Analysis of Proper Depth for Gaining Seawater Heat for Heating and Cooling in Busan, Korea

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1. Introduction

- Use of heat from seawater could be different from the weather conditions of a coastal city and seawater temperatures near the city.
- It is impossible to get deep sea water for Busan area, since the maximum sea water depth around Busan is about 150m.
- It will be a good option to use surface layer water with Heat Pump system for using seawater cooling/heating in Busan.
- The study investigates the proper depth for seawater heat gain of Busan area in Korea : Sampling points are 0, 10, 20, 30, 50m from the surface of the Sea.
- Proper seawater intake depth for heating and cooling in Busan is suggested, through investigating the temperature of seawater according to the depth

2. Examples of seawater heat source facilities

Korean Cases

KIOST

* Use of Deep Seawater for Air conditioning of the building.

* A small size pilot project (60RT)

* About 86% of cooling energy is saved.

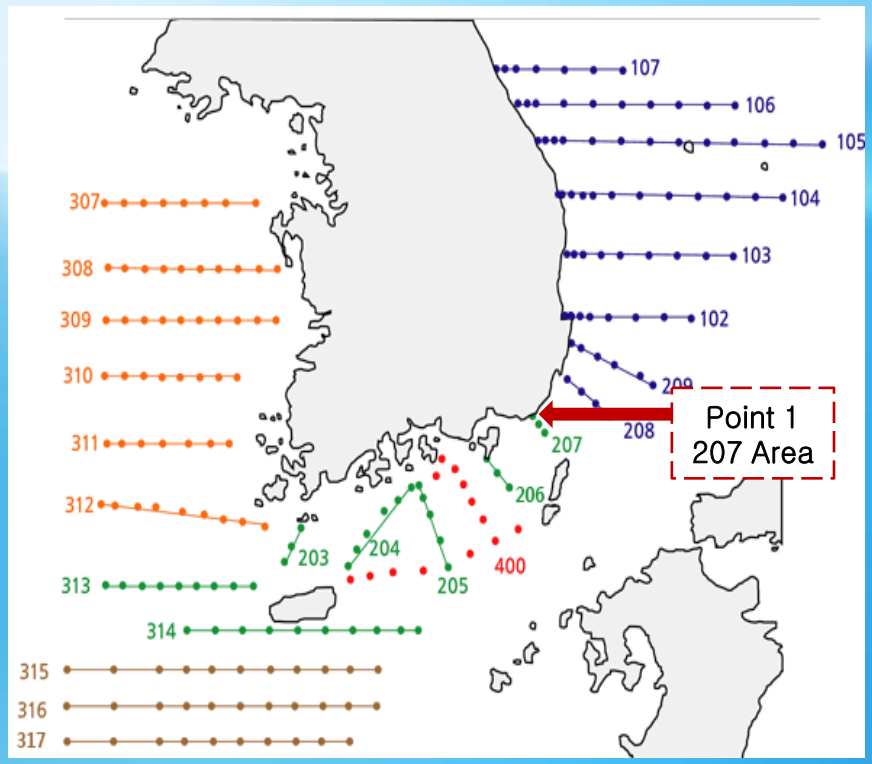
Korea Maritime University

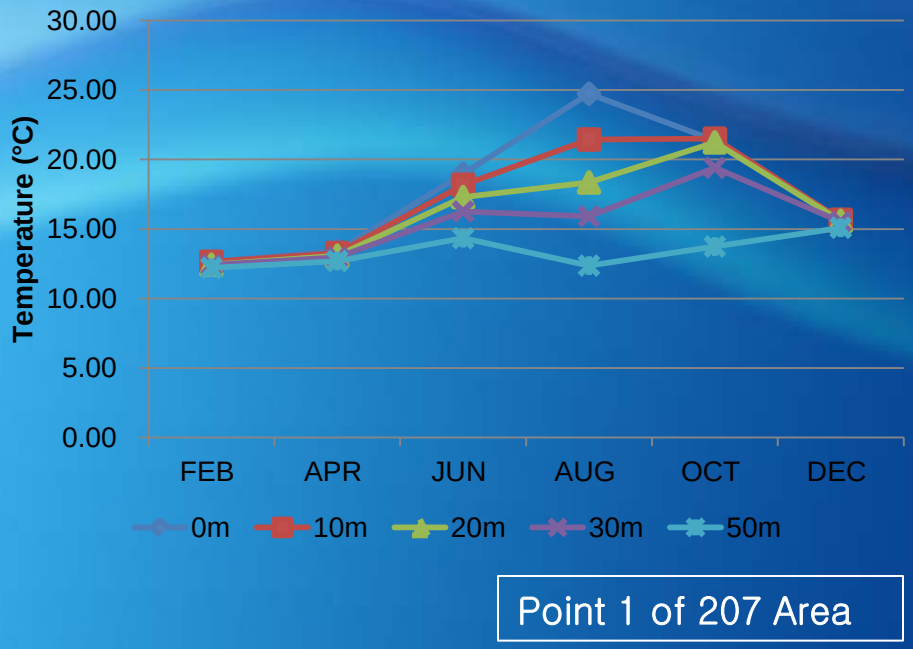
* 75RT Size Heating and Cooling System using Plate-type Heat Exchanger.

* Flow Rate : 60m^3/h ,
COP for Cooling : 7
COP for Heating : 6.8

* About 70% of electricity energy is saved.

3. Analysis of seawater temperature





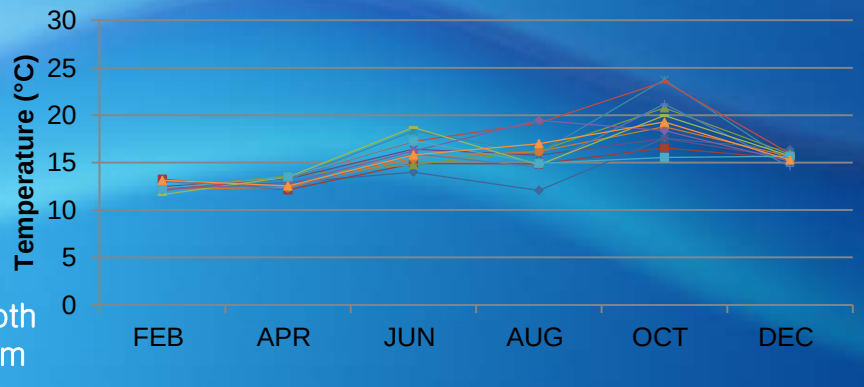
Point 1 of 207 Area

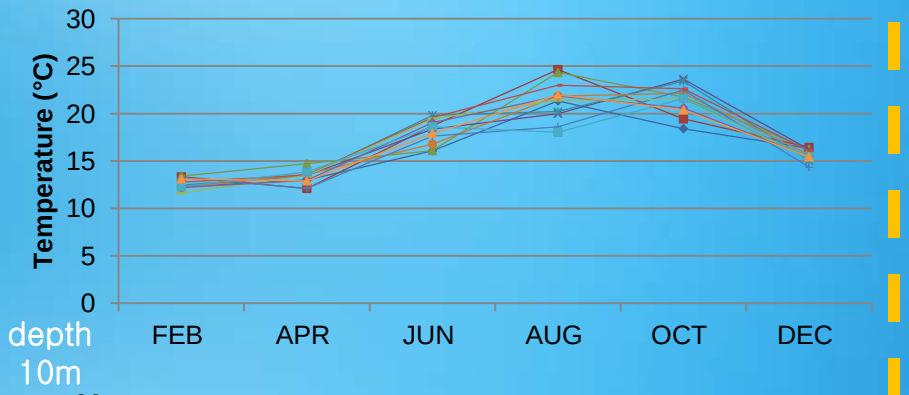
207 Area	Point 1	Point 2	Point 3
Distance	2km	14km	22km
Depth	84m	103m	115m

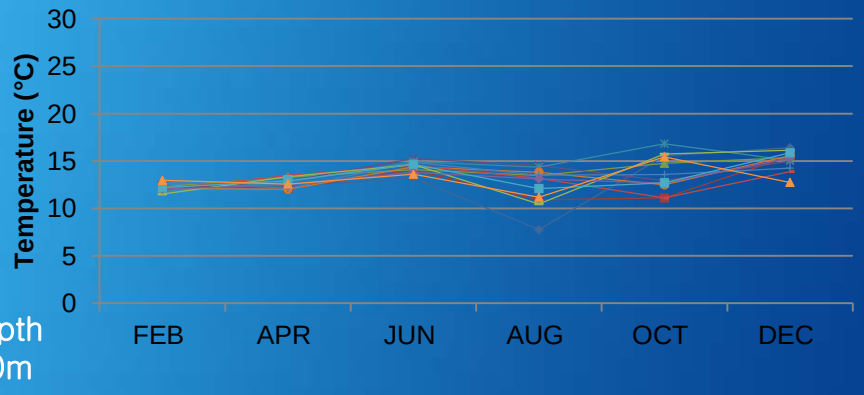
- Temperature Analysis for Sea Water at Point 1 of 207 area between 2000 and 2011.
- The temperature of surface water fluctuates according to the season, while that of deep sea water is constant.

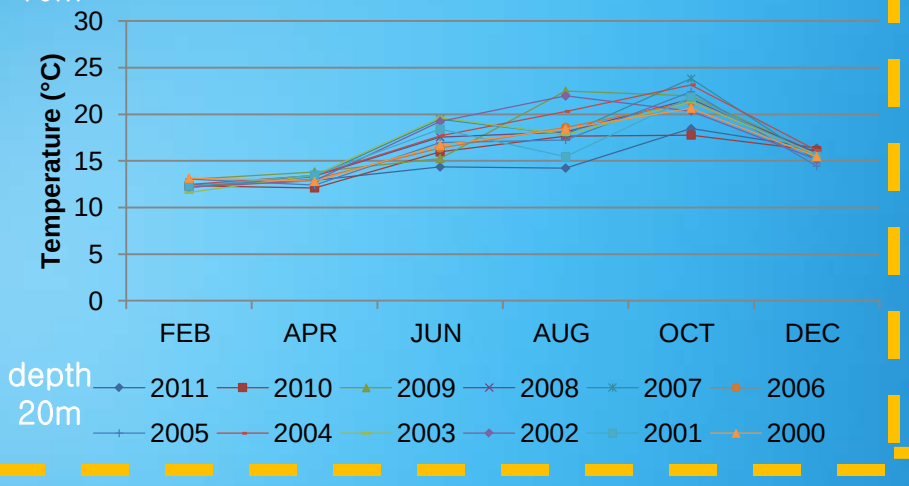
3. Analysis of seawater temperature

Point 1 of 207 Area









- Seawater temperature does not change significantly according to the depth in winter, while the temperature is quite different according to the depth in summer.

→ Comparison Parts

4. Energy potential of seawater heat source

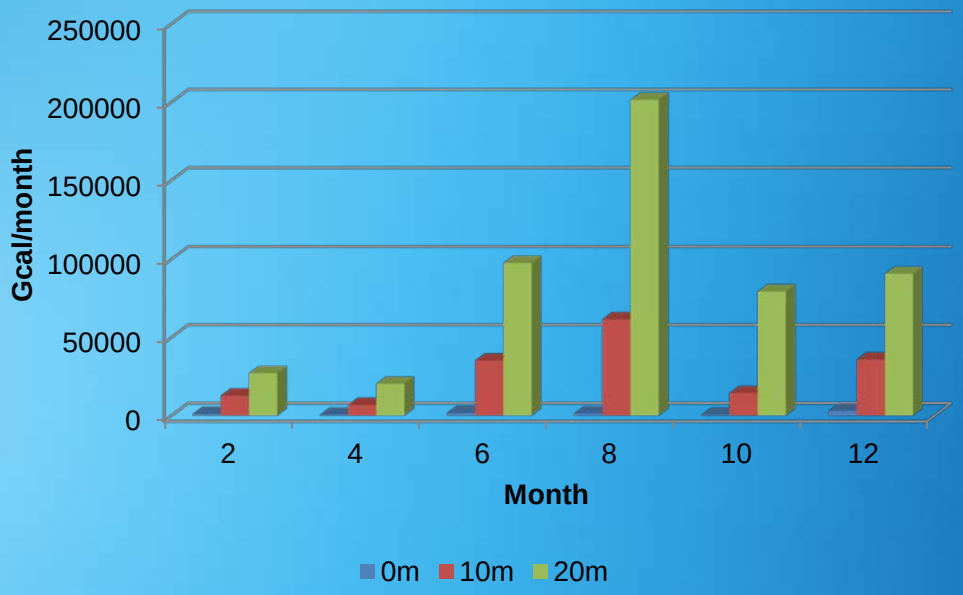
- Q is an energy potential of seawater heat source

$Q = \rho * Cp * W * \Delta t$

ρ : density of seawater(1,025kg/m^3) Cp : Specific heat (0.942kcal/kgK)

W : flow ($10^4 m^3$/month/m) Δt : temperature difference

Δt	FEB	APR	JUN	AUG	OCT	DEC
0m	4.84	1.28	4.33	10.07	0.8	6.75
10m	4.71	1.45	5.36	10.24	1.17	6.67
20m	4.34	1.94	7.96	14.66	8.72	6.24

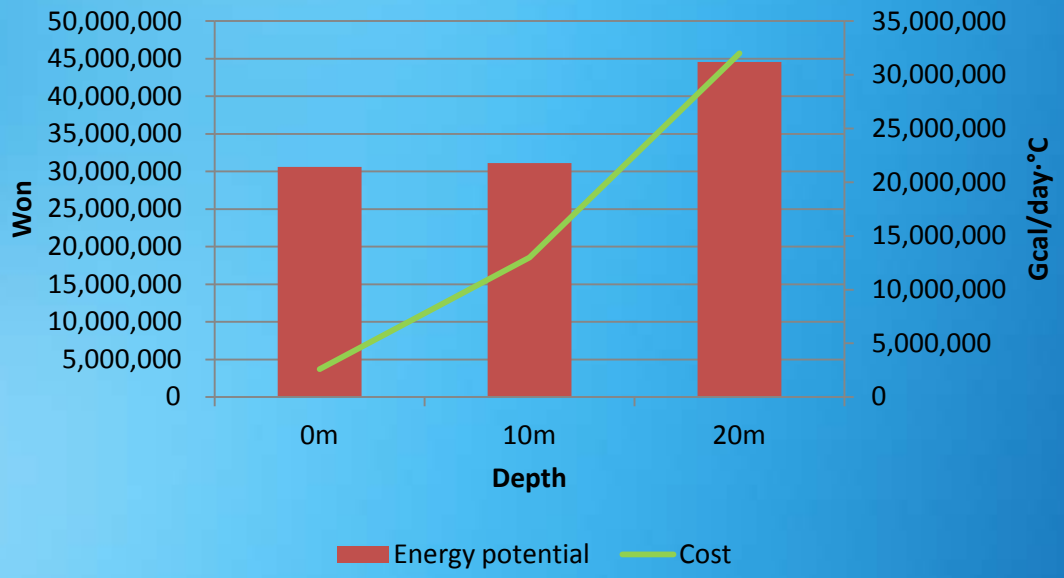


Energy potential is the biggest in summer depending on the temperature difference.

When the water level is deeper, the energy potential becomes bigger.

5. Analysis of cost for seawater intake pipes

- If the heat pump with 150A HDPE pipes is operated, the cost per pipe length(m) is 27,100 Won.
- The distance form the coast of 0 m depth below sea level is 0.095 km, that of 10 m depth is 0.476 km, and that of 20 m is 1.19 km
- The cost of pipes for the intake depth of 0 m is 2.6 million Won, that of 10 m is 130 million won, and that of 20 m is 320 million Won.



US$ 1 ≒ Korean Won 1,100

- The energy potential between 0m and 10m depth is similar.
- The cost of intake pipes varies by the distance from the coast and seawater depth level.

6. Conclusion

- The temperature difference according to the depth of seawater is relatively big during August, while it is almost the same from October to April.
- The installing cost for intake pipes for 20m depth is about 3 times higher than that for 10m.
- Although the COP of the system using deeper seawater is higher than that using shallower seawater, the initial cost of the system using deeper seawater is much higher that that using shallower seawater.
- Use of seawater from 10m depth is more economical than that from 20m.