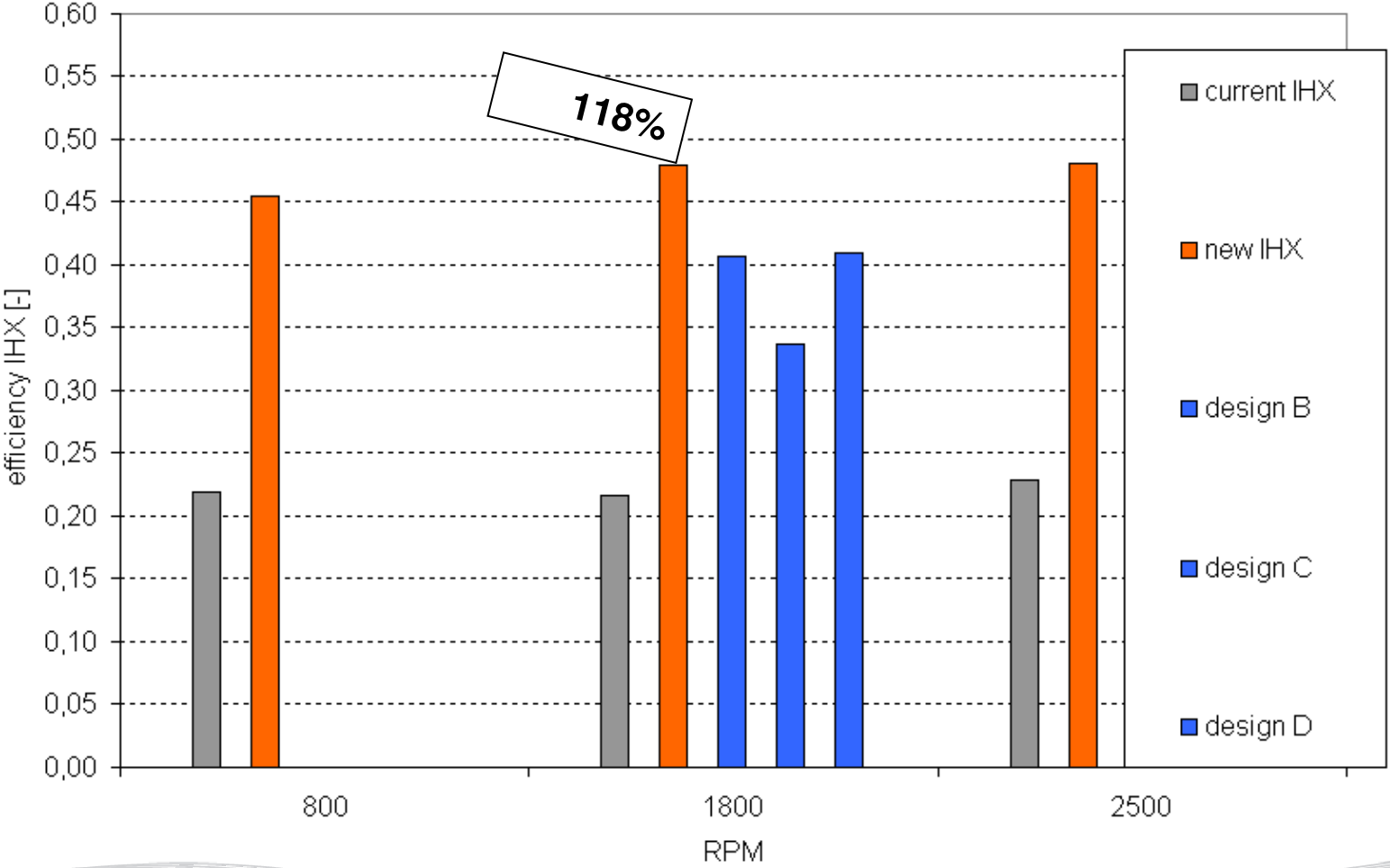
**Optimal size vs. performance with minimal pressure loss**

# R1234yf IHX - Discharge temperature



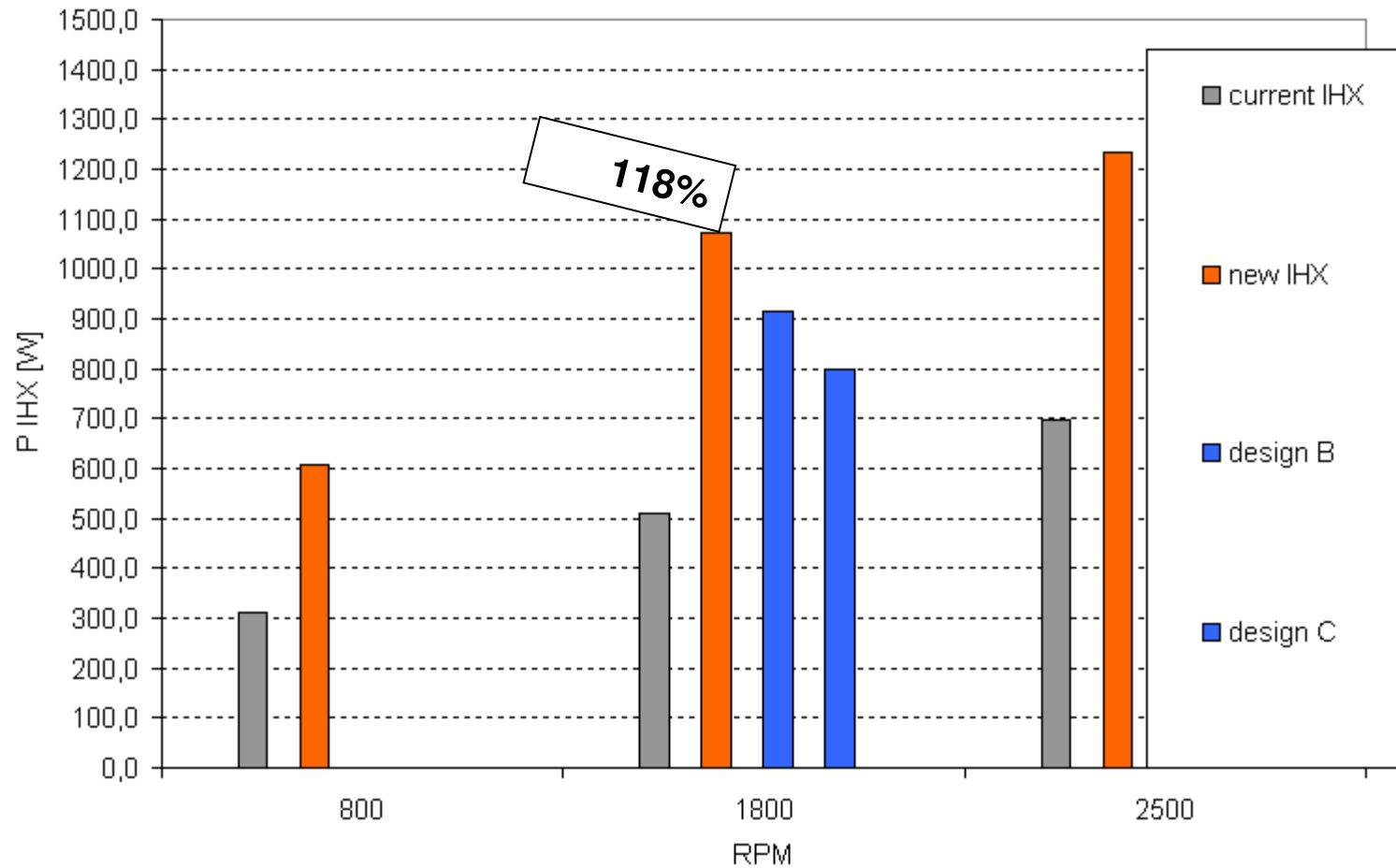
**Proposal meets maximum allowable discharge temperature ~ 130 °C**

# R1234yf IHX - efficiency



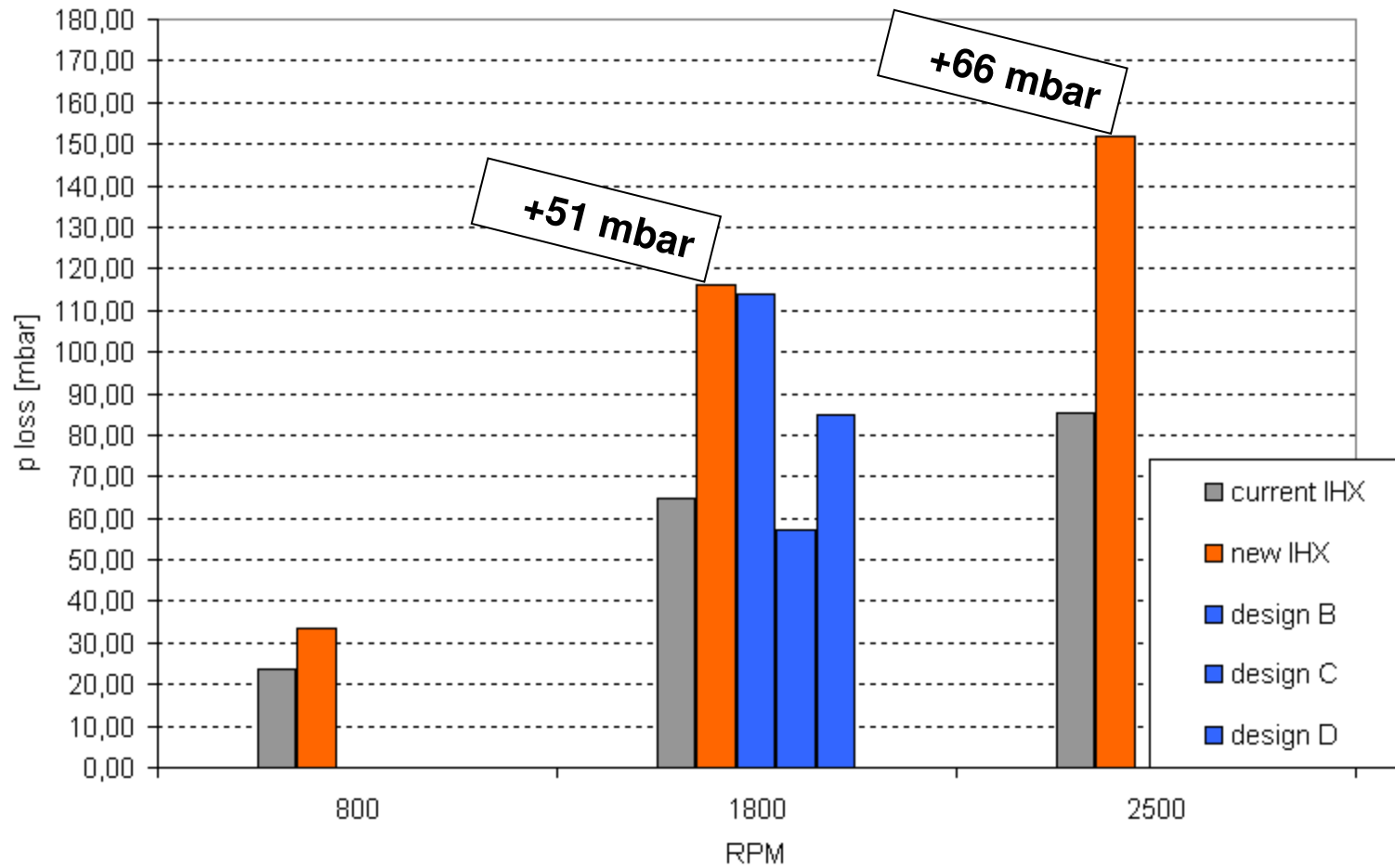
**Double efficiency**

# R1234yf IHX - capacity



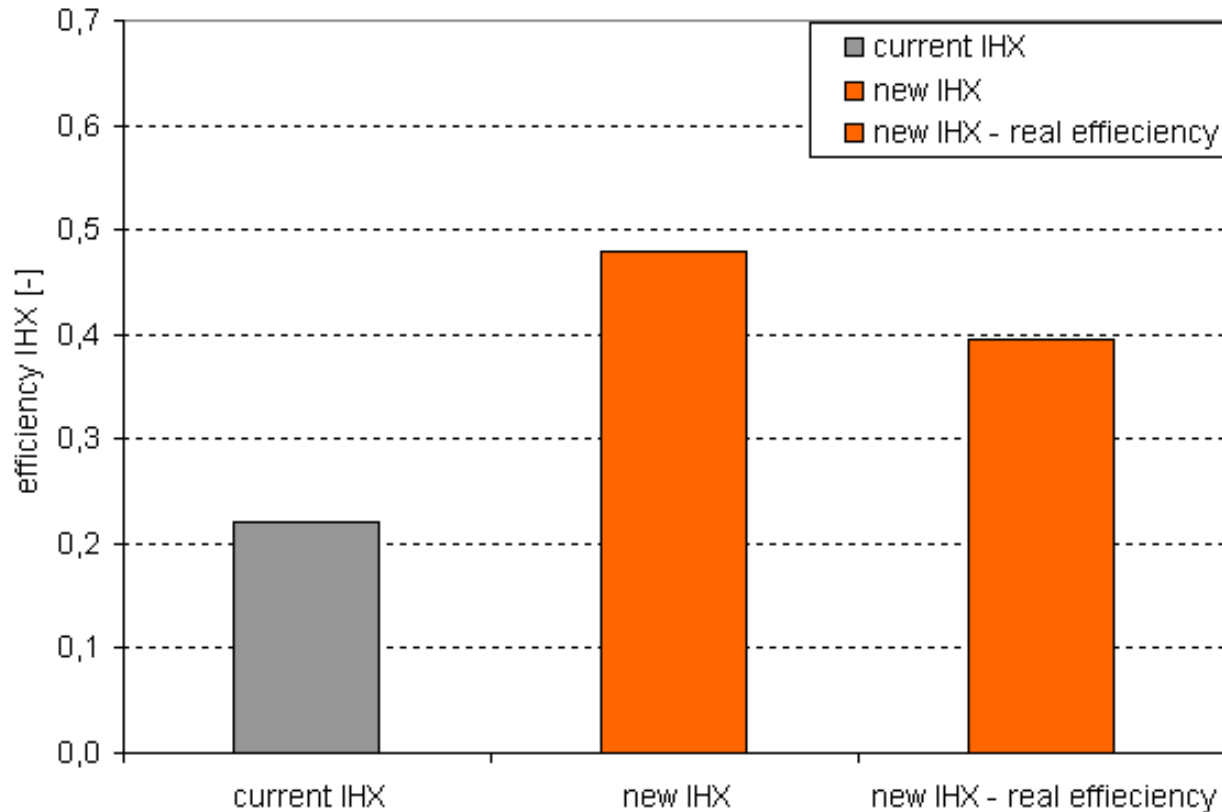
**Double performance**

# R1234yf IHX – pressure loss



**Acceptable pressure loss**

# R1234yf IHX - real efficiency



**Real efficiency improvement is 95% from current IHX design considering pressure drop**

# Conclusion

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- Improved efficiency of IHX with R1234yf is required to achieve performance equivalent to R134a with IHX
- Use of an IHX in R1234yf systems can offset performance degradation (5 to 10%) when compared to R134a
- Coaxial tube IHX is a cost effective solution that minimizes added pressure drop compared to stand alone heat exchangers

**Visteon's Coaxial tube IHX is a proven production solution**



[www.visteon.com](http://www.visteon.com)

