POTENTIAL ENERGY SAVING WITH HIGH ΔT CHILLED WATER DESIGNS COMPARED TO THE CONVENTIONAL LOW ΔT DESIGN FOR OFFICE BUILDINGS

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ABSTRACT

This thesis investigates the potential energy saving benefits associated with high delta T chilled water designs compared to conventional low delta T designs in office buildings. This high delta T requirement specified in the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1: 2016 under subsection 6.5.4.: “Chilled Water coil selection and theoretical background of temperature difference towards energy efficiency”. The aim of the study is to evaluate the capital cost reduction and annual energy savings achievable through the implementation of high delta T configurations and finally identify the applicability in tropical countries. The study followed a comprehensive research methodology that involved analysing 03 chilled water delta T options and assessing their impact on capital costs and energy consumption.

The findings of the study demonstrate a significant cost savings and energy efficiencies associated with high ΔT chilled water designs. A total capital cost reduction of 2.8% for the ΔT=7°C system and 3.6% for the ΔT=8.3°C system was observed compared to the conventional ΔT=5°C system. Additionally, the annual energy analysis revealed a 0.97% reduction in energy costs for the ΔT=7°C system and a higher energy cost saving of 1.93% for the ΔT=8.3°C system compared to the ΔT=5°C system.

These findings highlight the potential benefits of adopting high delta T chilled water designs in office buildings. The results not only demonstrate cost-effectiveness but also underscore the importance of energy efficiency and sustainability in building design and operation. The outcomes of this study contribute to the existing body of knowledge in the field and provide valuable insights for building professionals and stakeholders seeking optimal cooling system solutions. By embracing high delta T designs, practitioners can achieve tangible benefits in terms of reduced capital expenditures and ongoing energy consumption, leading to a more sustainable and economically viable built environment.

Keywords: Energy efficiency, high delta T, chilled water, office building, tropical country

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Abbreviation	Description
ACH	Air Changes per Hour
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
BOQ	Bill of Quantity
BS	British Standards
CAV	Constant Air Volume
CDWR	Condenser Water Return
CDWS	Condenser Water Supply
CHWR	Chilled Water Return
CHWS	Chilled Water Supply
CIBSE	Chartered Institution of Building Services Engineers
COP	Coefficient of Performance
DB	Dry Bulb
Delta T/ ΔT	Temperature Difference
ECWT	Entering Condenser Water Temperature
ESP	External Static Pressure
FA	Fresh Air
GHG	Greenhouse Gas
IAQ	Indoor Air Quality
LCHWT	Leaving Chilled Water Temperature
RA	Return Air
SA	Supply Air
SFP	Specific Fan Power
SLSEA	Sri Lanka Sustainable Energy Authority
SS	Single Split
TCC	Total Cooling Capacity
VRV/ VRF	Variable Refrigerant Volume/ Flow
WB	Wet Bulb

Notations	Description
Q	Heat transfer rate
ρ_w	Density of water
V_w	Water flow rate
Cp_w	Specific heat of water
ΔT_w	Chilled water temperature difference
P_P	Pump power
ΔP_w	Pressure drop of the circuit
η_p	Pump efficiency
ρ_a	Density of air
V_a	Air flow rate
Cp_a	Specific heat of air
ΔT_a	Conditioned air temperature
U_a	Thermal resistance air side
$MLTD_a$	Air side mean logarithmic temperature difference
$MLTD_w$	Water side mean logarithmic temperature difference
P_F	Fan power
ΔP_{coil}	Coil pressure loss
η_F	Fan efficiency

Subscripts	Description
a	Air
F	Fan
P	Pump
w	Water