HEAT CONDUCTION

Unit 20 Dr. John P. Cise, Professor of Physics, Austin Com. College, 1212 Rio Grande St. Austin Tx., 78701 jpcise@austincc.edu & New York Times Feb. 1, 2016 by John Markoff

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Microsoft Plumbs Ocean's Depths to Test Underwater Data Center

Ben Cutler, left, and Norman Whitaker, both of Microsoft Research, with the "Leona Philpot," a prototype underwater data center, at the company's headquarters in Redmond, Wash. REDMOND, Wash. — Taking a page from Jules Verne, researchers at Microsoft believe the future of data centers may be under the sea.

Microsoft has tested a prototype of a **(((self-contained data center that can operate hundreds of feet below the surface of the ocean, eliminating one of the technology industry's most expensive problems: the air-conditioning bill)))**. Today's data centers, which power everything from streaming video to social networking and email, contain thousands of computer **servers generating lots of heat. When there is too much heat, the servers crash**. **Putting the gear under cold ocean water could fix the problem.** It may also answer the exponentially growing energy demands of the computing world because Microsoft is considering pairing the system either with a turbine or a tidal energy system to generate electricity. **Microsoft manages more than 100 data centers around the globe and is adding more at a rapid clip.** "When you pull out your smartphone you think you're using this miraculous little computer, but actually you're using more than 100 computers out in this thing called the cloud," said Peter Lee, corporate vice president for Microsoft Research and the NExT organization. **The company recently completed a 105-day trial of a steel capsule — eight feet in diameter — that was placed 30 feet underwater in the Pacific Ocean off the Central California coast near San Luis Obispo.** It is a large white steel tube, covered with heat exchangers, with its ends sealed by metal plates and large bolts. Inside is a single data center computing rack that was bathed in pressurized nitrogen to efficiently remove heat from computing chips while the system was tested on the ocean floor. **Even if putting a big computing tube underwater seems far-fetched,** the project could lead to other innovations, he said.

INTRODUCTION: $\Delta Q/\Delta t = K\ A\ [\Delta T/\Delta X]$, **Heat/time = (conductivity coefficient) (Area) (temperature difference/distance difference).**
K_{IRON} = 80 Watts/ m C^o , Temperature of sea water off California = 58° F , Temperature of hot servers in cylinder = 120° F .
Once this cylinder (see pictures above) with servers [inside are servers at 120° F] is placed in the cold (at 58° F) sea water heat (Q) per unit time will flow out of cylinder into the sea. Purpose is to find ΔQ/Δt flowing out of 1-inch-thick iron cylinder.

HINTS: Area of a circle = πR^2 , area of a cylinder = $2\pi R L$, L = length , $\Delta C/\Delta F = 5/9$, 0.0929 m^2 = 1 $ft.^2$, Watt = W = Joule/s = J/s

QUESTIONS: (a) Find area A (surface + both ends) iron cylinder in $ft.^2$? (b) Convert area to $m.^2$?, (c) Convert ΔF (between inside Cylinder and sea water temperature) to ΔC ? (d) Find ΔQ/Δt = Heat/ time flowing out of hot cylinder (with servers) into sea?

ANSWERS: (a) 401.6 $ft.^2$, (b) 37.3 $m.^2$, (c) $\Delta C = 34.44\ C^2$, (d) ~ 4.06 X 10^6 J/s
COMMENT: Microsoft servers work best around 80^0 F . So, this methodology to cool servers seems possible. JC (- :