

Experimental Investigation of Chilled Water Flowrate Due to Temperature Change in Cooling Coil

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Abstract: The experiment conducted shows that repeated cooling capacity of 18.00W has steady buoyancy. At this set point air densities, convective heat transfer coefficients and volumetric mass flowrate tends to compensate objective constraints of heat loss within air handling units. When forced heat transfer convection occurs, differential pressure and water flow rate varies haptic relief valve was set at 40.20W cooling capacity. This research estimated the pressure drop due to piping using counter flow to attain 0.90 effectiveness. When the inlet and outlet temperature decreases at 0.30W at 3 percent of effectiveness. The heat sink was relatively reduced with uniform 2.74kg/s mass flow rate with slight heat sink. We were able to use flow sensor to reduce overheating by creating laminar flow regime dropping the temperature from 38.03 °c to 30.10 °c. At 5 minutes the pressure drops further from 6.02 pascal to 1.07pascal when vapor bubbles were regulated within the air handling unit at volumetric range of 1.9 m³/s and 1.10 m³/s.

Keywords: Experimental, Investigation, Chilled Water, Flowrate, Temperature, Cooling Coil.

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I. INTRODUCTION

The motion of heat within open space and building has a significant role in shaping thermal comfort. This depends on the material thermal conductivity, sunlight position of buildings and system design threshold load. For instance, heat exchanger is made with different gauge factor to regulate pressure, fluid flow, temperature change and relative humidity. These design parameters might not necessarily align with future climatic change over decades causing increase in cost of developing system control mathematical models (Bataineh & Taamneh, 2016, Shirazi et al., 2017). The chillers and chilled water system has different components. The basic ones are made of compressor, condenser, expansion valve and evaporator. When water flows some air densities differ alongside kinetic collision get more excited. Temperature gets delayed when insoluble compounds settle within the pump lining. The primary aim of chiller is to utilize heat to form cooling released into buildings with huge number of occupants. Most times the heat takes about 30 % of global energy consumption and suitability is highly important factor to be addressed (Deng, et al., 2025, Jensen, 2017, Li, 2021). In this research water flow rate and air flow rate would be investigated when pressure drops. To optimize heat loss and poor cooling coil energy alongside heat gain for predictive monitoring.

II. LITERATURE REVIEW

Several research was conducted giving an instant how heat can be transferred into air cooling. Similarly, experiment was conducted on vapor compression system from natural cooling with an air-cooled data collection to enhance integrated coefficient of performance from 6.24 to 8.83 (Anka et al., 2023). Further insight was clarified using lithium bromide to form double effect compartment having parabolic trough solar collector. But the theoretical frame work is to test only the system operation, energy optimization, economic sustainability and environmental responses (Zheng et al., 2020). In contrast to the existing work model predictive control was developed to enhance central air condition system embedded to cold storage unit to estimated swift demand responses to efficiently control air within indoor and energy usage (Tang & Wang, 2019).

However, findings were evaluated through model-based knowledge by varying datasets and model to distinguish simplicity, computational complexities, internal problems and external inaccuracy of cooled air exchanges in a building (Killian & Kozek, 2016, Zhan & Chong, 2021 Langner et al., 2024). Nevertheless, its relevance in real world application still has numerous difficulties retaining low sample efficiency, inconsistent early training and increment in data request for optimal machine learning, sensing with delayed

feedback responses (Wang & Hong, 2020, Nagy et al., 2023). All this research differs from using hierarchical optimization control strategy using multi zone heating ventilation air conditioning system to rectify fan energy consumption to enhance indoor air circulation (Cui & Liu, 2024).

Our finding uses predictive density valve opening and closing to minimise heat loss and vapor bubble air trap within an enclosed system using theoretical concept.

III. METHODOLOGY

An aluminium tube with coated copper plate fin 3.0mm thickness was used to compare cooling capacity behavior.

Thermocouple sensors and infra-red sensors were mounted at specific ports each for inlet air coils and outlet water chillers at uniform 2.74kg/s mass flow rate. Initially the sensor detected cooled water temperature difference of 38.03 °c dropping back to 30.10 °c . At 5 minutes the pressure drops further from 6.02 pascal to 1.07pascal within the air handling unit with volumetric flow rate range of 1.9 m³/s and 1.10 m³/s. The flow test was conducted in six runs with varied speed and wave patterns. While the cooling capacity for water chiller were conditioned at a pumping threshold of 0.018W.

Table 1 Comparison of Temperatures and Flow of Chilled-Water Cooling System

Cooling Capacity (W)	Water mass flow rate (kg/s)	Specific heat Capacity (J/kg.K)	Outlet water Temperature (°c)	Inlet water Temperature (°c)	Cooling Effectiveness
21.90	2.74	1.007	30.10	38.03	0.90
18.00	2.74	1.007	8.60	15.00	0.90
18.00	2.74	1.007	3.50	10.00	0.90
13.20	2.74	1.007	1.20	6.00	0.90
30.00	2.74	1.007	35.30	46.00	0.90
23.00	2.74	1.007	18.30	27.00	0.90

IV. RESULTS AND DISCUSSIONS

The chilled water exhibited adaptive cooling load and temperature variation due kinetic vibration of the valves. Thick line indicated passive cooling and dotted line represents controlled fluid flow, thickness of pump diameter, axial stress and pressure loss were evaluated at different flow regimes. The experiment conducted consider vapor and

cooling steady state using the equations below for computation to compensate pump thickness expansion.

$$Q = UA\Delta T \quad (1)$$

$$Q = MC\Delta T \quad (2)$$

$$E = \frac{Q}{Q_m} \quad (3)$$

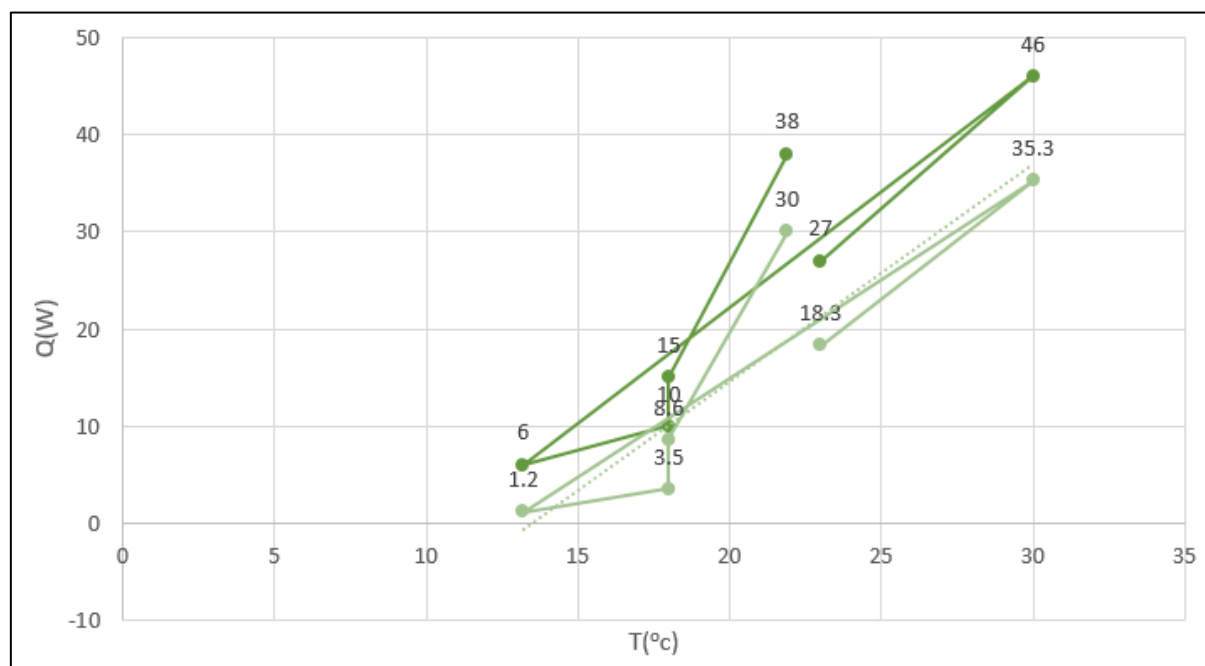


Fig 1 Heat Transfer Performance for Chilled Water at Varied Flowrate

There was rise in cooling capacity up to 46 (W) at initial area of 7.93m^2 with $10.70\text{ }(^{\circ}\text{C})$ temperature. It shows nonlinear correlation of -10W cooling capacity slight -0.1 W/m^2 heat flux tolerance. The energy pattern for the chilled water remains negligible as result heat of decreasing pressure. Because, heat recovery is less within sharp edges of the pump than the thick layer from $1.20\text{ }^{\circ}\text{C}$ to $46\text{ }^{\circ}\text{C}$ flow regime

temperatures. It shows that increasing water flow increases the pumping power. Hence, chilled water block diagram has a cascaded model using algorithm to trigger anomaly temperature at range of $10.60, 18.33\text{ }^{\circ}\text{C}$ up to $35.3\text{ }^{\circ}\text{C}$ with linear dotted line trajectory. While the outlet port temperatures increases and remain stable twice at 18.00W in table 1.0 and figure 1.0 above.

Table 2 Predicted Thermal Responses of Cooling Coil

Cooling Capacity (W)	Overall heat transfer coefficient ($\text{w/m}^2\text{k}$)	Area (m^2)	Mean Temperature ($^{\circ}\text{C}$)	Cooling Effectiveness
23.70	0.27	7.93	10.70	0.90
12.40	0.17	6.40	11.22	0.90
8.30	0.06	6.50	18.60	0.60
4.20	0.03	4.80	24.00	0.40
1.60	0.01	10.70	13.90	0.30
3.00	0.02	8.70	12.90	0.20

When the pressure drops the inlet temperature of the pumping power shows two cross flow and null counter flow behavior in figure 1.12 below. As the effectiveness increases the cooling capacity consistently shows positive response by

the cooling coil. At cooling capacity of 0.3W about 3 percent of effectiveness determines the maximum heat were retained at 0.99W .

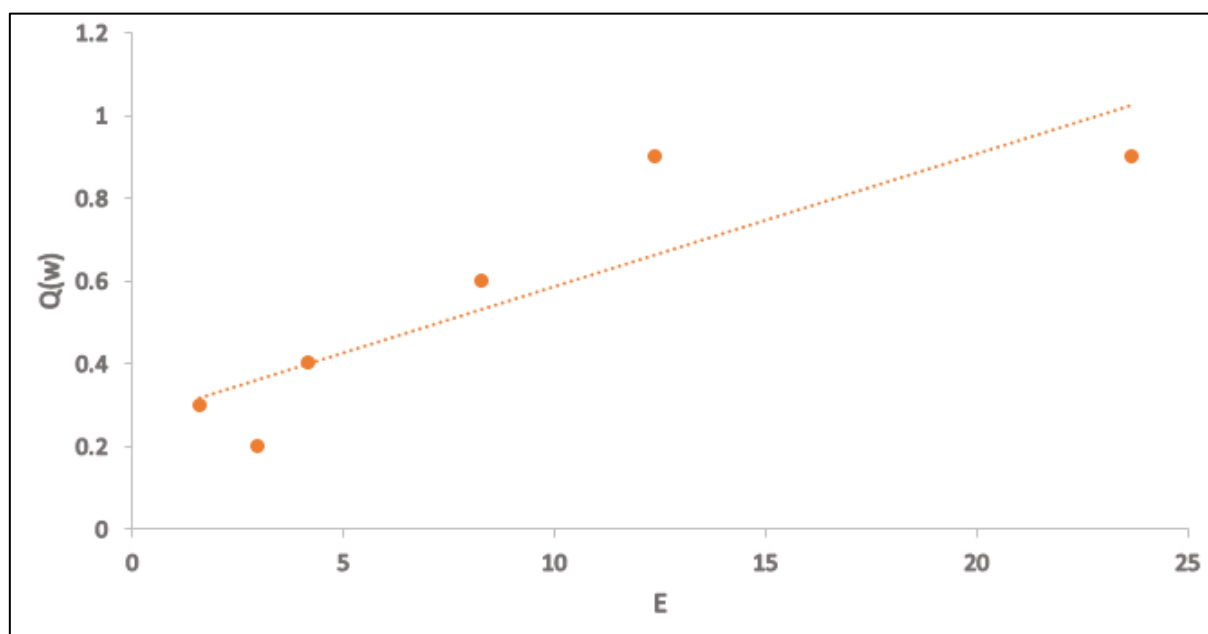


Fig 2 Predicted Thermal Responses of Cooling Coil

V. CONCLUSION

This research evaluates simple mathematical and qualitative approach to resolve flow instability and cavitation effect to determine coiling performance of a closed system. It was found that at extreme temperature masses of heat forms bubble at area with less roughness surface.

RECOMMENDATION

Further research should be on fuzzy logic concept and resonant frequency to moderate heat sink inside a building. This will simply energy consumption by the fan causing air lag within the pump channel.

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