# EVAPORATIVE COOLING

## What exactly is Evaporative Cooling?

Evaporative cooling uses the principle of water evaporation to cool, no environmentally dangerous refrigerants, just cool clean water. Just like that cool feeling you got when you were a kid running through the sprinkler on a windy day. With evaporative cooling wind +water=cool, it Is as simple as that.

## Why use evaporative cooling?

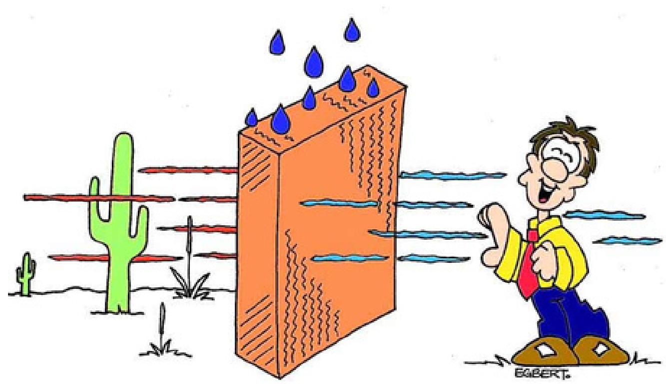
* Environmentally friendly: Evaporative Cooling reverses environmental concerns from refrigerants used in mechanical refrigeration. Just cool clean water.

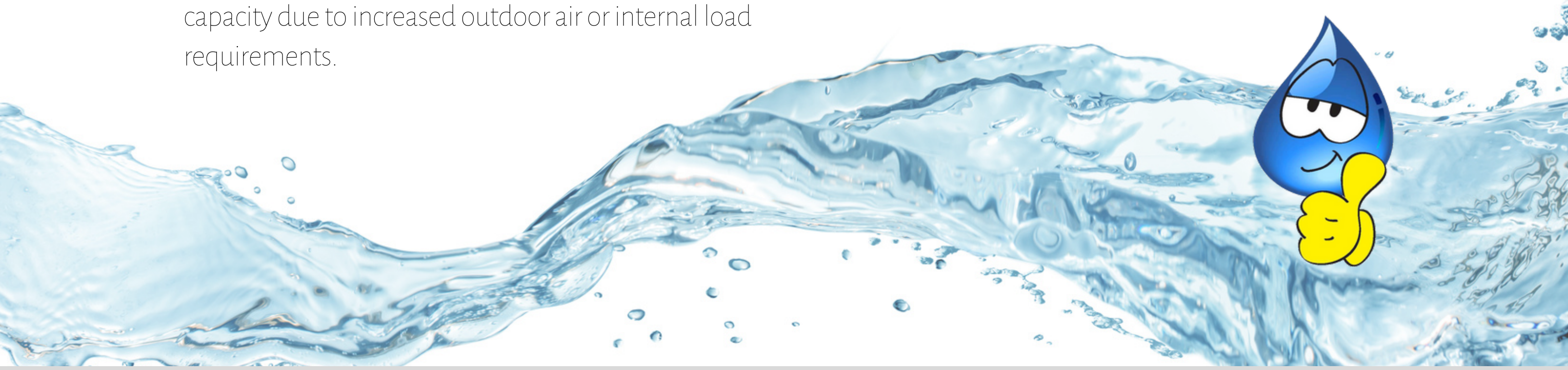
* Improved indoor air quality Just cool clean water circulating fresh air through the indoors.

* Low energy usage versus other systems enhances your energy, management, and saves money.

* Low operational costs evaporative cooling a great alternative to traditional ventilation-only systems.

* Transportable Evaporative Cooling can reduce overall cooling requirements on systems which are struggling with capacity due to increased outdoor air or internal load requirements.



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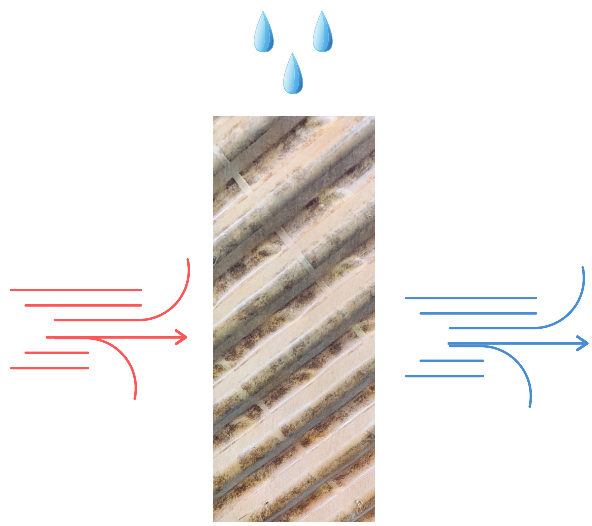
## The Principle

The Evaporative Cooling Principle: Water applied to an extensive, corrugated media surface and mixes with air which passes through the media. Energy is required to change the liquid water into a vapor, this process called "Evaporation" absorbs heat from the air stream which decreases the air temperature while increasing the relative humidity. Over 4,000 years ago an ancient Egyptian inventor hung a mat over his doorway wetted with water. As the water was evaporated off of the mat by the mild breeze that blew into the dwelling, the air was cooled and evaporative (or swamp) cooling was born.

## Cooling for Today

We have come far from the Egyptians but the principle remains the same. Through the years many materials from hog's hair and shredded aspen wood to high efficiency, rigid cell- honeycomb paper material, have replaced the Egyptian wetted mat. The media is wetted from either a drip-type or spray-type water distribution system to saturate the media. The media is corrugated to maximize the contact area between the air and water. The hot air is passed through the media and is cooled as it evaporates the water into the air stream. In this process, called direct evaporative cooling, the air's temperature is lowered but the moisture content is increased.

## Direct Evaporative Cooler



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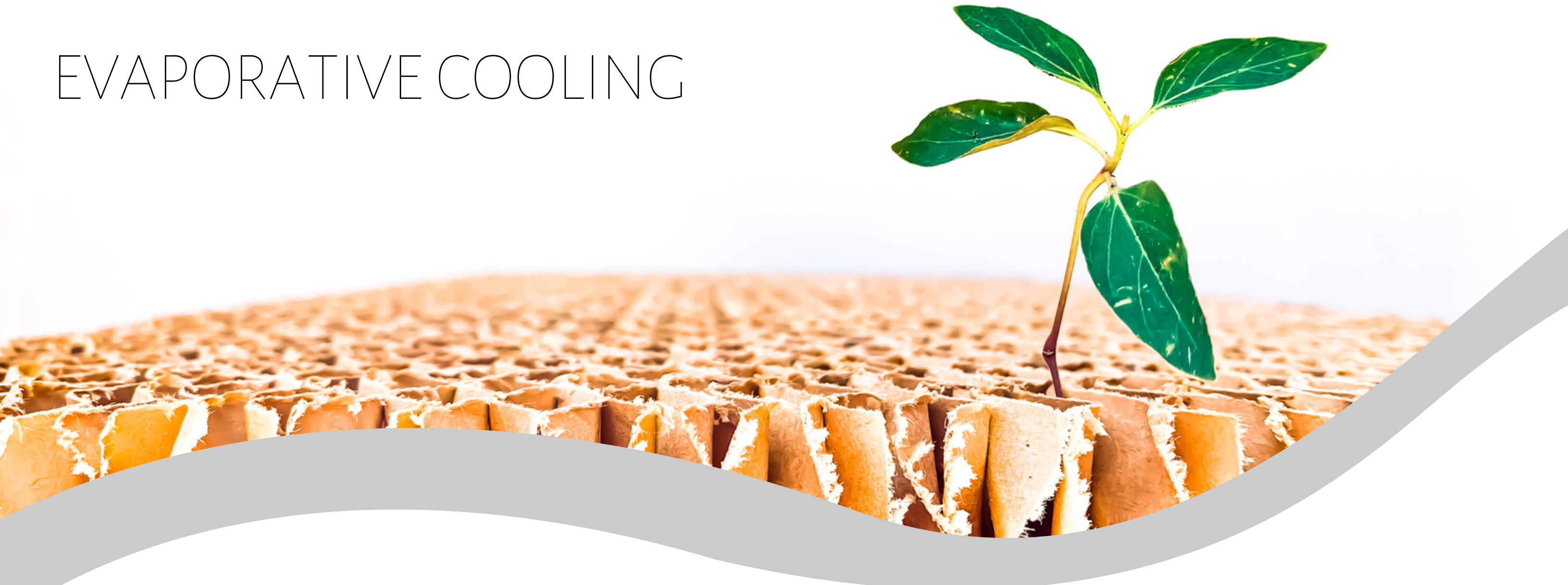
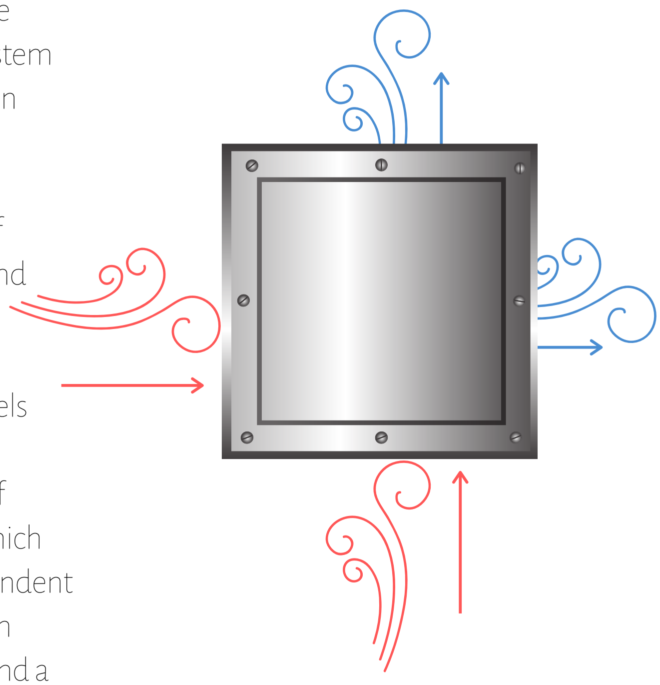


As the air is passed through traditional portable evaporative coolers the air is cooled to 78°F with 70°F wet bulb temperature, 68% relative humidity, and 96 grains of moisture. Obviously, the temperature is significantly cooler and the humidity level is much higher. All of this cooling is achieved with relatively low energy consumption since the cooling uses only a water pump and a little more horsepower for air movement. Typically, an evaporative cooling system will utilize approximately 80% less energy than a mechanical refrigeration system.

In many areas, the increased humidity levels are a welcome advantage of evaporative cooling as a source of humidification during both summer and winter seasons.

However, in other regions and applications higher ambient humidity levels make direct evaporative cooling less effective and comfortable. Indirect evaporative cooling, a relatively new concept, utilizes the same process of direct evaporative cooling to cool a secondary independent air stream which cools some sort of medium. This medium then cools the primary independent air stream with no moisture addition to that primary air stream. Common processes include utilization of cross flow plate exchangers, heat pipes, and a system involving a cooling tower and a cool water coil.

Indirect Exchanger



The indirect cooling process is shown to the right, this is a cross flow plate exchanger. Water is distributed over the exchanger core at the secondary air outlet location.

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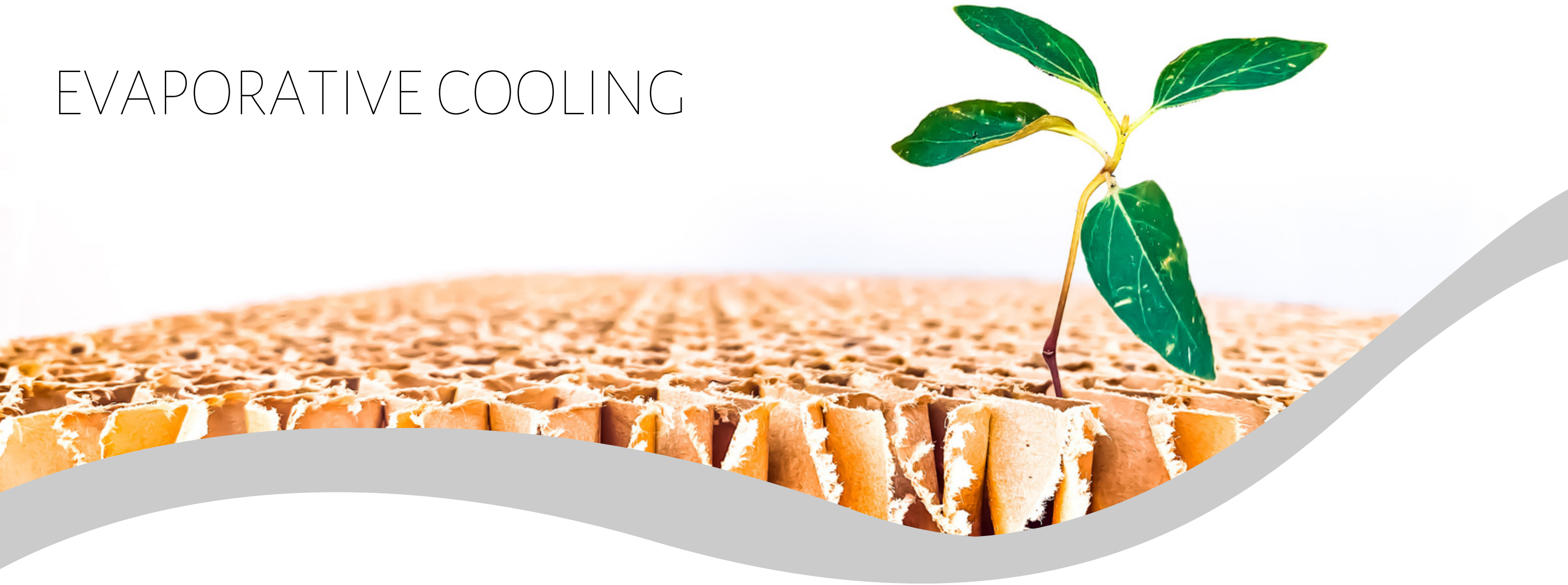
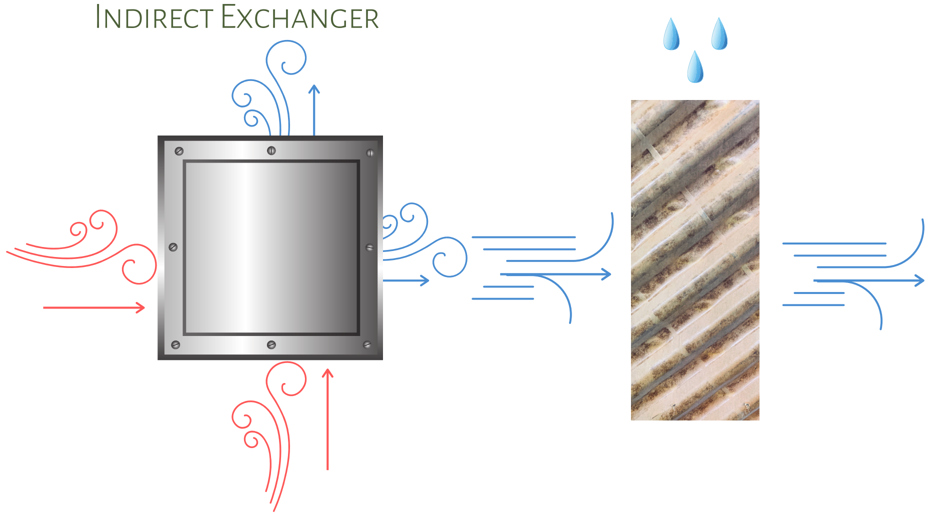


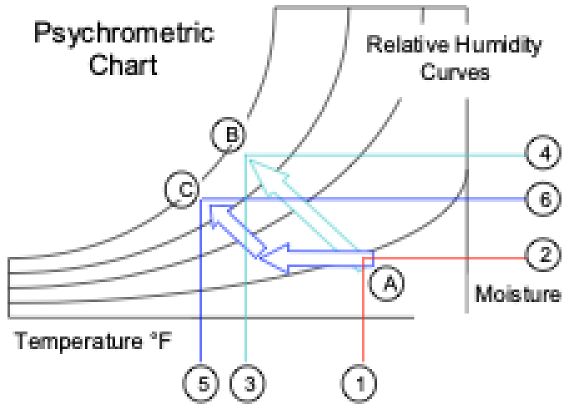
UTILIZING THE INDIRECT EXCHANGER AS A PRE-COOLER FOR A DIRECT EVAPORATIVE COOLING MEDIA IS ILLUSTRATED BELOW.

DIRECT EVAPORATIVE COOLER

INDIRECT EXCHANGER



THESE COOLING PROCESSES ARE SHOWN GRAPHICALLY BY A PSYCHROMETRIC CHART




NOTE THAT THE SLANTED ARROWS REPRESENT THE DIRECT EVAPORATIVE COOLING PROCESS AND THE HORIZONTAL ARROW REPRESENTS INDIRECT COOLING.

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This psychrometric chart is used to show the relationship between temperature and humidity of air. Point 'A' shows a typical design day in Phoenix, AZ where the design condition is 108°F and 48 grains of moisture. Point 'B' shows that conventional portable evaporative coolers provide air at 78°F and 96 grains of moisture. Point 'C' illustrates the ability of a two-stage cooler to provide air at 67°F and only 76 grains of moisture. It is apparent that indirect coolers produce more cooling (line 1-5 vs line 1-3) with less moisture content (line 2-6 vs line 2-4). An indirect cooler can be operated without the direct stage to provide cooling with no moisture added. Direct evaporative cooling accomplishes significant cooling at very low operational/energy costs. Indirect/Direct evaporative cooling can be applied in a much greater climatic region as illustrated below.

| Location | Design °F | Direct EC Supply Air °F | 2-Stage EC Supply Air °F |
|---|---|---|---|
| Albuquerque, NM | 93 | 66.9 | 57.4 |
| Boise, ID | 94 | 69.5 | 60.5 |
| Denver, CO | 93 | 66.1 | 56.3 |
| Detroit, MI | 87 | 75.2 | 70.8 |
| El Paso, TX | 98 | 71.1 | 61.3 |
| Las Vegas, NV | 106 | 74.4 | 62.8 |
| Los Angeles, CA | 81 | 67.6 | 62.6 |
| Oklahoma City, OK | 96 | 78.6 | 72.2 |
| Phoenix, AZ | 108 | 78.0 | 67.0 |
| Pittsburgh, PA | 86 | 73.4 | 68.7 |
| Sacramento, CA | 97 | 74.9 | 66.8 |
| Salt Lake City, UT | 94 | 68.7 | 59.4 |
| San Antonio, TX | 97 | 78.8 | 72.2 |
| Temperatures do not include fan/motor heat gain | | | |