



# **Design and Test of Tube & Shell Heat Exchangers for Potential OTEC Application**

**Jeong-Tae Kwon<sup>1</sup>, Chang-Kyoung Lee<sup>1</sup>, Hyun- Min Kwon<sup>1</sup>,  
Young-Chul Kwon<sup>2</sup>, Chul Huh<sup>3</sup>**

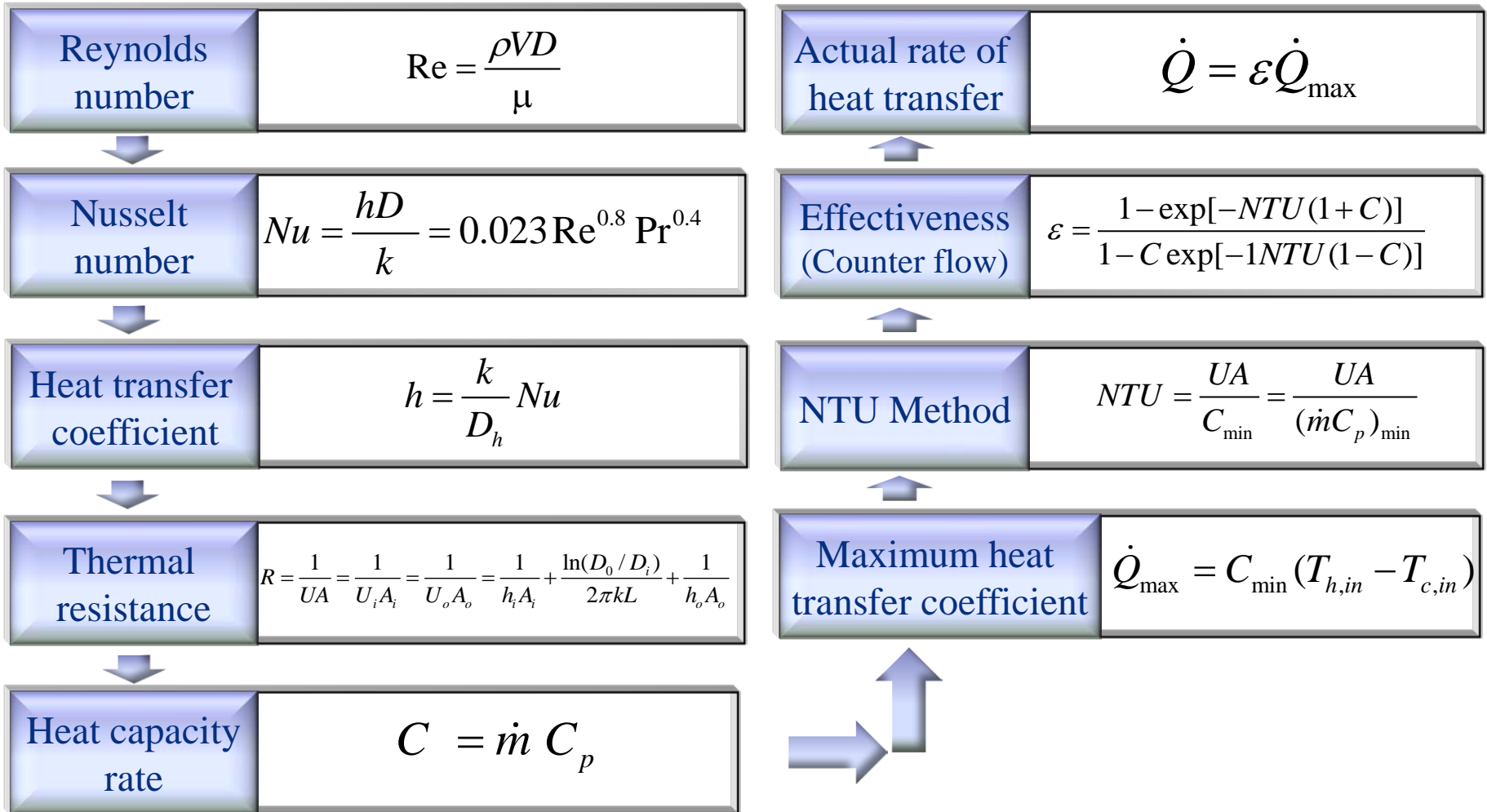
**<sup>1</sup>School of Mechanical Engineering, Hoseo University, South Korea**

**<sup>2</sup>Department of Mechanical Engineering, Sunmoon University, South Korea**







**<sup>3</sup>Offshore CCS Research Unit, Maritime & Ocean Engineering Research  
Institute, Korea Institute of Ocean Science and Technology, South Korea**

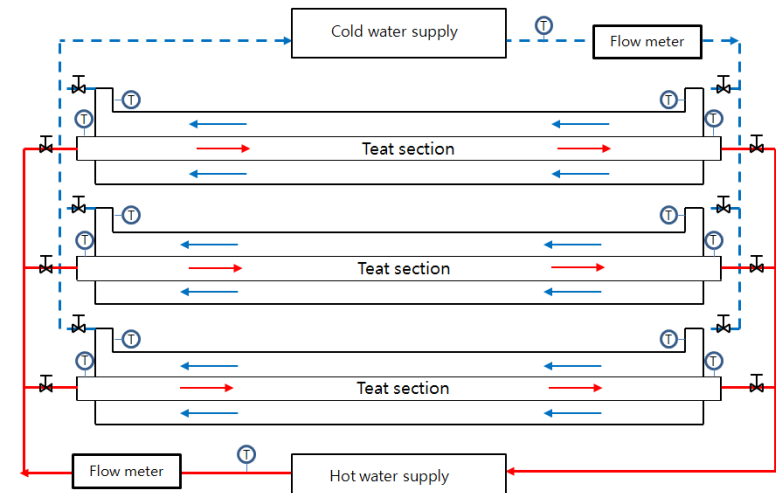
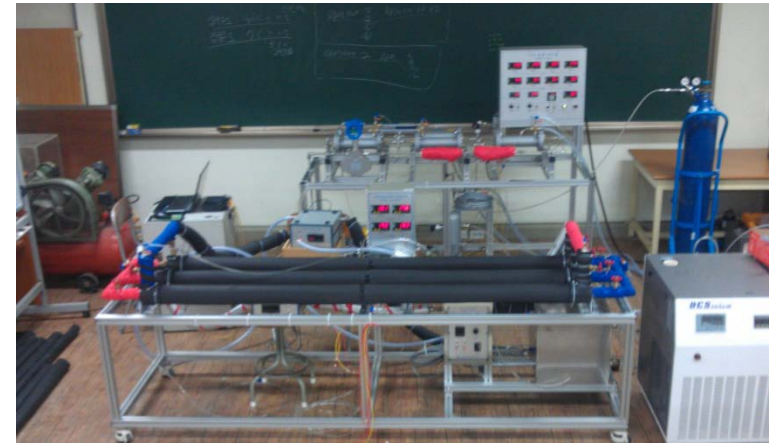
# Effects of Material on Heat Transfer Performance

## Analysis and design of double-tube heat exchangers

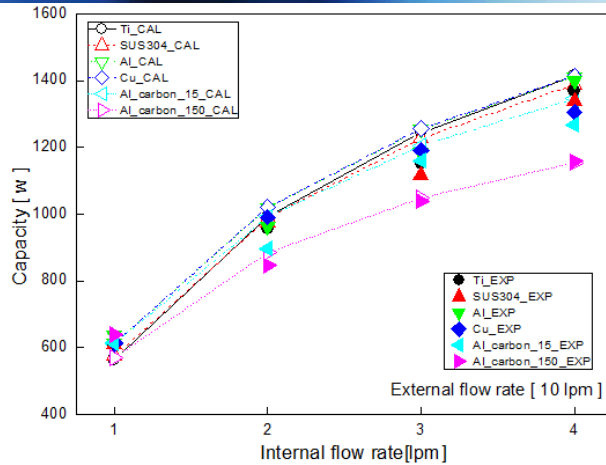


# Experimental apparatus

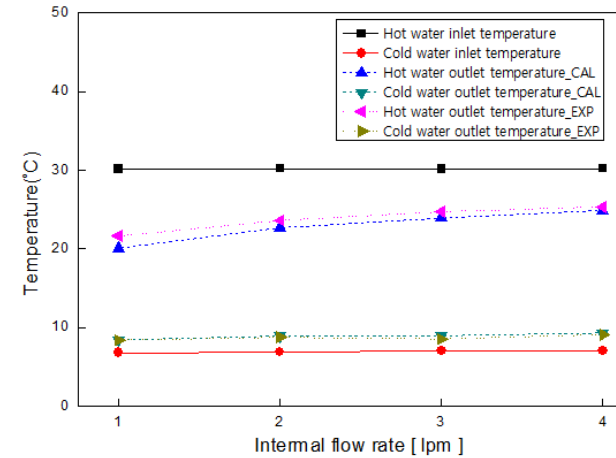
Metal Type	Ti	SUS304	Al	Cu	Al 15 $\mu$ m	Al 150 $\mu$ m
Photo						
k[W/mK]	22	15	237	401	30.8	3.9
Price [US\$/Kg]	6.9	1.5	1.7	7.1		



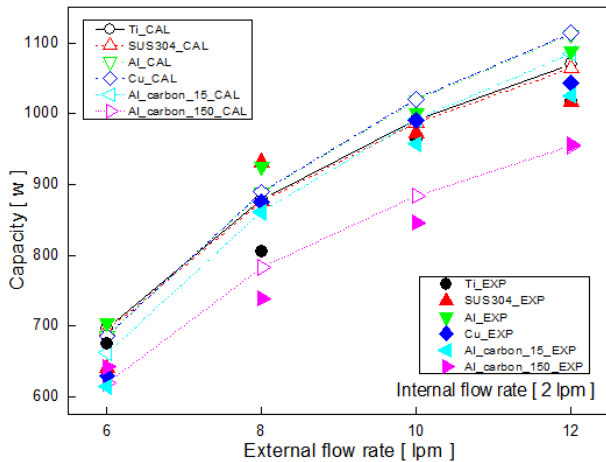
# Results



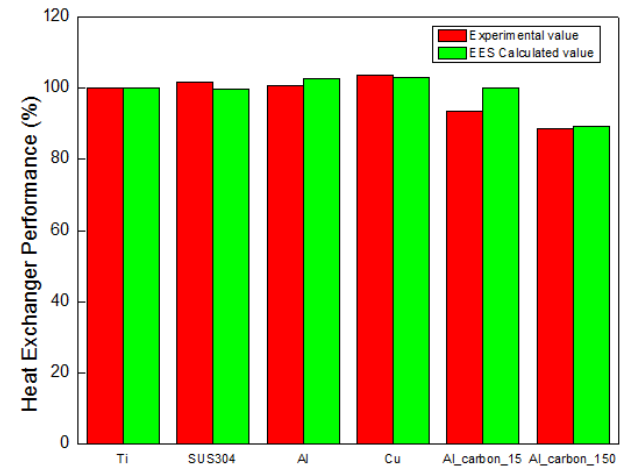
Experimental and calculation results for the heat transfer rate vs. internal flow rate



Outlet temperature vs. internal flow rate



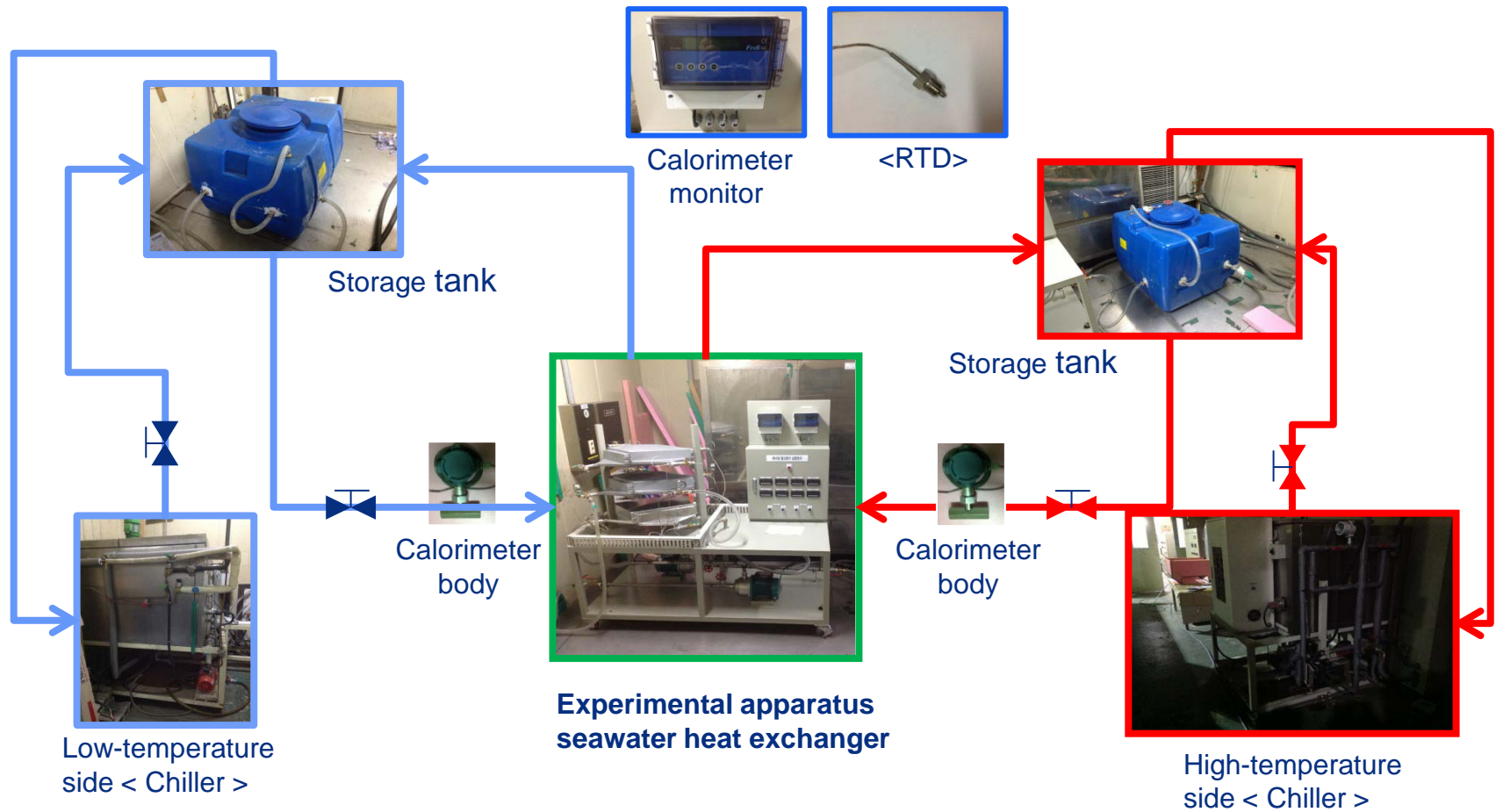
Experimental and calculation results for the heat transfer rate vs. outer flow rate



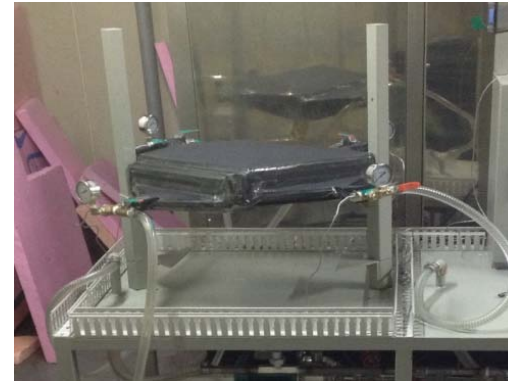
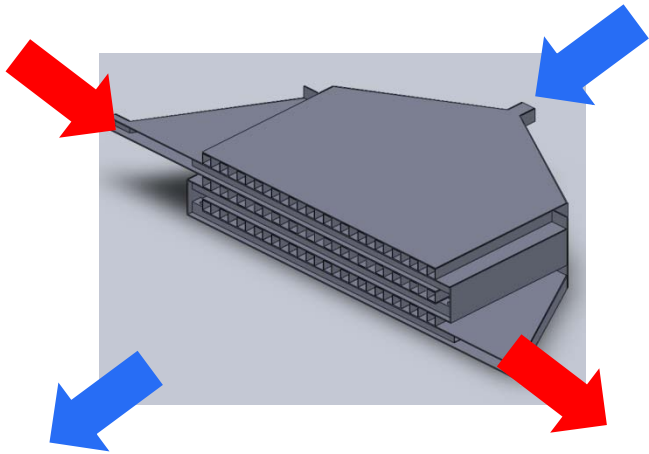
Experimental and calculation values of the heat transfer performance

# Heat Exchanger Development

## Experimental apparatus for seawater heat exchanger



# Experimental apparatus for seawater heat exchanger



Cross-Counter -1  
heat exchanger



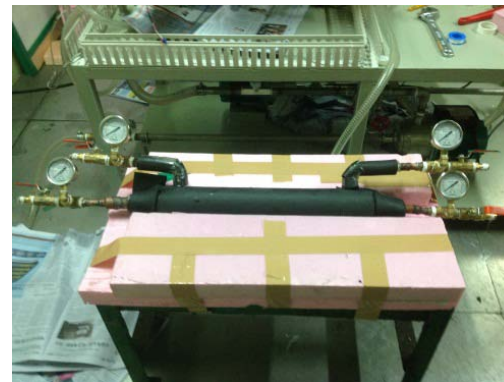
Cross-Counter -2  
heat exchanger



< High-temperature fluid flow path >



< Low-temperature fluid flow path >



Double tube  
heat exchanger

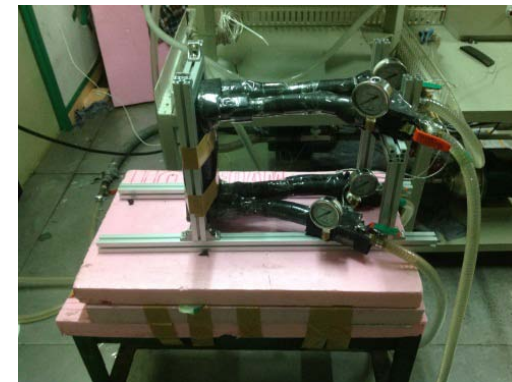
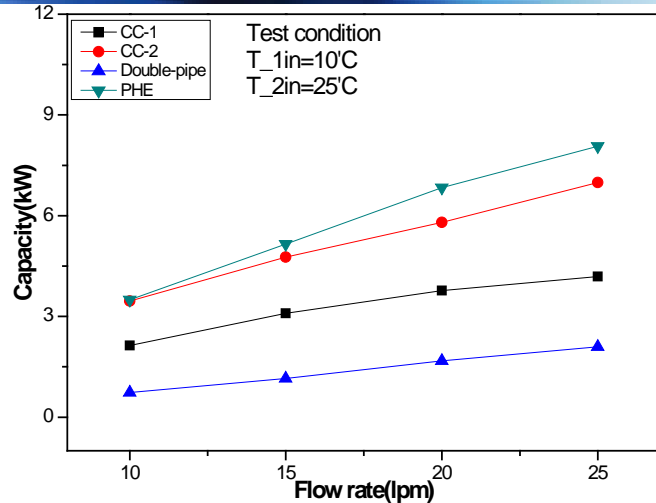


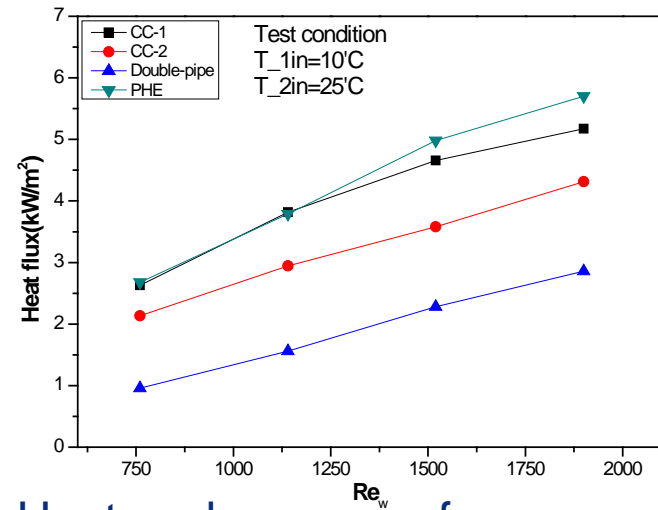
Plate Heat  
Exchanger



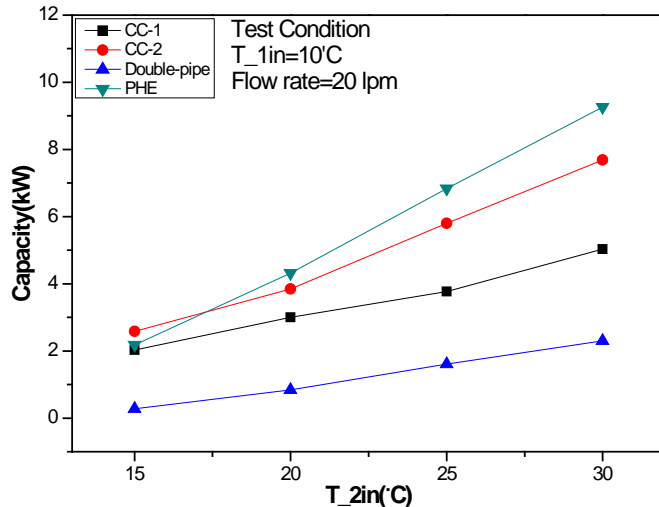
# Results



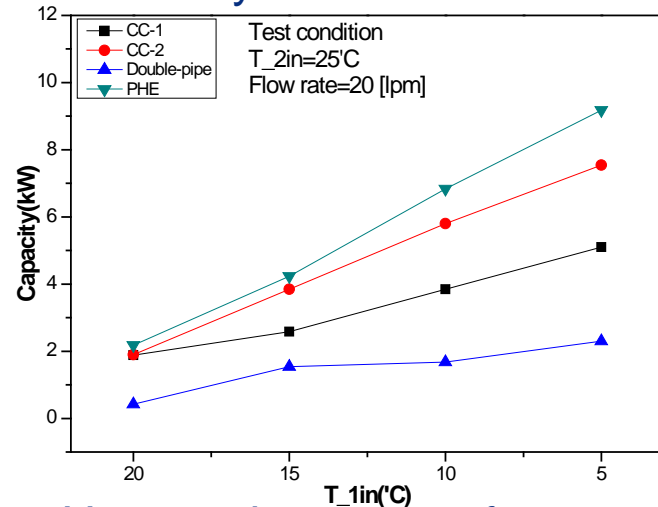
Heat exchanger performance vs. flow rate



Heat exchanger performance vs. Reynolds number



Heat exchanger performance vs. inlet hot water temp.



Heat exchanger performance vs. inlet cold water temp.

# Conclusion

## Effects of Material on Heat Transfer Performance

- Aluminum with electro-deposition (carbon black) coating is proposed as the possible candidate for replacing the Titanium.
- The coating thickness and durability might be the main factors for the development of heat exchangers using seawater.

## Heat Exchanger Development

- CC-heat exchanger shows a little bit smaller performance than that of plate heat exchanger, but its structure has advantages for electro-deposition coating process.
- The performance of CC-heat exchanger can be enhanced by developing the internal flow shape and heat exchanger structure.