# *Novel minichannel aluminium condenser with low internal volume*

KTH
Royal Institute of Technology
Björn Palm

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# Project Info

- **Description**: The GreenHP project investigates a new highly efficient heating system based on high-capacity air/water heat pumps for retrofitting multi-family houses and commercial buildings in cities.

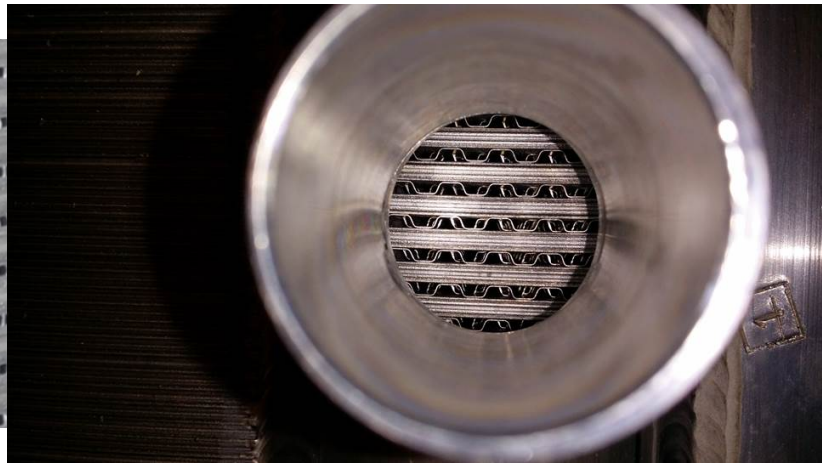
- **Targets**: The project aims at developing a new system level (interaction with electric grids, other energy systems and different system components) as well as a new heat pump unit and component units (refrigerant, compressor, evaporator, fan and air duct, condenser)

# Outline of presentation

- Description of geometry and
- Rationale behind design
- Test setup
- Test results
- Conclusions

# Description of geometry

- Multichannel aluminium tubes with offset strip fins

# Geometry of condenser

| Condenser Design | | V2 |
|---|---|---|
| Flow arrangement | | counter |
| Core dimensions | | |
| Core length | mm | 650 |
| Core width | mm | 203 |
| Core depth | mm | 113 |
| passages number for hot Fluid 1 | | 38 |
| passages number for cold Fluid 2 | | 39 |
| Tubes number side by side in each passage | | 5,5 |
| pass flow number for Fluid 1 | | 1 |
| pass flow number for Fluid2 | | 1 |
| | | |
| MPE tube design for propane | | R3 |
| Tube depth | mm | 18,02 |
| Tube height | mm | 2,01 |
| Channel type | | rectangular |
| Channel number | | 10 |
| | | |
| Fin for water | | 7018 |
| Type | | offset strip |
| Height | mm | 2,0 |
| Pitch | mm | 7,7 |
| Thickness | mm | 0,22 |

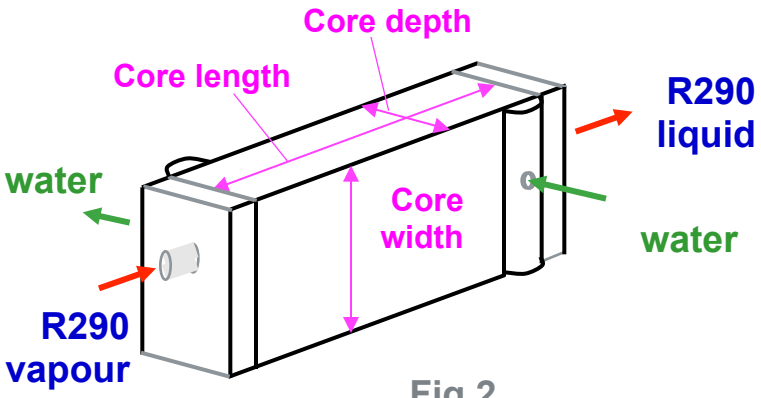



Fig.2

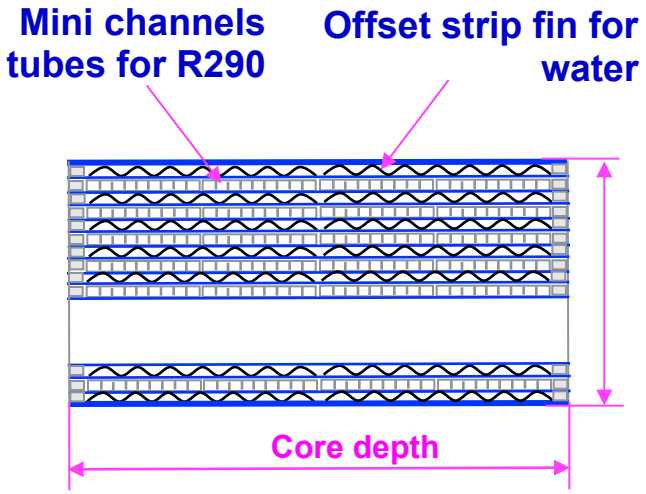
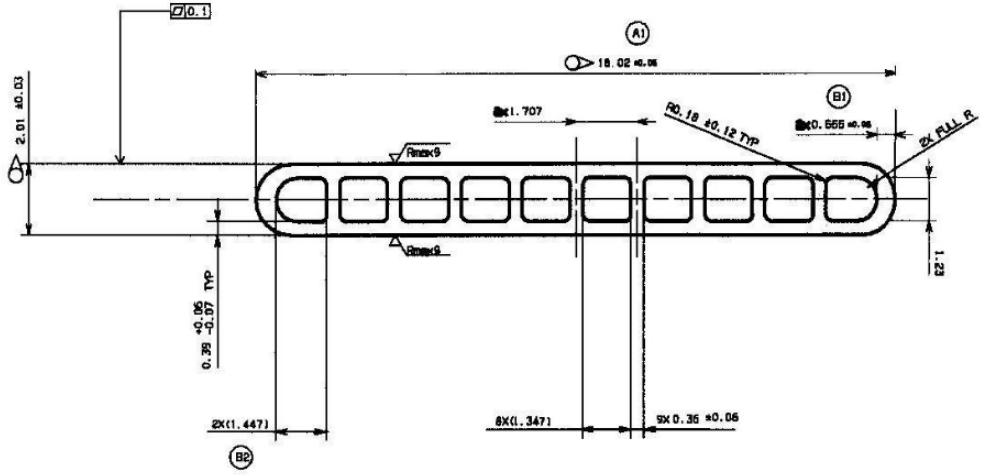



Fig.3

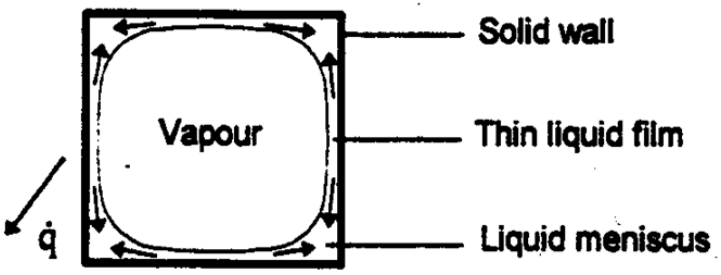
# Geometry, refrigerant side

- Small channels reduces channel volume/heat transfer area ratio



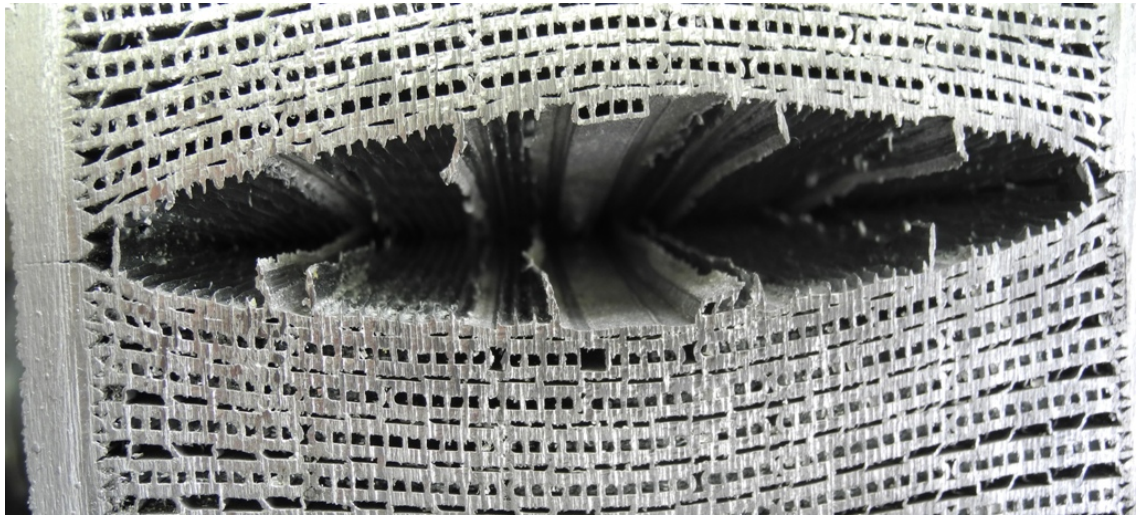

$$V/A = x\hat{}2 \cdot L/4 \cdot x \cdot L = x/4$$

- Surface tension forces draws liquid to corners, thereby reducing average film thickness



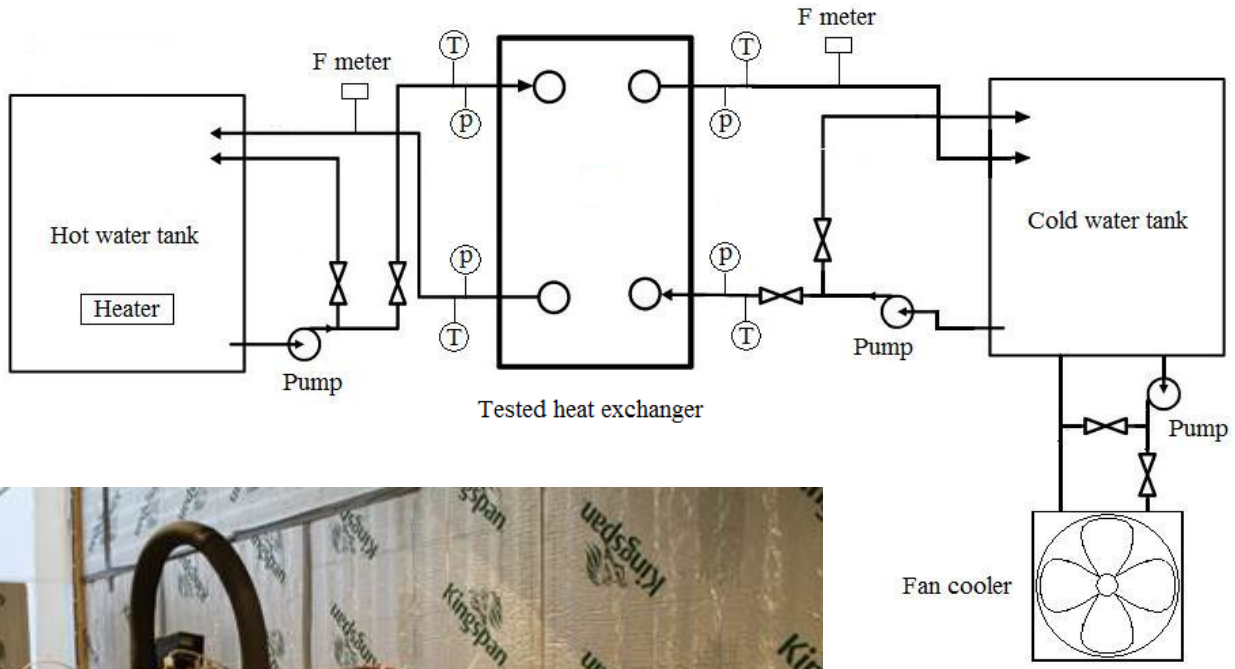

| Condenser geometry | |
|---|---|
| Cross sectional area | |
| per channel | 1,66 mm$^2$ |
| per tube | 16,5 mm$^2$ |
| for all tubes | 338 mm$^2$ |
| | |
| Internal volume | 4,07 liters |
| for all tubes | 2,24 liters |
| for two headers | 1,83 liters |
| | |
| Total mass @ 20 bar, 60C | 233g |
| for all tubes | 150g |
| for headers, no liquid | 82g |
| | |
| Heat transfer area (refrig) | 6,9 m$^2$ |

# Burst pressure 136 bar



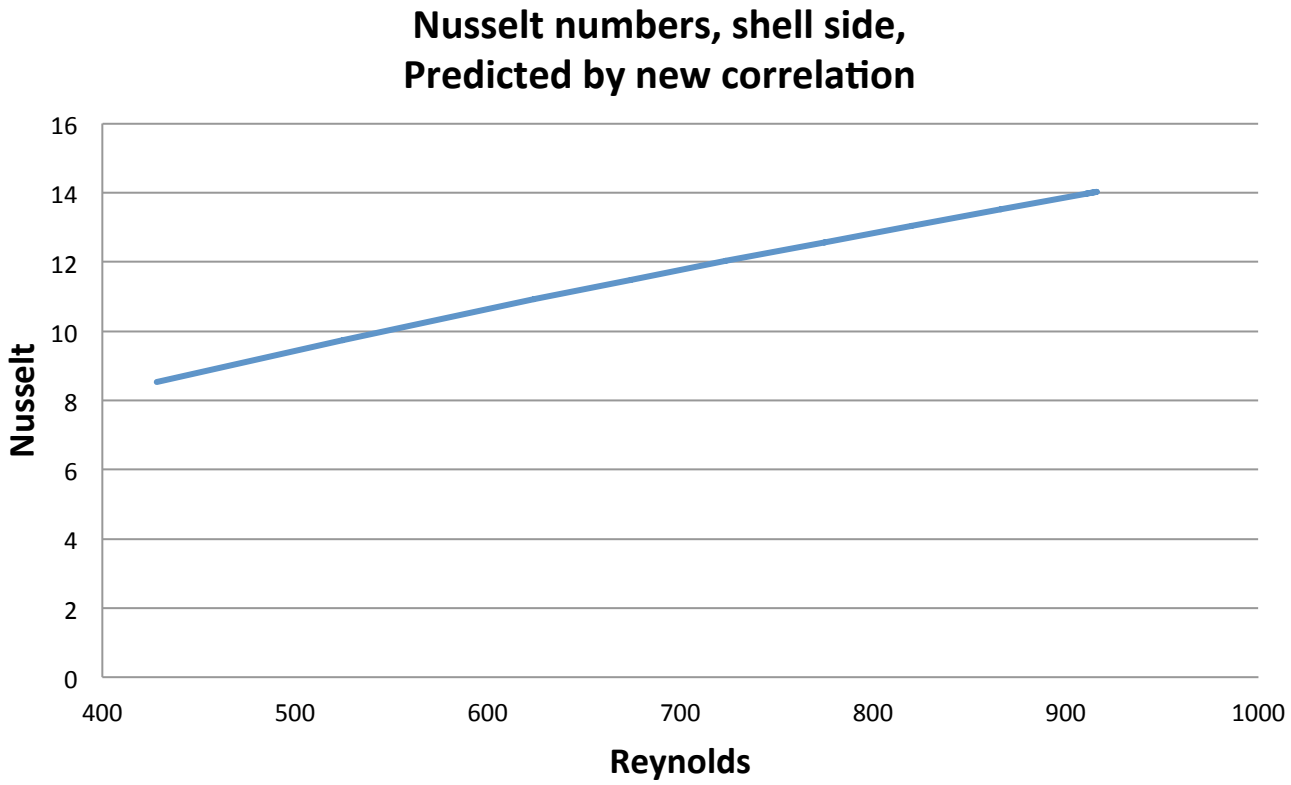
# Test setup

- Water/water tests for wilson plot

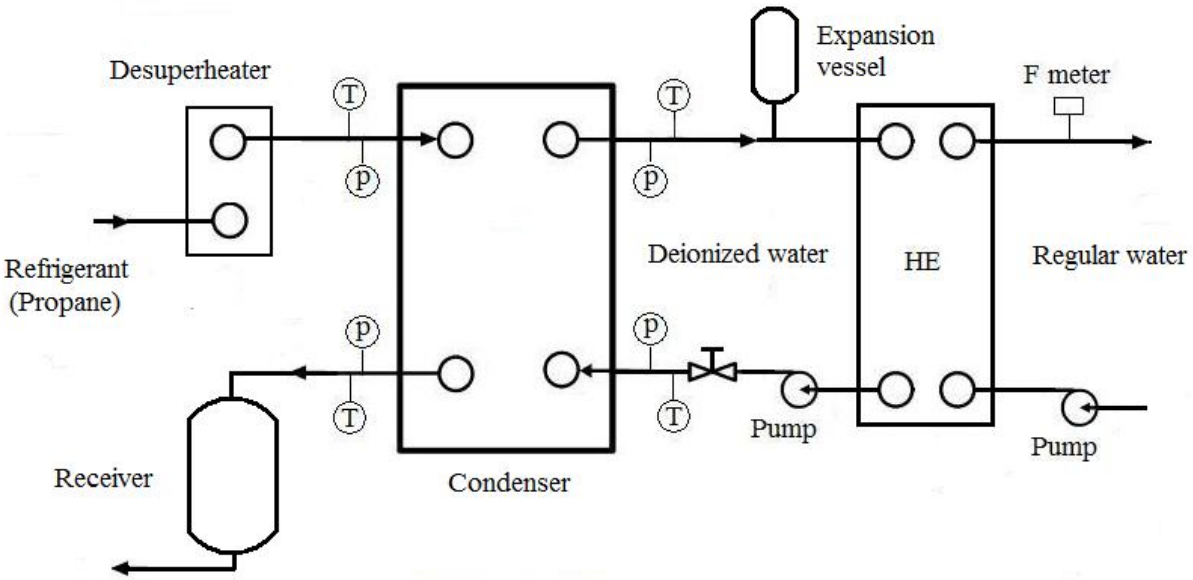



# Test results, water to water tests

- Diagram of Wilson plot tests (water/water)

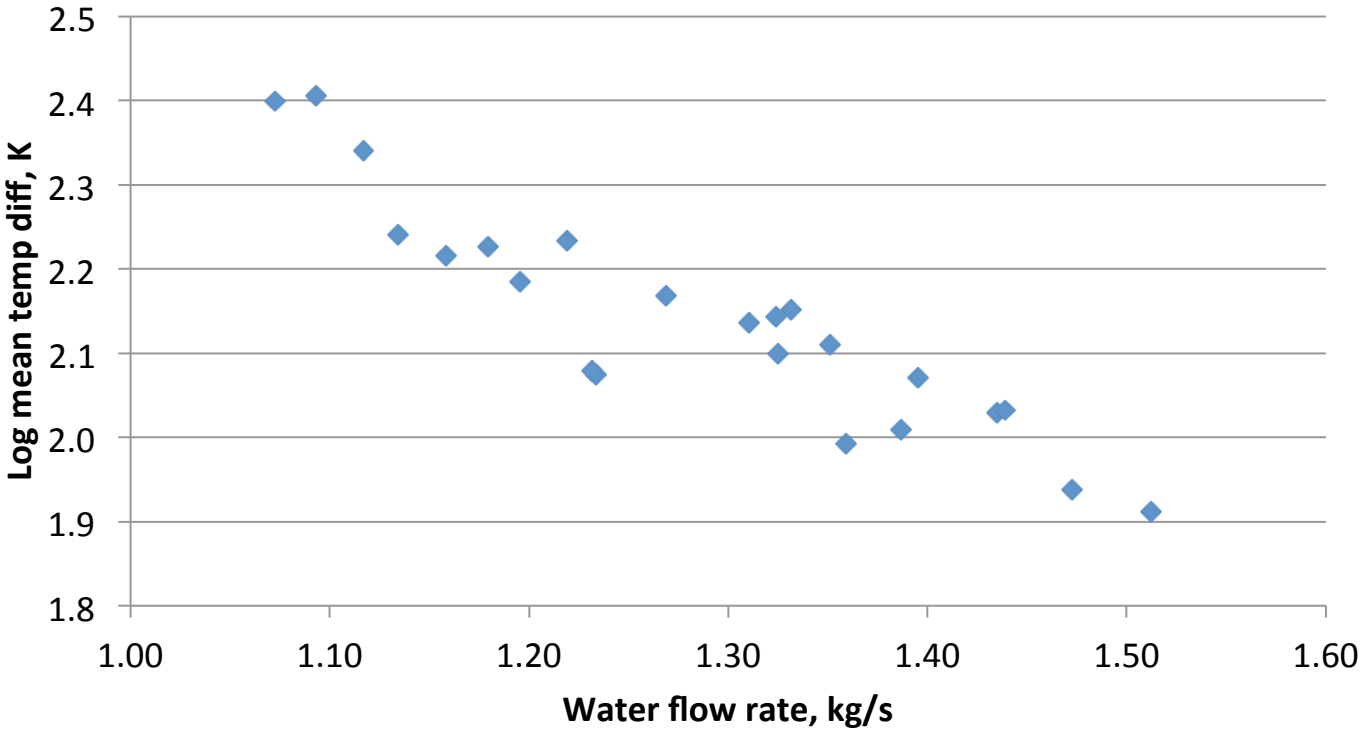


# Test setup, condensing tests



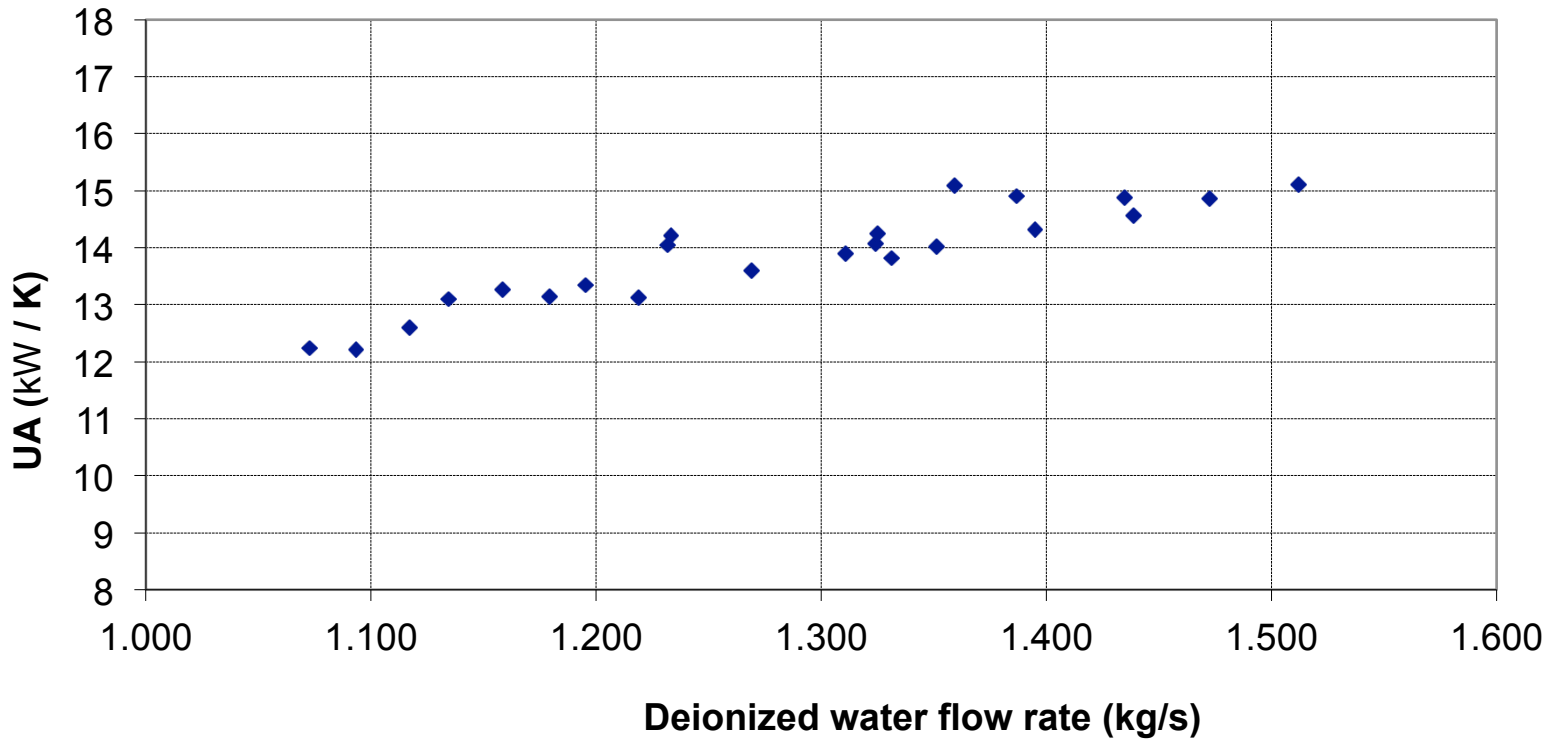

# Results, condensing tests, varying water flow rate, constant power, 30 kW , saturated state at inlet

- Logarithmic mean temperature difference for condensing section vs water flow rate



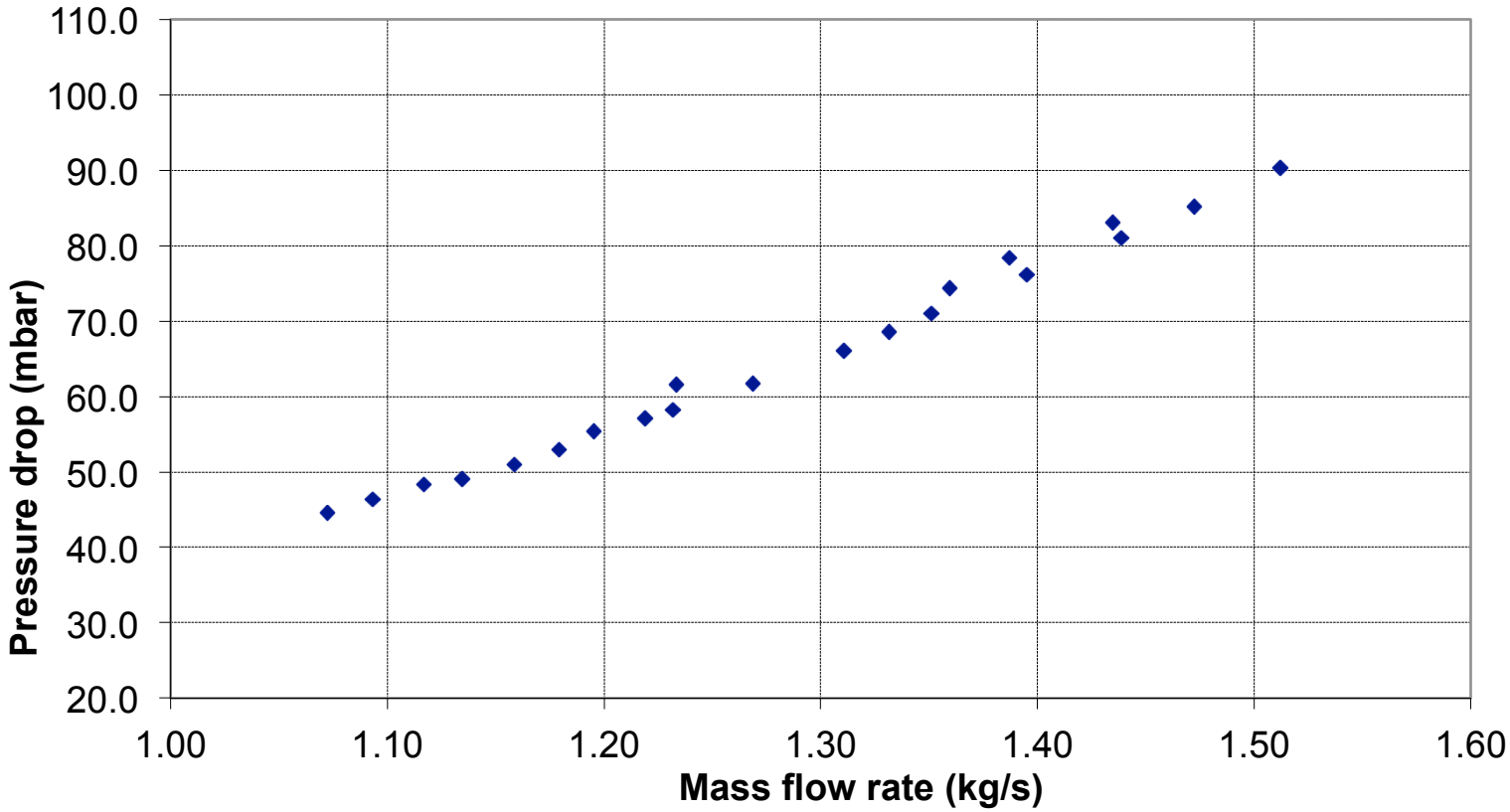
# Results, condensing tests, varying water flow rate, constant power, 30 kW , saturated state at inlet

- UA-value at varying water flow rate



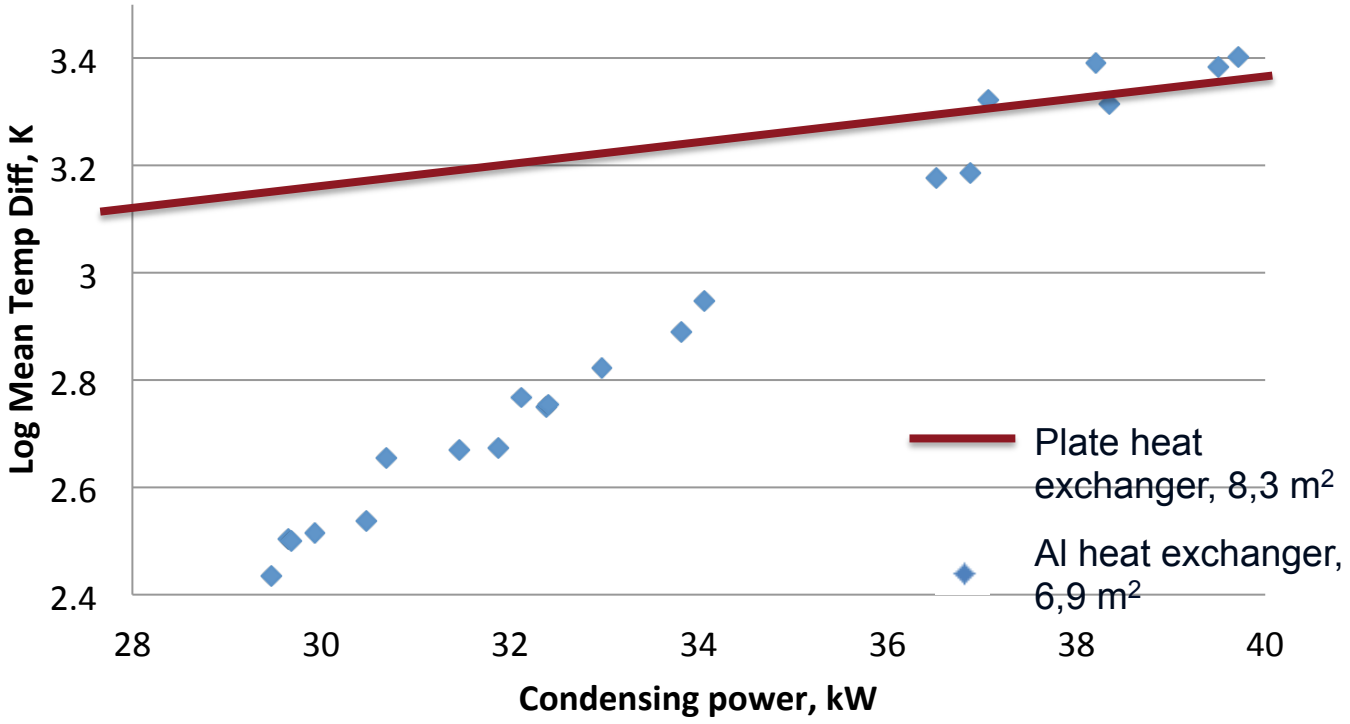
# Results, condensing tests, varying water flow rate, constant power, 30 kW , saturated state at inlet

- Pressure drop, water side, at varying water flow rates



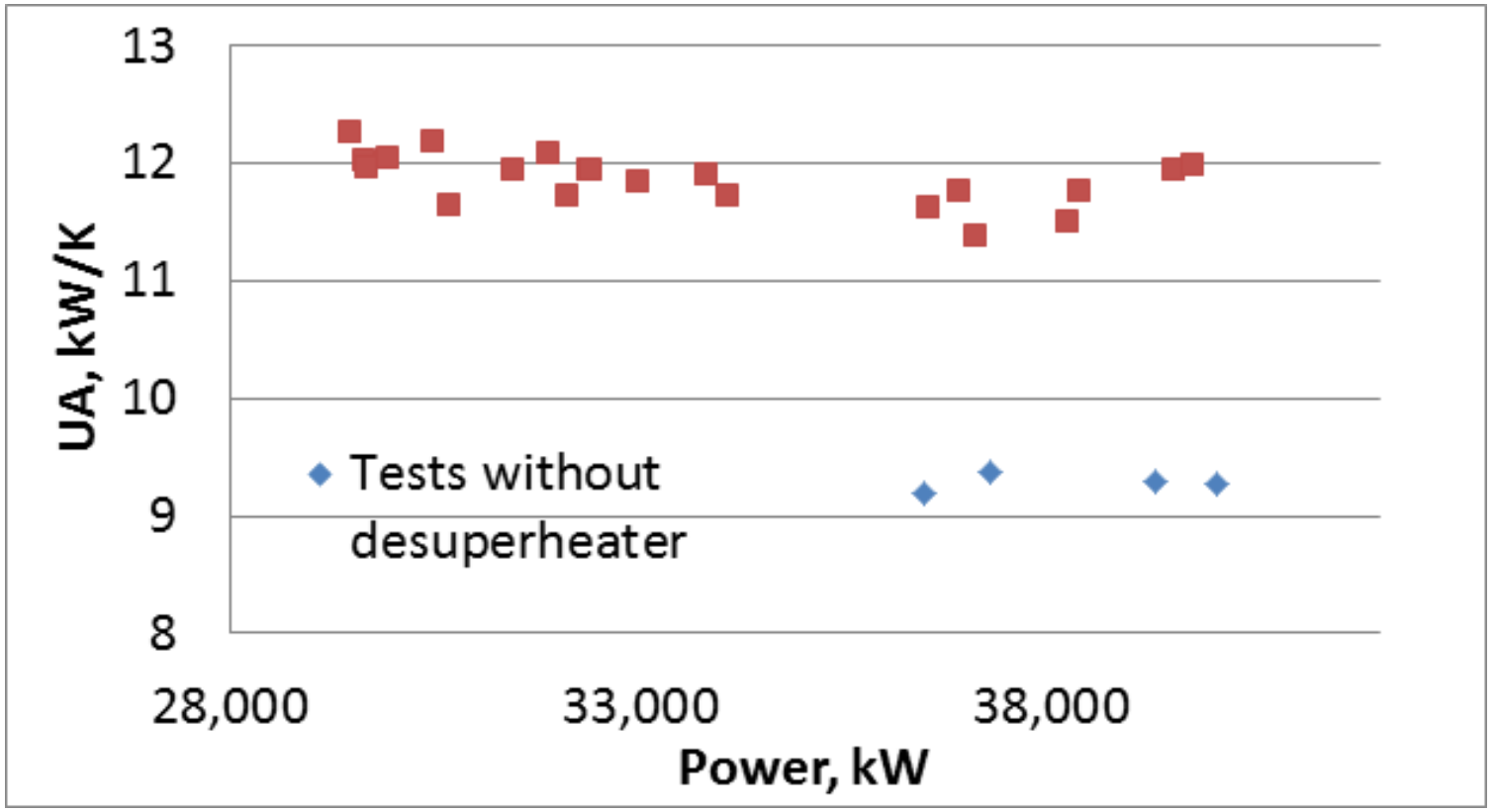
# Results, condensing tests, varying power, constant water flow rate , saturated state at inlet

- Logarithmic mean temperature difference for condensing section vs power.



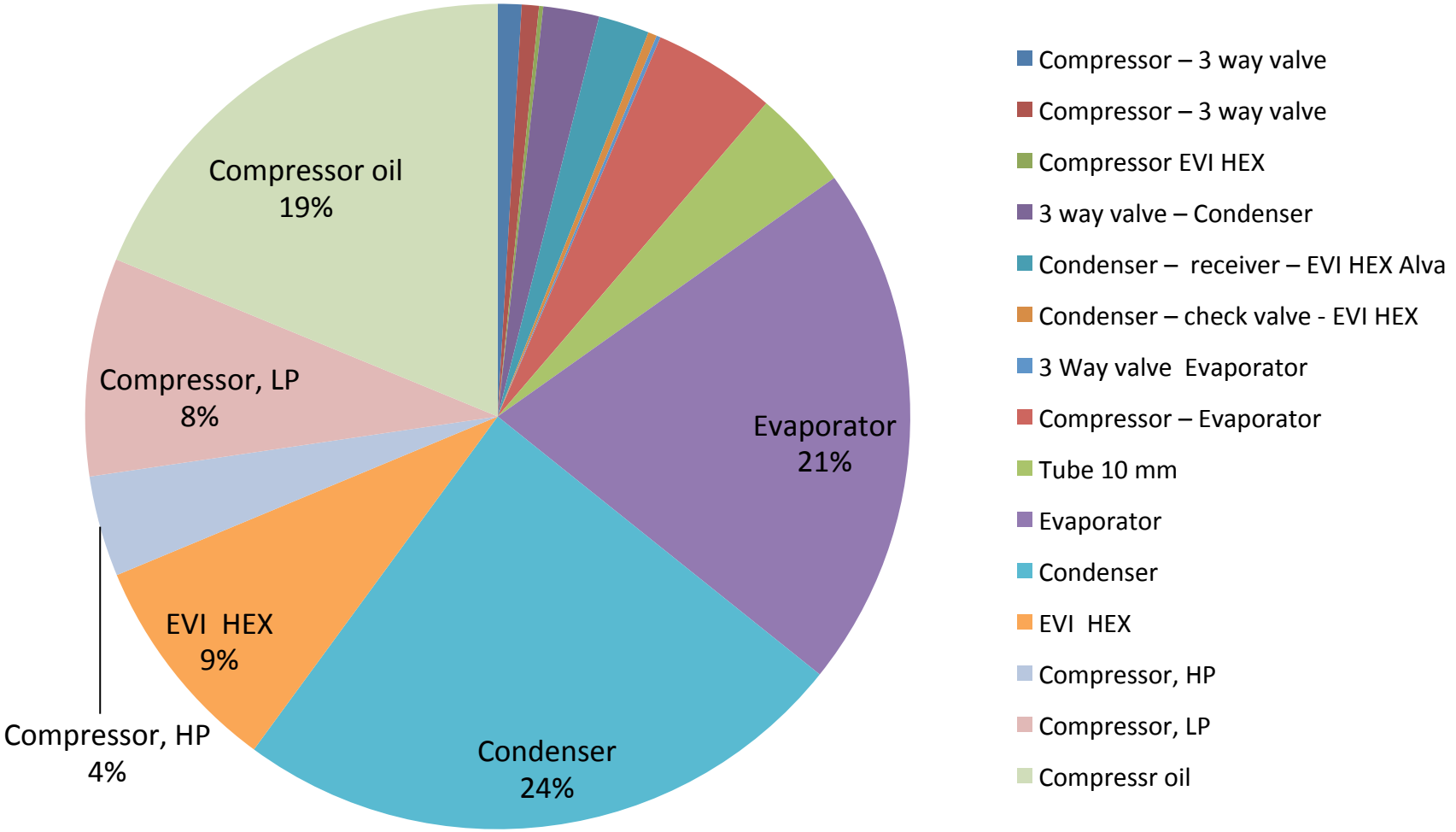
# Results, condensing tests, varying power, constant water flow rate , saturated state at inlet

- UA-value at constant water flow rate



# Estimated distribution of charge in complete system

- Total charge 960g (@ T1=50C, T2=5C)



# Conclusions

- A novel aluminium condenser has been designed and tested
  - Main features:
    - Low internal volume
      - Estimated charge less than 250g
    - Good thermal performance
      - Equal or better than conventional plate heat exchanger

# The GreenHP Partners

Austrian Institute of Technology, Project Coordinator

Emerson Climate Technologies GmbH, Germany

Fraunhofer Insitute for Solar Energy Systems, Germany

AKG Group, Germany

Royal Institute of Technology, Sweden

Ziehl-Abegg, Germany

European Heat Pump Association, Belgium

Gränges AB, Sweden

Hesch Schröder GmbH, Germany

## Thank you for your attention

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# contact

Project Coordination

**ANDREAS ZOTTL**

Engineer

Energy Department

Sustainable Thermal Energy Systems

**AIT Austrian Institute of Technology GmbH**

Giefinggasse 2 | 1210 Vienna | Austria

T +43(0) 50550-6309 | F +43(0) 50550-6679

andreas.zottl@ait.ac.at | http://www.ait.ac.at