

DESIGN AND DEVELOP TES SPLIT UNIT OF AIR CONDITIONING SYSTEM

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Date : APRIL 2010

Untuk Ibu Dan Ayah Tersayang...
Hanya Engkau Sahaja Ilham Hidupku...
Akan Ku Buktikan Kepadamu...
Yang Aku Juga Boleh Berjaya Seperti Orang Lain...

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ABSTRACT

Nowadays, most of the building were used the air conditioning refrigeration systems for a cooling down the temperature inside of the room. However, the air conditioning refrigeration systems is using more electric consumption. In generally, cool storage technology can be used to significantly reduce energy costs by allowing energy intensive, electrically driven cooling equipment to be predominantly operated during off-peak hours when electricity rates are lower. Thermal energy storage may refer to a number of technologies that store energy in a thermal reservoir for later reuse. Five step of methodology was used in experiment such as sketch the split unit system, prepare material or components are needed, install the component, recheck the component and run the system. Thermal energy storage had been created in order to saving energy consumption especially on electric power. The result of electric consumption for thermal energy storage is 0.3kW compare than conventional air conditioning which 1.232kW is needed for operate the system. Coefficient of performance of air conditioning can be determined by power use and capacity of ice in the storage. Where, value of coefficient of performance will increase with increasing of power pump, rate capacity of air conditioning and capacity of ice used.

ABSTRAK

Pada masa kini, kebanyakan bangunan adalah menggunakan sistem penyejukan penyaman udara untuk menyejukkan suhu di dalam bilik. Bagaimanapun, sistem penyejukan penyaman udara menggunakan lebih tenaga elektrik. Secara umumnya, teknologi penyimpanan tenaga sejuk boleh digunakan untuk mengurangkan kos tenaga dengan membenarkan tenaga intensif, kelengkapan penyejukan elektrik dipandu menjadi lebih banyak beroperasi semasa waktu tidak sibuk apabila kadar elektrik adalah rendah. Penyimpanan tenaga haba boleh dirujuk kepada nombor dari teknologi iaitu penyimpanan tenaga dalam takungan haba untuk digunakan semula kemudian. Lima cara dari langkah-langkah digunakan dalam eksperimen seperti lakaran sistem pengasingan unit, penyediaan bahan atau komponen yang diperlukan, memasang komponen, menyemak semula komponen dan sistem dijalankan. Penyimpanan tenaga haba adalah dicipta supaya untuk menjimatkan penggunaan tenaga terutamanya kuasa elektrik. Keputusan penggunaan elektrik untuk penyimpanan tenaga haba adalah 0.3kW dibandingkan dengan penyaman udara biasa yang mana 1.232kW diperlukan untuk sistem beroperasi. Pekali pelaksanaan dari penyaman udara boleh dikira dari kuasa yang digunakan dan muatan ais dalam simpanan. Di mana, nilai pekali pelaksanaan akan meningkat dengan peningkatan kuasa pam, kadar muatan dari penyaman udara dan muatan ais yang digunakan.

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LIST OF SYMBOLS

ρ	Density
C_p	Constant Pressure
K	Thermal Conductivity
α	Thermal Diffusivity
ω	Specific Humidity
m_a	mass
\dot{m}	Specific mass flow rate
ϕ	Relative humidity
V	Volume
T	Absolute Temperature
v_0	Specific volume
P	Pressure
μ	Dynamic viscosity, head coefficient, Degree of saturation
h	Enthalpy
f_g	Heat-transfer coefficient of the air film around the wetted surface

A	Area
k_d	Mass transfer coefficient of water vapor
h_{fg}'	Enthalpy of vaporization
Q_L	Latent heat transfer
Q_S	Sensible heat transfer
Q	Heat transfer rate
W	Work
COP	Coefficient of Performance
h	Enthalpy

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Nowadays, refrigerator system is most popular used at many home in this world compare than Thermal Energy Storage System (TES). Air conditioning was used for cooling down the temperature in the room, and the same time could heat the room depend on the situation. However, power usage per unit KW per hour (kW/h) is big and than need more energy to generate it.

Refrigerated air conditioning is similar to commercial refrigeration because the same components are used to cool the air such as evaporator, compressor, condenser and metering device. These components are assembled in several ways to accomplish the same goal, refrigerated air to cool space.

In Split System air conditioning the condenser is located outside, remote from the evaporator, and uses interconnecting refrigerant lines. The fan to blow the air across the evaporator may be included in the heating equipment, or a separate fan may be used for the air conditioning system.

1.2 Objectives

Consist of several objectives regarding to the title of this project. The objective for this project is:

1. To design Thermal Energy Storage (TES) Split unit air conditioning.
2. To calculate the cooling load and coefficient of performance (COP).
3. To determine the power consumption of Thermal Energy Storage (TES) Split unit air conditioning.

1.3 Scope

Scope of this title is:

1. To produce Split unit for thermal energy storage system.
2. Literature review based on the Journals, article, and other references.
3. To describe about components is needed in thermal energy storage system.
4. To make comparison between conventional air conditioning system and thermal energy storage air conditioning system for power consumption and psychrometric properties.
5. To get coefficient of performance (COP) of thermal energy storage (TES) split unit air conditioning system.

1.4 Problem Statement

Central air conditioning can be the largest electrical load in a home during the summer months. It is also used at times when the demand for electricity is high in other sectors as well, contributing to a system wide peak for which generation, transmission and distribution systems must be designed to accommodate. The high demand also drives up the real-time cost for power, which is not normally seen by the consumer or recovered by the utility. This effect puts central air conditioning systems under intense scrutiny for ways to make it more efficient and reduce its impact on the system peak. Many utilities, including have had rebate programs promoting the replacement of older systems with newer, higher efficiency units. Residential air conditioners are rated with a “seasonal” energy efficiency ratio (SEER) that is based on the system’s steady state and transient performance at an outside temperature of 89.6°F or 32°C. This Project tends to design their systems to maximize the SEER rating, leaving the consumer uninformed as to the performance of the system at the high ambient temperatures that drive the peak. In some cases, the performance of a new unit at high outside temperatures may not be significantly better than the system it is replacing, and will not contribute much to reducing the system peak. The focus of this study is on the components that make up a central air conditioning system; whether there are less costly upgrades that can be made to improve system performance, and which produces the greatest effect for the smallest investment. Several studies have shown that the easiest and best performance upgrade is to make sure the system is operating as designed (e.g. the refrigerant charge is correct, and the airflow through the system is not restricted by a dirty filter or evaporator coil, or by closed registers). Unfortunately, air conditioners are frequently not performing optimally due to improper installation or infrequent maintenance. Some reports have indicated that the type of expansion device used in the system can have an effect on the performance, particularly if the system is operating under off-design conditions.

The goal of this study was to further investigate the performance differences that exist with the choice of expansion device, and whether a retrofit of this component would result in any energy savings or demand reduction for a minimal cost.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction TES

Thermal energy storage may refer to a number of technologies that store energy in a thermal reservoir for later reuse. They can be employed to balance energy demand between on day and night time. The thermal reservoir may be maintained at a temperature above (hotter) or below (colder) than that of the ambient environment. The principal application today is the production of ice, chilled water, or eutectic solution at night, which is then used to cool environments during the day.

The need of thermal energy storage may often be linked to the following cases:

- There is a mismatch between thermal energy supply and energy demand,
- When intermittent energy sources are utilized, and
- For compensation of the solar fluctuation in solar heating systems.

Possible technical solutions to overcome the thermal storage need may be the following:

- Building production over-capacity,
- Using a mix of different supply options,
- Adding back-up/auxiliary energy systems,

- Only summer-time utilization of solar energy,
- Short or long-term thermal energy storage.

In traditional energy systems, the need for thermal storage is often short-term and therefore the technical solutions for thermal energy storage may be quite simple, and for most cases water storage. There are three main physical ways for thermal energy storage: sensible heat, phase change reactions and thermo chemical reactions. Storage based on chemical reactions has much higher thermal capacity than sensible heat but are not yet widely commercially viable. Large volume sensible heat systems are promising technologies with low heat losses and attractive prices.

2.2 Physical Principal TES

When a thermal storage need occurs, there are three main physical principles to provide a thermal energy function:

- Sensible heat

The storage is based on the temperature change in the material and the unit storage capacity [J/g] is equal to heat capacitance \times temperature change.

- Phase-change

If the material changes its phase at a certain temperature while heating the substance then heat is stored in the phase change. Reversing, heat is dissipated when at the phase change temperature it is cooled back. The storage capacity of the phase change materials is equal to the phase change enthalpy at the phase change temperature + sensible heat stored over the whole temperature range of the storage.

- Chemical reactions

The sorption or thermo chemical reactions provide thermal storage capacity. The basic principle is: $AB + \text{heat} \rightleftharpoons A+B$; using heat a compound AB is broken into components A and B which can be stored separately; bringing A and B together AB is formed and heat is released. The storage capacity is the heat of reaction or free energy of the reaction.

The storage systems based on chemical reactions have negligible losses whereas sensible heat storage dissipates the stored heat to the environment and need to be isolated.

SENSIBLE HEAT	
<ul style="list-style-type: none"> • water, ground, rock, ceramics • $T=60^{\circ}\text{C} - 400^{\circ}\text{C}$ 	
PHASE-CHANGE	
<ul style="list-style-type: none"> • inorganic salts, inorganic and organic compounds; classical examples : • $\text{Na}_2\text{SO}_4 \times 10 \text{H}_2\text{O} + \text{heat} (24^{\circ}\text{C}) \leftrightarrow \text{Na}_2\text{SO}_4 + 10\text{H}_2\text{O}$ • $\text{CaCl}_2 \times 6 \text{H}_2\text{O} (30^{\circ}\text{C})$ • Paraffin (melting at $20^{\circ}\text{C} - 60^{\circ}\text{C}$) 	
CHEMICAL REACTIONS	
<ul style="list-style-type: none"> • $S \times n \text{G} + \text{heat} \leftrightarrow S \times m \text{G} + (n-m) \times \text{G} ; \text{G} (\text{g}) \leftrightarrow \text{G}(\text{liqu})$ 	
G=working fluid/gas	S=sorption material
water	hydroxides ,hydrates
ammonia	ammoniates
hydrogen	metal hydrides
carbon dioxide	carbonates
alcohols	alcoholates

Figure 2.1: Examples of material suitable for thermal storage
(Source: Thermal Energy Storage- Gerhard Faninger)

2.3 TES System

There are many technologies available for TES, but in this guide only ice storage systems are considered. Chilled water storage is also very popular today; however, because these systems generally don't use glycol solutions, they are beyond the scope of this guide.

The two most common types of ice storage are "ice on pipe" systems (also known as "ice on coil" systems) and ice encapsulated in plastic containers. The ice on pipe systems consist of coils of plastic or metal tubing immersed in a tank of water. A chilled glycol and water solution is circulated through the tubes to build ice on the outside of the tubes during the off-peak hours. When air conditioning is needed the same solution is circulated through the tubes to melt the ice and provide chilled glycol solution for building cooling. The second type of system works in the same fashion except the glycol solution is circulated through a tank filled with plastic containers of water. The ice forms in the containers and is later melted by the same glycol solution when cooling is needed.

2.4 TES Design

The operating strategy depends on the objectives of the system design and, ultimately, on capital and operating costs. The operating strategy may vary with time due to seasonal weather variations or increased loads resulting from changes or additions to the facility.

A storage medium for thermal energy either changes temperature-sensible energy storage-or changes phases. Water or water-antifreeze solutions are the most common TES media currently used. They are used in both sensible and phase-change types of

storage. Eutectic salts are employed only in phase-change storage. Solids are used only in sensible storage, usually in applications requiring small storage capacities.

In order to reduce tank size and cost, storage in liquids is usually accomplished in stratified tanks rather than in separate tanks for warmer and cooler fluids. Stratification means that warmer liquid floats on top of cooler liquid. This may be achieved by using inlet and outlet diffusers as long as the temperature of the liquid in storage does not traverse the neutral buoyancy point.

Phase-change storage for cooling can be implemented in a variety of ways, all of which require circulating water or an antifreeze solution through the evaporator of a refrigeration machine, or chiller. Storage systems include freezing ice on arrays of tubes inside tanks, freezing ice or eutectic salts contained in capsules suspended in tanks, or storing slurry comprised of very small ice particles suspended in a water-antifreeze solution in a tank.

Stored thermal energy is lost over time due to the temperature difference between the storage medium and its surroundings. The loss offsets energy savings and should be taken into consideration. Insulation slows the rate of energy loss.

Mixing and heat transfer through the storage medium causes additional thermodynamic losses, particularly for stratified sensible storage. However, recent experience shows that both heated and cooled TES are capable of economically reducing the total energy used for heating and cooling.