



EUROPEAN UNION
European Structural and Investment Funds
Operational Programme Research,
Development and Education



MINISTRY OF EDUCATION,
YOUTH AND SPORTS

Thermal properties of cardioplegia heat exchangers

Erik Bartuli, Ph.D.
Ondřej Borkovec



Brno University of Technology



- ❑ Faculty of Architecture
- ❑ Faculty of Business and Management
- ❑ Faculty of Chemistry
- ❑ Faculty of Civil Engineering
- ❑ Faculty of Electrical Engineering
- ❑ Faculty of Fine Arts
- ❑ Faculty of Information Technology
- ❑ **Faculty of Mechanical Engineering**
 - ❑ **Heat Transfer and Fluid Flow Laboratory**

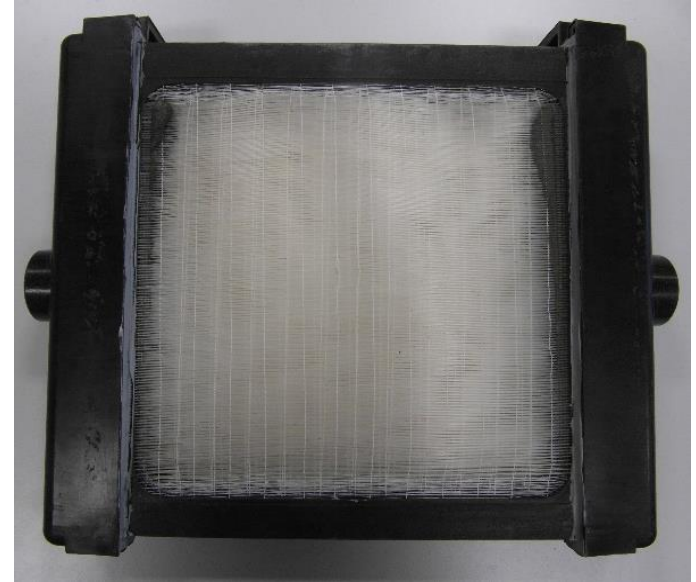
Heat Transfer and Fluid Flow Laboratory

HeatLab Interests:

- ❑ Secondary Cooling in Continuous Casting
- ❑ Roll Cooling
- ❑ Descaling
- ❑ Product Cooling (Heat Treatment)
- ❑ Computational Software
- ❑ Defogging of Automotive Lighting
- ❑ Plastic Laboratory

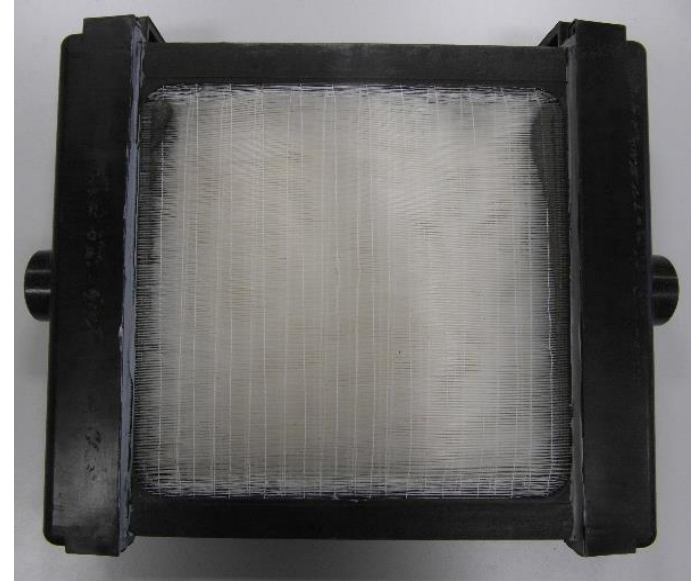
Polymeric Hollow Fiber Heat Exchangers (PHFHE)

- ❑ use **polymeric microchannels** as the heat transfer surface
- ❑ outer diameter - less than **1 mm**
- ❑ wall thickness - about **0.1 mm**

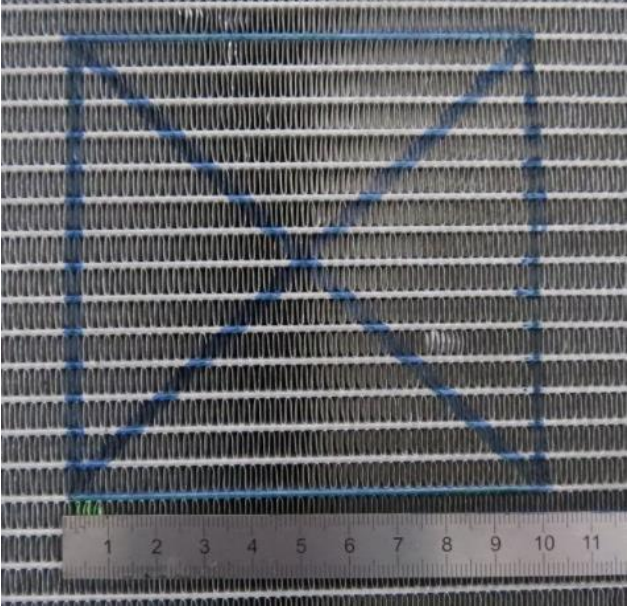
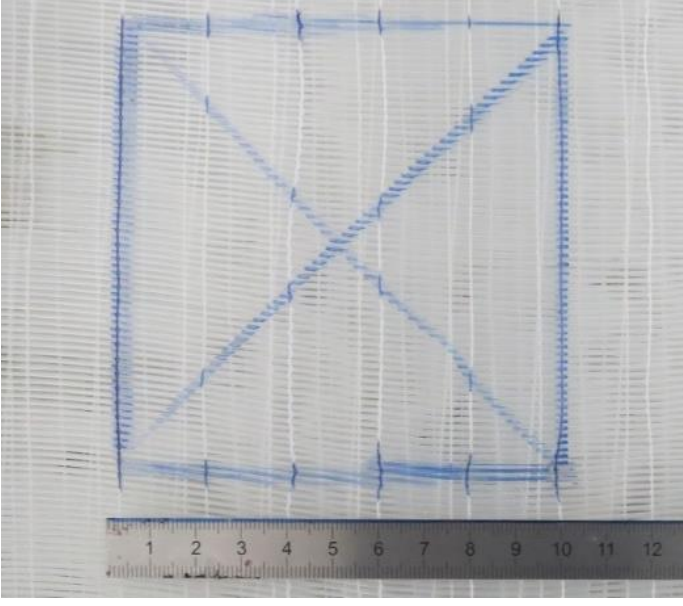


Polymeric Hollow Fiber Heat Exchangers (PHFHE)

- ❑ large heat transfer area with respect to its volume
- ❑ low weight and price
- ❑ environmentally friendly

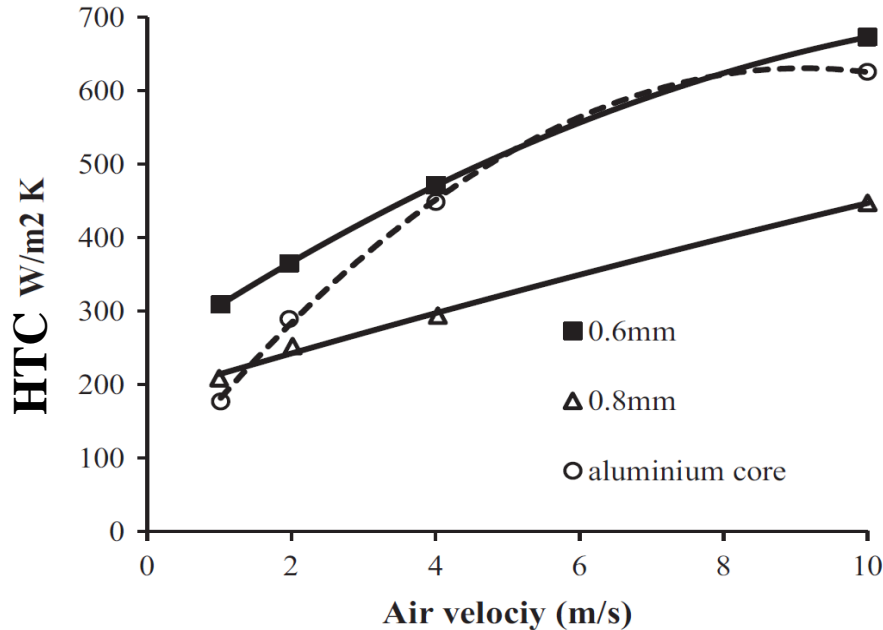


Comparison of Polymeric and Metal Heat Exchangers

Weight of empty core (without coolant), full core weight and weight ratio:	
933 g, 1502 g, 100%	101 g, 396 g, 26%
	

50/50% water glycol
coolant

Comparison of Polymeric and Metal Heat Exchangers

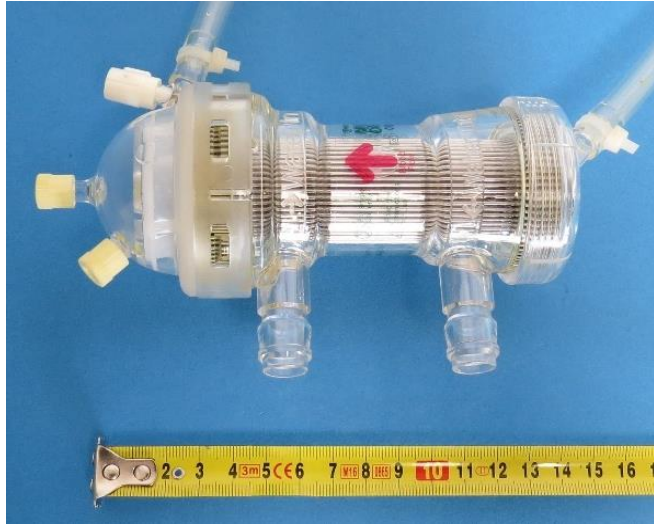


PHFHE is **10 time lighter**
than metal one

Application area

- corrosive environments (desalination, chemical industry)
- low-temperature heat recovery
- low-temperature water heating
- electronic industry (heat sinks)
- automobile cooling systems

Medicine as a promising area for PHFHE application



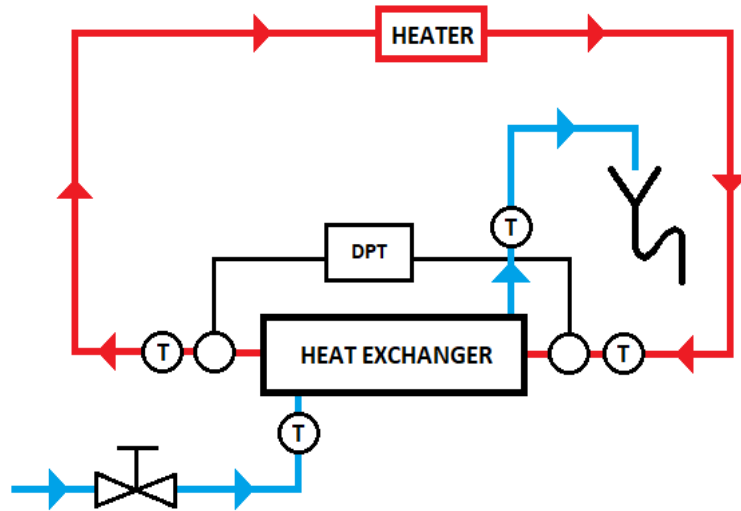
Capiox Cardioplegia



MYOthem XP

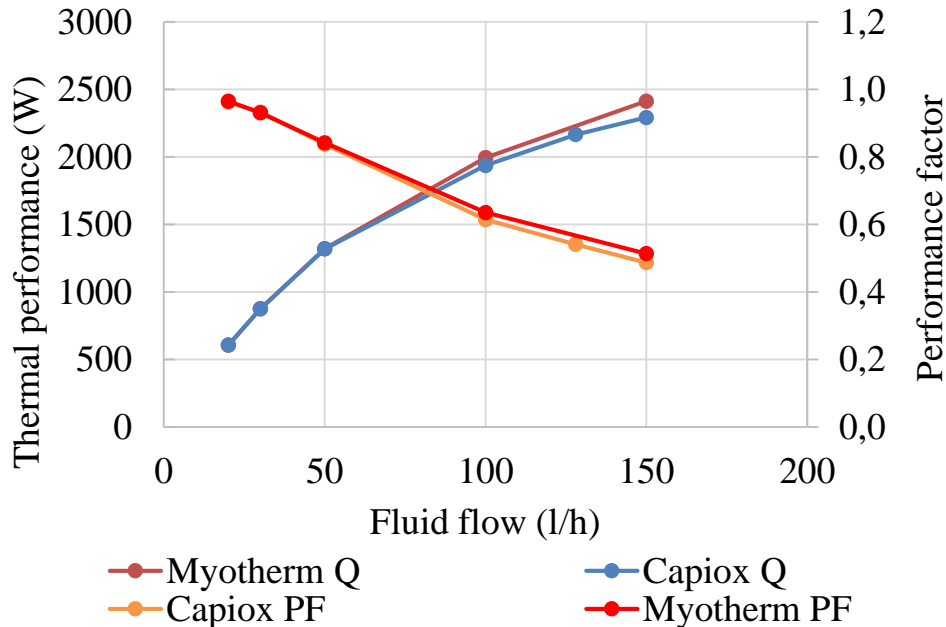
- ❑ Medicine is one of promising areas for PHFHE application
- ❑ Purpose of this work was to test commercial heat exchangers for the cardiopulmonary bypass machine (CPB) to further producing PHFHE with the same characteristics

Scheme of experimental setup



- ❑ Water was used as a substitution for blood
- ❑ Hot water temperature was set as **35 °C** and a flow rate changed in a range **20-150 l/h**
- ❑ Cold water temperature was set as **13 °C** with the constant flow rate **700 l/h**

Results and Discussion



The efficiency of the heat exchangers determined by **performance factor R:**

$$R = \frac{T_{BO} - T_{BI}}{T_{WI} - T_{BI}},$$

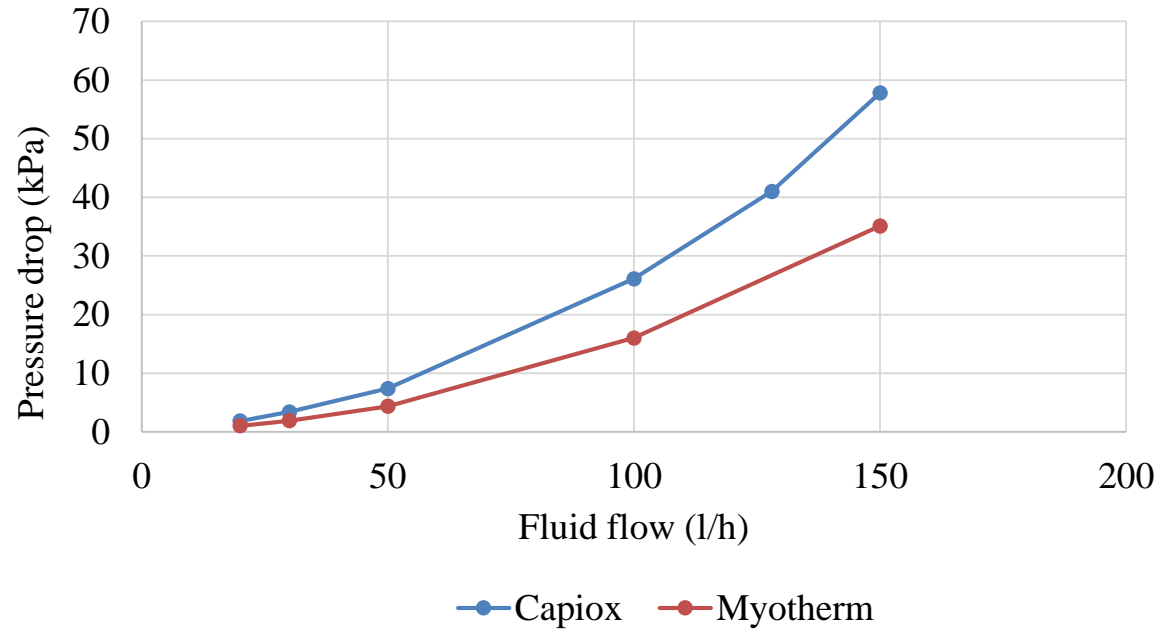
where

T_{BO} is the temperature at the tube outlet,

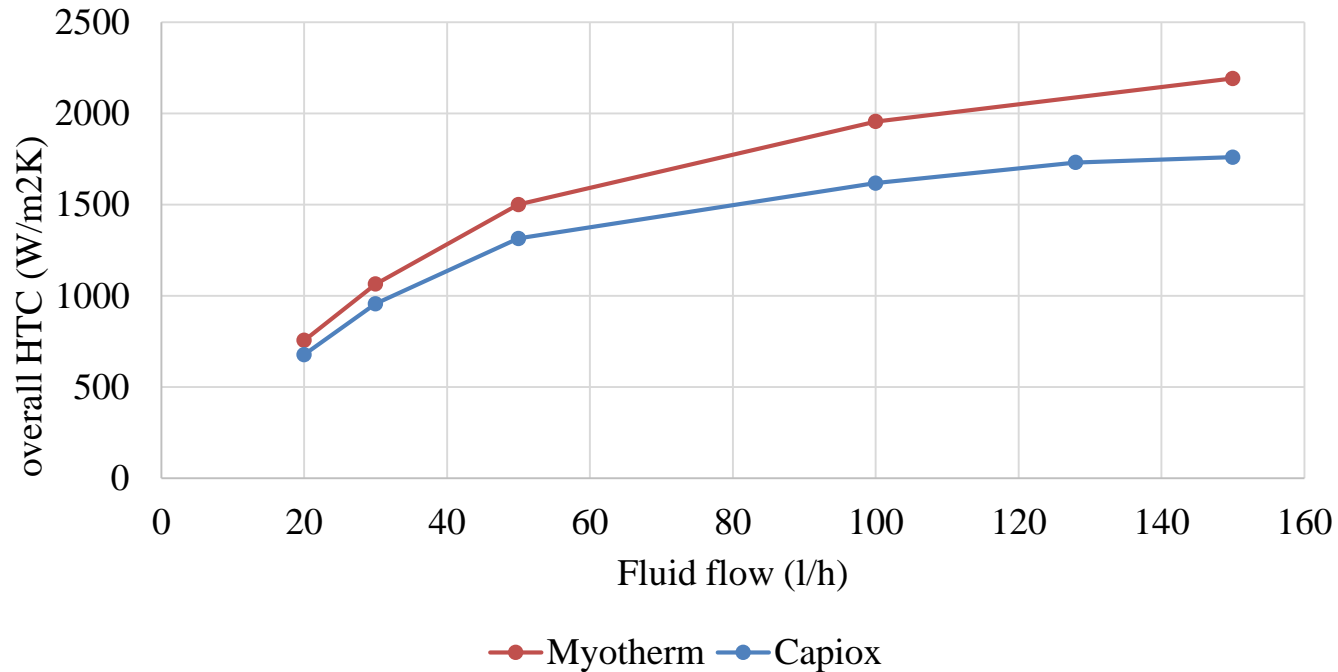
T_{BI} is the temperature at the tube inlet

T_{WI} is the temperature of the water at the shell inlet.

Dependence of the pressure drop on „blood“ side on the flow rate



Dependence of the overall HTC on „blood“ side on the flow rate



Conclusions

- ❑ For low flow less than **60 l/h** the difference between heat exchangers was negligible
- ❑ The maximum value of pressure drop was **35.1 W/m²K** and **57.8 W/m²K** for MYOthem XP and Capiox Cardioplegia, respectively
- ❑ The maximal achieved thermal performance of the heat exchangers was **2.4 kW** for MYOthem XP and **2.3 kW** for Capiox Cardioplegia
- ❑ The maximum value of HTC was **2191.3 W/m²K** and **1760.2 W/m²K** for MYOthem XP and Capiox Cardioplegia, respectively
- ❑ Next step of the work will be developing of PHFHE with similar characteristic

**THANK YOU FOR YOUR
ATTENTION**



EUROPEAN UNION
European Structural and Investment Funds
Operational Programme Research,
Development and Education



MINISTRY OF EDUCATION,
YOUTH AND SPORTS

RESEARCH CENTRE OF LOW- CARBON ENERGY TECHNOLOGIES

BRNO UNIVERSITY OF TECHNOLOGY
FACULTY OF MECHANICAL ENGINEERING
Project reg. Nr. CZ.02.1.01/0.0/0.0/16_019/0000753

