



Wet Cooling Towers: A Review of Current Technology, Products Under Development and Research Needs

ASME-IMECE Congress/NSF-EPRI Workshop on
Advanced Power Plant Cooling:
Reducing Water Consumption

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NOVEMBER 9-15
2012
HOUSTON, TEXAS

ASME 2012 International Mechanical Engineering
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Presentation Summary



- Current technology
 - Evaporative (wet) cooling towers
 - Cooling tower packing (fills)
 - Droplet capture (drift eliminators)
- Products under development
- Research needs



Current Technology

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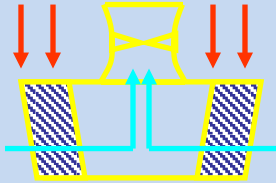
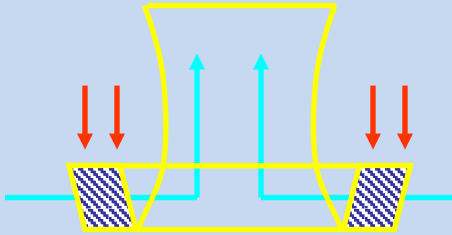
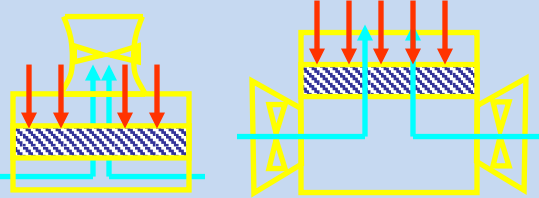
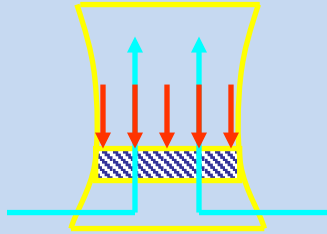
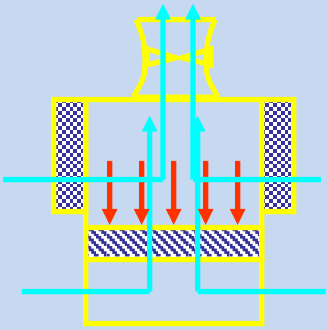
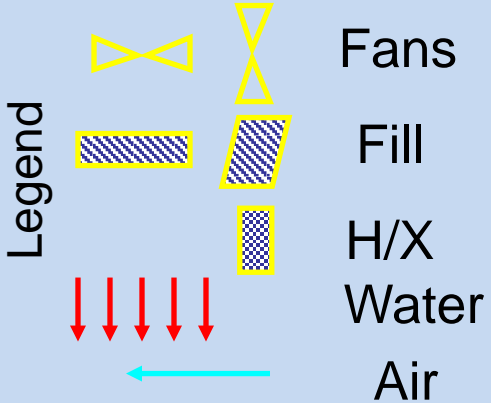
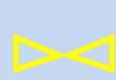



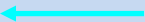
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Current Types of Wet Cooling Towers

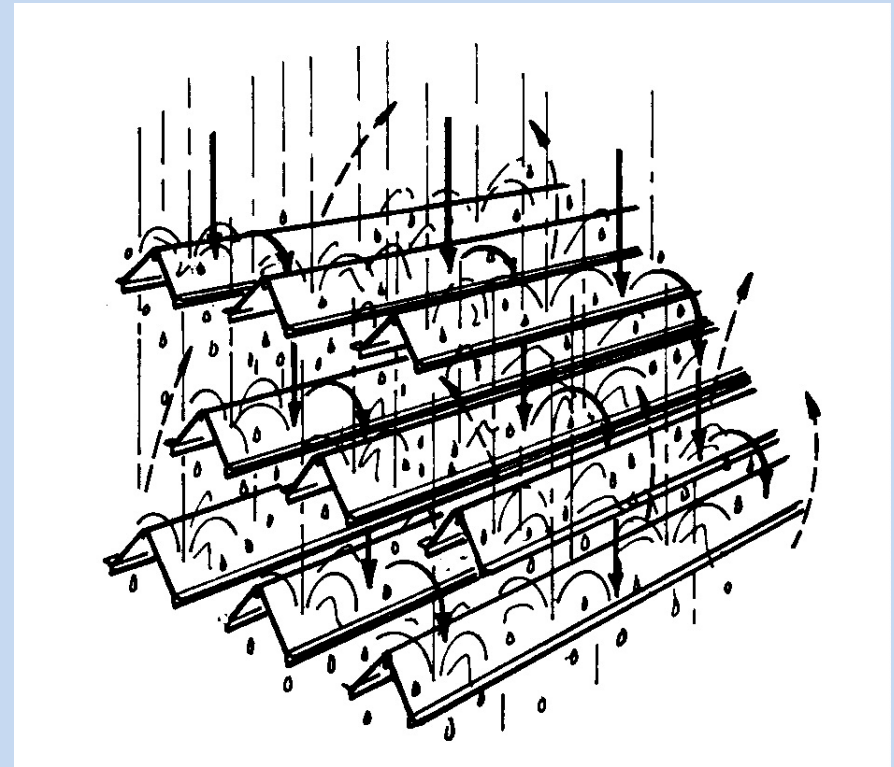
	Mechanical Draft	Natural Draft
Crossflow		
Counterflow		
Counterflow Plume abated		
		<p>Legend</p>  <ul style="list-style-type: none">  Fans  Fill  H/X  Water  Air



How Splash Fill Works

Splash fill works by interrupting the falling water with splash bars which cause the droplets to break up into smaller droplets.

One droplet breaking into eight smaller droplets increases its surface area by a factor of two.



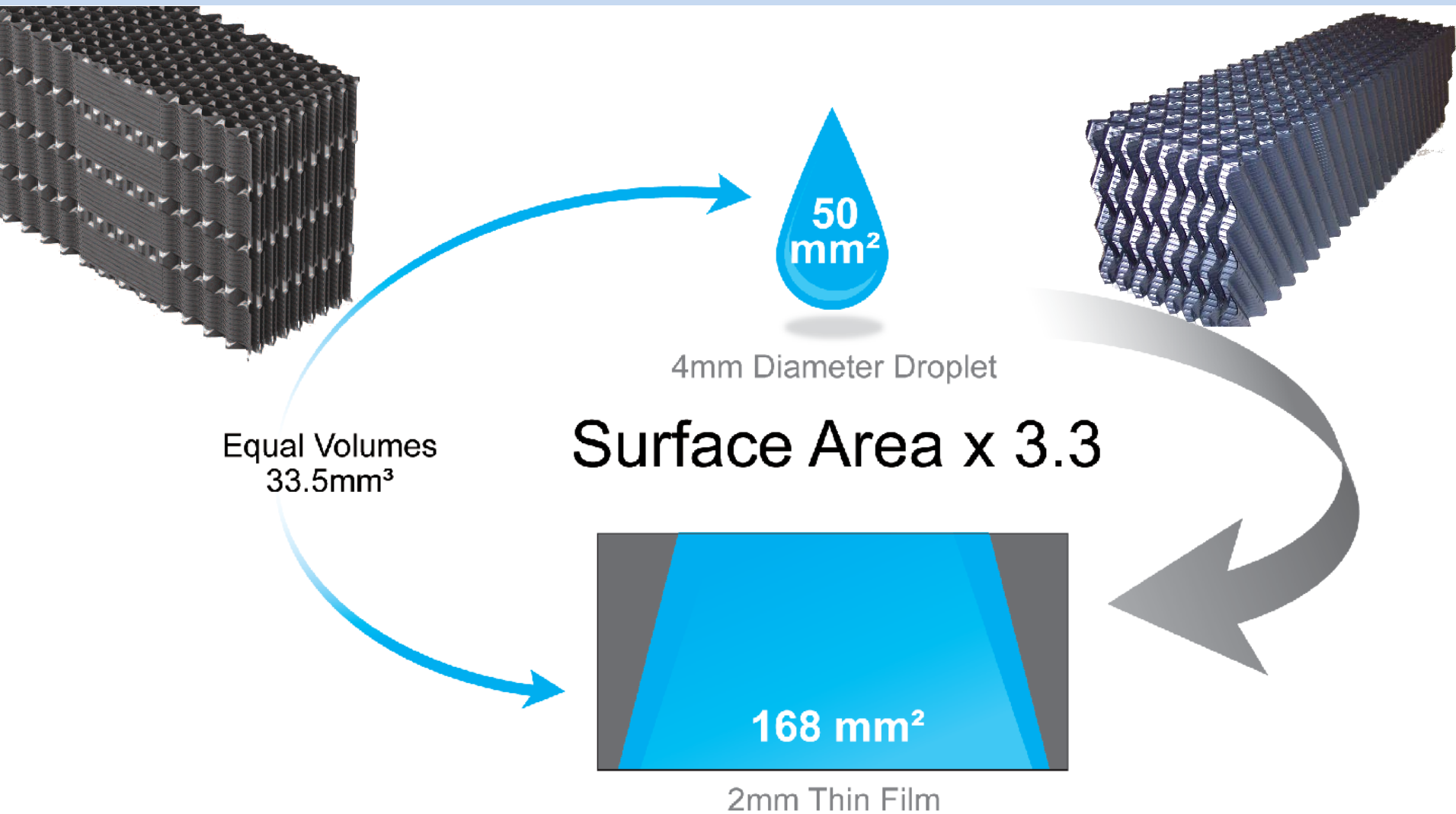
Round Concrete XF Cooling Tower



Splash Fill Close-Up



How Film Fill Works



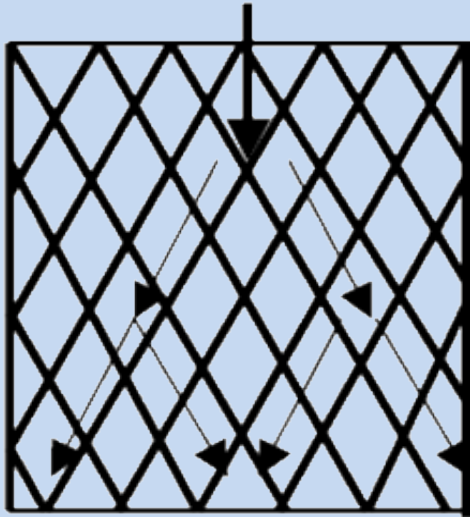
Induced Draft Counterflow Tower



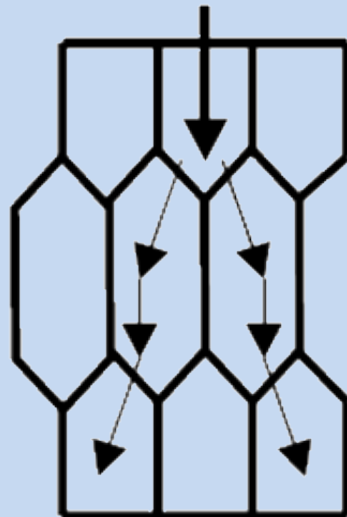
Film Fill Close-Up



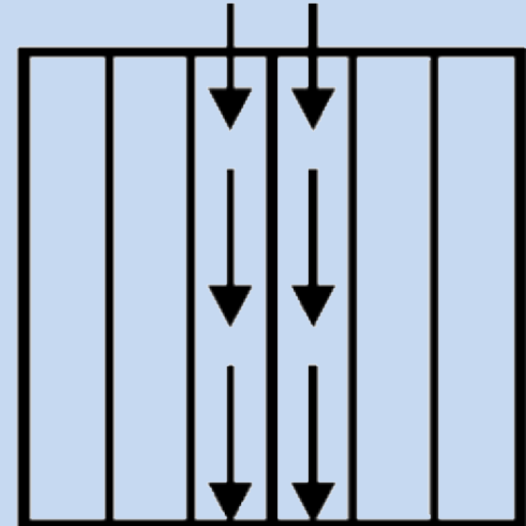
Film Fills Designed for All Water Qualities



Cross-Flute Design



Offset-Flute Design



Vertical-Flute Design

Decreasing tendency to clog

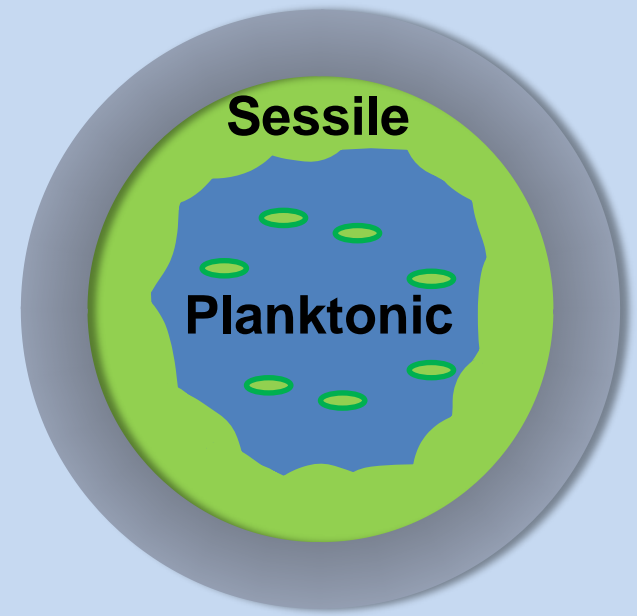
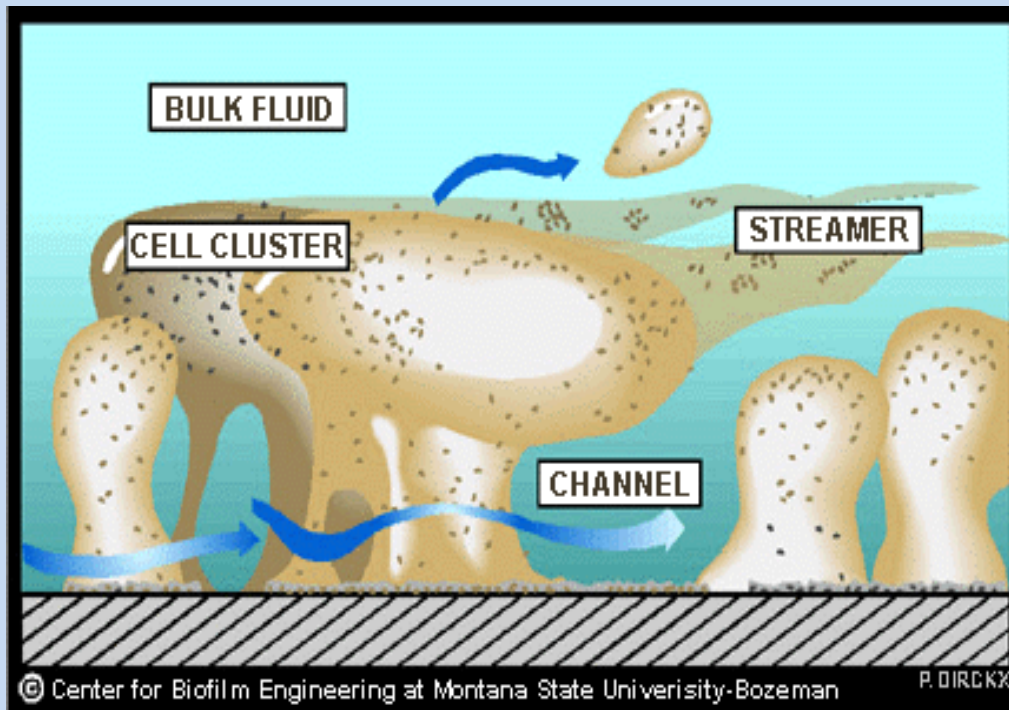


Increasing performance



Anti-Microbial Impregnated Materials

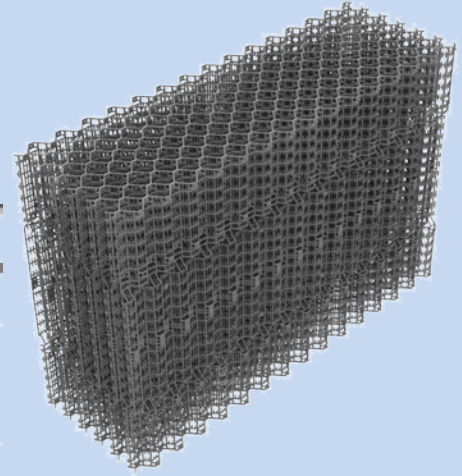
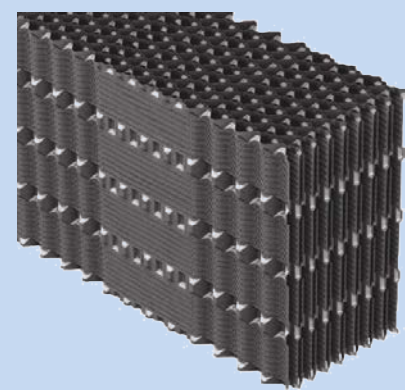
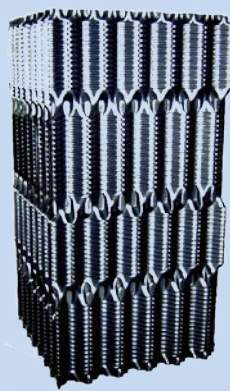
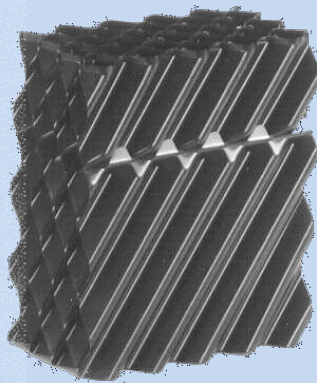
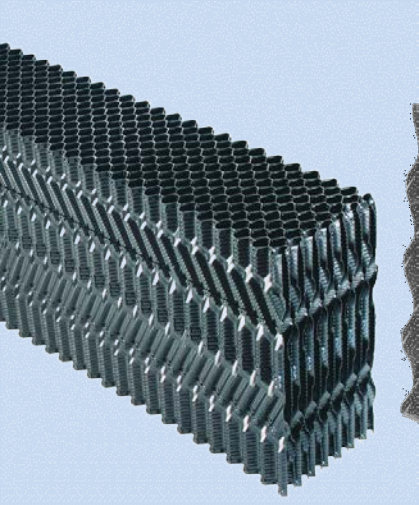
- Organic and inorganic compounds added to the polymer resin to inhibit the sessile bacteria that create biofilms. Biofilms are the trigger to film fill fouling



Cooling Tower Fills



Some Fill Designs Used in Today's Wet Cooling Towers.



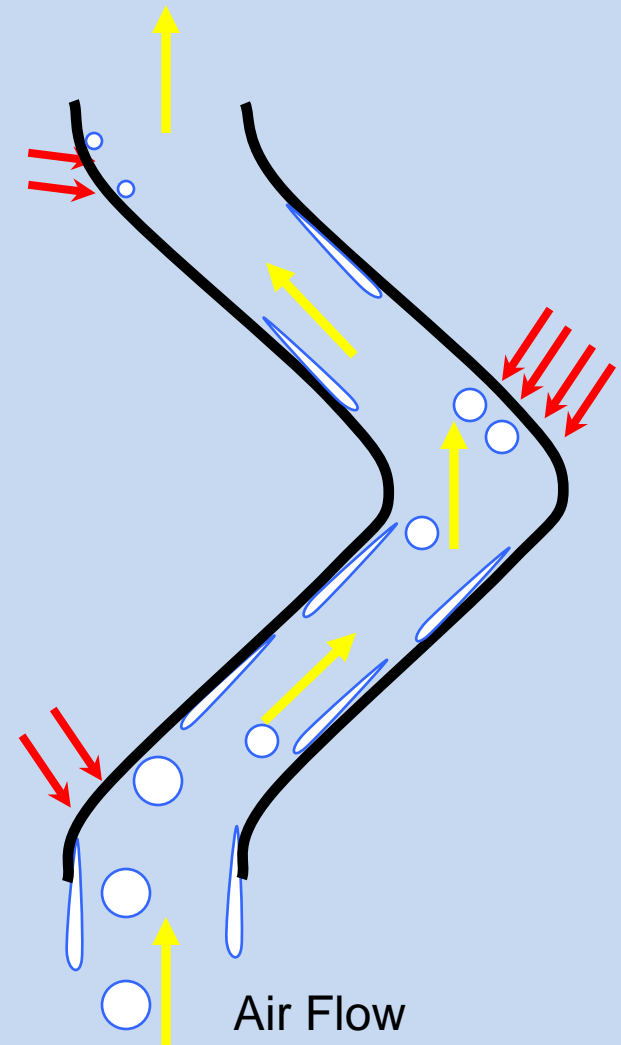
Typical Induced Draft XF Tower

Evaporation
and Drift



How Do Drift Eliminators Work?

- Blade and cellular designs work by inertial impaction
- The inertia of the heavy droplets cause them to impact the walls of the drift eliminators
- Cellular types work better since they have more surface for droplet impaction
- Collected droplets form a water film and drain



We Can Do Better

- Estimated drift loss of all US wet cooling towers (WCT) - 0.005% of the cooling water circulation rate (about 400 x less than the evaporation rate)
- If all WCT could achieve the best available control (BAC) of 0.0005%, a nationwide savings of over 11,000,000 gpd could be achieved
- Achievable Now - with attention to proper maintenance and BAC installed



Excessive Drift Means Excessive Water Use

- 135 MWe cogeneration plant using 50% well water and 50% low surface tension process waste water
- Low efficiency droplet capture due to larger population of small droplets



Excessive drift also means...

- Increased health and safety risks
 - Bacterial dispersion - esp. Legionella
 - Particulate emissions - Asthma
- Increased equipment corrosion
- Increased mineral deposition on surroundings



Products Under Development

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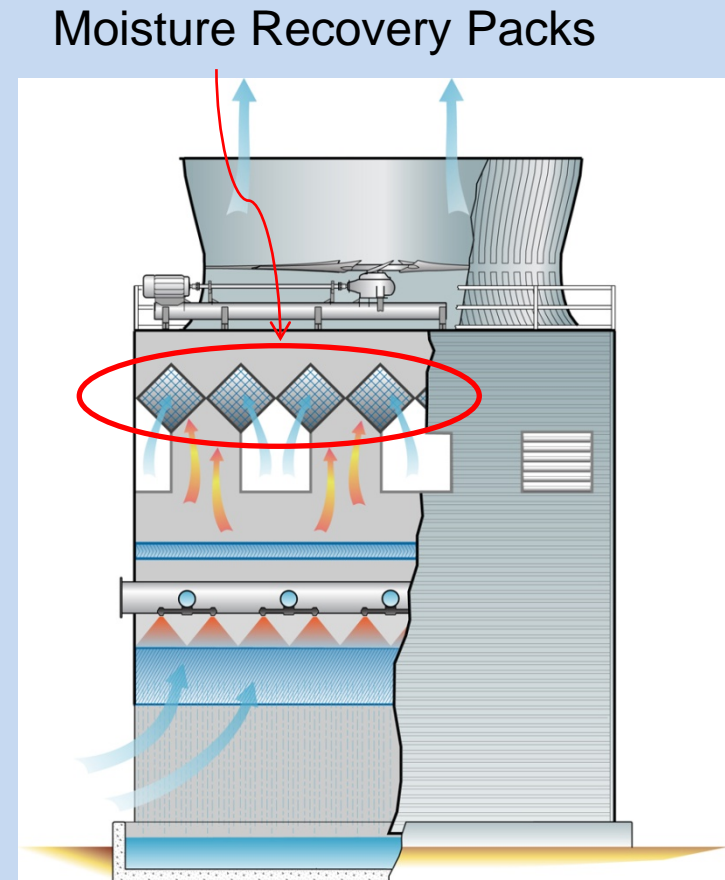


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Moisture Recovery

- Depending on operating and environmental conditions, WCT's evaporation rate typically range between 1%-3% of the water circulation rate
- If we could capture and return only 5% of this evaporated water the savings would be sizable.
- Nationwide estimate: 230,000,000 gpd!



Super Hydrophobic Coatings

- Coatings that repel water cohesion to the fill's surface
- Reduces or eliminates scale formation and fouling
- Would allow ultra high CoC and even lower quality water sources

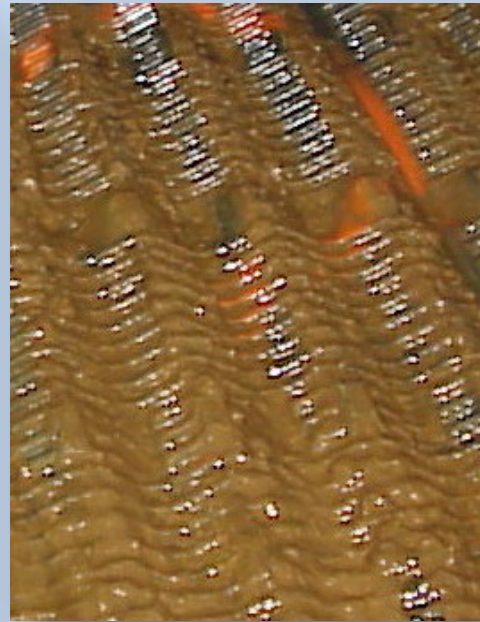


Control with three coatings under test



Super Hydrophobic Coatings

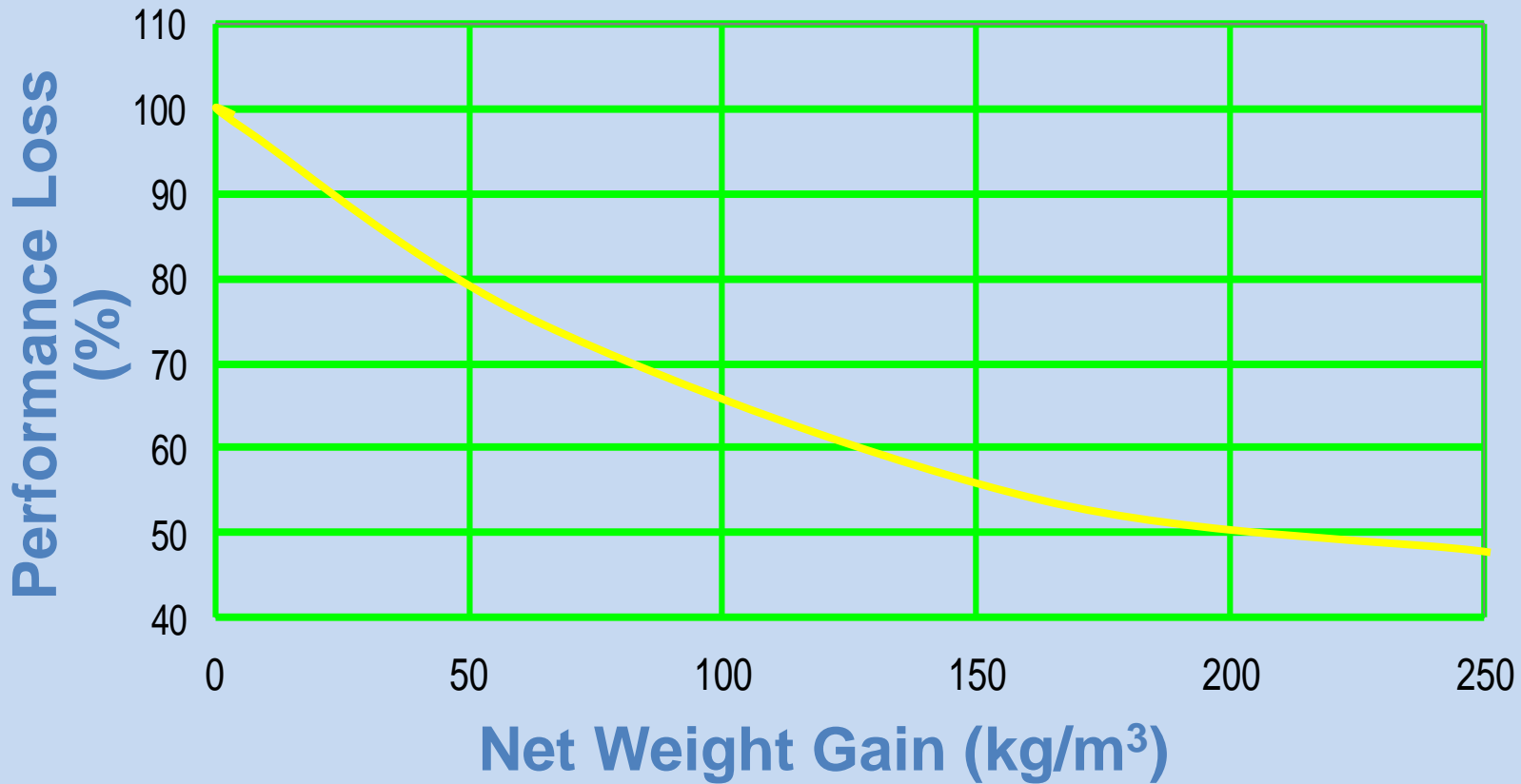
- Scaled and fouled fill is the most significant cause of poor WCT performance



Effect of Fill Fouling on Performance



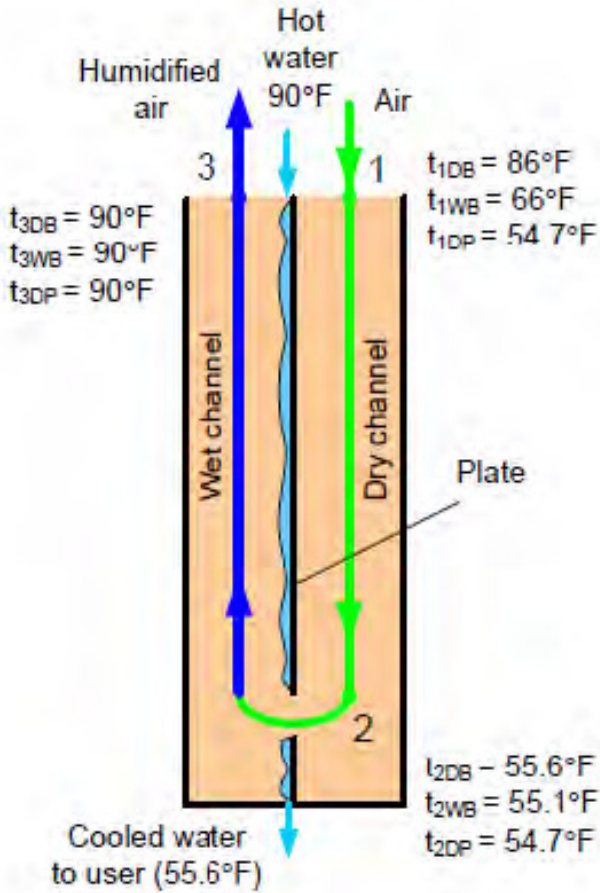
Estimate of Performance Loss vs. Fouling



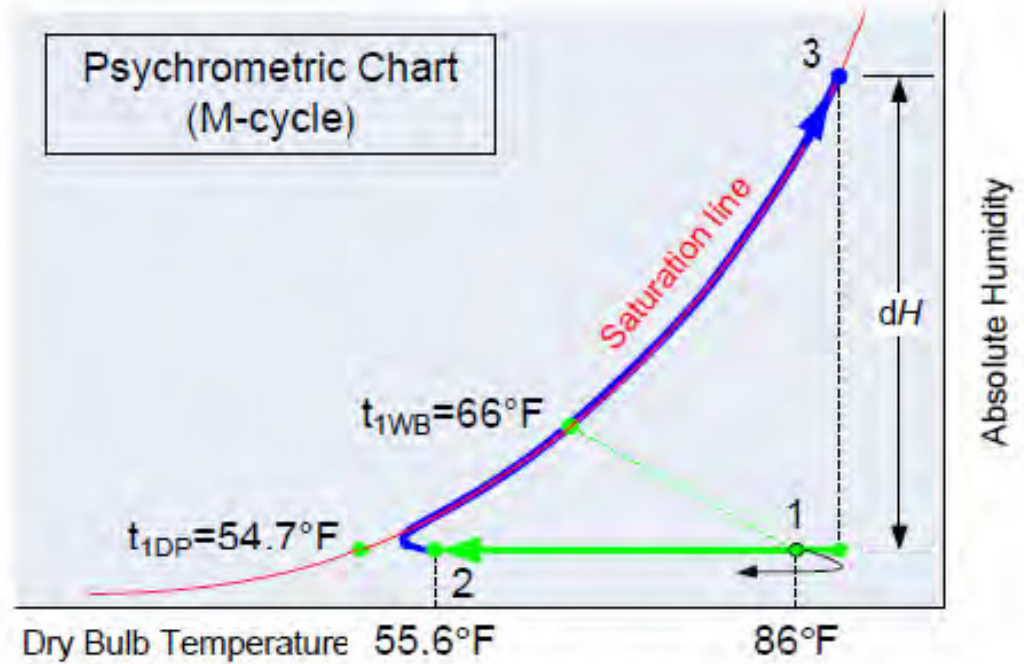
Source: CTI Technical Paper TP93-06, "Research of Fouling Film Fill"



Maisotsenko (M)-Cycle (Wet/Dry Packing)



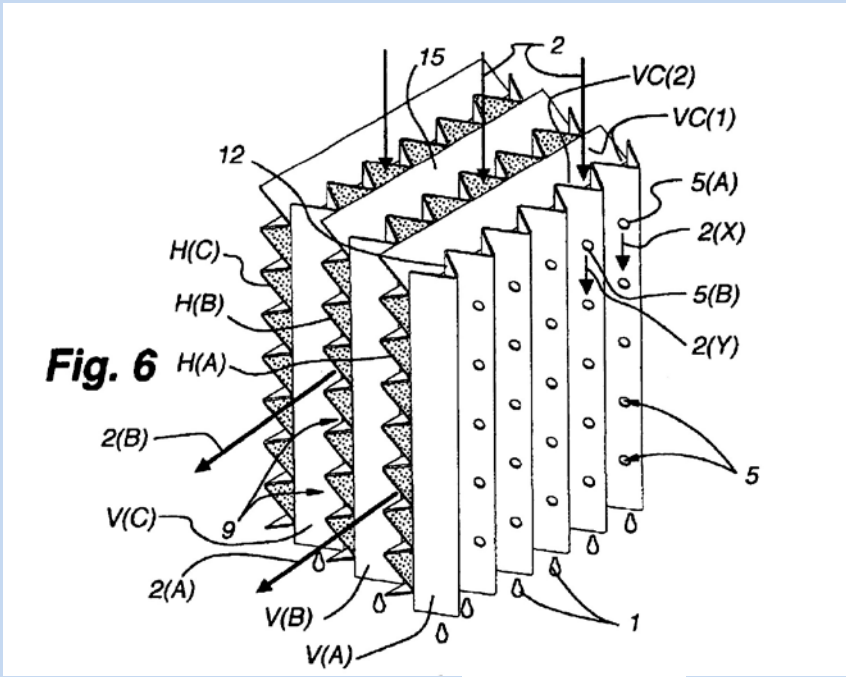
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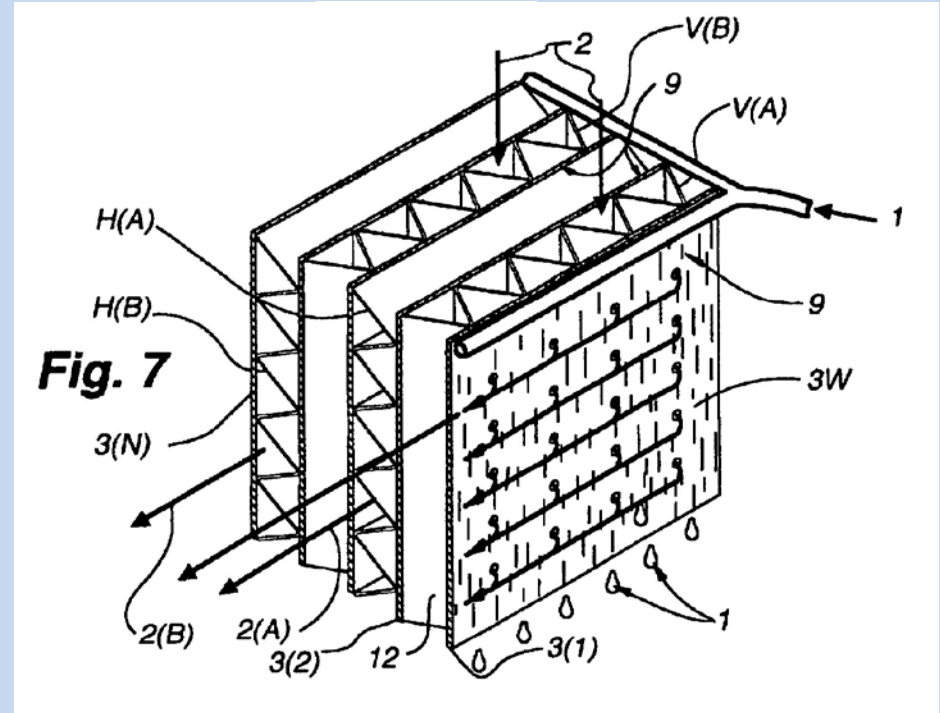
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M-Cycle (Wet/Dry Packing)



Two Embodiments of the Invention
US Patent 6,854,278



Potential for reduced water consumption and lower cooling tower leaving water temperature



Research Needs

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Fills - Research Needs

- Scale and fouling resistant film fill designs with low pressure drop and high heat/mass transfer rates
 - New flute and surface geometries
 - Surface treatments (plasma, coatings, etc.) to reduce fouling/scaling potential while maintaining adequate water film formation
 - More cost effective, efficacious and environmentally friendly anti-microbials to reduce biofilm formation
- Computational tools to provide heat/mass transfer and pressure drop predictions based on 3D solid-models.



Drift Eliminators - Research Needs



- Improve existing technology-current droplet size with 100% capture efficiency: 50-60 microns, lower needed
 - Lower needed due to use of compromised waters
 - More restrictive EPA PM10 & PM2.5 regulations
- Better and more accurate field measurement techniques
- New designs for lower pressure drop to reduce energy consumption



Thank you for your attention

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