# LABROTORY INSTUMENTATION AND TECHNIQUES

BY

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# LECTURE 7

# REFRIGERATOR & HOT AIR/BOX OVEN

**How Does a Refrigerator Work?**

In the refrigeration cycle, there are five basic components: fluid refrigerant; a compressor, which controls the flow of refrigerant; the condenser coils (on the outside of the fridge); the evaporator coils (on the inside of the fridge); and something called an expansion device. Here's how they interact to cool your food.

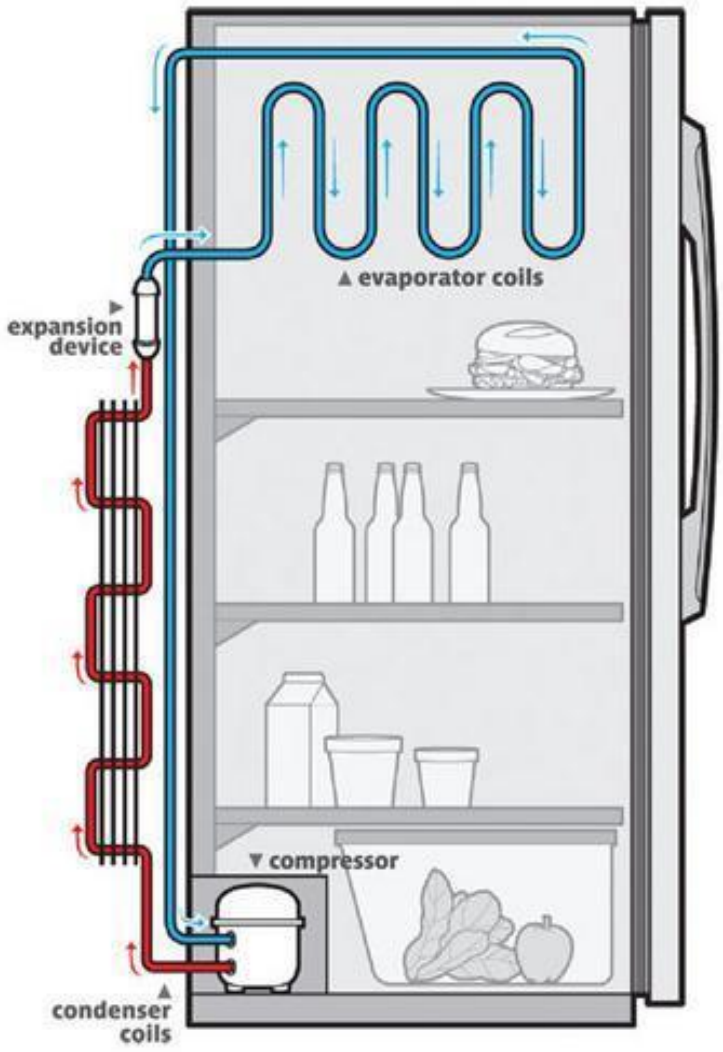
1.The compressor constricts the refrigerant vapor, raising its pressure, and pushes it into the coils on the outside of the refrigerator.

2. When the hot gas in the coils meets the cooler air temperature of the kitchen, it becomes a liquid.

3. Now in liquid form at high pressure, the refrigerant cools down as it flows into the coils inside the freezer and the fridge.

4. The refrigerant absorbs the heat inside the fridge, cooling down the air.

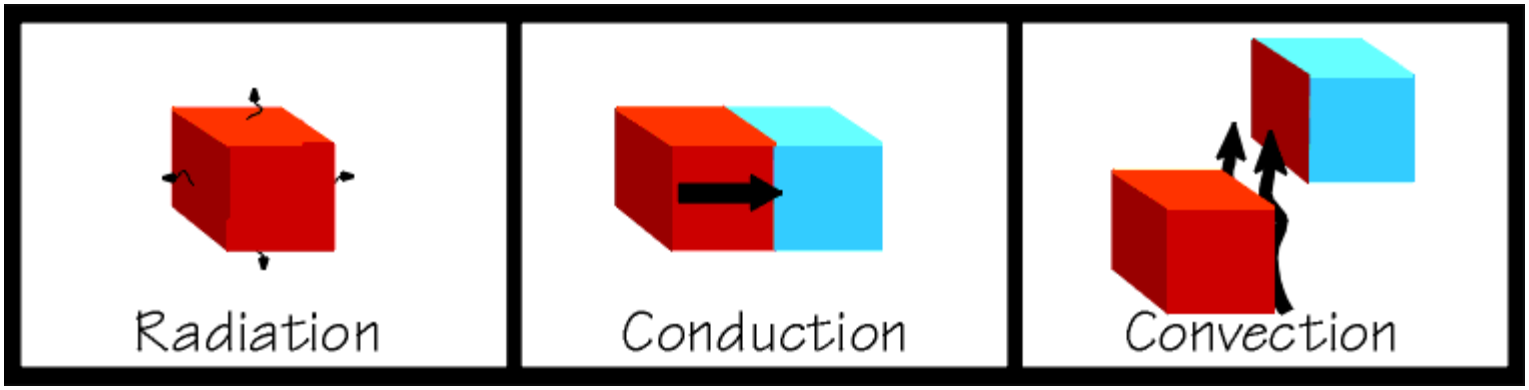
5. Last, the refrigerant evaporates to a gas, then flows back to the compressor, where the cycle starts all over.


evaporator coils
expansion device
compressor
condenser coils

**Refrigeration Basics**

You can describe something as cold and everyone will know what you mean, but cold really only means that something contains less heat than something else. All there really is, is greater and lesser amounts of heat. The definition of refrigeration is The Removal and Relocation of Heat. So if something is to be refrigerated, it is to have heat removed from it. If you have a warm can of pop at say 80 degrees Fahrenheit and you would prefer to drink it at 40 degrees, you could place it in your fridge for a while, heat would somehow be removed from it, and you could eventually enjoy a less warm pop. (oh, all right, a cold pop.) But lets say you placed that 40 degree pop in the freezer for a while and when you removed it, it was at 35 degrees. See what I mean, even "cold" objects have heat content that can be reduced to a state of "less heat content". The limit to this process would be to remove all heat from an object. This would occur if an object was cooled to Absolute Zero which is -273º C or -460º F. They come close to creating this temperature under laboratory conditions and strange things like electrical superconductivity occur.

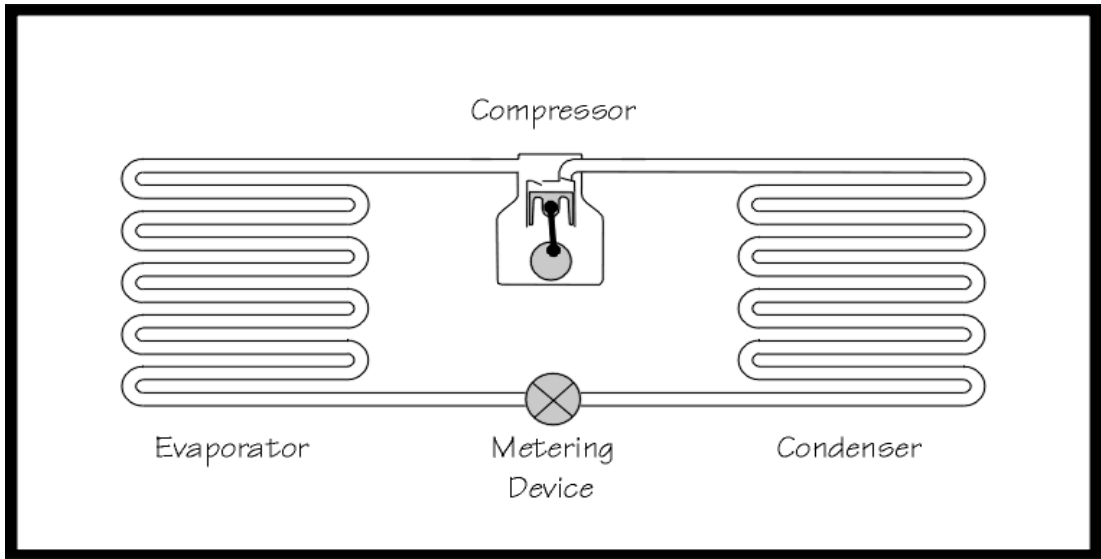
**How do things get colder?**




The latter two are used extensively in the design of refrigeration equipment. If you place two objects together so that they remain touching, and one is hot and one is cold, heat will flow from the hot object into the cold object. This is called conduction. This is an easy concept to grasp and is rather like gravitational potential, where a ball will try to roll down an inclined plane. If you were to fan a hot plate of food it would cool somewhat. Some of the heat from the food would be carried away by the air molecules. When heat is transferred by a substance in the gaseous state the process is called convection. And if you kicked a glowing hot ember away from a bonfire, and you watched it glowing dimmer and dimmer, it is cooling itself by radiating heat away. Note that an object doesn't have to be glowing in order to radiate heat, all things use combinations of these methods to come to equilibrium with their surroundings. So you can see that in order to refrigerate something, we must find a way to expose our object to something that is colder than itself and nature will take over from there. We are getting closer to talking about the actual mechanics of a refrigerating system, but there are some other important concepts to discuss first.

**Main Components**

There are 4 main components in a mechanical refrigeration system. Any components beyond these basic 4 are called accessories. **The compressor** is a vapor compression pump which uses pistons or some other method to compress the refrigerant gas and send it on it's way to the condenser. **The condenser** is a heat exchanger which removes heat from the hot compressed gas and allows it to condense into a liquid. The liquid refrigerant is then routed to the metering device. This device restricts the flow by forcing the refrigerant to go through a small hole which causes a pressure drop. And what did we say happens to a liquid when the pressure drops? If you said it lowers the boiling point and makes it easier to **evaporate,** then you are correct. And what happens when a liquid evaporates? Didn't we agree that the liquid will absorb heat from the surrounding area? This is indeed the case and you now know how refrigeration works. This component where the evaporation takes place is called the evaporator. The refrigerant is then routed back to the compressor to complete the cycle. The refrigerant is used over and over again absorbing heat from one area and relocating it to another. Remember the definition of refrigeration? (the removal and relocation of heat).



**Metering Device**

We will now take a closer look at the individual components of the system. We will start with the metering device. There are several types but all perform the same general function which is to cause a pressure dropThere should be a full column of high pressure liquid refrigerant (in the liquid line) supplying the inlet of the metering device. When it is forced to go through a small orifice it loses a lot of the pressure it had on the upstream side of the device. The liquid refrigerant is sort of misted into the evaporator

**HOT AIR/BOX OVEN**

The electrical devices which are called as hot air oven are used in sterilization by providing the dry heat.

They were originally developed by Pasteur. The oven uses dry heat to sterilize articles. Generally, they can be operated from 50 to 300 degC (122 to 572 degF) . There is a thermostat controlling the temperature. These are digitally controlled to maintain the temperature. Their double walled insulation keeps the heat in and conserves energy, the inner layer being a poor conductor and outer layer being metallic. It is used in the sterilization of pharmaceutical products and other materials. It is double walled chamber made of steel.

**TYPES OF OVEN**

- Laboratory Oven.
- High Temperature Lab Oven.
- Industrial Oven.
- Top Loading Annealing Oven.
- Pharmaceutical Oven.
- Vacuum Oven.
- Bench Oven.

Laboratory ovens are forced air thermal convection ovens or in other terms Hot Air Oven. These hot air ovens are used to attain constant temperatures inside every corner of the oven chamber. The most common size of Laboratory oven being used has (24 x 24 x 24) inches Inner Chamber dimensions, although they start from (12 x 12 x 12) inches Inner Chamber Dimension. The Maximum temperature for Laboratory Ovens can vary from 100 degree Celsius to over 350 degrees Celsius, However 250 degrees Celsius is the most preferred range as it falls midway and is suitable for most lab applications. These can also be termed as Clean Room Ovens.

High Temperature Lab Oven is an advanced version for Laboratory oven as discussed above having the same principle of operation i.e through forced air thermal convection. The only difference in High Temperature Lab Oven is the temperature range, these ovens are generally classified as ovens having temperatures from 300 degree Celsius to 550 degree Celsius

conntrol unit ensure a homogenous temperature profile in the chamber,

**WORKING PRINCIPLE**

The working of the hot air oven is based on the hot air inside the chamber of oven by the forced circulation. As it is a universal scientific fact that in any chamber hot air rises above, So by utilizing this principle when the hot air reaches the top of chamber it is circulated back to bottom by a fan installed inside the chamber and hence optimum amount of heat is achieved gradually inside the hot air oven.

After heating the content of the oven for two hours at 160 ˚ c, the articles are allowed to remain there, till the temperature comes down to 40 ˚c. then the sterilized materials is then removed from the oven.

**APPLICATIONS**

1. It is mainly used for the sterilization of glasswares such as pestle and motar, petridishes, flasks, pipettes, bottles, test tubes etc.
2. It is used for the sterilization of powders such as sulphacetamides, sulphadiazenes, kaolin, zinc oxide, starch etc.
3. Injections where fixedoils is used as the vehicle are sterilised by the dry heat method
4. Example: injections of progestrone, injection of testosterone propionate and injections of oestradiols dipropionate.
5. It is also used for sterilisation of scalpels, scissors, spatula, blades and glass syringes.

6. The chemicals, glassware in laboratories, research institutions, industries, hospitals use hot air ovens are suitable for temperature upto 250˚C.

7. Hot air ovens suits to various applications like heating, drying, sterilizing & baking.

**ADVANTAGES**

1. It is used for the sterilisation of those substances which gets spolied during moist heat sterilisation. Eg: oily materials and powders.

2. The method is suitable for sterilisation of assembled equipments such as all glas syringes due to expose to high temeprature for a long time.

3. It is not so damaging to glass and metals equipments as moist heat.

4. Dry heat will not corrode or rust instruments or needles.

5. Dry heat will sterilize instruments containing many parts that can not be disassembled

**DISADVANTAGES**

1. This method is not suitable for the surgical dressings.
2. This method is not suitable for the most of the medicaments, rubber and plastic good because the articles are exposed to a very high temperature for a long period.
3. Dry heat penetrates slowly and unevenly.
4. Dry heat requires long exposure times to effectively achieve sterility.
5. Dry heat requires higher temperatures that many items cannot be safely exposed to.
6. Dry heat requires specialized packaging materials that can sustain integrity under high heat conditions.
7. Dry heat may require different temperature and exposure times, depending on the type of item being sterilized.

**PRECAUTIONS**

1. Glass apparatus must be wrapped with the clean cloth or filter paper and containers must be plugged with non assorbants cotton wool.
2. The article and substances which are to be sterilised should not be placed at the floor of the oven as it receieves direct heat and becomes much hotter.
3. The oven should not be over loaded with the materials meant for sterilisation.
4. There should be sufficient space in between the artilcles, so that there is uniform distribution of heat