Fundamentals of Refrigeration and Air Conditioning

المرحلة الثانية

محاضرة رقم (1)

مفاهيم تكييف الهواء والتطبيقات

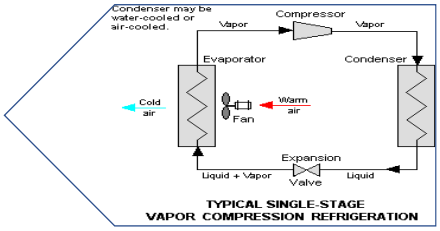
Air Conditioning Concept and Applications

Email (Hassan.Ghanim.Hassan@uomus.edu.iq)

Fundamentals of Refrigeration and Air Conditioning

Hassan Rijabo

Lecture 1
Air Conditioning Concept and Applications



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Lecture1. Air Conditioning Concept and Applications

الكتاب المنهجي للمقرر
Text book

1- Heating, Ventilating And Air Conditioning by McQuiston, Parker and Spitler

Grading Program أسلوب التقييم

Spring 2025

Quizzes	*10%*
Assignments	*10%*
Reports	*10%*
Projects / Lab.	*10%*
Midterm Exam	*10%*
Final Exam	*50%*

Keys to success in course *مفاتيح النجاح في المقرر*

1. حضور المحاضرات النظرية والتدريبية سواء بالحضور الاعتيادي او الالكتروني عن بعد، وتدوين الملاحظات بعناية.
2. اصطحاب جداول ومخططات تبريد وتكييف الهواء وآلة حاسبة كل محاضرة.
3. مراجعة وإعادة كتابة الملاحظات بعد المحاضرة في أسرع وقت.
4. تخصيص على الأقل ضعف زمن المحاضرة لمراجعة ما تم اعطاءه فيها.
5. مراجعة الكتاب المنهجي، والتدرب على حل أكبر عدد من المسائل بما فيها الاختبارات السابقة.
6. لا تتردد في سؤال أستاذ المقرر والاستفسار عن اي شئ غير مفهوم في المقرر.
7. التواصل مع أستاذ المقرر أثناء الساعات المكتبية او من خلال التواصل الالكتروني .

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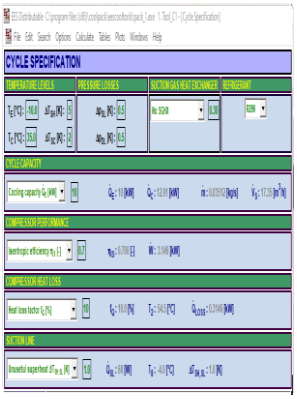
Application of Refrigeration and Air Conditioning

- ✓ Food processing, preservation and distribution
- ✓ Chemical and process industries
- ✓ Cold treatment of metals
- ✓ Medical
- ✓ Comfort air-conditioning
- ✓ Computer rooms
- ✓ Vehicular
- ✓ Textiles

Available Software's in Refrigeration and Air Conditioning Analysis and Simulations:

- HAP : Hourly Analysis Program
- ENERGY PLUS
- REVIT Autodesk
- CoolPack



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1. Air conditioning Concept

Air conditioning (often referred to as *A/C*, *AC* or *aircon*) is the process of altering the properties of air (primarily temperature and humidity) to more comfortable conditions, typically with the aim of distributing the conditioned air to an occupied space to improve thermal comfort and indoor air quality.

2. History

The basic concept behind air conditioning is said to have been applied in ancient Egypt, where reeds were hung in windows and were moistened with trickling water. The evaporation of water cooled the air blowing through the window. This process also made the air more humid, which can be beneficial in a dry desert climate.

In Ancient Rome, water from aqueducts was circulated through the walls of certain houses to cool them. Other techniques in medieval Persia involved the use of cisterns and wind towers to cool buildings during the hot season.

- Modern air conditioning emerged from advances in chemistry during the 19th century, and the first large-scale electrical air conditioning was invented and used in 1902 by American inventor Willis Carrier.
- The introduction of residential air conditioning in the 1920s helped enable the great migration to the Sun Belt in the United States.
- In 1902, the first modern electrical air conditioning unit was invented by Willis Carrier in Buffalo, New York.

Willis Carrier

Carrier in 1915

Born	Willis Haviland Carrier November 26, 1876 Angola, New York, U.S.
Died	October 7, 1950 (aged 73) New York City, New York, U.S.
Nationality	American
Alma mater	Cornell University (BS in Engineering)
Occupation	Engineer, inventor
Known for	Inventing modern air conditioning
Awards	ASME Medal (1934)

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3. What are the benefits of Air Conditioning ?

- *The benefits of Air Conditioning are to give a comfortable environment at work or at home throughout the seasons, Spring, Summer, Autumn and Winter.*
- *An Air Conditioning unit can have two functions - heating and cooling. With an auto changeover switch on most new units, you set the temperature and the unit will cool or heat as required automatically.*
- *Also air purification is another benefit as an anti-fungus filter is used in most modern air conditioning units. This catches allergy-causing mites, smoke particles and odours, making the air in your environment clean and fresh.*
- *When outside air temperatures reach uncomfortable levels, the coolest temperature we can hope to maintain within our homes is the same, despite any amount of ventilation through the use of conventional fans. In reality, our homes become even warmer than the outside air temperature, through solar gains and additional heat-loads from within.*

- *With air-conditioning equipment installed, we can quickly reduce the temperature within any of the rooms within the home to a comfortable level, whilst at the same time reducing the humidity.*
- *Doors and windows can be kept closed improving the security of your home, whilst at the same time keeping out nuisance insects and any external noise pollution.*
- *The air within the room is recirculated through filters to trap dust and pollens, in turn benefiting people suffering from allergies and respiratory problems.*

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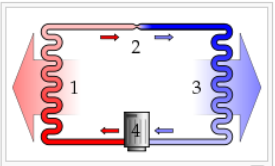
4. The methods used in air conditioning

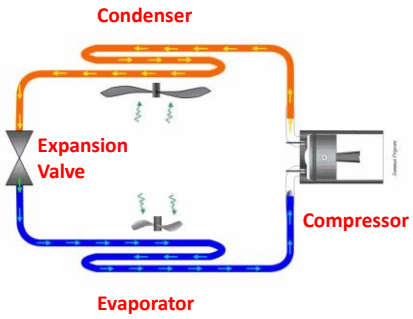
4.1 Refrigeration cycle

- In the refrigeration cycle, heat is transported from a colder location to a hotter area. As heat would naturally flow in the opposite direction, work is required to achieve this. A refrigerator is an example of such a system, as it transports the heat out of the interior and into its environment (i.e. the room). The refrigerant is used as the medium which absorbs and removes heat from the space to be cooled and subsequently rejects that heat elsewhere.



A simple stylized diagram of the refrigeration cycle: 1) condensing coil, 2) expansion valve, 3) evaporator coil, 4) compressor

- Circulating refrigerant vapor enters the compressor and is compressed to a higher pressure, resulting in a higher temperature as well. The hot, compressed refrigerant vapor is now at a temperature and pressure at which it can be condensed and is routed through a condenser. Here it is cooled by air flowing across the condenser coils and condensed into a liquid. Thus, the circulating refrigerant rejects heat from the system and the heat is carried away by the air.



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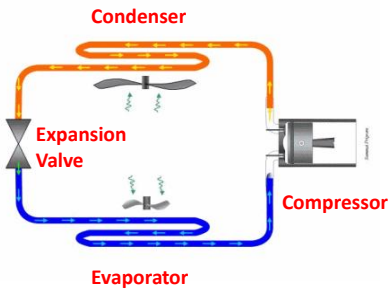
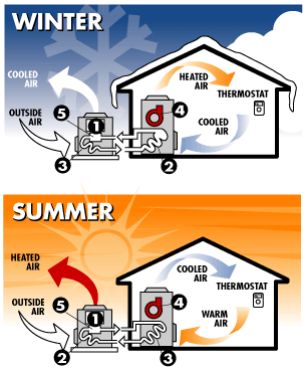
- The condensed and pressurized liquid refrigerant is next routed through an expansion valve where it undergoes an abrupt reduction in pressure. That pressure reduction results in flash evaporation of a part of the liquid refrigerant, lowering its temperature. The cold refrigerant is then routed through the evaporator. A fan blows the warm air (which is to be cooled) across the evaporator, causing the liquid part of the cold refrigerant mixture to evaporate as well, further lowering the temperature. The warm air is therefore cooled.



- To complete the refrigeration cycle, the refrigerant vapor is routed back into the compressor.
- The engineering of physical and thermodynamic properties of gas-vapor mixtures is called psychrometrics

Heat pump

- Heat pump is a term for a type of air conditioner in which the refrigeration cycle can be reversed, producing heating instead of cooling in the indoor environment. They are also commonly referred to, and marketed as, a "reverse cycle air conditioner".
- Using an air conditioner in this way to produce heat is significantly more energy efficient than electric resistance heating. Some homeowners elect to have a heat pump system installed, which is simply a central air conditioner with heat pump functionality (the refrigeration cycle can be reversed in cold weather).
- When the heat pump is in heating mode, the indoor evaporator coil switches roles and becomes the condenser coil, producing heat. The outdoor condenser unit also switches roles to serve as the evaporator, and discharges cold air (colder than the ambient outdoor air).



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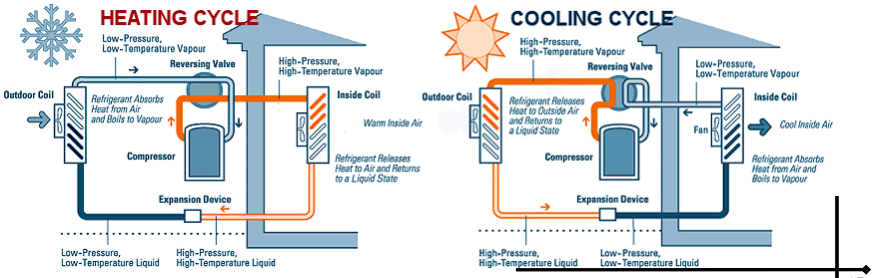
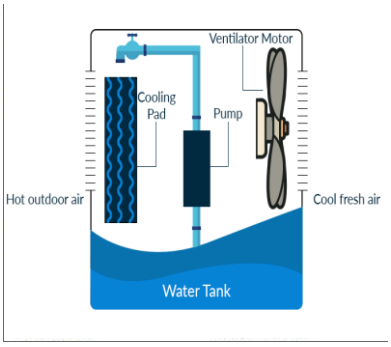
- Heat pumps are more popular in milder winter climates where the temperature is frequently in the range of 40–55 °F (4–13 °C), because heat pumps become inefficient in more extreme cold. This is due to the problem of ice forming on the outdoor unit's heat exchanger coil, which blocks air flow over the coil. To compensate for this, the heat pump system must temporarily switch back into the regular air conditioning mode to switch the outdoor evaporator coil *back* to being the condenser coil, so that it can heat up and defrost. A heat pump system will therefore have a form of electric resistance heating in the indoor air path that is activated only in this mode in order to compensate for the temporary indoor air cooling, which would otherwise be uncomfortable in the winter

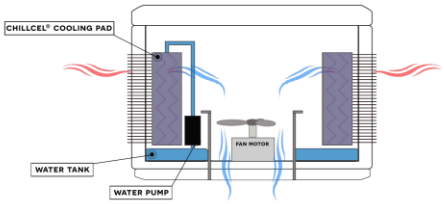


4.2 Evaporative cooling

- In very dry climates, evaporative coolers, sometimes referred to as swamp coolers or desert coolers, are popular for improving coolness during hot weather.
- An evaporative cooler is a device that draws outside air through a wet pad, such as a large sponge soaked with water.
- The sensible heat of the incoming air, as measured by a dry bulb thermometer, is reduced. The total heat (sensible heat plus latent heat) of the entering air is unchanged. Some of the sensible heat of the entering air is converted to latent heat by the evaporation of water in the wet cooler pads. If the entering air is dry enough, the results can be quite cooling.



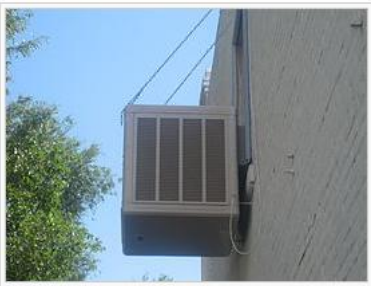
- Evaporative coolers tend to feel as if they are not working during times of high humidity, when there is not much dry air with which the coolers can work to make the air as cool as possible for dwelling occupants.
- Unlike other types of air conditioners, evaporative coolers rely on the outside air to be channeled through cooler pads that cool the air before it reaches the inside of a house through its air duct system; this cooled outside air must be allowed to push the warmer air within the house out through an exhaust opening such as an open door or window. These coolers cost less and are mechanically simple to understand and maintain.



Pros and cons

- **Pros: (الايجابيات)**
- Costs less to install in some instances.
- Costs less to run. (careful some can have 1600w fans! that isn't necessarily cheap tor run)
- Allows you to vent heat from the house if it cools down outside by drawing in cool ambient air.

- **Cons: (السلبيات)**
- Increases humidity.
- They can only cool relative to that day's wet bulb temperature.
- Generally require slightly more maintenance than air conditioning.
- Consider carefully before purchasing in water restricted areas or where dependent on limited water as water consumption can be up to 80 litres per hour.


An evaporative cooler

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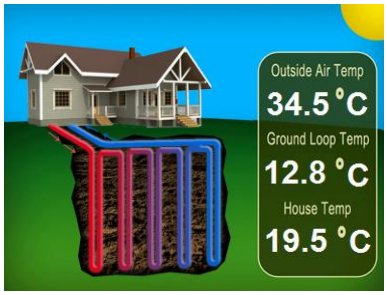
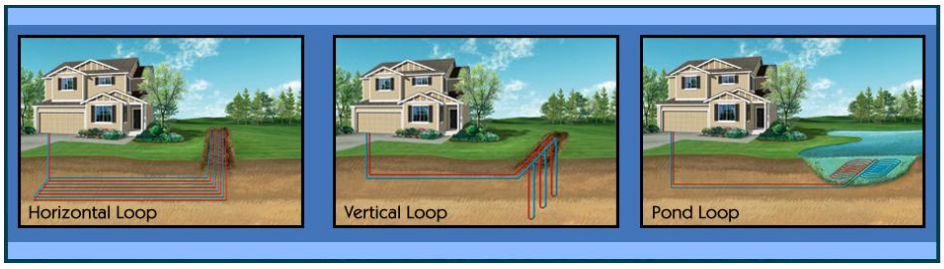
4.3 Free cooling

Air conditioning can also be provided by a process called free cooling which uses pumps to circulate a coolant (typically water or a glycol mix) from a cold source, which in turn acts as a heat sink for the energy that is removed from the cooled space.

- Common storage media are deep aquifers or a natural underground rock mass accessed via a cluster of small-diameter boreholes, equipped with heat exchanger. Some systems with small storage capacity are hybrid systems, using free cooling early in the cooling season, and later employing a heat pump to chill the circulation coming from the storage. The heat pump is added because the temperature of the storage gradually increases during the cooling season, thereby declining its effectiveness.



- Free cooling systems can have very high efficiencies, and are sometimes combined with seasonal thermal energy storage (STES) so the cold of winter can be used for summer air conditioning.



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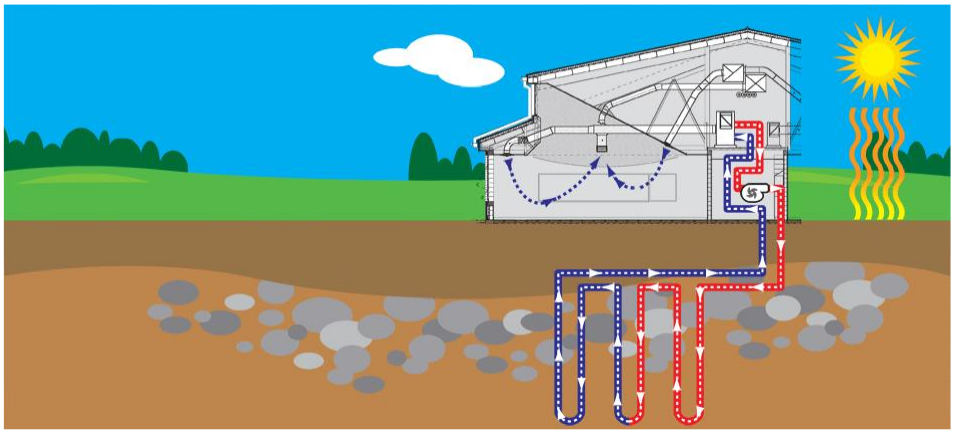
Al-Mustaqbal University
Department of Mechanical Power Engineering
Class (2nd)
Subject (**Fundamentals of Refrigeration and Air Conditioning**)

Lecturer (Hassan Ghanim Rijabo)
2nd term – Lect. (**Air Conditioning Concept and Applications)**



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