Evaporative Cooler Water Use

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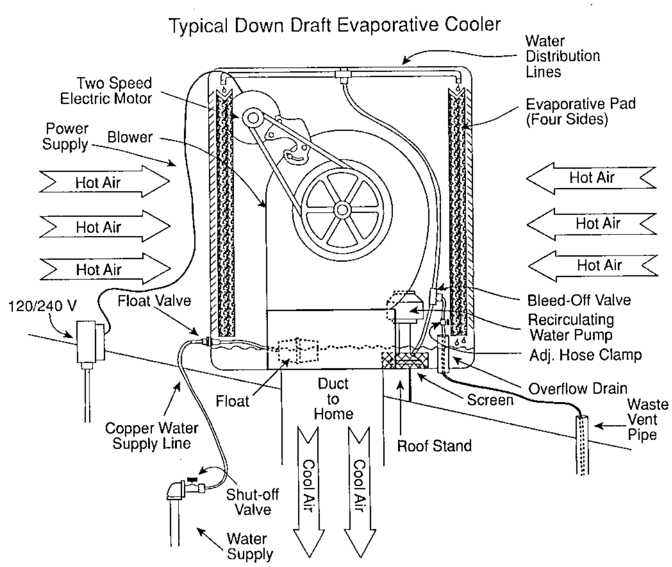
Arizonans have traditionally regarded evaporative cooling as a good way to keep cool in the summer. Before the advent of residential air-conditioning it was the only mechanical means available to make home interiors livable in the hot, dry, desert summers. Evaporative coolers function well except for the few weeks of the summer "monsoon" season with its accompanying elevated humidity and thus decreased cooler efficiency. These cooling systems are economical in terms of energy usage. During the energy crunches of the last two decades, evaporative cooler use was promoted as one means to control household utility bills. However, little thought was given to cooler water consumption. With Arizona's rapidly increasing population, warm temperatures, and limited water supply, evaporative cooler water usage can no longer be ignored.



With conservation as the cornerstone of the Groundwater Management Act, researchers at The University of Arizona Office of Arid Lands Studies developed in the mid-1980s a "W-Index" or index of residential water efficiency. The index was proposed as a device to evaluate residential water savings and as a management tool to motivate water-saving practices.[1] The researchers noted that for home cooling, the highest index rating is received for having no evaporative cooler, the alternative being air-conditioning which although using more energy, uses practically no on-site water.[2] This advice flies in the face of all the energy-conservation practices supported by utility companies, industry and educational institutions and leads to confusion with mixed messages to consumers.

In all but a few of Arizona's cities and towns, some means of cooling home interiors in the summer is essential. Consumers have learned that air-conditioning uses three to five times as much electricity to cool their homes as evaporative cooling. They know how much their utility bills rise in the summer months. Some have added evaporative cooling for use during the hot, dry summer months and switch to air conditioning during the “monsoon” season.

Others have changed over completely to evaporative cooling, reducing their cooling utility bills. Yet evaporative cooling consumes significant amounts of water, and water is a precious and increasingly costly commodity in Arizona.

How much water does an evaporative cooler use? Data for evaporative cooler water use are scarce since little research on this topic has been undertaken, and many factors, from household composition to location of the cooler, influence cooler water use. In *Cool Houses For Desert Suburbs*, Jeffrey Cook, a Phoenix architect, estimates that a 4500 CFM (cubic foot per minute) cooler, under certain weather conditions, uses 200 gallons of water per day.[3]

On the other hand, in a television interview in Tucson in September 1990, a Tucson Water Company employee stated that an evaporative cooler adequafindte to cool a 1,500 square foot home uses approximately four gallons of water per hour or 96 gallons per day, an estimate 50 percent lower than Cook’s. Further, the Arizona Department of Water Resources estimates that a typical Tucson household cooler uses a year-round average of 16 gallons per day.[4] These projections of water use convert to annual water costs in Tucson ranging from about $16 to $97 for a 26-week cooling season.

Recently, a research study was initiated by the Office of Arid Lands Studies at the University of Arizona and the Water Services Department at The City of Phoenix with funding from the Arizona Department of Water Resources. This study monitored evaporative coolers at 46 homes in Phoenix. The preliminary data from this study indicates that water usage of an evaporative cooler in Phoenix was about 7.6 gallons for each hour that the cooler was operated (4.4 gallons per hour for systems without bleed-off and 10.4 gallons per hour for systems with bleed-off).[5]

The following questions and answers are designed to improve consumer awareness, thus helping preserve our precious natural resources.

Questions and answers on evaporative coolers

1. What are the major parts of an evaporative cooler?

The typical evaporative cooler consists of eight major parts: housing (metal or fiberglass), a blower, recirculating water pump, water reservoir, float valve, pads, water distribution lines, and electric motor.

2. How does an evaporative cooler work?

The cooling process works on the principle of evaporation of moisture. The fan of the cooler draws outside air through pads soaked with water. The evaporation of the water lowers the temperature of the air passing through the wet pads of the cooler. This cooled air is blown through an opening into the building.

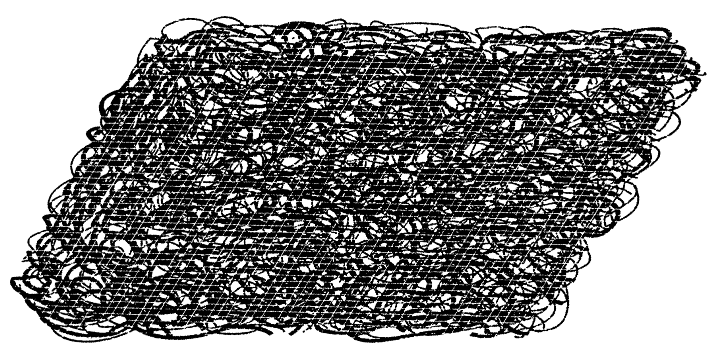
The movement of the cooled air is directed by the homeowner by means of ducts to appropriate areas around the home and exhausted from partially opened windows, doors or ceiling ducts.

3. What are the ways to use evaporative coolers?

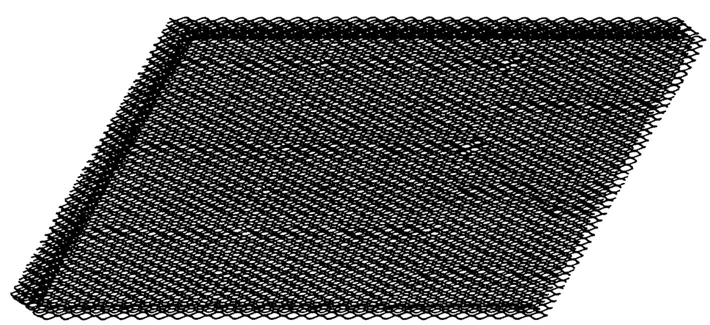
There are three ways to use evaporative cooling: (1) as the sole cooling system, (2) as a second alternative cooling system to refrigeration (air conditioning, heat pump), and (3) as a “dual” or “combined” system with a refrigeration system.

One advantage to having both systems is that you get the best of two worlds - evaporative cooling during the dry months in spring and fall, and refrigeration in the hot summer months when the temperature and humidity are higher.

Despite the convenience of the combined system, there are drawbacks. For example, considerable air movement is required for comfort with evaporative cooling. Refrigeration ducts are often too small for this



Aspenwood fiber pad



Paper cellulose pad

and result in insufficient air flow and more noise. Also from the utility standpoint, the use of both systems results in an enhancement of the peaking problem for both water and power suppliers and, therefore, contribute to the need for additional capacity of these systems which are poorly utilized in off-peak demand periods.

For systems using shared ductwork, dampers must be installed to separate the two units. Without dampers, refrigerated air will escape to the outside through the evaporative cooler and, conversely, moist air from the evaporative cooler will enter and corrode the refrigeration unit. Many systems have dampers that are automatic. They should be checked annually for correct operation.

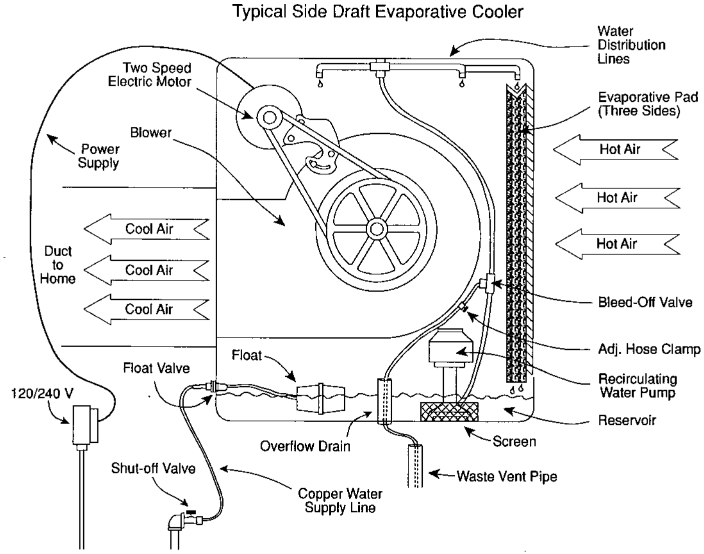
Care must be used when operating the evaporative cooler and refrigeration unit alternately. The refrigeration system will work much harder than normal since it has to remove the moisture brought into the house by the evaporative cooler. Moisture from the cooler will condense on the refrigeratant coil and increase electrical costs appreciably; therefore, one should not directly precool air to be refrigerated.[6]

4. Where are coolers typically placed on a building?

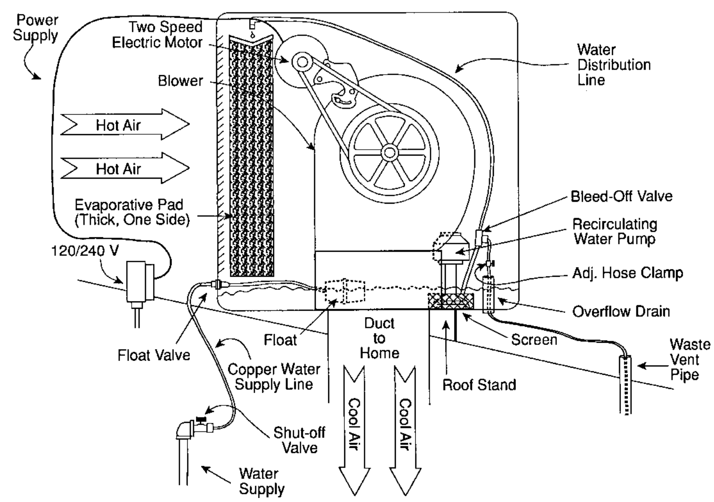
Evaporative coolers can be classified according to the position of the cooler in relation to the building. Generally, there are three types: (a) down-draft (roof mounted), (b) side-draft (typically eave or window mounted), and (c) up-draft (ground mounted).

Roof mounted, down-draft coolers (a) are sometimes preferred since they can usually be more readily connected to duct systems and are out of the way on the roof. However, eave mounted (b) or ground mounted (c) units can be more easily and safely serviced since the person doing the maintenance does not have to use a ladder to inspect or repair the system.

Typical Side Draft Evaporative Cooler



Single Pad Evaporative Cooler



5. Are there any coolers on the market that use less water than others?

The use of water by coolers is generally dependent on their size, air movement and relative humidity of the air. Therefore, all things being equal, a 4500 CFM cooler uses less water than a 6000 CFM cooler. Research is showing that some units appear to more efficiently evaporate water and, thus, produce more cooling per unit of water use.[7]

6. I need a new cooler, but I don't know what size to buy.

A simple formula can help you decide. First, you'll need to determine your home's cubic footage. Multiply the square footage (length by width) of the floor area by the ceiling height and divide by two. For example, a 1600 square foot home multiplied by a ceiling height of eight feet is 12,800 cubic feet, divided by two is 6400. An evaporative cooler with a CFM number closest to 6400 should be adequate for your home. CFM are usually clearly marked on the front of the cooler. Consult with your cooler supplier about cooler size. Too large or too small coolers are wasteful of both water and energy and will not provide the comfort or efficient use of resources you are seeking for your home.

7. Should I buy a cooler with a two-speed motor?

The advantage of a two-speed system is that low speed can be used at night when exterior temperatures drop or on days when temperatures are not excessive. Low speed could also be used during the day when family members are working. When family members return home, high speed would quickly lower the temperature. Coolers usually run more quietly at low speed and provide about 66 percent of the airflow of high speed. They also use about 30 percent of the energy needed to run the cooler at high speed, thus reducing operating costs. Many individuals believe it is more economical overall to leave the coolers off when the building is not occupied.

8. Do coolers use less water when operating at low speed?

The amount of cooling generated by an evaporative cooler is a function of the amount of evaporation that occurs in the unit. Increased dry air movement over the wet cooler pads will increase the amount of evaporation and produce more cool air. At the same time, decreased air movement will decrease the amount of water used for cooling, while the bleed-off rate will remain the same.

9. How often should maintenance be performed on an evaporative cooler?

A cooler should be inspected monthly and serviced as needed during operation. The owner's manual should be read to determine if more frequent servicing is required. Before starting any maintenance operations, read all operating and maintenance instructions and observe all cautions and warnings. During these maintenance inspections all parts should be inspected for wear or damage. Belt tension and water level in the reservoir should be checked. Since cooling efficiency is determined by how much water is evaporated, it is important to see that the pads receive a uniform wetting and be thoroughly wet at all times to provide the most cooling. Dry spots will greatly decrease cooling efficiency. The Arizona Department of Commerce Energy Office publishes a pamphlet that describes in detail cooler maintenance procedures.[8]

10. My neighbor's system operates on a thermostat. Is there any advantage to that?

A thermostat can be set to start the cooler when a certain temperature, for example 80 degrees, is reached in the home. When the cooler is not operating, it is using neither water nor energy. Thermostats cost from $30.00 - $45.00. Timers can also be used to start the cooler and begin the cooling of the home prior to the arrival of the family. The use of 2 function thermostats starts the wetting of the cooler pads prior to air movement and thus prevents the blowing of dry air into the residence.

11. What kind of pads should I use in my cooler?

Cooler pads (sometimes called media) come in several alternatives. University of Arizona agriculture engineers have long recommended aspenwood fiber pads. They are encased in chemically treated cheesecloth to absorb more water, and they offer the least amount of resistance to air flow through the cooler. Aspenwood pads can be used for an entire cooling season. Although aspenwood pads are efficient in distributing cooled air, they may also produce debris in the water reservoir, increasing cooler maintenance. Some cooler manufacturers recommend a cellulose fiber media or pad for use with their equipment. The media is said to be uniform throughout, to provide consistent cooling performance and to last for several seasons. They are superior to spun aluminum and plastic pads available at hardware or do-it-yourself stores or supermarkets. These are less expensive initially than aspenwood but may need to be changed several times in one cooling season.

The newer single pad coolers require a much thicker pad. This type of pad is more expensive than the traditional aspenwood fiber pad but is designed to last for several years if the cooler is operated in compliance with the owner's manual.

12. Do the minerals in hard water affect the operation of evaporative coolers?

Mineral deposits and scale build-up caused by hard water can cause rust and corrosion in metal coolers. Some estimates are that this rust and corrosion can shorten a cooler's life by 50 percent. Further, scale build-up on cooler pads can cause uneven distribution of water, leading to "hot spots" on the pads and reduced cooling because of reduced air flow. Some manufacturers recommend installing a "bleed-off" valve to the recirculating water line. A bleed-off valve is installed in the recirculating line and is typically connected to a drain line or directed to irrigate turf areas or other landscaping. This results in draining part of the recirculating water, reducing buildup of hard water minerals. Bleed-off valves are controversial because it is estimated that they increase cooler water usage from 10 to 50 percent. Data from the Phoenix cooler study indicates that bleed-off systems use an average of about 8,650 gallons during the cooling season.[9] Horticulture specialists discourage collecting bleed-off water for irrigating plants. The high concentration of minerals in the water may kill or damage plants.[10] The high salt content also can result in the sealing of soils, especially soils with a high clay content, thus preventing moisture penetration. Some plant species such as Bermuda and salt grass can tolerate the high salt content water.[11]

Bill Witschi, the Water Systems Manager at the University of Arizona, suggests that bleed-off should be about 1/3 makeup water. The rate could be lowered if no scale is observed forming on the cooler pads.[12]

13. If I decide not to install a bleed-off valve because it increases water usage, what can I do to prolong the life of the cooler?

Thorough cleaning of the cooler is suggested to remove mineral deposits and scale build-up at least once during the cooling season. Additives to the water supply also are available to help reduce scale build-up. Chemicals will not reduce scale build-up but they can increase the solubility of calcium and other minerals, thus allowing a lower bleed-off rate, or they can combine with the calcium and produce a softer scale that is easier to remove.[13] Some cooler manufacturers do not recommend their use because they may damage the protective coating on the cooler. Caution should also be exercised about what chemicals are used because these can be blown into the home during the normal operation of the cooler.[14] Ask your cooler supplier. However, you may have to replace the cooler sooner than you would if you used a bleed-off valve.

14. Can coolers be used to circulate air only, without water?

With cool air in the evening and nighttime hours, the cooler fan can be run with dry pads. This brings cool air into the home and circulates it without using water. Ceiling and/or oscillating fans used in occupied rooms can help circulate the air for increased comfort. If cooler pads have been allowed to dry out, either through non-use or by circulating air only, it is advisable to run the pump and saturate the pads thoroughly before running the cooler fan. This ensures that cooler air begins to circulate sooner and reduces the introduction of dust and pollen into the home.

If you switch to air conditioning during the “monsoon” season and then switch back to the evaporative cooler as the relative humidity decreases at the end of the rainy season, remember that standing water in the cooler pan is a stagnant pool. This water can become a good place for the growth of bacteria, even the bacteria that causes Legionnaire’s Disease. For safety it is best to drain the cooler if it will not be used for several days. Alternatively, the water in the cooler pan can be treated with chlorine for at least 30 minutes before turning the cooler back on[15].

15. How much does a new cooler cost?

A new, completely installed 4500 CFM cooler costs about $700. Coolers are available for less money and for more money. This is an “average” figure.

16. Should softened water be used to operate an evaporative cooler?

The sodium added to water by water softening will accumulate on the cooler pads and will become concentrated in the water reservoir. Softened water also may increase the need for pad maintenance and the rate of rusting of metal cooler parts.

17. What are ceiling vents?

Ceiling vents or open windows are required to permit the exhaustion of the air blown into the home by the blower. Unlike refrigeration systems which recycle air within the home, coolers blow large volumes of cooled outside air into the living areas, and this air needs to be vented from the home.

Ceiling vents make it possible to keep windows and doors closed while the cooler is running. This is helpful for security. These prefabricated exhaust ducts are installed in the ceiling in several rooms of the home. These exhaust air into the attic which must have an adequate amount of vents. UL tested ducts that automatically close in case of fire are available from cooler equipment suppliers. The venting of house air into the attic will also reduce the air temperature in the attic and thus the amount of heat gain in the living area of the home.

Homeowners could also benefit from window stops, available from most hardware stores for almost all types of windows. With stops in place, windows cannot be opened beyond a certain point chosen by the homeowner, usually 6 to 8 inches. they are easy to install, very inexpensive, and discourage entry. Plants with many spines and thorns, such as cactii and other desert species, can also be planted near windows to enhance security.

18. How much does it cost to operate an evaporative cooler?

Studies have indicated that the average annual cooling energy usage for a 1,600 square foot home is approximately 6,000 kilowatt hours for refrigeration and 1,500 kilowatt hours for evaporative cooling.

If electricity costs were 10 cents per kilowatt hour (a sample cost), the average annual cost would be $600.00 for a refrigeration system versus $151.00 for evaporative cooling. However, the cost of water must be added to the electricity cost for evaporative cooling. Based on the cost of $2.00 for 1 Ccf (hundred cubic feet or 740 gallons), the use of about 19,000 gallons of water by an evaporative cooler with a bleed-off system the average annual cost for water would be $54.00 for an evaporative cooler compared to $0 for a refrigeration system.

It should be remembered that water and energy are inseparable. It takes 0.5 gallons of water to generate 1 kwh of electricity[16] and electricity is needed to treat, pump and/or transport water to your home.

19. Why cover a cooler during winter?

A cooler cover can provide protection for the cooler from rain, dust, and wind, and this helps to extend the life of the unit.

Like any other space heating or cooling system, evaporative coolers have advantages and disadvantages. Listed below are points consumers should weigh carefully in deciding how to cool their homes for summer comfort while trying to conserve water and energy, not only for the present but for future generations of Arizonans.

Advantages

1. Coolers are economical to operate, using one-third the energy of refrigerated air-conditioning.

2. Installing a new evaporative cooling system adequate for a 1,500-square-foot home costs about $700. For the same home, installing a new air-conditioning system, using existing duct work, costs about $2,500.

3. Most cooler maintenance and repairs can be accomplished by the homeowner.

4. Most cooler replacement parts (pads, belts, etc.) are nominal in cost when compared to air-conditioning system replacement parts.

5. Coolers bring fresh, cooled, outside air into the home.

6. Coolers provide a healthy environment for plants.

Disadvantages

1. Coolers use on-site water, a non-renewable resource in some parts of Arizona, for cooling.

2. Coolers are aesthetically unattractive if not maintained and overflow of concentrated salts from the cooler can damage roofs.

3. Air velocity when operating on high speed may cause annoying noise.

4. Open windows to exhaust air may be a security hazard. This can be overcome by installing ceiling vents. Adequate attic ventilation is necessary for ceiling vents to function properly.

5. Cooled air may bring dust and pollen into the home causing discomfort for allergy sufferers. Growth of microorganisms such as molds on the cooler pads may cause allergy problems in sensitive individuals.

6. Coolers require regular maintenance, difficult if the cooler is roof-mounted.

Things to consider before deciding

The first is cost. Get at least three estimates from reliable cooling suppliers or contractors in your community, and don't forget to include the hidden costs, like installation, maintenance, and operational costs of utilities (electricity and water).

Perhaps the greatest advantage of evaporative cooling is the low cost: about one-third as much as refrigeration. The costs for operating a system will depend on the size and number of units, and how homeowners choose to run the evaporative cooler or refrigeration unit and the overall thermal properties of the home (insulation, thermal mass, amount of window area, orientation of the structure).

The next consideration is comfort. Evaporative cooling cannot keep every home comfortable all the time. A typical desert home will not be able to achieve temperatures in what is usually considered the comfort range on days when the humidity is high. Performance can be maximized, however, if all the windows are shaded from direct sunlight, the walls are properly insulated, and protected from direct sunlight, especially on the east and west sides or passive solar concepts were used in the construction of the home. Keep in mind that air movement, not just air temperature, contributes to comfort: 82 feels like 75 in a moderate breeze.

The basic principle of evaporative cooling is simple and in the past the typical coolers were very simple devices. More recently, however, many variations and innovative concepts are being applied to cooler design and construction to achieve cooling efficiency. Therefore, before deciding what type of cooling, air conditioner or heat pump you wish to purchase, shop by comparing their differences, comfort, capital and operating cost. For evaporative coolers compare purchasing and operating costs, pads, construction materials (metal vs fiberglass or stainless steel).

Conclusions

Evaporative cooling has both advantages and disadvantages, and the choice rests with the individual homeowner. We encourage consumers to investigate all of the alternatives and make a decision based on their lifestyle and individual priorities.

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