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Maintenance Guide for Greenhouse Ventilation, Evaporative Cooling Heating Systems[1]

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Greenhouses, and their environmental control systems, are susceptible to many destructive forces. Of these, the most common are lack of preventive and corrective maintenance. A good greenhouse manager should observe potential problem areas in the facilities, equipment and grounds. Records should be kept on when routine maintenance checks were made and what corrective measures, if any, were taken. The records should include such entries as evaporative cooling pad replacement, fan belt replacement, boiler compound addition, fertilizer injector maintenance, fumigation equipment inspection, and bearings and motor lubrication. Of course corrective maintenance should be done when the need is discovered, but a good preventive maintenance program will reduce the number of corrective maintenance actions necessary and could save many dollars in equipment down time and labor saved. This fact sheet will emphasize corrective and preventive maintenance procedures for ventilation, evaporative cooling and heating systems.

VENTILATION SYSTEMS

The operating efficiency of a ventilation fan can be reduced 30-50% by the buildup of dust on fan blades or by shutters that do not operate freely. Regardless of how well a ventilation system has been designed and installed, the system will not function properly without maintenance and care. When a ventilation system is not operating properly, the results can be pockets of stagnant air, inadequate cooling from evaporative cooling pads, high heating expenses, heavy condensation in winter, reduced life and reliability of ventilation equipment, and high repair bills. The sizing of fans for winter, summer, and spring-fall ventilation is presented in Fact Sheet AE 10, "Greenhouse Ventilation." Detailed information on fan ratings, fan selection, and fan efficiency is presented in Fact Sheet AE 12, "Fans for Greenhouses."

The major points to consider in any maintenance program for fans and their components are:

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- Be sure the fan blades, fan housing, and shutters are clean. The accumulation of only ounces of dust on fan blades can create enough imbalance in the fan to reduce operating efficiency by 30%. Clean the fans and components as often as necessary to prevent dust accumulations.

- Whenever cleaning the fans, lubricate the fan bearings, motor, and shutters. Any parts that do not move freely should be replaced.

- Check the fan belts for proper tension to prevent slippage. If the belts are cracking, splitting, or fraying, replace immediately. Otherwise, the belt may fail when no one is available to install a new belt.

- Inspect the electrical supply cords to fans from the receptacle and from the thermostat. Whenever the insulation begins to crack or split, replace with UL, approved insulated wire.

- Check fan wheel for proper rotation. Fan rotation is sometimes reversed when fans are installed, repaired, or when the polarity of wiring circuits is alternated. Since fans move a fraction of their rated capacity when running backwards, reversed direction often goes unnoticed in spite of much less efficient performance. Proper direction of rotation is generally marked on the fan housing.

- Remove weeds and shrubs growing outside greenhouses close to each fan. Nothing should obstruct the flow of air from the fan within a distance of two blade diameters of the fan. Any weeds or shrubs would make it harder for the fan to exhaust the air; hence, the fan would operate with lower efficiency.

- Never allow any obstructions that would limit the flow of air into a fan within a distance of one blade diameter of a fan. Any obstructions to the flow of air would also make the fan operate with less efficiency.

- If it is necessary to replace any fans, always replace with fans rated according to AMCA (Air Moving and Conditioning Association) standards. Such fans will carry an AMCA seal on the fan housing and in the sales literature.

- When it is necessary to replace the fan motor, always replace it with a totally enclosed motor having sealed bearings. This type motor is required to protect the motor windings from the corrosive effects of high humidity and dust accumulations that would otherwise shorten the service life of the motor.

- Check for openings around fan housings that permit air flow to bypass the desired air inlet pattern. Close all other openings in the house such as laps or unions between sections of glazing materials, service utility entrances, cracks around evaporative cooling pads and frames, voids in evaporative cooling pads, and doors where outside air can enter. Efficiencies of heating, cooling, and ventilation systems can be drastically reduced by the presence of such openings.

- Calibrate thermostats and humidistats to insure that fans operate according to the prescribed environmental conditions. Be sure to carefully wipe any accumulated dust from the sensing elements of the controls before calibrating. Aspirated sensing units are preferred because of faster response to changes in greenhouse environments. Thermostats and humidistats should be placed at or near crop level, rather than human level, to insure most accurate environmental control for the plants.

EVAPORATIVE COOLING SYSTEM

The efficiency of evaporative cooling can be greatly reduced by compacting of cooling pads, improper operation of fans, greenhouse doors remaining open, and insufficient water supply to cooling pads. Whenever the efficiency of evaporative cooling is reduced, the air temperature inside the greenhouse increases. Details of evaporative cooling are presented in Fact Sheet AE 14, "Evaporative Cooling of Greenhouses in Florida." Since evaporative cooling requires efficient ventilation systems in greenhouses, see Fact Sheet AE 10 "Greenhouse Ventilation," for details on ventilation. Major factors to consider in any maintenance and care program for evaporative cooling are difficult to

generalize because several different types of cooling pads are now available. The major factors are:

- Be certain that the rated air flow passes through the cooling pad, not through open doors, cracks, or other openings in the greenhouse. Check pads and supporting frames to insure tightness of fit and good condition of pads. Cracks around pads should be sealed and pads with holes exceeding 1/4-inch diameter should be repaired or replaced. Only air that passes through the cooling pad is cooled; air entering through other openings is not cooled. Furthermore, if any openings exist because of open doors, cracks, etc., virtually all the air will enter through these openings rather than through the cooling pads. If pads are covered with algae, which increases resistance to air flow, they should be cleaned or replaced.

- Check the fan ratings to be certain the proper volume of air is drawn through the cooling pads at the required static pressure resistance. Air volumes may range from 150 to 400 cubic feet of air per minute (cfm) per square foot of pad area at static pressures ranging from about 0.05 to 0.30 inches of water. Be sure to follow the manufacturers' specifications. Fans must be properly maintained to perform at rated capacities.

- Use water meters, rotameters, or bucket-andstopwatch to check the rate of water supply to the cooling pads. The specified rate of water supply differs for various types of cooling pads; therefore, follow the manufacturers' recommendations. For aspen pads, the recommended water rate is 1/3 to l/2 gallon per minute per lineal foot of pad. A check of the water supply should be performed at the beginning of each cooling season.

- Use fungicides in the water supply system to retard the growth and buildup of algae in the cooling pads. Algae and other bacteria will hasten the deterioration of the pads and also increase resistance to air flow.

- If using aspen cooling pads, replace with new pads whenever the void area in the pads is 10% or greater of the original total pad area. Replacement is necessary because cooling efficiency is reduced as an increasing volume of air enters the greenhouse through the void space rather than through the cooling pads.

- If replacing cooling pads, seriously consider replacing with the newer types of pads such as concrete coated cooling pads or corrugated cellulose coolpads. Research has shown the cooling efficiencies of these newer pads to be as high as or higher than new aspen pads and much higher than rubberized hog hair pads and aging aspen pads. Life expectancy of these new pads is longer than that of aspen pads.

HEATING SYSTEMS

There are three basic types of heating systems commonly used. They are:

- unit space heaters,

- hot water heaters, and

- steam heaters.

The latter two require a boiler to produce the hot water or steam. There are a number of ways that these systems can be applied. Normally, unit space heaters are either oil or gas fired although space heaters utilizing hot water from a boiler are used in some instances. A fan is used to distribute the heat uniformly throughout the house. Unit heaters should be spaced in such a way and have sufficient fan capacity to provide uniform heat distribution and good air circulation (a speed of 40 feet per minute is considered minimum). In an enclosed greenhouse, all fossil fueled heating units should be vented to the outside. Byproducts of combustion are injurious to many kinds of plants and it is possible to have as much or more plant damage from combustion by-products of unvented heaters as from the low temperatures which would result if no heat were supplied.

The basic concepts of the several alternative heating systems and how to calculate heating requirements are described in Fact Sheet AE 11, "Heating Greenhouses." They will not be repeated here. Rather, a check list is given, which, if followed will eliminate many of the problems and equipment failures enduring the heating season.

- Vent all fossil-fueled unit heaters to the outside in any enclosed house. The vent stack should extend a minimum of four feet above the house ridge or any nearby building or other obstruction.
- Make sure you have good air circulation. Auxiliary fans may sometimes be a good investment.
- Locate thermostats which control the system near plant bed level.
- Do not expose the thermostat to a nearby heat source or draft. It may be necessary to use a protective shield and a small fan to move air across the thermostat in order to obtain proper temperature conditions at the bed level.
- Check all burner nozzles, clean fan blades, and oil fan motor as recommended by manufacturer prior to initial operation.
- Check all flues for leaks and make sure the stack extends the proper height as described earlier.
- Check all pipes in a hot water or steam system for leaks.
- Where unit hot water systems are used, check to be sure fan blades are clean, fan motors properly oiled (if recommended by manufacturer) and that orientation of each unit is proper to give optimum heat and air distribution at plant level. If fans are belt driven, check all belts and pulleys to be sure they are in good condition.
- Do not increase number of hot water unit heaters or, if bench hot water lines are used, extend their length, without making sure the boiler or furnace has sufficient capacity to handle the added load.
- Keep pipes in a hot water system clean. Accumulation of dust can decrease efficiency significantly. The same is true for registers or finned pipe which are used in a steam system.
- Allow for heat losses in the transport pipe from the boiler to the house when calculating the heating requirements for a house heated with hot water or steam. Normally, 15-25% should be added to take care of this loss. An experienced heating contractor or engineer should probably be retained to design and supervise installation of these type heating systems. Make sure all boiler components are in proper working condition well ahead of the heating season.
- If a polytube heat distribution system is used, be sure length of tube, size, spacing and location of openings in tube are properly matched to the heating unit(s) and house configuration for good heat and air distribution. Normally the manufacturer will provide dependable instructions for installation and operation.
- Do not use unvented fossil fuel heaters. If, however, you feel this is necessary to save your plants from freezing, provide as much ventilation (either natural or mechanical) as practical to reduce damage from the by-products of combustion. Some plants are more tolerant than others. Determine degree of tolerance prior to the heating season if it is anticipated that unvented heaters may have to be used.
- Contact your fuel dealer well in advance of the heating season to be sure of an adequate fuel supply in the event a fuel shortage should develop.
- When building new houses, consider the efficiencies of alternative systems and local availability of different types of fuel.