



# **Equipment required for controlling green house environment**



- Precise control of various parameters of green house environment is necessary to optimize energy inputs and thereby maximize the economic returns.
- Basically, the objective of environmental control is to maximize the plant growth.
- From the origin of greenhouse to the present there has been a steady evolution of controls.



- Five stages in this evolution include manual controls, thermostats, step-controllers, dedicated micro processors and computers.
- This chain of evolution has brought about a reduction in control labour and an improvement in the conformity of green house environments to their set points.

# Active summer cooling systems



- Active summer cooling is achieved by evaporative cooling process.
- The evaporative cooling systems developed are to reduce the **problem of excess heat** in green house.
- In this process cooling takes place **when the heat required for moisture evaporation is derived from the surrounding environment causing a depression in its temperature.**
- The two active summer cooling systems in use presently are fan-and pad and fog systems.

# a) Fan-and Pad cooling system



- Along one wall of the green house, water is passed through a pad that is usually placed vertically in the wall.
- Traditionally, the pad was composed of excelsior (**wood shreds**), **but today** it is commonly made of a cross-fluted **cellulose material** some what similar in appearance to corrugated card board.
- **Exhaust fans** are placed on the opposite wall.
- Warm outside air is drawn in through the pad.



- The supplied water in the pad, through the process of evaporation, absorbs heat from the air passing through the pad as well as from surroundings of the pad and frame, thus causing the cooling effect.
- **Khus-khus grass mats** can also be used as cooling pads.

## b) Fog cooling system



- A high pressure pumping apparatus generates fog containing water droplets with a **mean size of less than 10microns** using suitable nozzles.
- These droplets are sufficiently small to **stay suspended in air** while they are evaporating.
- Fog is dispersed throughout the green house, cooling the air everywhere.
- As this system **does not wet the foliage**, there is less scope for disease and pest attack. The **plants stay dry** throughout the process.

# Question



- The fan-and pad system can lower the temperature of incoming air by about 80% whereas the fog cooling system can lower the temperature by nearly 100%. Why ?



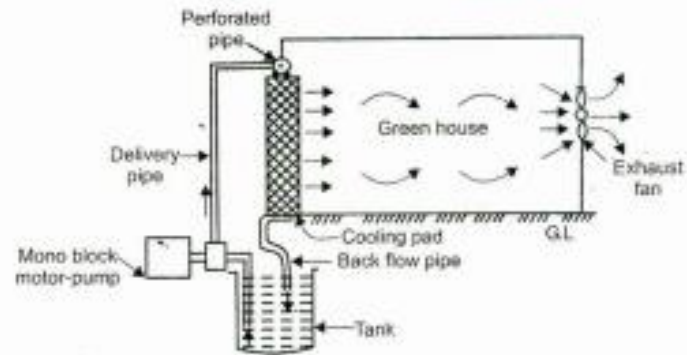
# Answer



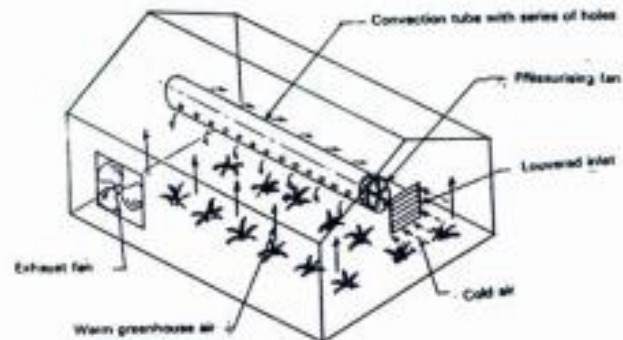
- Because complete evaporation of the water is not taking place because of bigger droplet size in fan and pad, whereas in the fog cooling system, there will be complete evaporation because of the minute size of the water droplets.
- Thus lesser the dryness of the air, greater evaporative cooling is possible.



## Fan - and - pad cooling system



## Convection tube type cooling system



# Active winter cooling systems



- Excess heat can be a problem during the winter.
- In the winter, the ambient temperature will be below the desired temperature inside the green house.
- Owing to the green house effect the entrapment of solar heat can rise the temperature to an injurious level if the green house is not ventilated.
- The actual process in winter cooling is tempering the excessively cold ambient air before it reaches the plant zone.



- Otherwise, hot and cold spots in the green house will lead to uneven crop timing and quality.
- This mixing of low temperature ambient air with the warm inside air cools the green house in the winter.
- Two active winter cooling systems commonly employed are ***convection tube cooling and horizontal air flow (HAF) fan cooling systems.***

# Green house ventilation

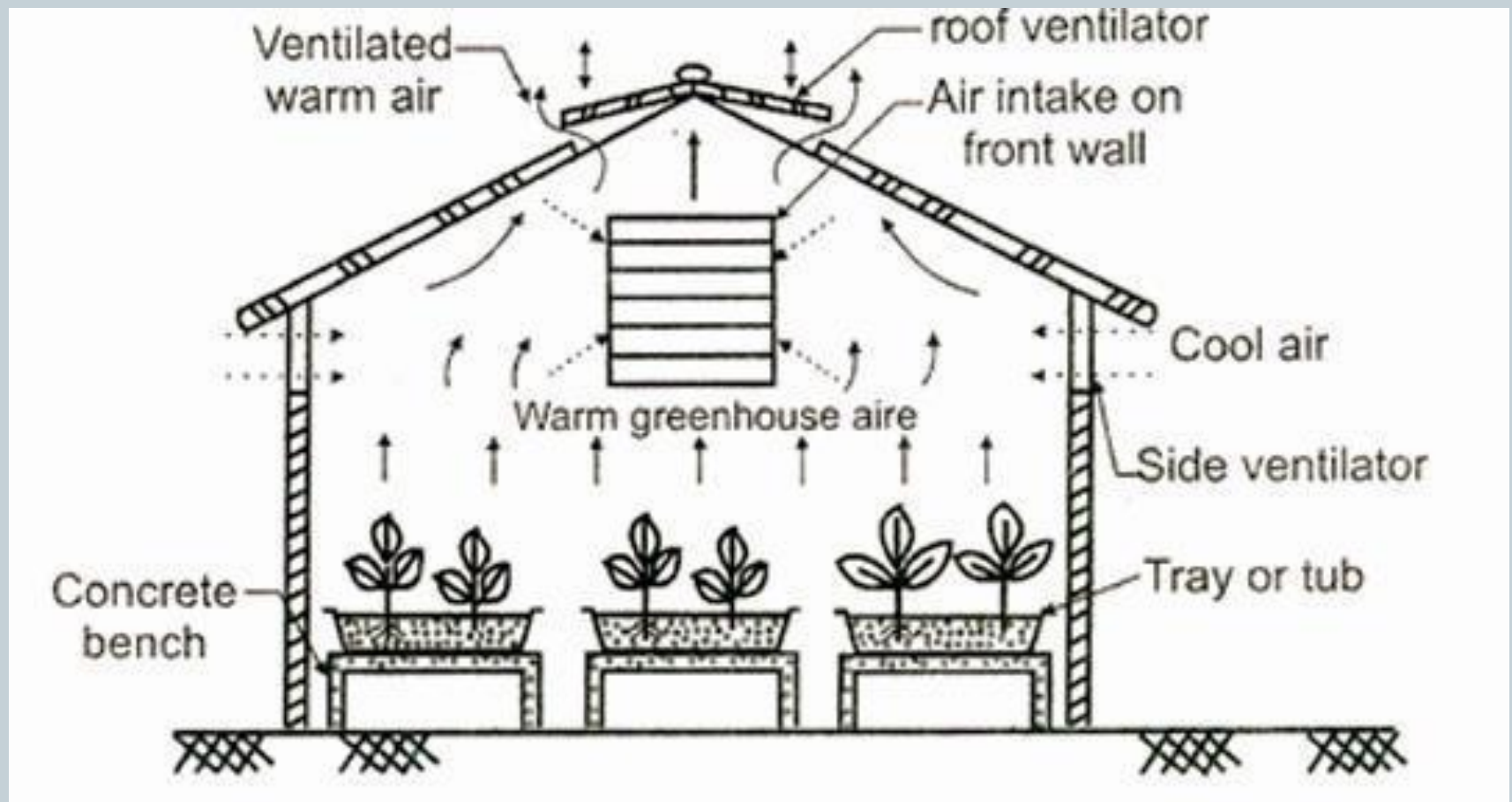


- Ventilation requirements for green houses vary greatly, depending on the crop grown and the season of production.
- The ventilation system can be either a passive system (natural Ventilation) or an active system (forced ventilation) using fans.
- Usually green houses that are used seasonally employ natural ventilation only.



- Manual maintenance of uniform environmental condition inside the green house is very difficult and cumbersome.
- A poor maintenance results in less crop production, low quality and low income.
- For effective control of automatic control systems like micro processor and computer are used presently to maintain the environment.

## c) Natural ventilation





- **In the tropics**, the sides of greenhouse structures are often left open for natural ventilation.
- Tropical greenhouse is primarily a rain shelter, a cover of polyethylene which leads to foliage diseases.
- Ventilators were located **on both roof slopes** adjacent to the ridge and also on both side walls of the greenhouse.
- The **ventilators** on the roof as well as those on the side wall accounts, each about **10% of the total roof area**.





- **During winter cooling phase**, the south roof ventilator was opened in stages to meet cooling needs.
- When greater cooling was required, the north ventilator was opened in addition to the south ventilator.
- **In summer cooling phase**, the south ventilator was opened first, followed by the north ventilator.
- As the incoming air moved across the greenhouse, it was warmed by sunlight and by mixing with the warmer greenhouse air.



- With the increase in temperature, the incoming air becomes lighter and rises up and flows out through the roof ventilators.
- This sets up a **chimney effect** , which in turn draws in more air from the side ventilators creating a continuous cycle.
- **This system did not adequately cool the greenhouse.** On hot days, the interior walls and floor were frequently injected with water to help cooling.

## d) Forced Ventilation



- In active ventilation, mechanical devices are used to expel the air.
- This type of ventilation can achieve **uniform cooling**.
- These include **summer fan-and-pad** and **fog cooling** systems and the **winter convection tube** and **horizontal airflow systems**.
- For mechanical ventilation, low pressure, medium volume **propeller blade fans**, both directly connected and belt driven are used for greenhouse ventilation.
- They are placed at the end of the green house opposite to the air intake, which is normally covered by gravity or motorized louvers.



- Evaporative cooling in combination with the fans is called as fan-and-pad cooling system.
- The fans and pads are usually arranged on opposite walls of the greenhouse.
- The common types of cooling pads are made of excelsior (wood fiber), aluminum fiber, glass fiber, plastic fiber and cross-fluted cellulose material.
- Evaporative cooling systems are especially efficient in low humidity environments.



- At this stage, the vents for natural ventilation are closed.
- When both options for cooling are designed in greenhouse construction, initial costs of installation will be more.
- But the operational costs are minimized in the long run, since natural ventilation will, most often meet the needed ventilation requirements.

# Fogging systems



- Fogging systems is an **alternative** to evaporative pad cooling.
- They depend on absolutely clean water, Free of any soluble salts, in order to prevent plugging of the mist nozzles.
- Such cooling systems are not as common as evaporative cooling pads, but when they become more cost competitive, they will be adopted widely.
- **Fogging systems** are the **second stage of cooling** when passive systems are inadequate.

# Computerized environment control



- **Microprocessors**
- **Computers**

# Assignment no. 6



- Write the working principle and parts of convection tube cooling and horizontal air flow (HAF) fan cooling systems with proper diagram.



# Assignment no.7



- Describe briefly about the computerized environment control techniques, its parts and also describe about its advantages and disadvantages with suitable diagrams.