efficient, well managed system, you should be able to reduce the temperature of the air entering the house to within 3-4°F of the wet bulb temperature. Remember, this will not be the temperature in all areas of the house. As the air moves across the house to the exhaust fans, it will pick up solar heat so that the exhausted air will likely be 7-8°F higher than the entering air. In a poorly managed system, the exhausted air could have a much greater temperature differential.

The basis of any evaporative cooling system is the evaporation of water into an airstream. The most common way of accomplishing this is the fan and pad system shown in Figure 1.

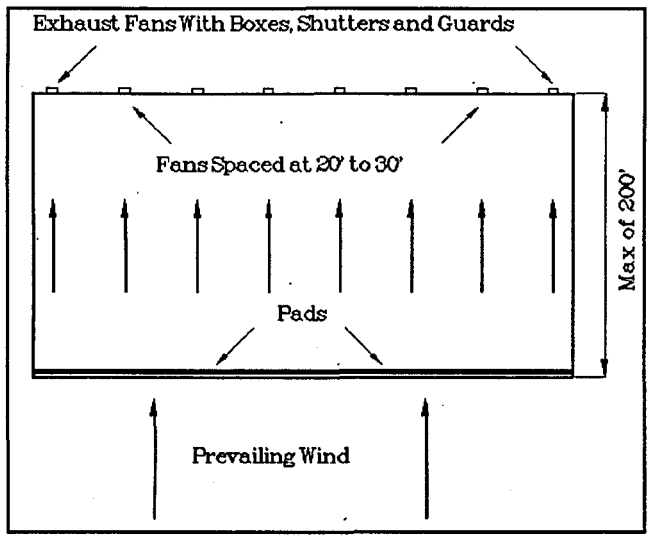

Figure 1. Typical pad-fan greenhouse arrangement.

In recent years, high pressure fog systems have started seeing use in greenhouses. These fog systems can be designed and operated to maintain more uniform temperatures and humidities in greenhouses than are possible with fan and pad systems. Fog systems are more expensive than fan and pad systems but when uniform temperatures and high humidity levels are important they can be the best method of evaporative cooling.

FAN AND PAD EVAPORATIVE COOLING SYSTEMS

Fan and pad systems consist of exhaust fans at one end of the greenhouse and a pump circulating water through and over a porous pad (Figure 2) installed at the opposite end of the greenhouse.

If all vents and doors are closed when the fans operate, air is pulled through the wetted pads and

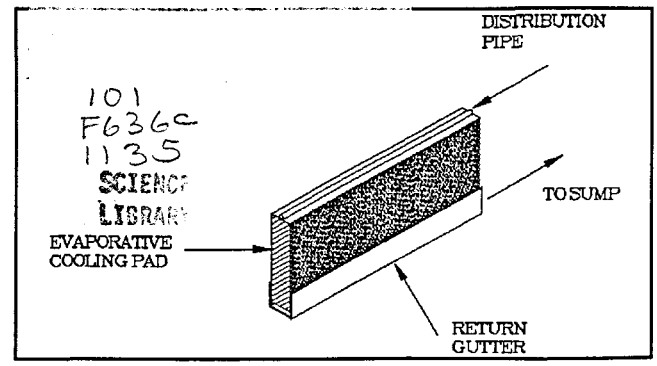

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Figure 2. Evaporative cooling pad. The sump should be large enough to hold all run-off when the pump is turned off.

water evaporates. As each gallon of water is evaporated, 8,100 BTUs of heat energy are absorbed from the air by the water in the change from liquid to vapor. Removing energy from the air lowers the temperature of the air being introduced into the greenhouse.

The air will be at its lowest temperature immediately after passing through the pads. As the air moves across the house to the fans, the air picks up heat from plants and soil and the temperature of the air gradually increases. A temperature gradient across the greenhouse results, with the pad side being coolest and the fan side warmest.

TEMPERATURE GRADIENT

The temperature gradient across the greenhouse is hard to predict because many variables affect the gradient. Some of these are bench arrangements, physical obstructions to the movement of air across the house, percentage of floor area covered by plants, or whether the floor is bare soil or covered with concrete. The configuration of the roof can also have an influence on temperature gradient. Experience has shown that air may heat up as rapidly as 1°F for every 10' of movement on sunny summer days. The slower the air movement, the faster the air heats up, and the greater the gradient.

The temperature gradient across the house at plant level is most important. In most systems, the air tends to diverge upward at an angle of about 7° above horizontal, or roughly 1' in 8'. The upper layer of cooled air rises toward the peak of the building above the crop zone and thus does little cooling of the plants. In a cross flow arrangement of gutter