

**OPEN**

Compute Summit

**May 2-3, 2012**

**San Antonio**



# Operational Performance and Efficiencies

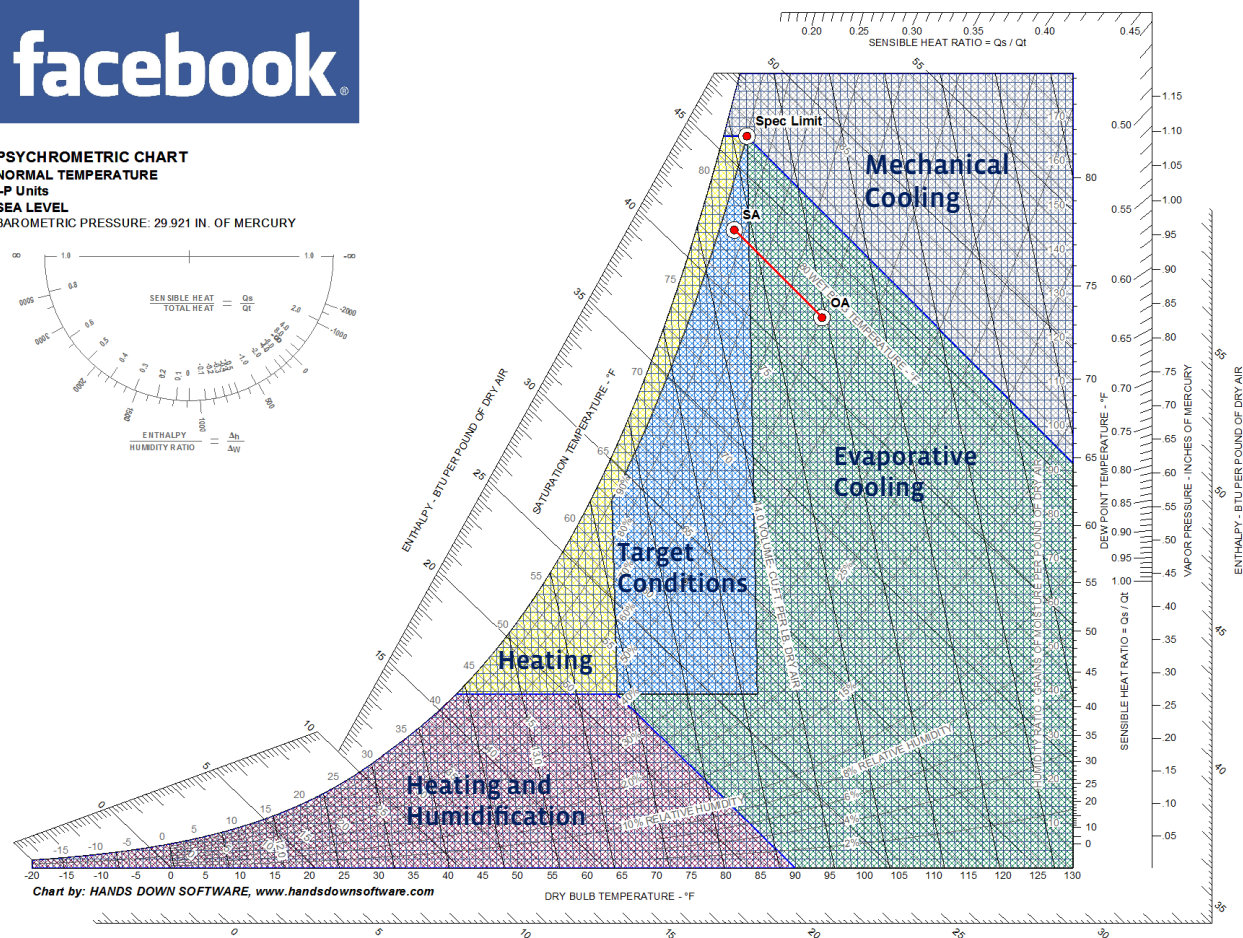
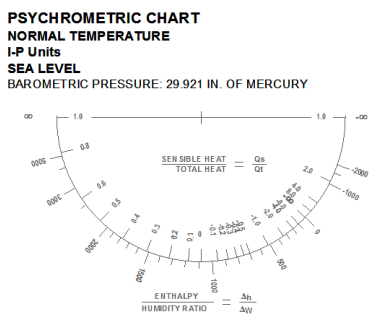
## Direct Evaporative Cooling/Humidification Systems Comparison

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# Evaporative Cooling

## Scientific Facts:

- Water evaporates and cools (“free cooling”)
- Water evaporates on water surface
- Water evaporation rate is proportional to surface area available



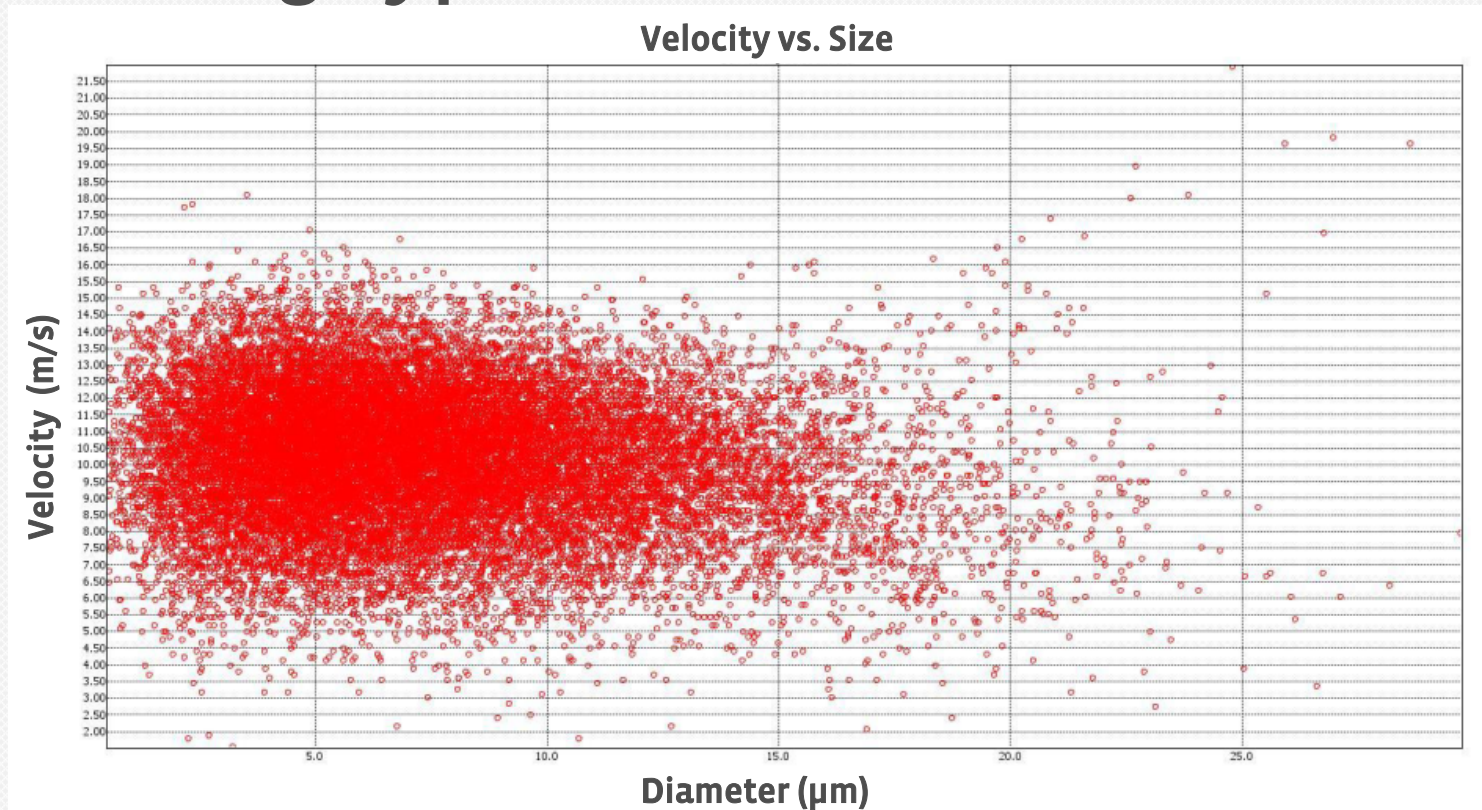
# Atomizing Type Humidifiers

- Humidifiers break up water into mist, micron sized droplets, for rapid moisture absorption
- There are 2 methods of atomizing water into droplets
  1. Pressure Atomizing: High pressure and shear force at humidifier nozzles break water up into a fine mist, used at Facebook
  2. Ultrasonic: Ultrasonic vibration breaks water up into a fine mist, not used at Facebook



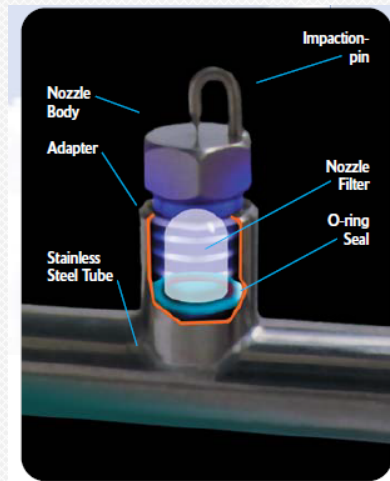


# Atomizing Type Humidifiers

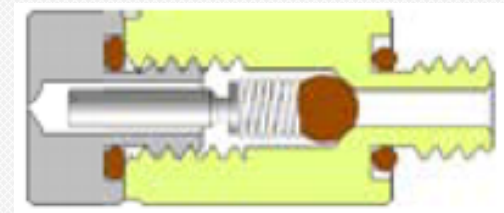


# Atomizing Type Misting Nozzles

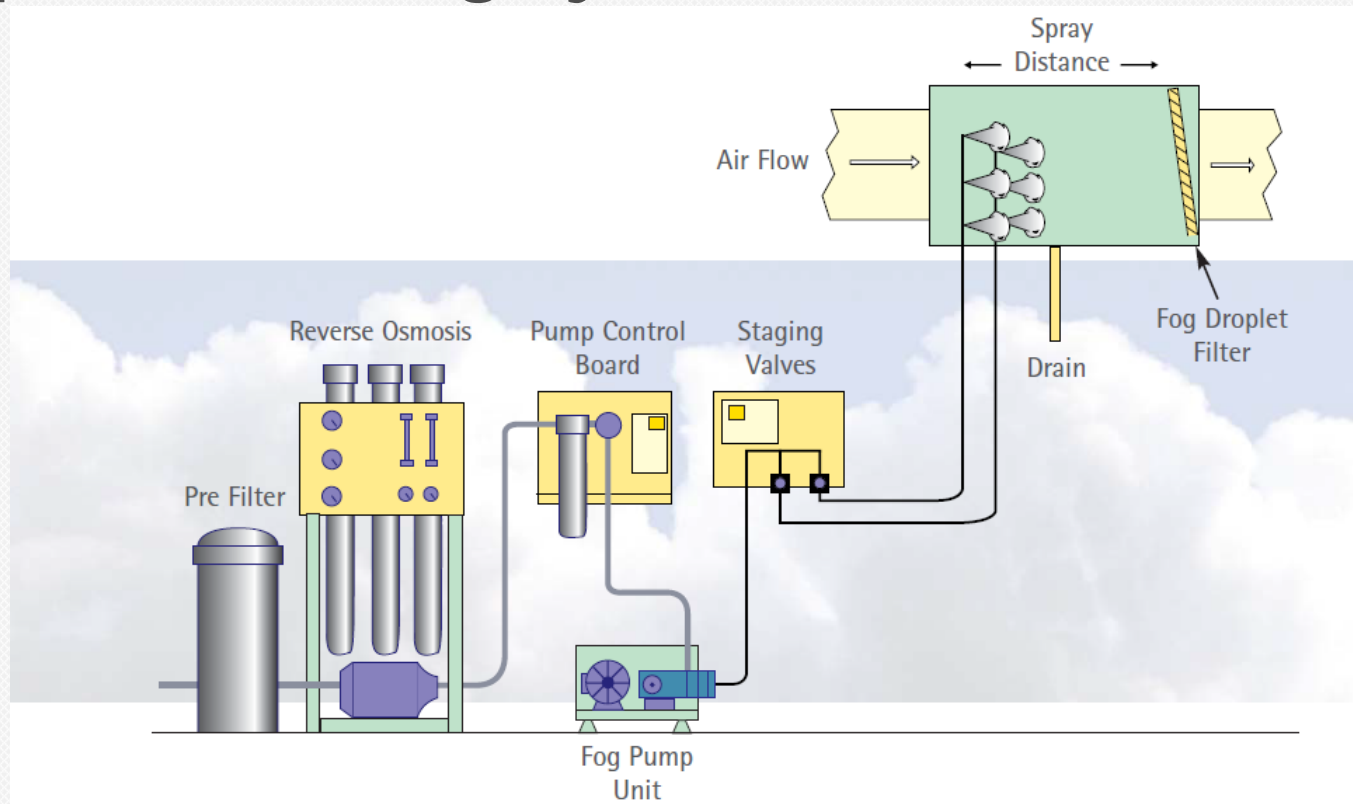
Misting nozzle with impingement pin



Misting nozzles with plunger

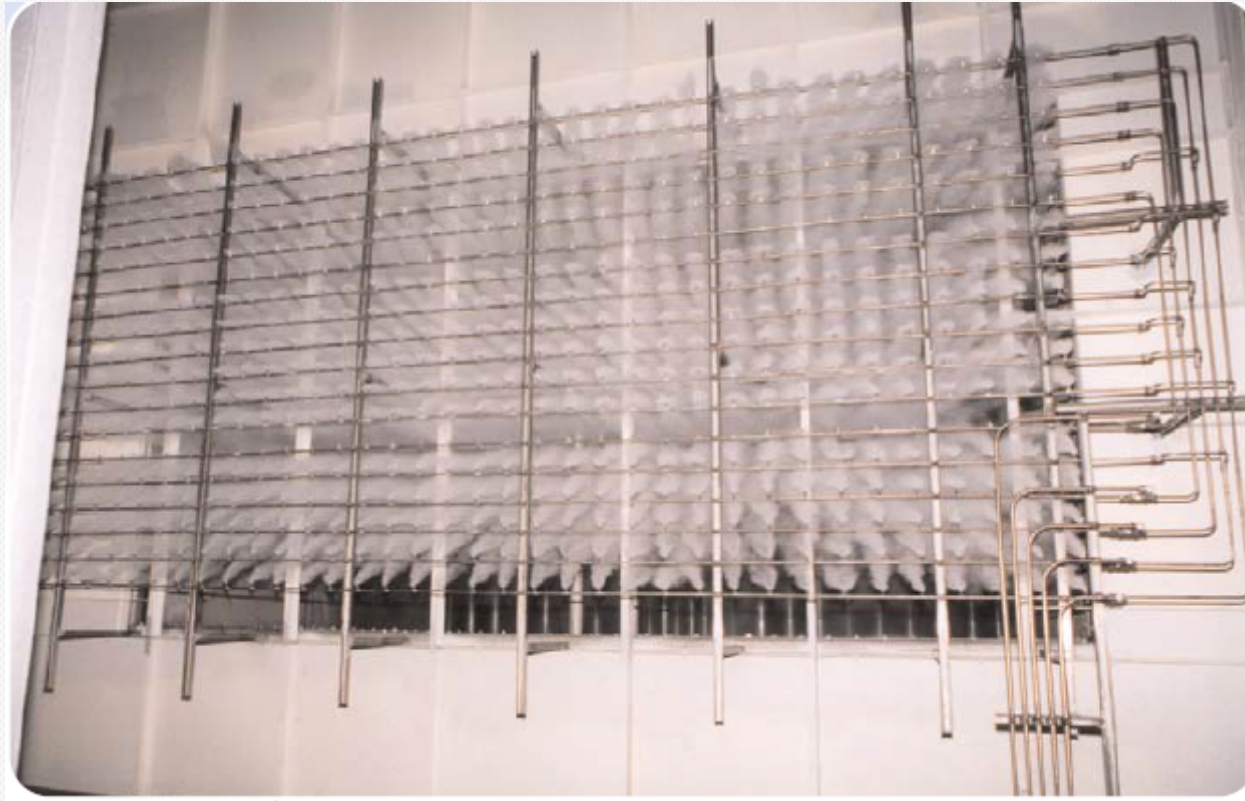


# Typical Misting System Installation





# Typical Misting Array



# Atomizing Type Misting Systems

- Pros:

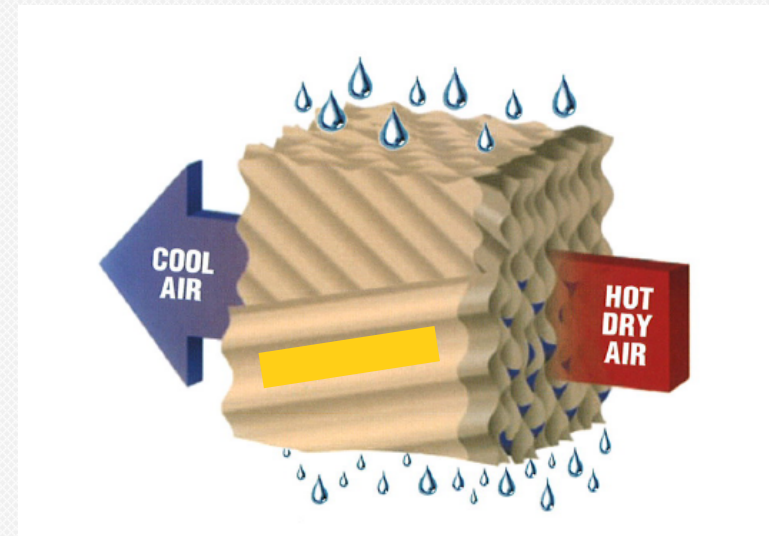
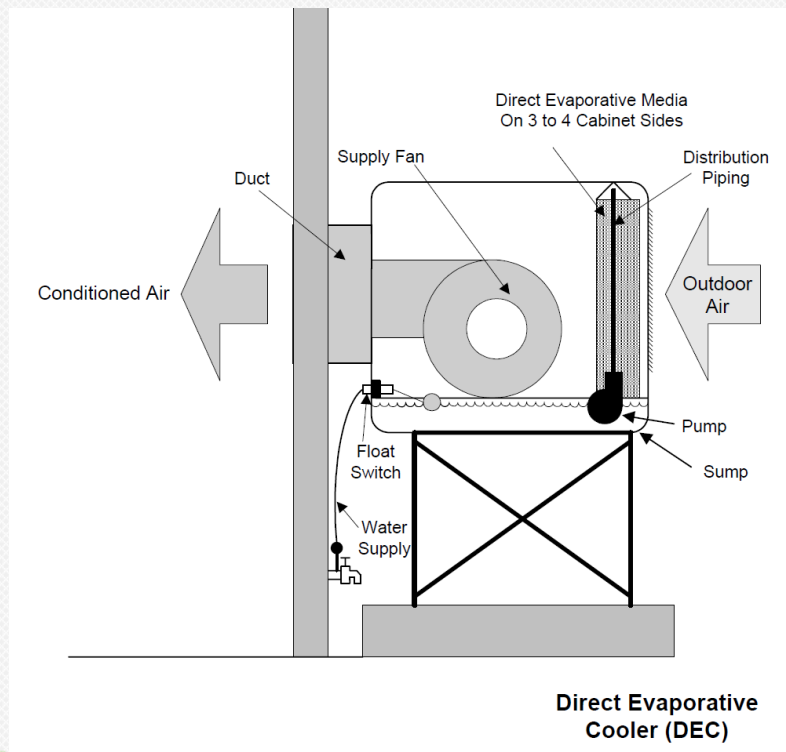
1. Good capacity control
2. Not consumable
3. Almost no pressure drop at misting nozzle array

- Cons:

1. Need RO water => CAPEX/OPEX and foot print for RO Plant
2. RO blow-downs consumes more water than media
3. Types of pressure atomizing heads have impingement pins at the nozzle which need precise tuning to maintain optimal atomizing efficiency. Others have moving parts (plungers/check valves) in the nozzles that may fail
4. Misting nozzle orifices are very small => Subject to clogging
5. Components on high pressure side (1000psig) are made of stainless steel => CAPEX
6. Need space to provide the absorption distance
7. Good percentage (15-20%) of water being sprayed drops out of air stream, need mist eliminator and water recycling/polishing system
8. Mist eliminator cause pressure drop in the system => Money to buy and energy to operate



# Typical Media System Installation



# Direct Evaporative Media Type System

**Fiberglass media in humidifier sections provide extended wet surface for adequate water evaporation to humidify**

- **Pros:**

1. No RO system required => Save cost and foot print for RO system
2. No misting nozzle orifices to potentially clog up
3. No impingement pins to adjust or moving parts in misting nozzles
4. Save space => Absorption distance 8-inches vs. 6-feet
5. System operating pressure is low, no stainless steel components required=> low equipment cost and installation cost
6. Lowest TCO
7. Better Particles removal capability

- **Cons:**

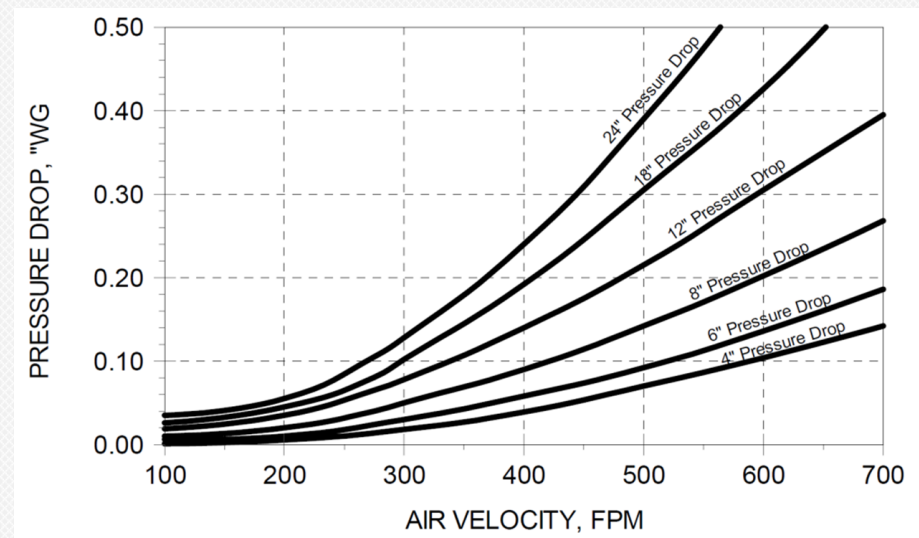
1. Poor capacity controls: Finite number of steps available
2. System lag: Time to wet ( up cycle ) and time to dry ( down cycle )
3. Media has limited life span, 3-5 years normal use, but could be shorten due to rapid wetting and drying or improper system blow-downs
4. Pressure drop across media



# Air Pressure Drop Comparison

DRY		WET	
Velocity (fpm)	Pressure Drop ("WC)	Velocity (fpm)	Pressure Drop ("WC)
3294	3.340	3311	3.340
3055	2.920	2931	2.700
2776	2.430	2750	2.380
2535	2.040	2479	1.950
2129	1.450	2282	1.660
1538	0.820	2061	1.360
1168	0.480	1822	1.050
1002	0.400	1669	0.958
634	0.190	1281	0.609
528	0.142	733	0.202
495	0.134	538	0.152
441	0.115	507	0.135
388	0.093	462	0.115
327	0.072	417	0.103
269	0.057	356	0.082
243	0.050	299	0.064
191	0.036	276	0.056
152	0.027	221	0.040
78	0.012	119	0.017

**Mist Eliminator**

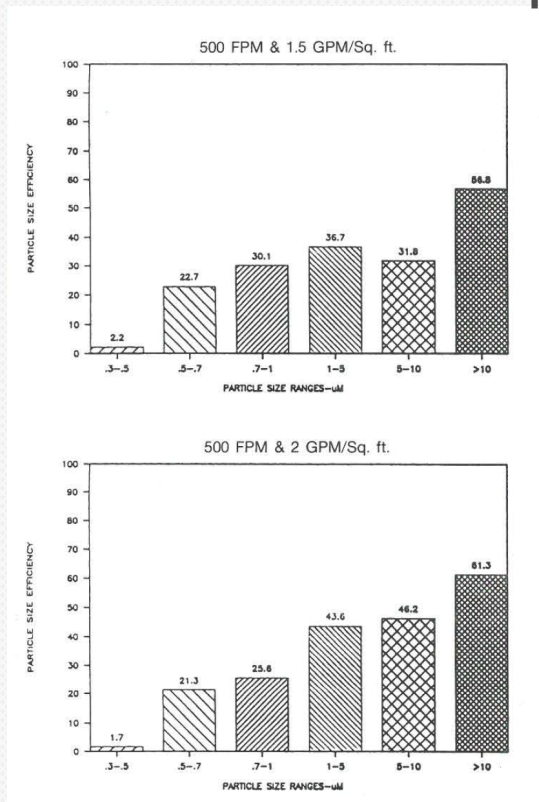


**Direct Evaporative Media**

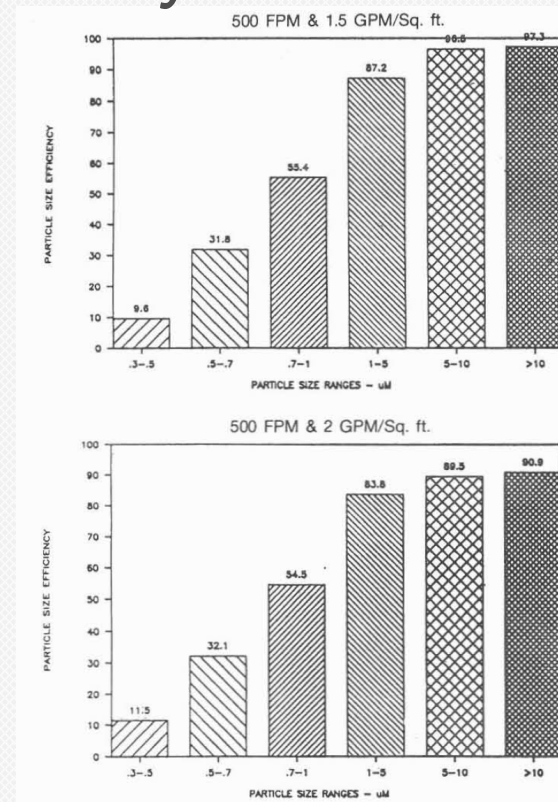




# Particulates Removal Capability of Media System



**6" Deep Media**



**12" Deep Media**

# Attributes Comparison

	Misting	Media	Remarks
Reverse Osmosis System	Required	Not required	
Reverse Osmosis Plant Space	Required	Not required	
Piping material	Stainless	CPVC	
Absorption Distance	6-10ft	8-12 inches	
Misting Nozzle Adjustment	Required	Not required	
Misting Nozzles clogging	Yes	No	
Capacity Control	Good	Acceptable	
Water Consumption	Slightly higher	Slightly lower	RO and Softener blow-down
System Consumable	No	Yes	Media need Replacement
Particles Removal Capability	Less favorable	More Favorable	
Pressure Drop	equal	equal	Media vs. Mist eliminator
CAPEX	High	Low	At least a 15% savings
OPEX	Slightly Higher	Slightly lower	RO up-keep vs. Media replacement RO Blow-down vs. Over spraying
Overall	Less Favorable	More Favorable	

