ENERGY CONSERVATION IN REFRIGERATION AND AIR CONDITIONING

By

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Energy Savings

The assumption that oil and natural gas will become unavailable as source of energy within 30 years has become a fixed idea. Concomitant to the development of atomic energy and other alternative forms of energy, we must incessantly try to enforce energy savings itself. The heat structure applied to houses in cold curtails the heating load itself, which fulfills a fundamental condition of energy savings; however, there are also waste concerning the air conditioning system that must be ameliorated along with the improvement of equipment for high efficiency.

The efficiency of equipment is given by EER (energy efficiency ratio) which is expressed by the numbers Kcal/watt or by Btu/watt, and shows the refrigerating capacity at the time of input. The effect differs according to size and purposes of the equipment but on the whole, the ratio is increasing every year.

COP (coefficient of performance) similarly is used for measuring the power at the time of input. Because it gives no dimensions, the figure simply tells how many times the original one unit energy has been utilized as the result. It is generally used to express the efficiency of the heat pump as opposed to electric heat; Example COP = 3.5. The heat pump has 3.5 times as much power of heating as the electric heat, thus it has been regarded and is relied upon as a potential energy saving device.

The heat recovery is a process of utilizing the heat generated from machine, lights and human bodies. The heat in this case, is acquired either directly from the source, or indirectly through a heat pump. In supermarkets, the refrigerant utilized for cooling the display case is then directly compressed within the air conditioning circuit to be further utilized for heating.

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In other countries, the use of solar heat for supplying hot water had been practised for sometime. But a serious attempt at a solar heat utilization began only after the oil crisis. The number of institutions and nursing homes that utilize solar energy for supplying hot water, heating or cooling the building are increasing rapidly. But unfortunately, the flat plate collector cannot make the temperature of warm water high enough to effectively operate the absorption-type refrigerator, therefore the development of more efficient/collectors as well as Rankin-Cycle engines are desired.

The establishment of the inspecting organization in order to promote energy savings is essential that efficiency of each product is to be tested by a public inspecting organization and that its competence be authorized. At the moment, the efficiency of all products are examined by respective manufacturers independently but in order to strictly encourage energy saving and efficiency, the establishment of a public inspecting organization is essential.

Along this organization with its operation and the extension of applicable equipment, the efficiency of the refrigeration and air conditioning equipment will take even greater strides. Concomitant to these attempts, the standardization of equipment is to be enforced. The performance test method, product standard, catalogue indication method, safety standard and so on should be established or reexamined for each different types of equipment.

Energy savings due to proper design criteria are as follows:

a. proper building orientation

b. recommendation of proper insulation to reduce load capacity

c. proper shading on glass panels

d. unnecessary loads

e. ventilation free movement of air on external surface of the building

f. recommend proper paintings

$$\text{COP} = \frac{\text{Refrigerating Effect}}{\text{Work}}$$

$$= \frac{Q}{\text{Wknet}}$$

Example of Heat Recovery

Aircon — Water heater test result based on (12,000 BTU/f cooling capacity) rated at 1375 watts input against a 20 gallon capacity conventional automatic electric water heats:

Test Data	Aircon Water Heater	Automatic Water Heater
Water flow rate gpm	.2	2
Water in °F	.88	88
Water out °F	102	98.3
ΔT °F	14	10.3
Heating Capacity BTU/f	1375	3000
COP	3.03	1

The cost of every 10,000 Btu of heat from the aircon-water heater compared to the other types of water heaters are tabulated below:

Types of Water Heater	Cost of fuel/energy	Heat content BTU	Cost 10,000/BTU	Savings when using air con water heater
Conventional electric	P 0.50/kwHR	3,412/kwHR	P1.46	67%
LPG	4.79/kg	43,000/kg	1.11	56%
Diesel	10.14/gal	144,000/gal	0.70	31%
Air con water heater	0.50/kwHR	10,326/kwHR	0.48	—

Existing designs of condenser coils have limited heat recovery application mainly due to their lack of operating flexibility. According to the cooling medium used, the present condensers are classified as:

1. Air Cooled (plate fin and tube)

2. Water Cooled

   (a) shell and coil
   (b) shell and tube
   (c) double tube

3. Evaporative Condenser

Heat recovery systems installed nowadays use air cooled condensers fitted with desuperheaters similar to shell and coil or double tube heat exchangers. The COP attainable from these types of heat recovery system is less than 0.70.

Other heat recovery systems incorporate any one of the water cooled condensers, wherein the water for cooling these condensers are piped directly to the hot water pipe system. The biggest disadvantage of this heat recovery system however is that once the hot water requirement is satisfied the air condition will have to be stopped. To continue using the air condition would result in wasting a lot of water.

Furthermore, both of these heat recovery systems are also relatively bulky and cannot fit into the compact room air conditioners. Modification in the design of this type of equipment were made to improve the heat transfer by imbedding its aluminum fins, a water tube circuit between the refrigerating tubes circuits in the air cooled condenser coil. Thus passing water through this circuit heat transfer from the superheated refrigerant inside the refrigerant circuit to the water is effected efficiently by conduction when over the condenser air cooling is stopped.

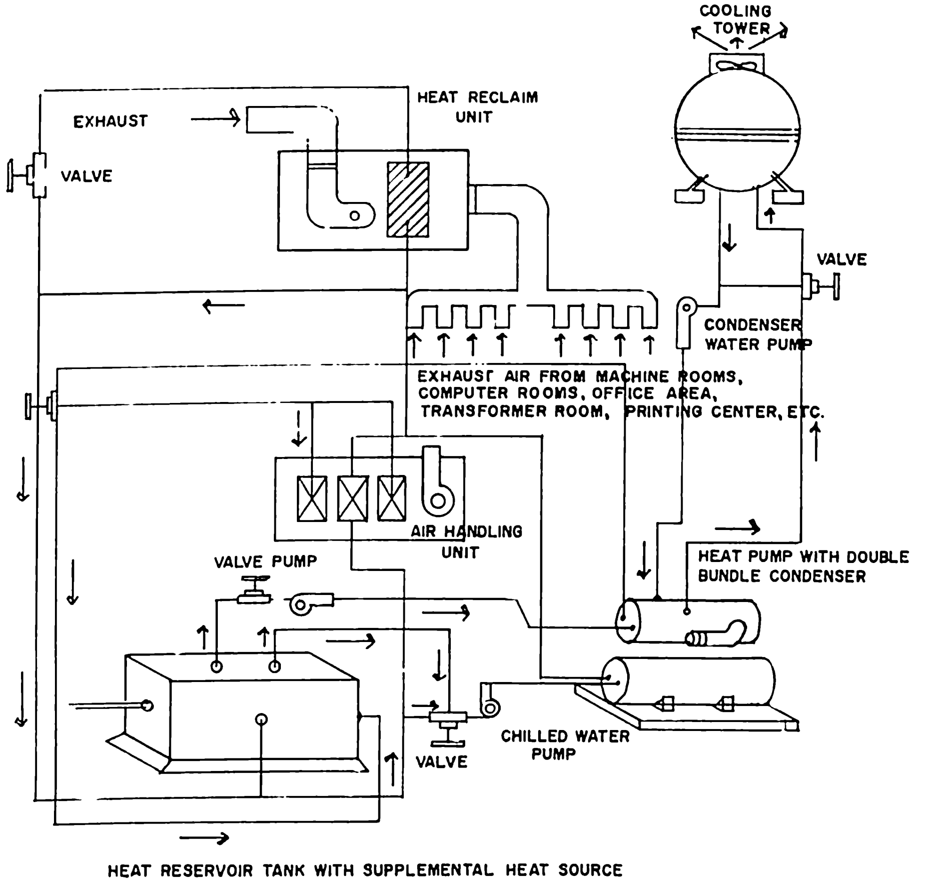
Stopping the condenser air cooling system was accomplished by:

1. Using separate motor for the condenser fan (conventional) room air conditioner uses only one double shaft motor to drive both evaporator shower and condenser fan.

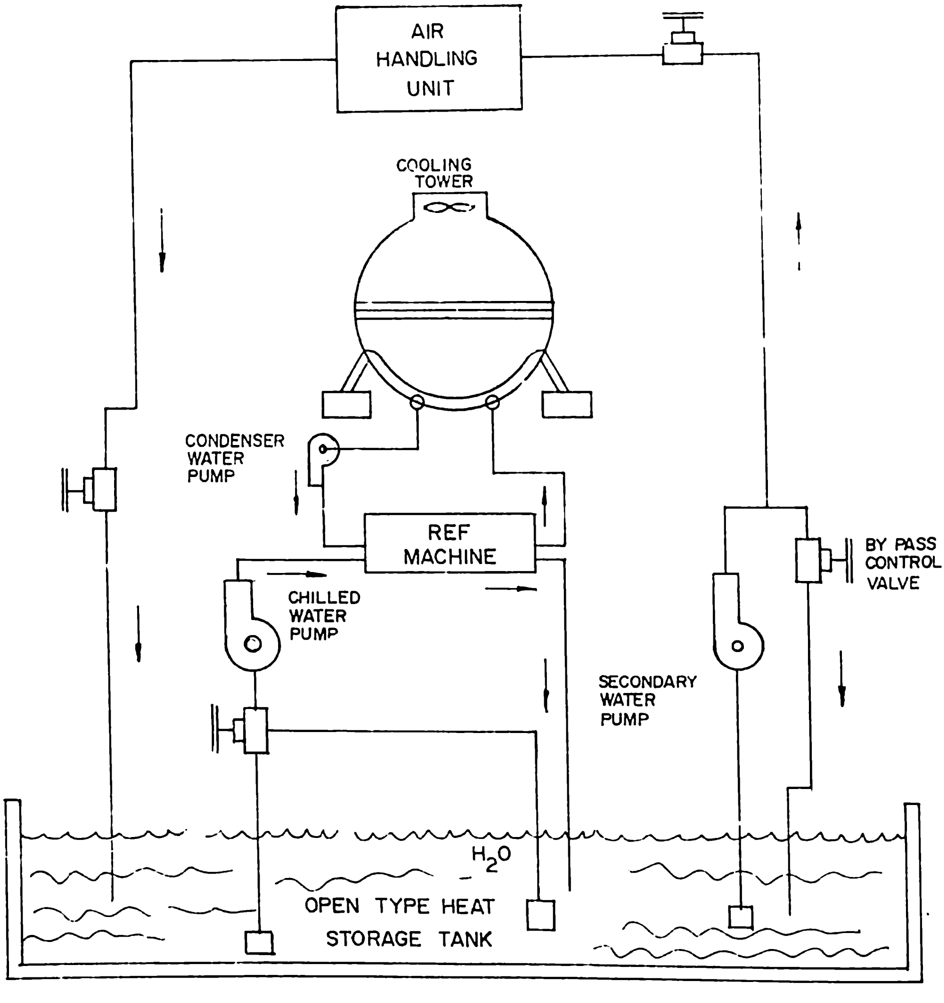
2. Installing a water flow switch to stop the condenser fan motor whenever water flows through the water circuit of the condenser coil. Thus the heat from the evaporator coil and heat due to work of the compressor is recovered, effectively and efficiently, by the water flowing inside the circuit. A very negligible amount of heat is lost by convection and radiation.

Heat Storage System

It is a method wherein the heat source unit capacity is reduced to less than the load at the time of the maximum load and the storage at the time of the maximum load is replenished by heat from the storage tank in which heat is stored by night operation even in a hot summer day. It is only one or two hours when a refrigerating machine operates under the full load, maximum load operation is seldom during the course of one year. Usually it is operated at partial load inefficiently. In this method, high load and highly efficient operation is always attained, resulting in economy of operation cost as well as, because of levelled demand of electric energy, highly efficient operation and effective run of generator are possible.



BASIC CONCEPT OF THE HEAT RECLAIM HEAT PUMP SYSTEM



BASIC CONCEPT OF THE HEAT STORAGE SYSTEM

Automation Control and Centralized Control System

In both comfort air conditioning and industrial air conditioning, automatic control and centralized control system are playing a major role to produce the optimum artificial climate and to monitor and control each process stage in manufacturing plants. At the present state of buildings enlarged in size and complicated in structure, maintenance and supervision of building requires centralized control. Central control units are obtaining the desired results. It being so, automatic control, accentral control and sanc-energy plan are inseparably related to each other, and accomplishment of sanc energy plans would be remotely possible without such installations. Automatic controls can economically adjust to the environment at a speed with an accuracy incomparable to manual operation. Central control installations can collect and process various complicated data through introduction of computers to contribute greatly to operation and control of high rise buildings being enlarged and building facilities being diversified and complicated. The development of computer softwares such as the optimum starting control, the demand control, etc. for sanc energy plans is promoted in various ways, thus making a great contribution to the energy conservation.

Example:

a. By chilller optimizer

Reduces chiller power consumption in the range of 20%, considering brand new.

b. Kilowatt/control Demand Limiter

Reduces Chiller electrical demand by as much as 20%, modulates the chiller's capacity to maintain occupant comfort while saving electricity.

c. The York Turbo-Modulator

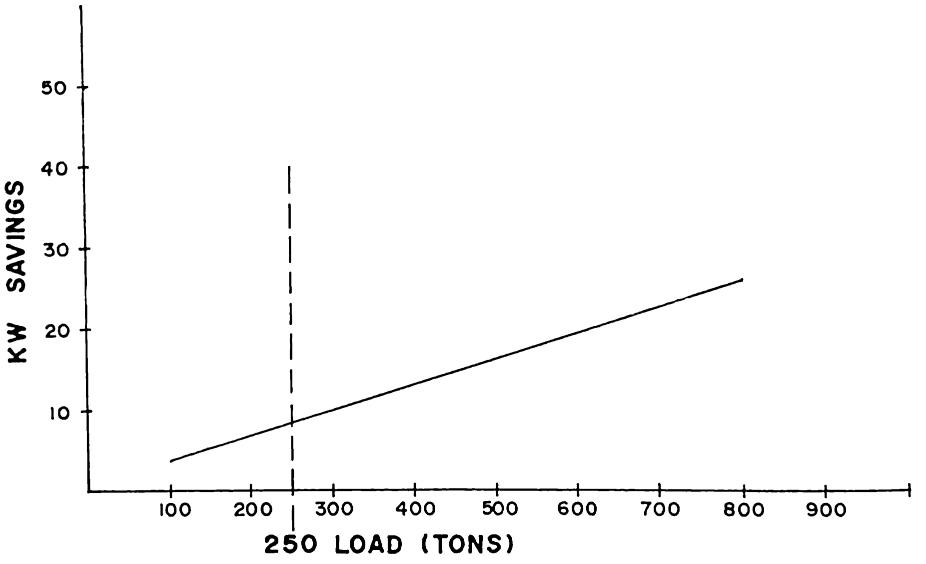
Reduces the energy consumption of your chiller by as much as 30% annually. Its electronic control system automatically modulates motor speed to precisely match the variable cooling load of your building, thus reducing energy consumption.

Maintenance Savings

Proper systematic maintenance helps retain equipment performance and prevents the increase in operating cost caused by warm parts and

GRAPH NO. 1

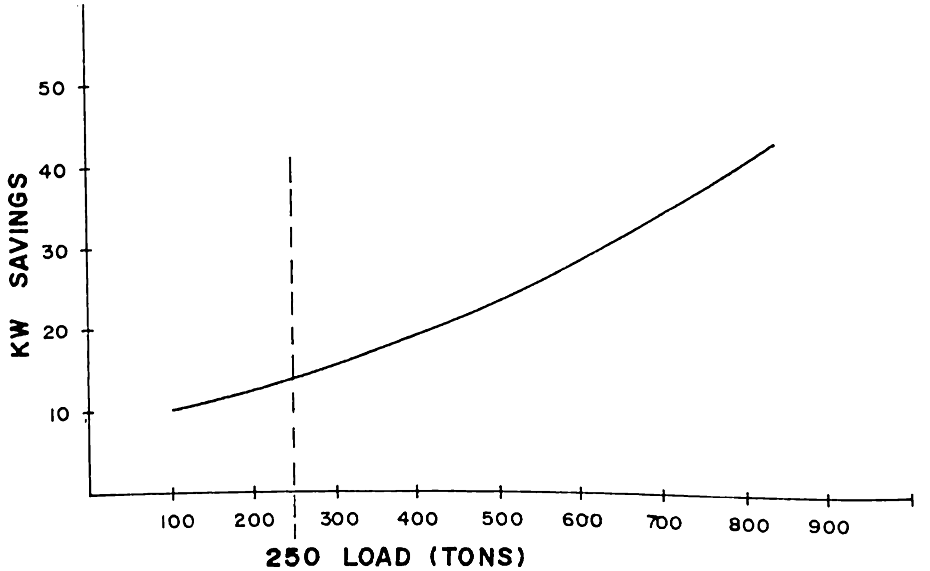
0.0005 CONDENSER TUBE FOULING FACTOR (DESIGN) VS 0.001 FOULING FACTOR



SAVINGS RESULTING FROM CLEAN CONDENSER TUBE

GRAPH NO. 2

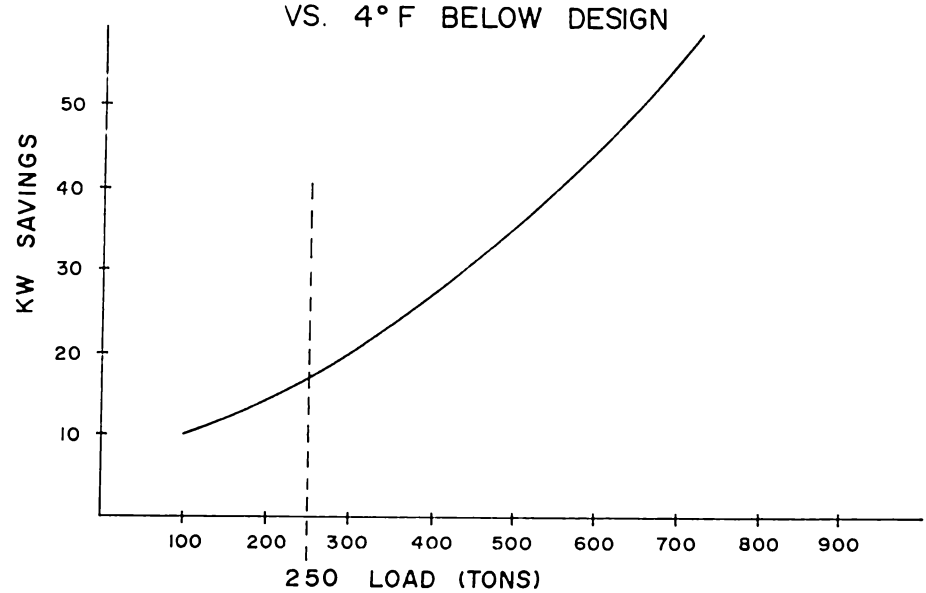
PRESSURE IN CONDENSER AT DESIGN VS 2 PSI ABOVE DESIGN



SAVINGS DUE TO ELIMINATING NON-CONDENSABLES IN SYSTEM

GRAPH NO. 3

LEAVING CHILLED WATER TEMPERATURE AT DESIGN VS. 4° F BELOW DESIGN



SAVINGS RESULTING FROM PROPERLY ADJUSTED TEMPERATURE CONTROLS

the gradual build-up of contaminants within the system. Since it is not possible to hermetically seal a large air conditioning or refrigeration system, years of operation can result in condenser or cooler tube fouling factor, incorrect refrigerant charge, non-condensables, high oil concentration, and other undesirable conditions. Each of these inefficient conditions cost your money because the system must work harder and use more energy to meet the design conditions. York Certified Maintenance is the same over $4,000 per year in energy with proper maintenance. Based on the following data:

1. Design conditions — 500 tons, 425 kw
2. Operating time — 3000 hours per year
3. Energy rate — 4¢ per kwhr
4. Average actual load, kw — 250 tons, 213 kw
5. Condenser tube fouling — design (graph #1)
6. Non-condensable — design (graph #2)
7. Control Setting — design (graph #3)

Annual Energy Savings = operating hours X energy rate X (condenser tube fouling savings + non-condensable savings + improper control setting savings)

Annual Energy Savings = 3000 hrs X 4¢ kwhr X (8kw + 14kw + 14kw)

= $4,320

Other Energy Savings (Compressor Modifications)

With a detailed analysis of your present system are cooling needs remarkable savings may be achieved by a simple change in compressor impeller size or gear ratio. This is the same as buying a new, high efficiency system at a fraction of the cost.

These are just a few of many energy-saving options available from your maintenance and energy services expert. Because no two systems are identical each energy saving recommendation is custom tailored to your specific requirements.

Specific Examples of Potential Savings that have Resulted from York Evaluations

1. Conversaion of an 800 ton compressor from steam turbine to electric motor drive resulted in yearly savings of over $50,000.

2. Compressor conversion of an existing 400 ton. Centrifugal heat pump system, with a slight reduction in total capacity, delivered projected savings of $20,000 to $25,000 annually.

3. Centrifugal compressor modifications including an impeller change in a 24% reduction in compressor energy cost.

Acknowledgements:

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