

**Packed Columns
for Life Support Systems
Why and How**

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Purpose of this presentation

Enable the design, evaluation, maintenance and improvement of packed columns to provide the maximum performance and benefit to the animals in our care.

Why do we use packed columns?

Packed columns are used in many applications. For life support systems we primarily use them for gas exchange and biofiltration.

Gas Exchange Basics

Packed columns are an efficient way to increase the surface area between air and water. They permit CO₂, H₂S, O₃ and other undesirable gases to leave the water and allow oxygen to enter. In order to accomplish this function, there must be a flow of fresh air through the column.

Biofiltration Basics

Biofiltration is the microbial oxidation of ammonia and other dissolved organic contaminants and waste products. The bacteria do all the work, our job is to provide them with a suitable environment. Good water distribution, proper packing selection and sufficient air movement are the keys to maximum performance.

The performance of packed columns is controlled by :

- The type of packing or media
- The amount of packing
- The shape of the vessel
- The ratio of air to water
- The temperature
- The distribution of air through the tower
- The distribution of water through the tower

Water distribution is a key design variable

1. If the water distribution is poor, nothing else you do will improve the performance of the column.
2. Improving water distribution is often the most cost effective way to get more performance or capacity.

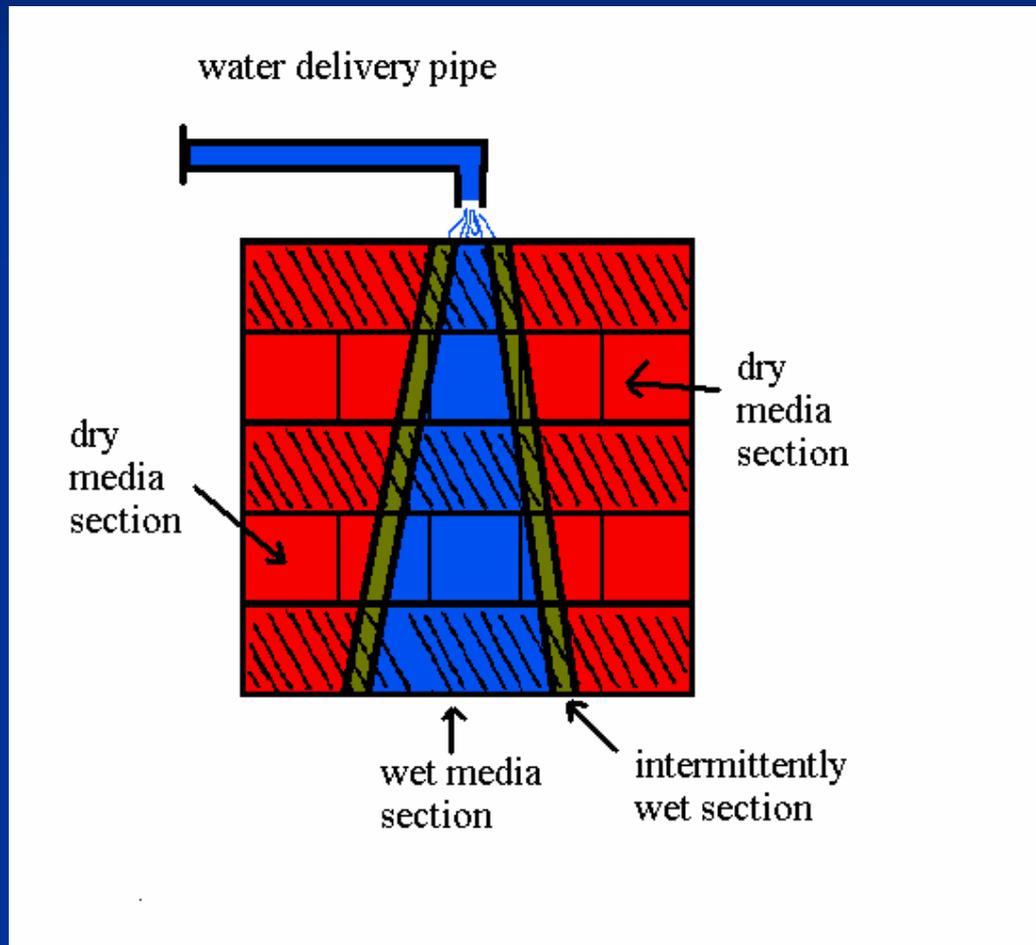
Poor Water Distribution



Poor water distribution can lead to the following problems:

- Loss of performance due to dry surfaces in the packing bed.
- Loss of performance due to air bypass through the dry areas.
- Erosion of the packing due to heavy hydraulic loadings.
- Plugging of the packing due to scale deposits in the intermittently wetted areas.

Profile of a Bad Example



The following water distribution methods are less than optimum.

- A single pipe that dumps water in the center of the vessel.
- A pipe with a few large holes drilled into the bottom or side.
- A pipe with multiple small holes drilled into the bottom or side.
- A grid or drip plate.
- A system of troughs or launders with notches cut into the edge.
- A single, hollow cone nozzle.

Is this your biofilter?



The Obvious Question

What will it cost to have a good water distribution?

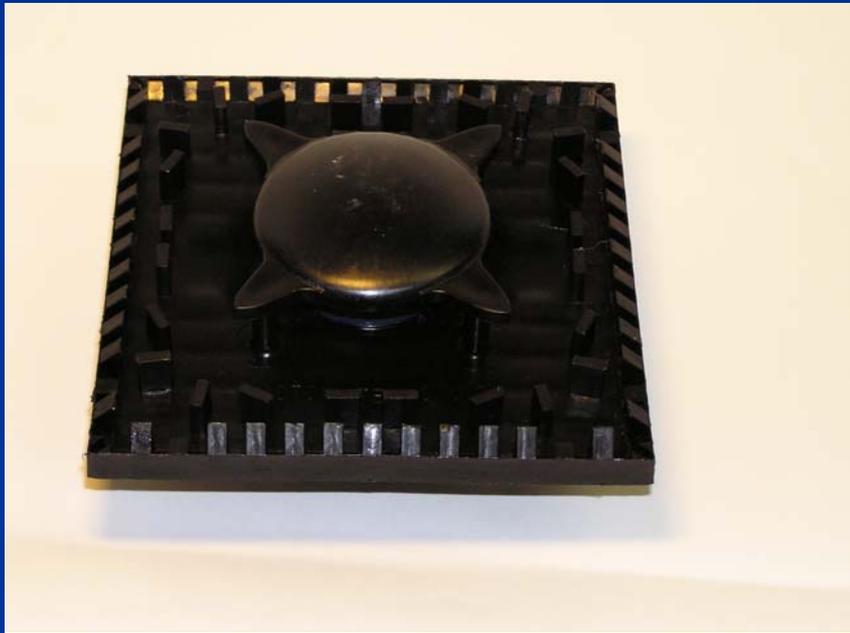
The Answer

About the same amount of money as a bad system.

Full Pattern Pressure Spray Nozzle



Square pattern, solid cone, medium pressure nozzles \$15 each



Very low head nozzles



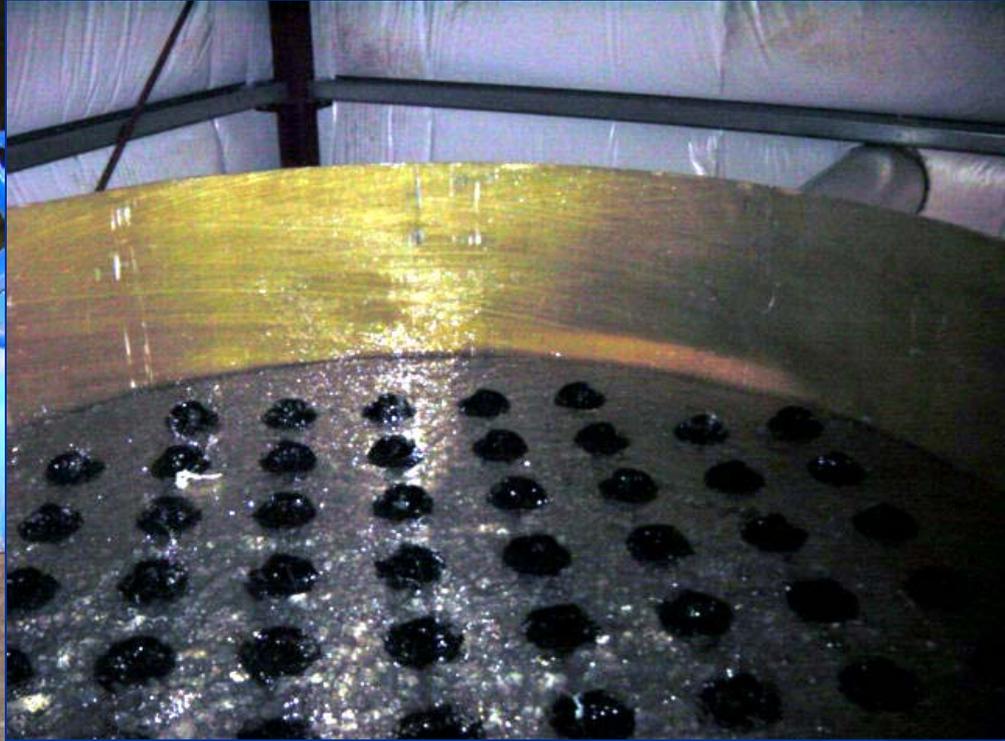
Example of a pipe and nozzle array for a round vessel



Very low pressure nozzles - \$6.00 each



Example of a Pan Type System



Target nozzles for pan or tray systems



Non Ventilated Vessels

Vessels with little or no air exchange will have little or no gas exchange.

In order to add oxygen to water, new air must be introduced into the vessel.

In order to remove CO_2 or O_3 from water, high concentration air must be removed and replaced with low concentration air.

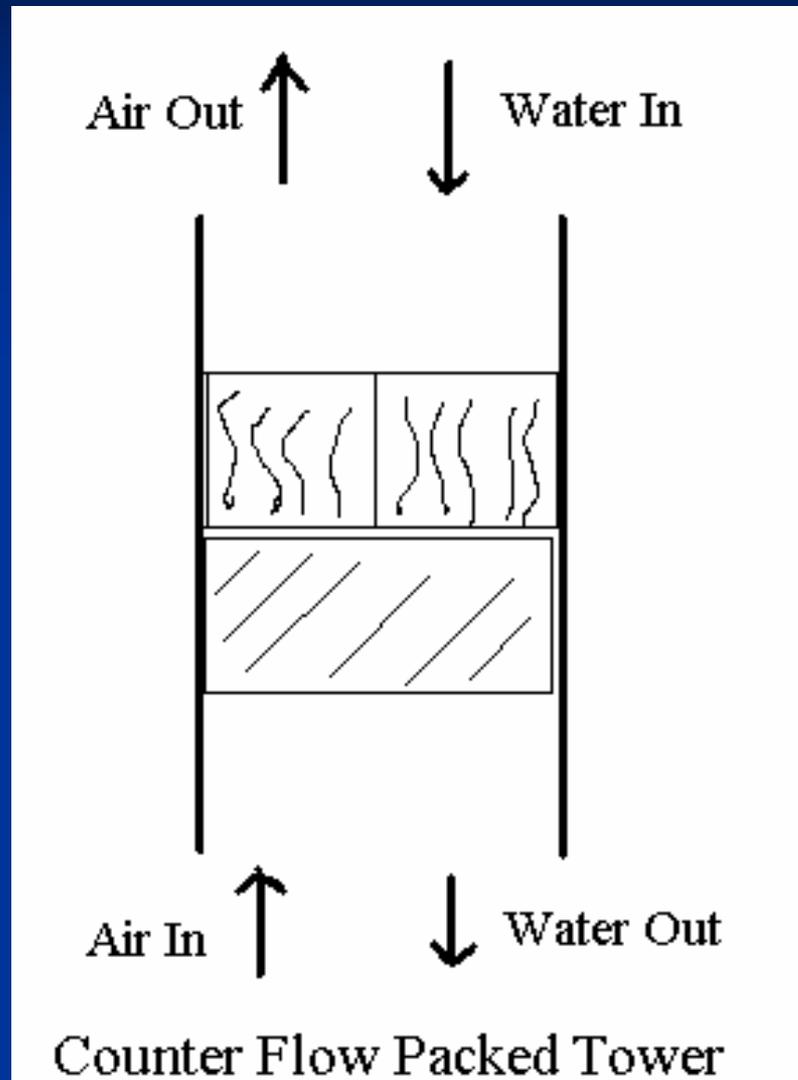
Ideally, air removed from a packed tower should be exhausted from the building.

Methods of Ventilation

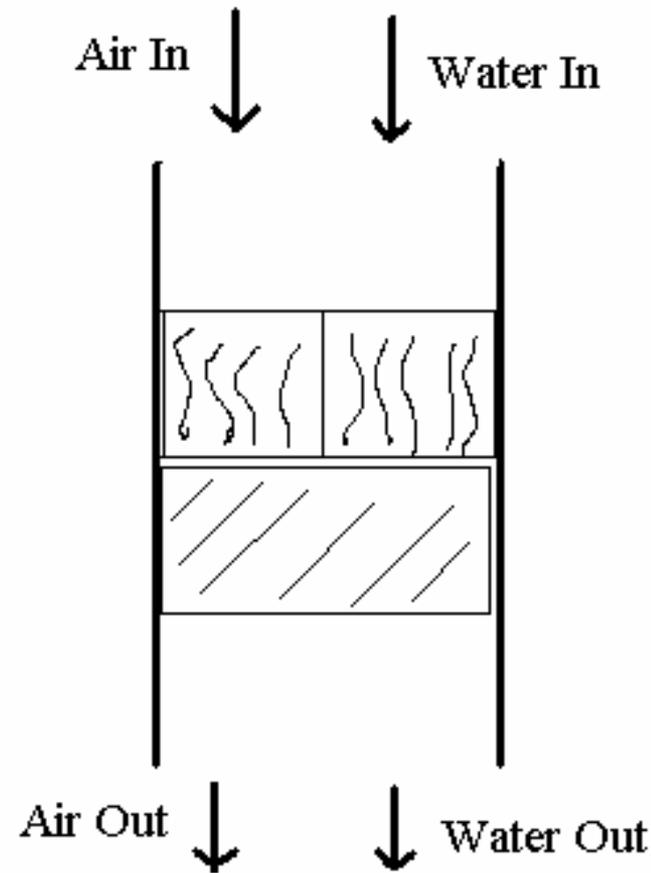
- Counterflow – Air moves up and water moves down.
- Cocurrent – Air moves down and water moves down.
- Crossflow – Air moves horizontally and water moves down.

For most life support applications, there will be no significant performance differences among these three methods.

Counter Current Flow

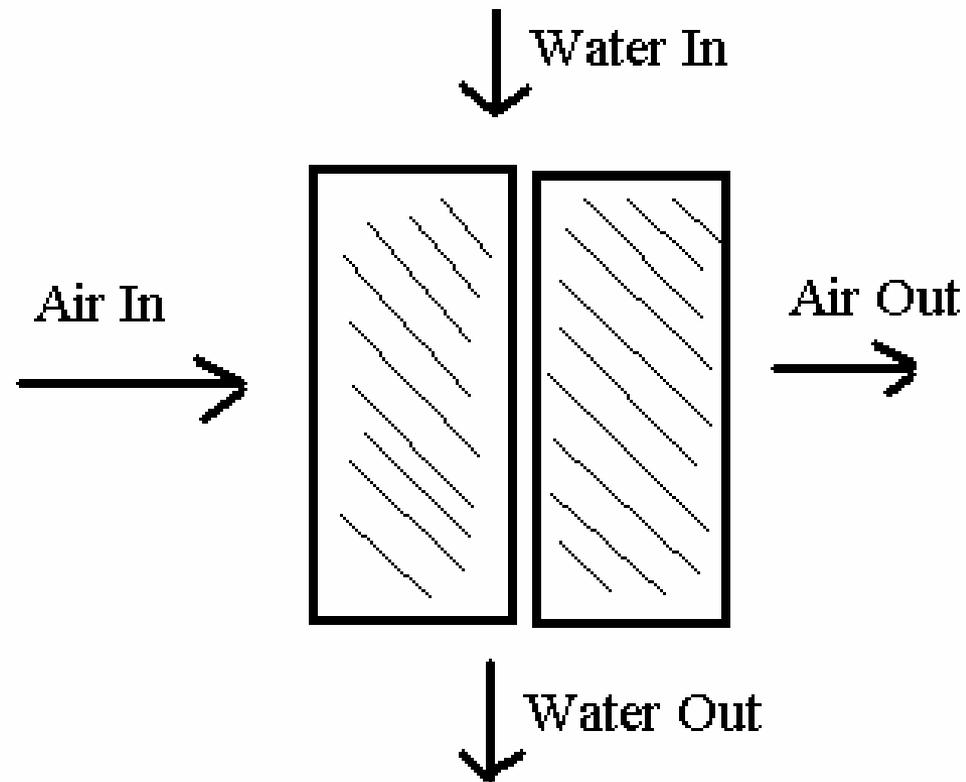


CoCurrent Flow



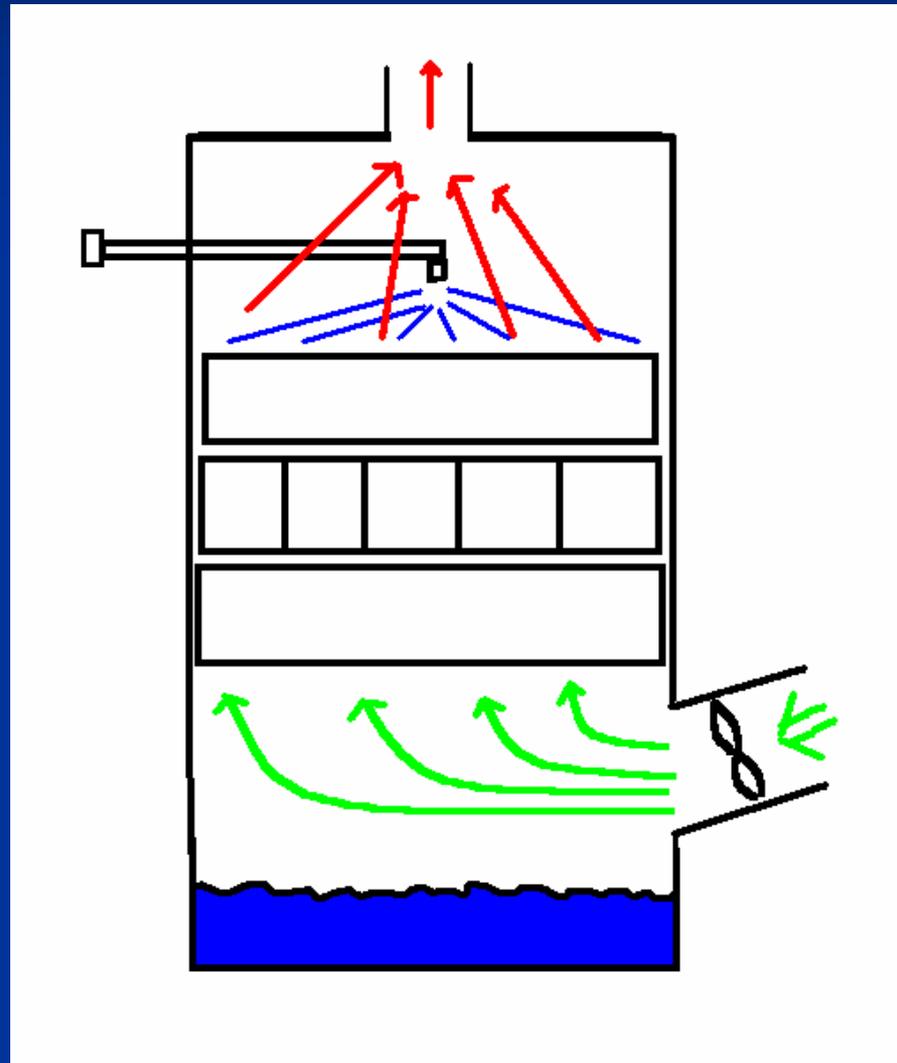
Cocurrent Packed Tower

Cross Flow

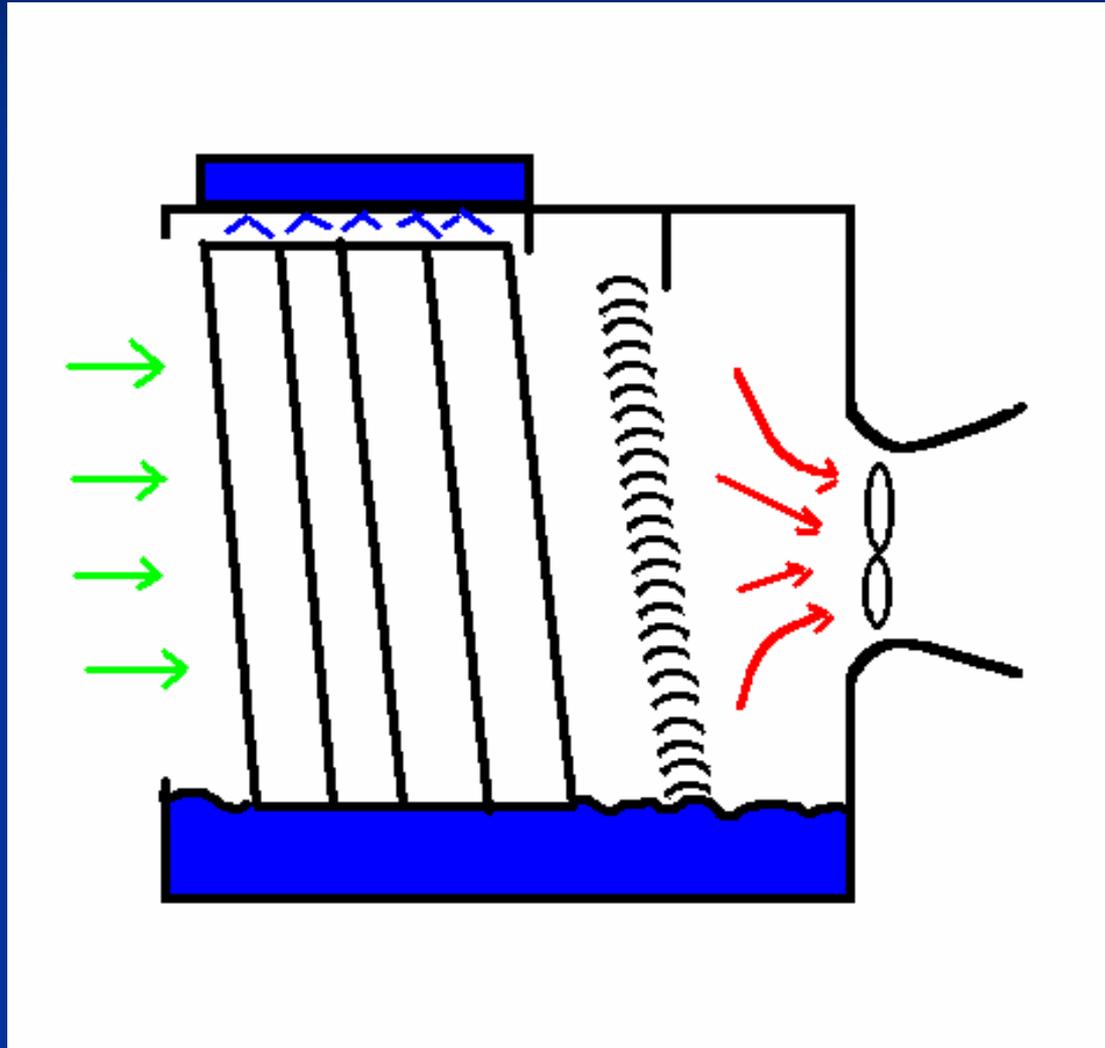


Cross Flow Packed Tower

Typical Counter Flow Tower



Typical Cross Flow Tower



Materials of Construction

The two main considerations are structural integrity and resistance to corrosion or other chemical attack.

The best materials vary based on their function:

Vessel – Fiberglass, Concrete, Polyolefins (PP + HDPE)

Packing – PVC (PolyVinylChloride), Ceramic, PP
(Polypropylene)

Piping – PVC, CPVC

Nozzles – PP

Random dumped Media



Structured Media



Good Packing Characteristics

- Inert Material of construction
- Low cost per unit surface area
- Good mechanical strength
- Light weight
- Wetability
- Easily Handled
- Light Attenuation

Typical Areas for Improvement

Water Distribution – Covering all the surfaces with water is essential for full performance. Dry surfaces are useless.

Air Movement – Gas exchange is dependent on a fresh stream of clean air moving through the vessel.

Summary

Packed columns are expensive pieces of equipment. You should get your moneys worth from your tower. Getting full performance is a function of good design and proper component selection. Even water distribution, proper air flow and modern media are the keys to full performance. If your system is operating at less than full capacity, consult with your tower or media supplier to improve the performance of your packed columns and biofilters.

The End

Summer Sunset on Captiva Island, FL

