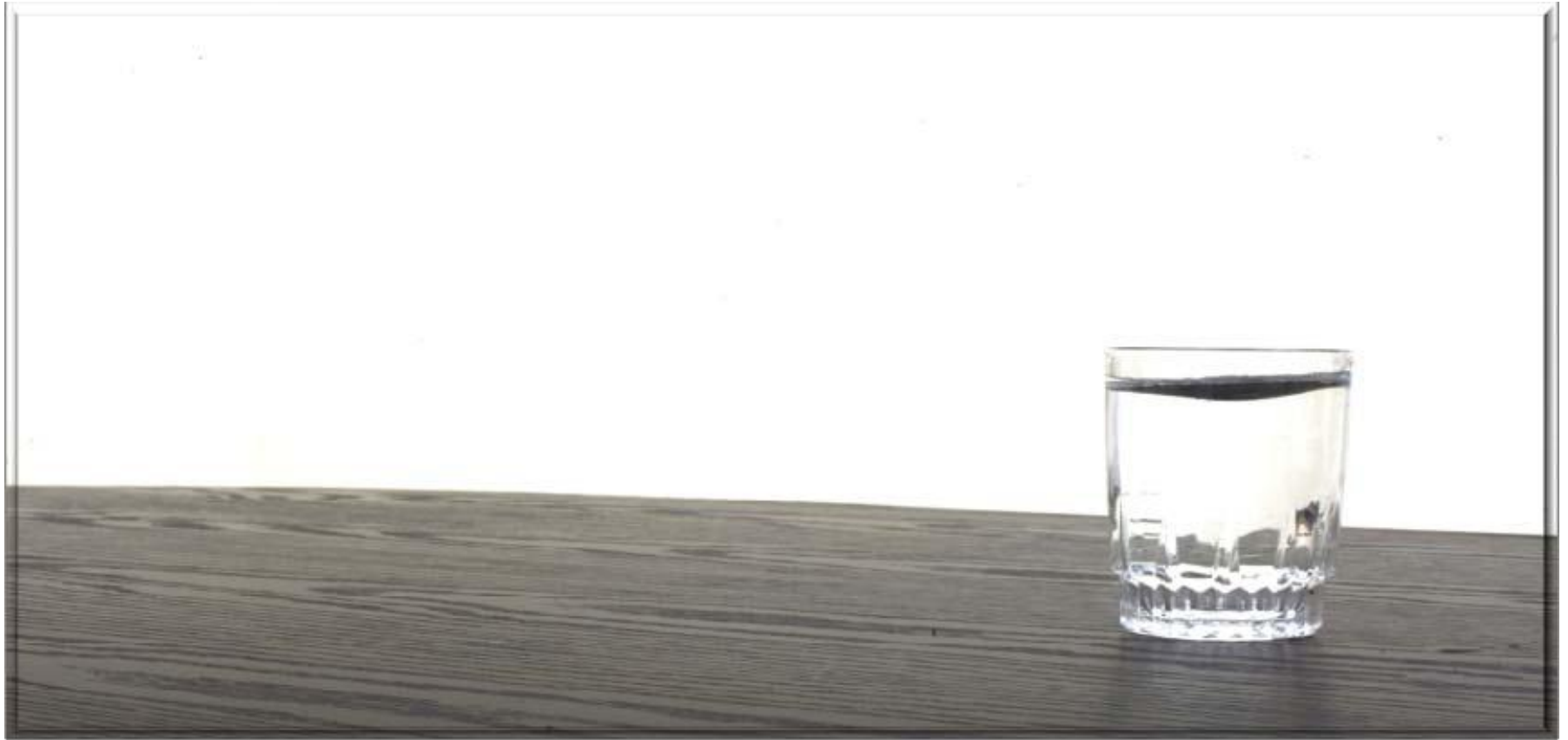
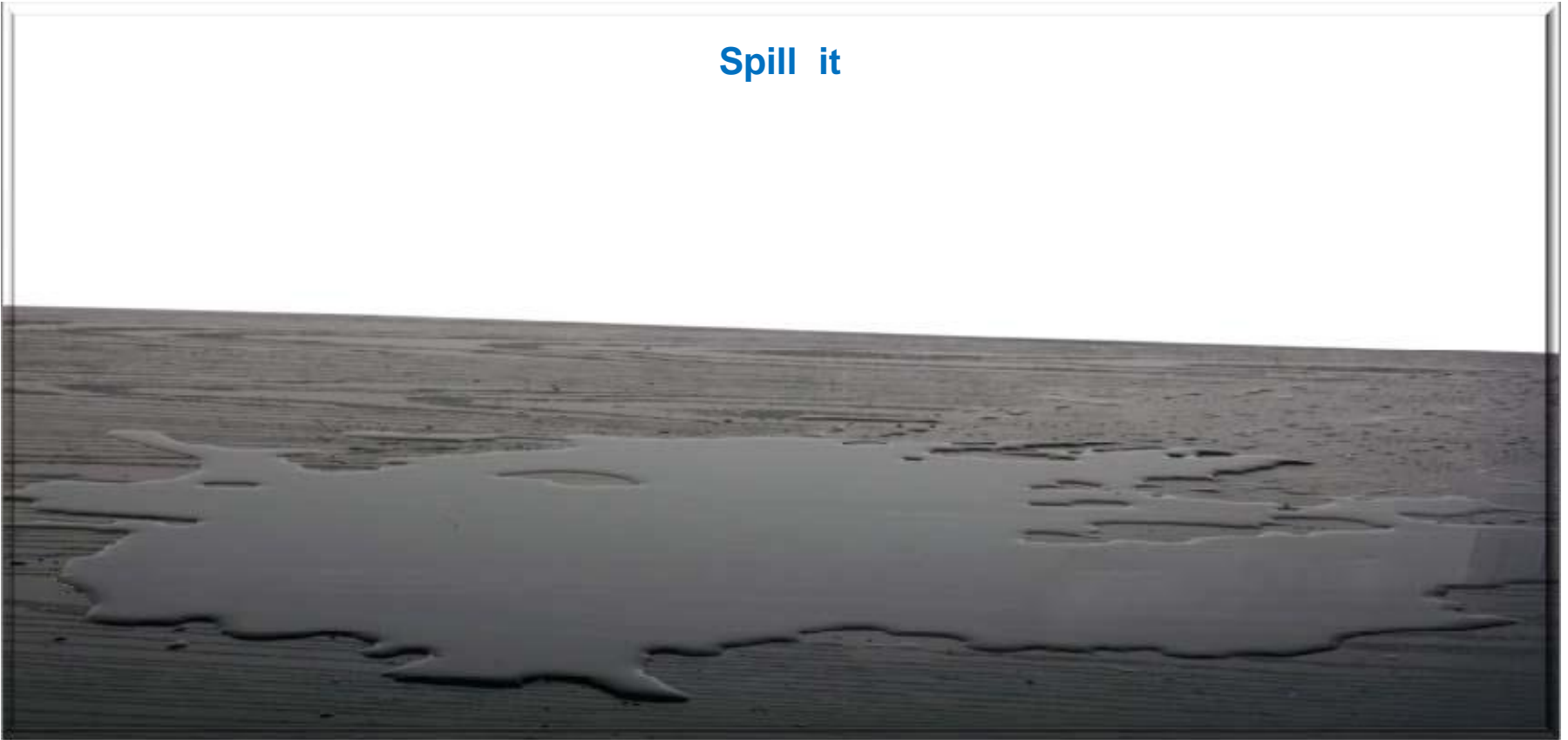


Efficiency improvements in Solar evaporation

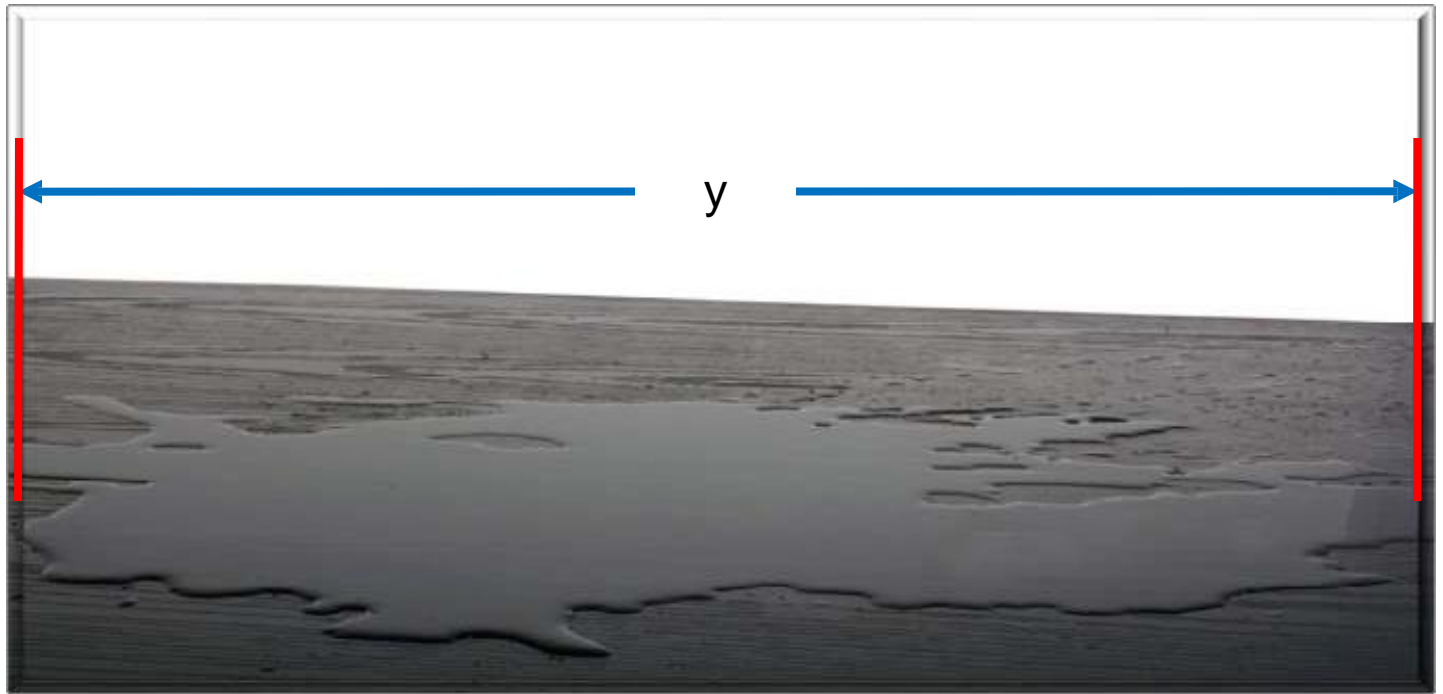
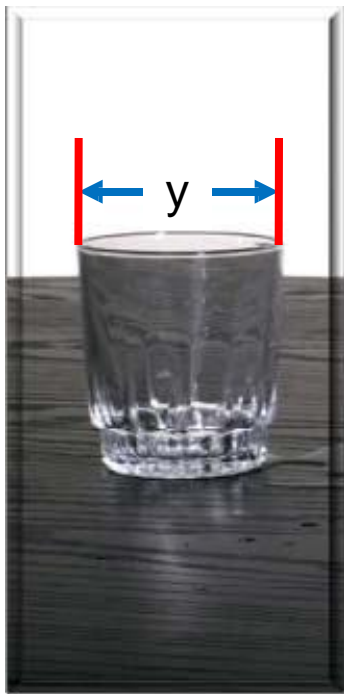
**HOW DO YOU EVAPORATE THE
WATER IN THE GLASS QUICKLY?**



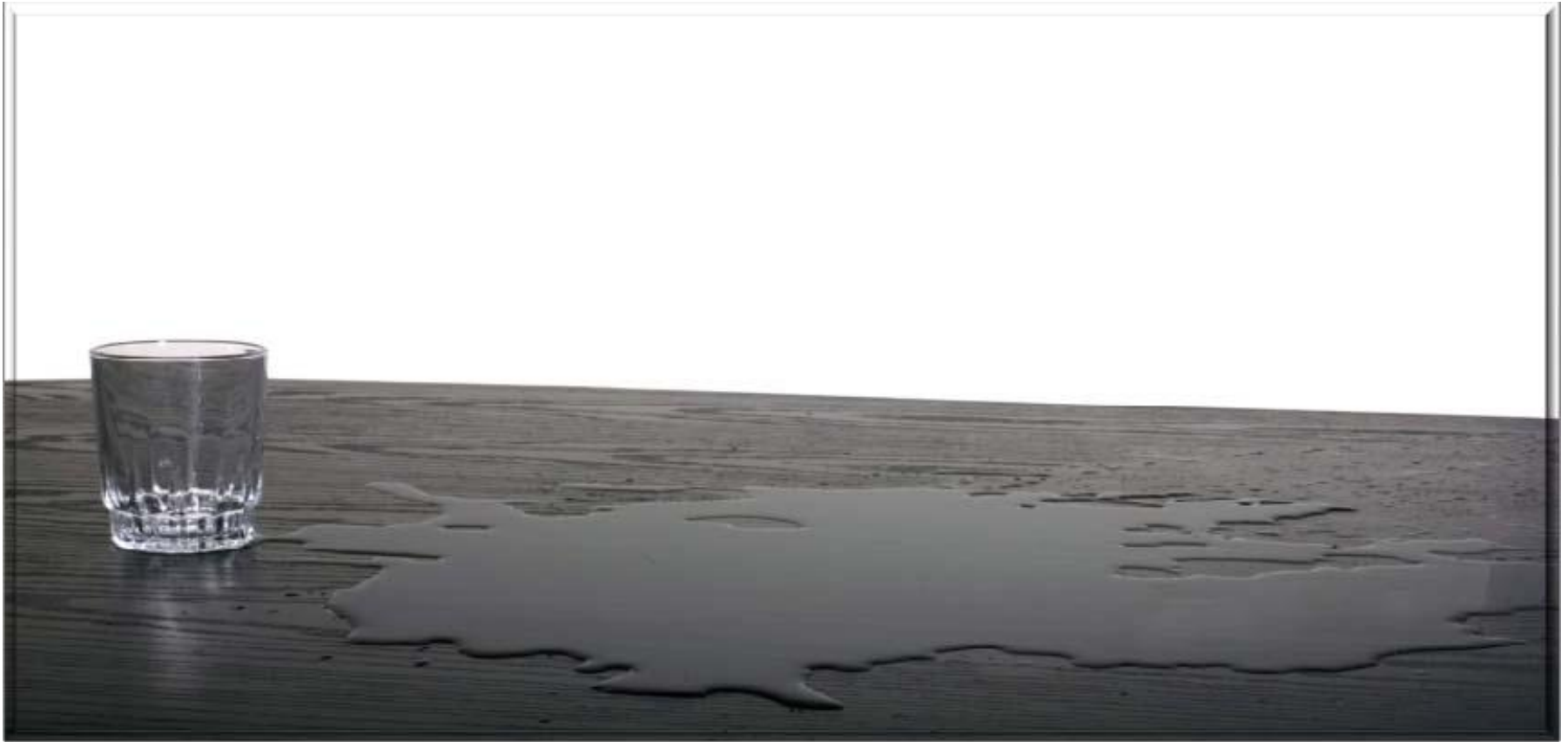
Spill it



In other words, increase the surface area of the liquid exposed. The water being distributed over a greater area has each molecule exposed to more incoming air particles. Thus each molecule can get enough energy to fly off faster rather than waiting for each layer to evaporate, keeping the layers below trapped (in this case inside the glass)

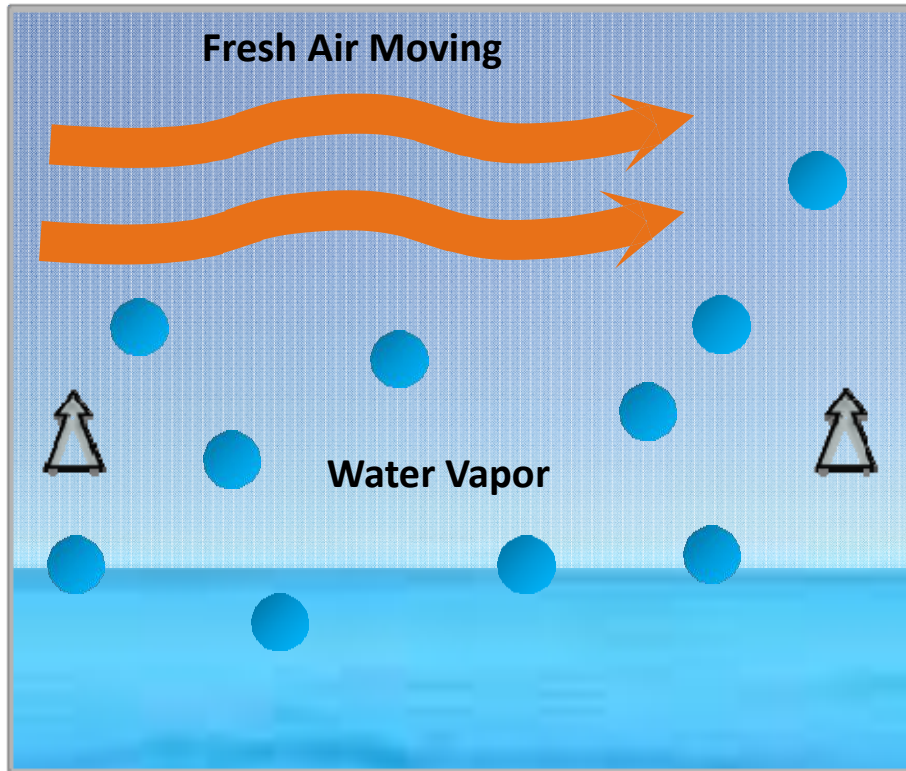


HOW TO ACCELERATE EVAPORATION RATE FURTHER?



**ADD A FAN AND INDUCE AIR MOVEMENT
NEAR THE SURFACE OF THE LIQUID**
(For example: clothes dry faster in a windy day)





The velocity of air on the surface of water can speed evaporation in three ways

- First, it brings in fresh unsaturated air across the water surface . With no air movement the evaporation will stop at one point when the atmosphere gets saturated with water vapor
- Secondly, it can agitate the water, breaking up the surface tension and still increasing the surface area, exposing more molecules to the atmosphere
- Thirdly , velocity and pressure have inverse relationship (this is how lift works for airplane). So, as air increases speed across the surface of water, it also lowers pressure locally. The combination of agitation and pressure drop work together to speed up the evaporation



**HOW THIS PRINCIPLE
IS APPLIED IN
EVAPORATION OF
INDUSTRIAL
WASTEWATERS
CONVENTIONALLY ?**

SOLAR PONDS



Water is spread over a large area to increase the available area for evaporation with natural wind blowing across the surface of the water

ADVANTAGES AND DISADVANTAGES OF SOLAR POND

Advantages

Operation costs : Nil

Disadvantages

Evaporation rate is very slow, not suitable for high volumes of water
Requires very large area:

- 1) limitation in availability of land
- 2) land costs are prohibitive

PAN EVAPORATION RATES

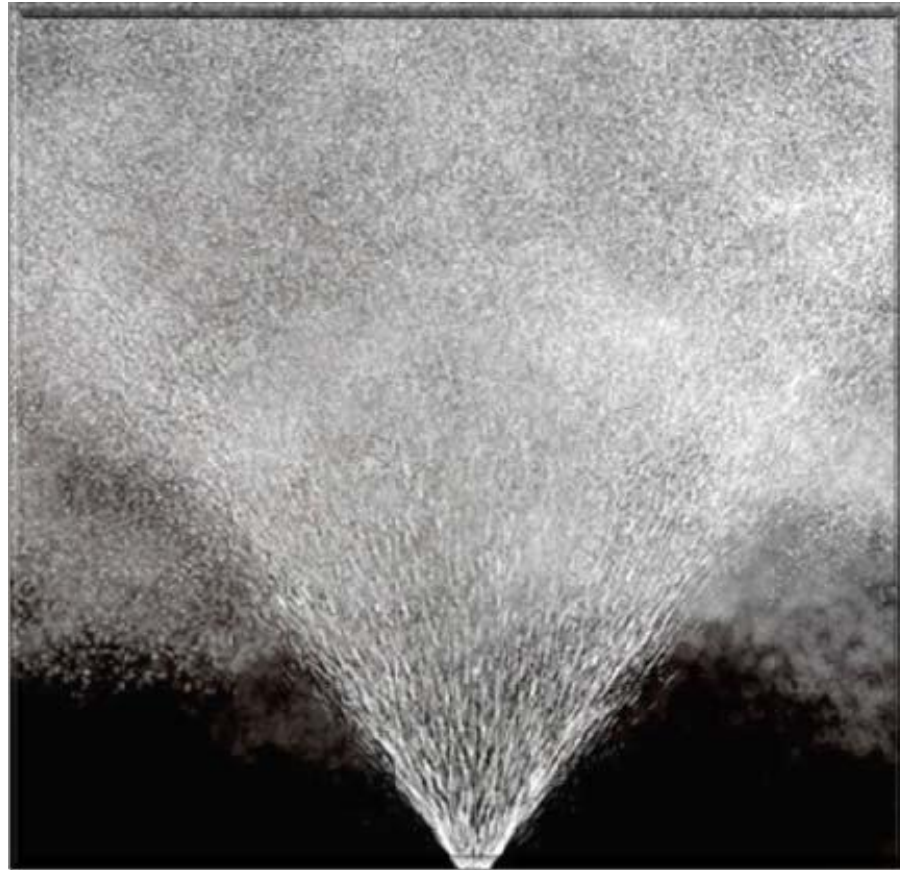
Year	Bangalore MM/day	Chennai MM/day	Kolkatta MM/day	Nagpur MM/day	New Delhi MM/day	Bombay MM/day	Ahmedabad MM/day	Srinagar MM/day	Shillong MM/day	Trivendrum MM/day
Jan	3.9	3.1	1.4	4.1	2.2	2.4	6.3	0.0	1.3	3.9
Feb	4.8	4.6	2.6	5.1	4.2	3.3	7.2	0.0	1.9	4.4
Mar	6.1	5.9	4.2	5.4	7.2	4.1	8.8	1.8	3.5	5.0
Apr	5.4	7.1	5.5	6.4	9.9	4.8	9.3	2.6	4.2	4.8
May	5.7	8.1	4.8	7.2	10.9	5.0	12.6	3.0	3.1	4.0
Jun	3.5	7.7	3.7	5.0	10.1	3.7	14.5	5.0	2.7	2.5
July	3.1	5.4	2.5	3.5	4.7	3.0	10.1	5.1	2.2	3.3
Aug	3.2	5.5	2.7	3.3	5.0	2.2	8.5	3.8	2.2	3.9
Sep	3.5	4.8	2.3	3.9	6.1	2.9	9.9	3.6	2.1	4.4
Oct	3.4	4.1	2.5	3.8	5.1	2.8	8.7	1.8	2.1	3.9
Nov	2.9	3.1	1.9	3.6	4.0	2.7	8.1	0.9	1.7	2.9
Dec	3.9	3.0	1.6	2.9	3.5	2.3	7.0	0.0	1.4	3.7
Annual Average	4.1	5.2	3.0	4.5	6.1	3.3	9.3	2.3	2.4	3.9

SOLAR POND AREA REQUIRED TO EVAPORATE 100 CU.M/DAY

Place	Acres
Bangalore	6.02
Chennai	4.75
Kolkatta	8.24
Nagpur	5.49
New Delhi	4.05
Bombay	7.49
Ahmedabad	2.65
Srinagar	10.74
Shillong	10.30
Trivendrum	6.33

**HOW TO ACHIEVE LARGE SURFACE AREA
WATER
WITHOUT
ADDITIONAL LAND**

**SPREAD THE WATER IN THE ATMOSPHERE
AND MIX FORCED AIR WITH IT**

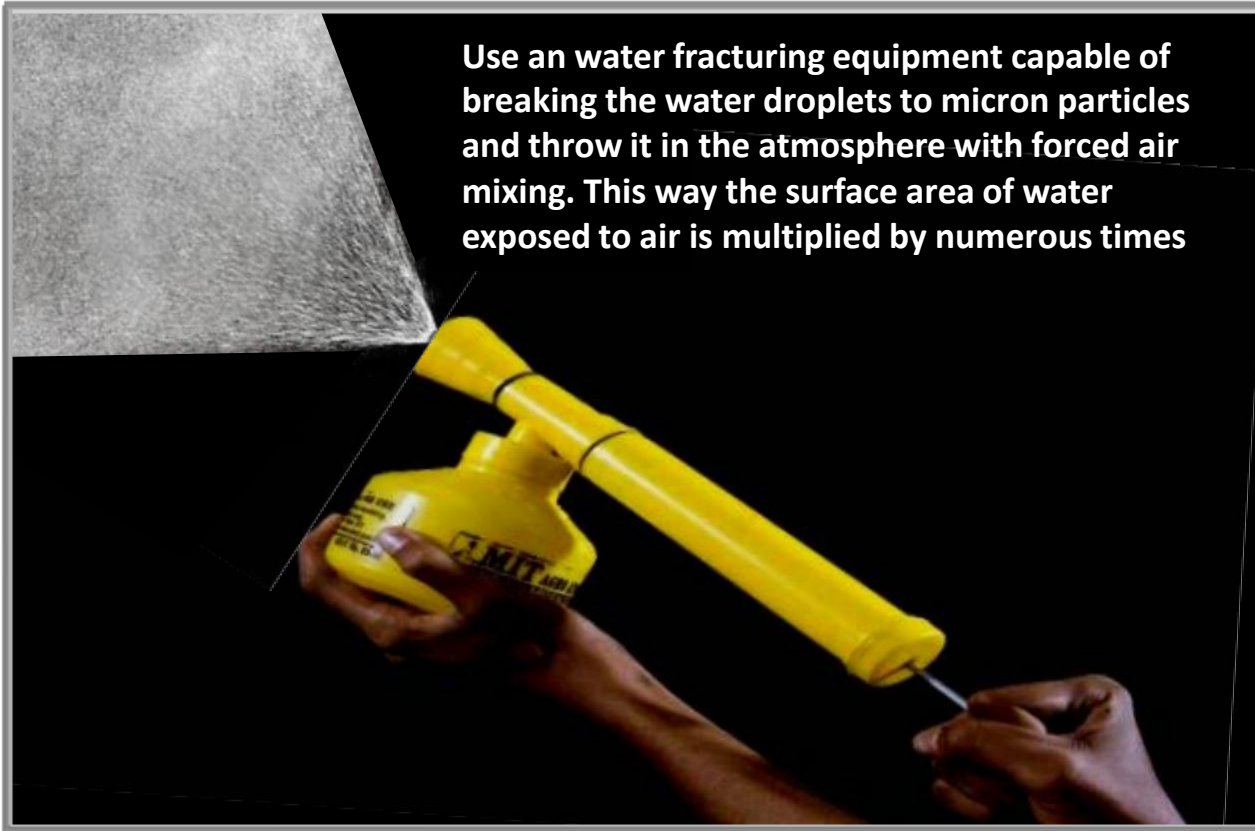


Use an water fracturing equipment capable of breaking the water droplets to micron particles and throw it in the atmosphere with forced air mixing.

This way the surface area of water exposed to air is multiplied by numerous times



Use an water fracturing equipment capable of breaking the water droplets to micron particles and throw it in the atmosphere with forced air mixing. This way the surface area of water exposed to air is multiplied by numerous times



THE SURFACE AREA RESULTING FROM SUCH ATOMIZATION OF A LIQUID IS CONSIDERABLE

Figure-1 shows the surface area of feed after being atomized into droplets of different sizes

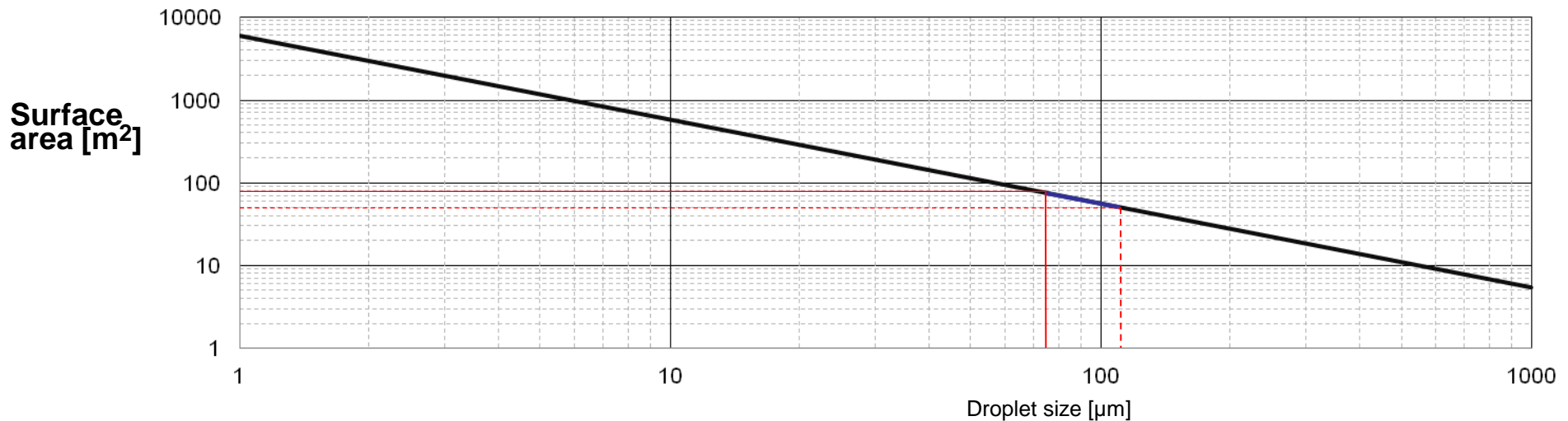
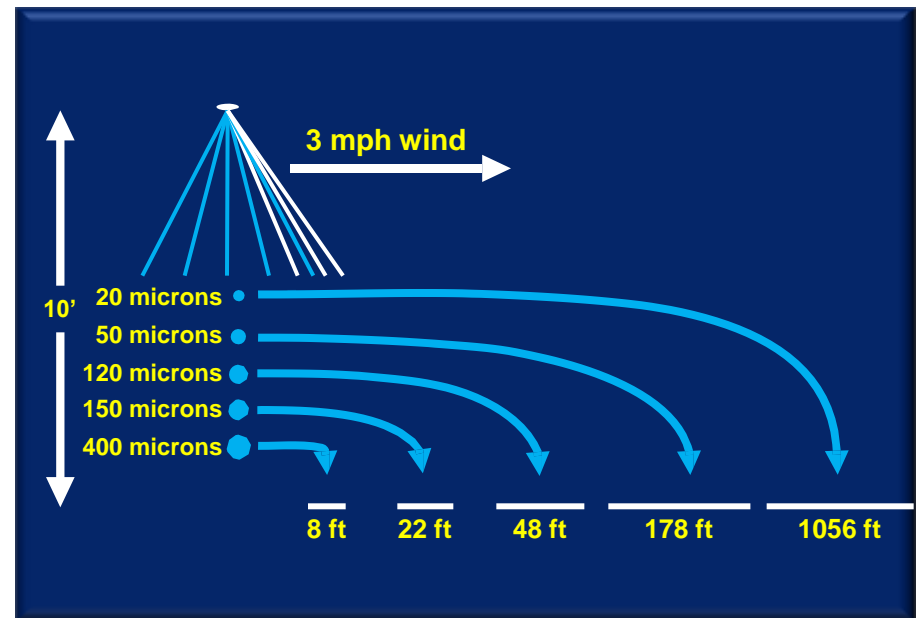
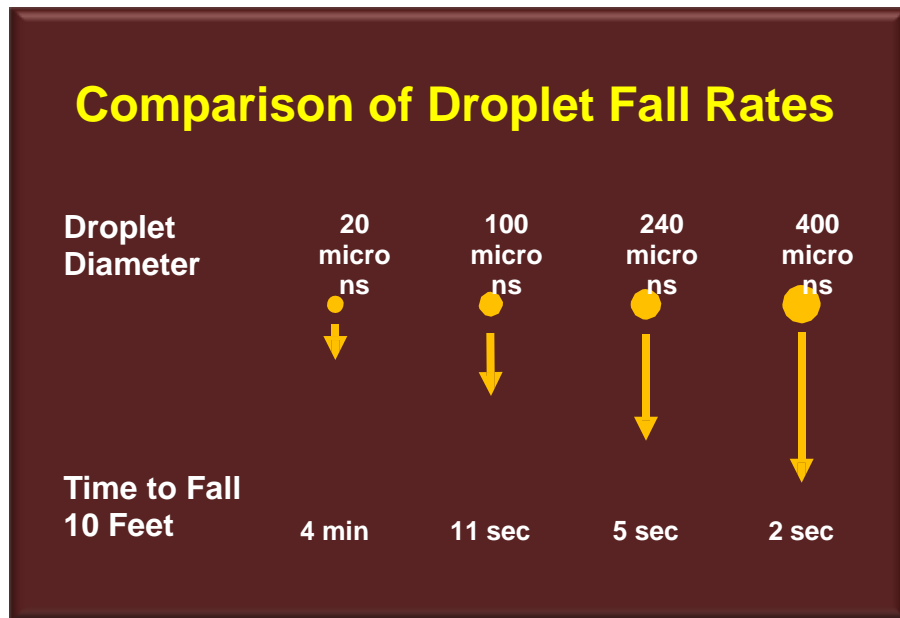


Figure-1 Total surface area of one litre of feed atomized into different droplet sizes

Effective atomizers create droplet spectra from as low as 50 micron to 150 micron or larger, with a typical operational range between 75 and 110 microns. Based on the above surface area chart, surface area of one litre of water is increased to 50 to 75 square meters and hence the evaporation rate achieved will be tremendous

ALSO FIND BELOW THE DRIFT TIME OF THESE DROPLETS WHICH WILL EVAPORATION ENHANCE RATE FURTHER



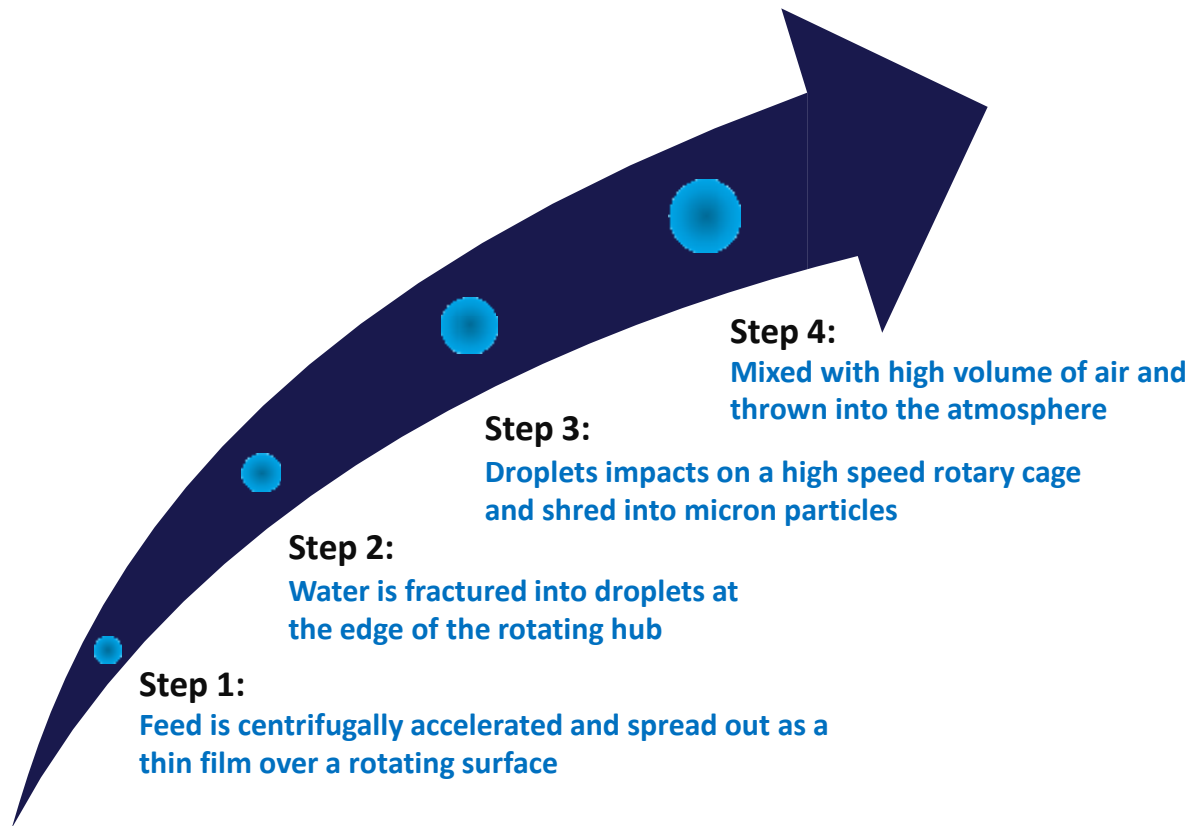
Droplet Size to be reduced

Watrix rotary evaporator

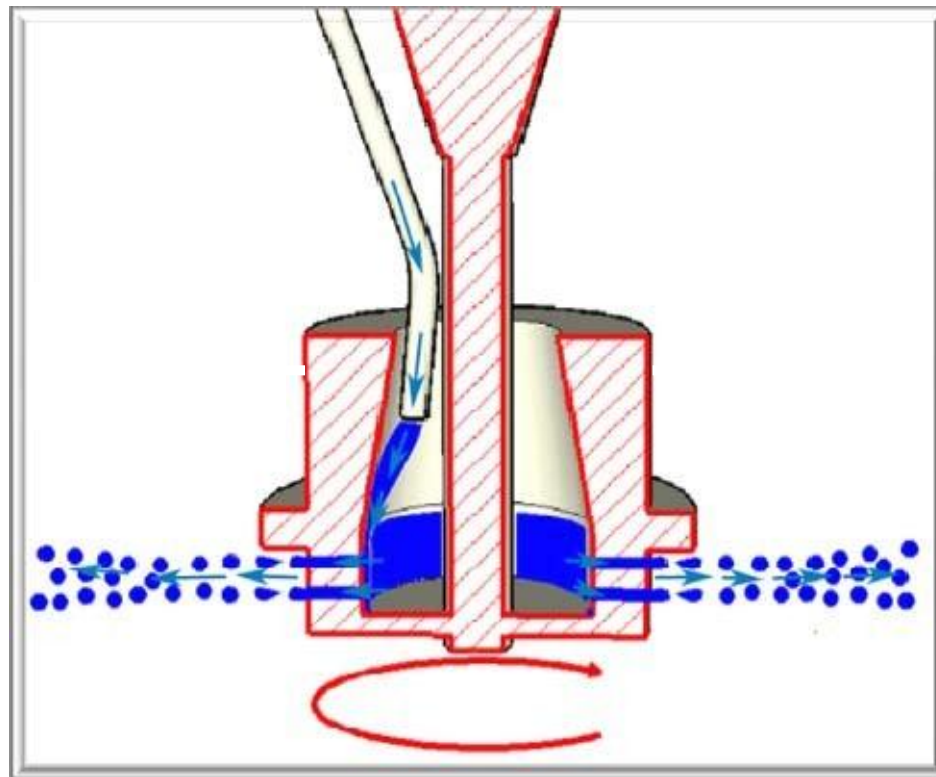
Nozzle of Various Sizes

REVOLUTIONARY WATRIX ROTARY EVAPORATOR

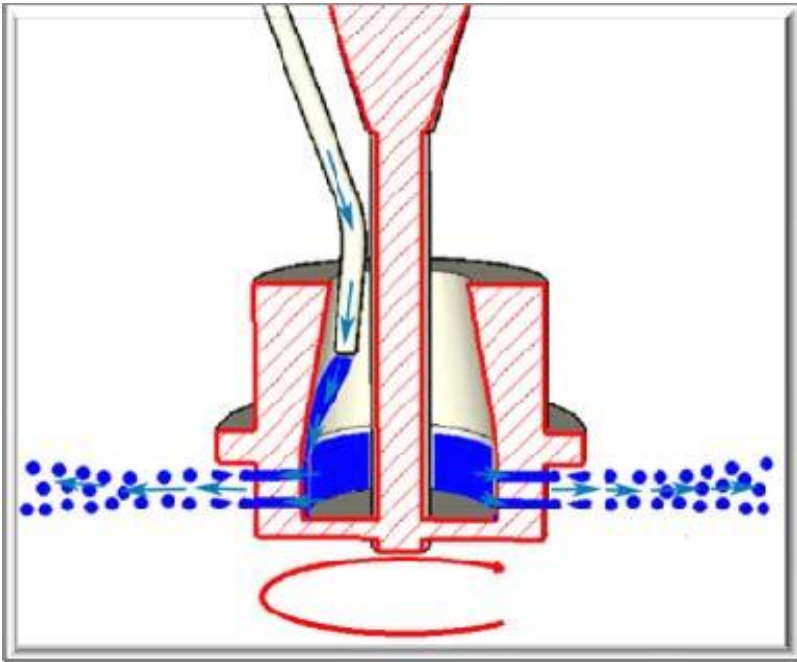
Operation Principle



**STEP 1: FEED IS CENTRIFUGALLY
ACCELERATED AND SPREAD OUT AS
A
THIN FILM OVER A ROTATING
SURFACE**



STEP 2: WATER IS FRACTURED INTO DROPLETS AT THE EDGE OF THE ROTATING HUB



STEP 3: DROPLETS IMPACTS ON A HIGH SPEED ROTARY CAGE AND SHRED INTO MICRON PARTICLES



STEP 4: MIXED WITH HIGH VOLUME OF AIR USING A FAN AND THROWN INTO THE ATMOSPHERE

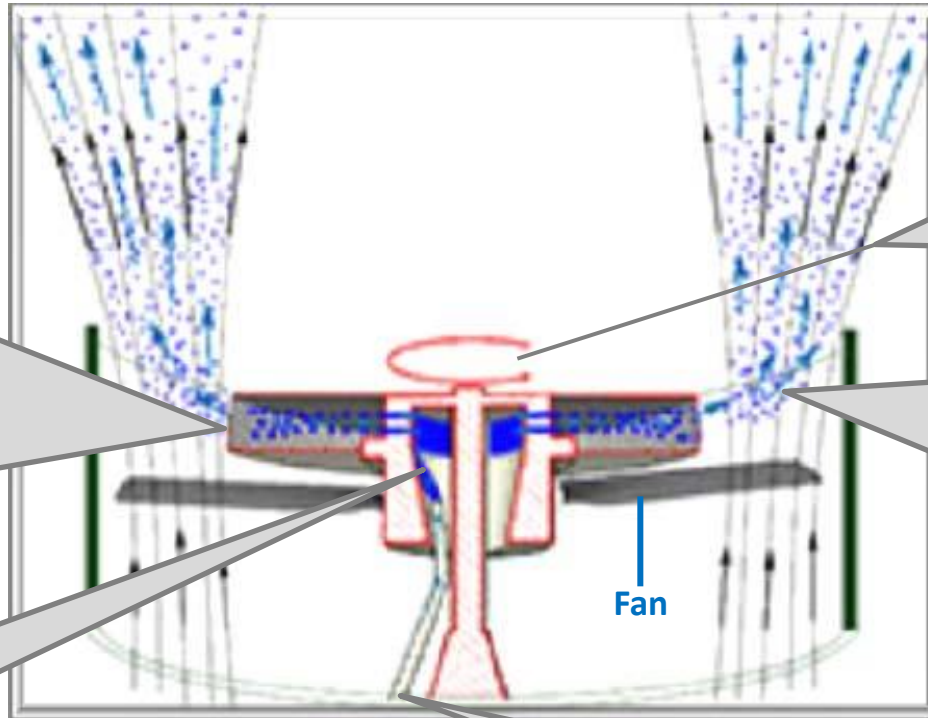


REVOLUTIONARY WATRIX ROTARY EVAPORATOR

Operation Principle

3. The thin film of liquid is shredded into droplets at the edge of the rotating wheel. These droplets with high velocity will next hit a micron level rotary cage screen rotating at high RPM to further atomize the fluid and create extremely fine droplets and distributed over the entire screen mesh which creates superior resistance to clogging and abrasive

2. The feed is centrifugally accelerated in the wheel to a high velocity and spread out over the rotating surface as a thin film



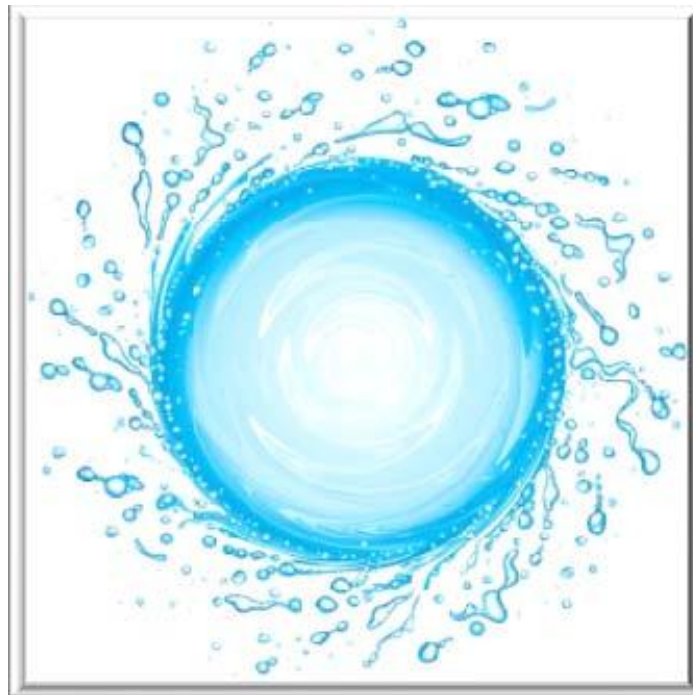
4. Droplet size of the spray is controlled by varying the rotating speed of the wheel and varying the screen mesh size

5. The micron water particles are then entrained in a conical jet of air induced through an inbuilt fan, propelling liquid up to 30 meters or more (100 feet) with droplets from 40 to 250 microns

1. The feed is introduced to the centre of a rotating wheel

EVAPORATION BY MECHANICAL FORCE

Watrix rotary evaporators use mechanical centrifugal force to atomize fluids. There are several significant advantages to rotary evaporation that allow Watrix to operate where other evaporation technologies cannot



SIMPLE INTEGRATED DESIGN

No separate motors for atomizer and fan. Integrated design

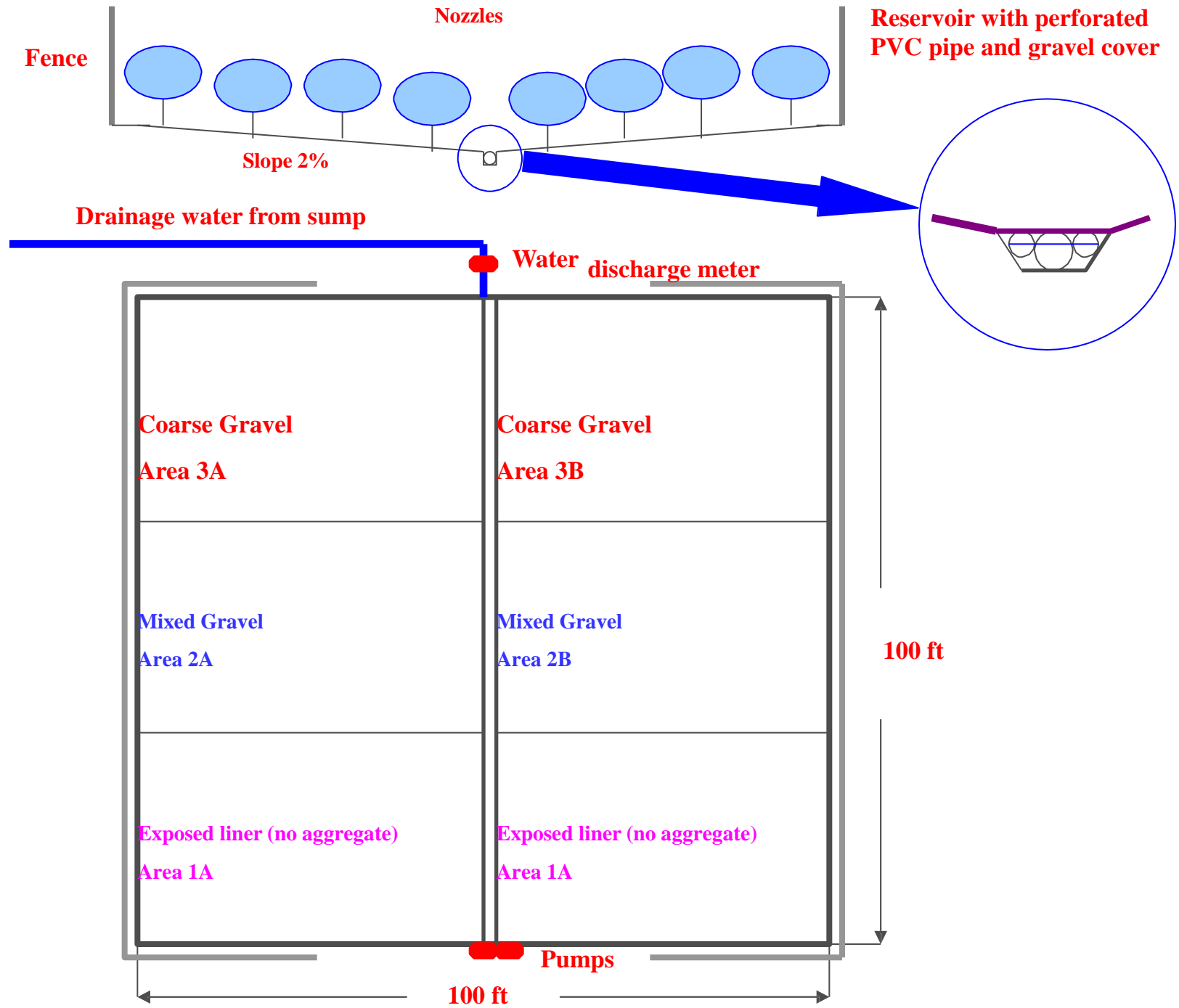
This simple design combines the atomization system with the fan delivery system creating a complete, durable unit that can deliver high volumes of atomized liquid in a directed jet of air

SIMPLE MAINTENANCE

The screen mesh and cup can be easily inspected when the unit is shut down, and worn parts can be quickly replaced to reduce downtime and costs associated with failure

This is an important feature with certain challenging fluids which can erode even the toughest atomizer system







Types of Gravel Evaluated



Solar Evaporator Test: Evaporative Surfaces



Test Nozzles

**Nozzle height increases the
evaporation rate is also
Increasing**



**Vertically oriented nozzle position with different riser heights
(riser=1.5 ft) note windbreak fence**



riser=1.5 ft



Nozzle positions with different angles and with varying riser heights were tested in 2003 (riser=1.0 ft)

Nozzle riser= 1.0ft,

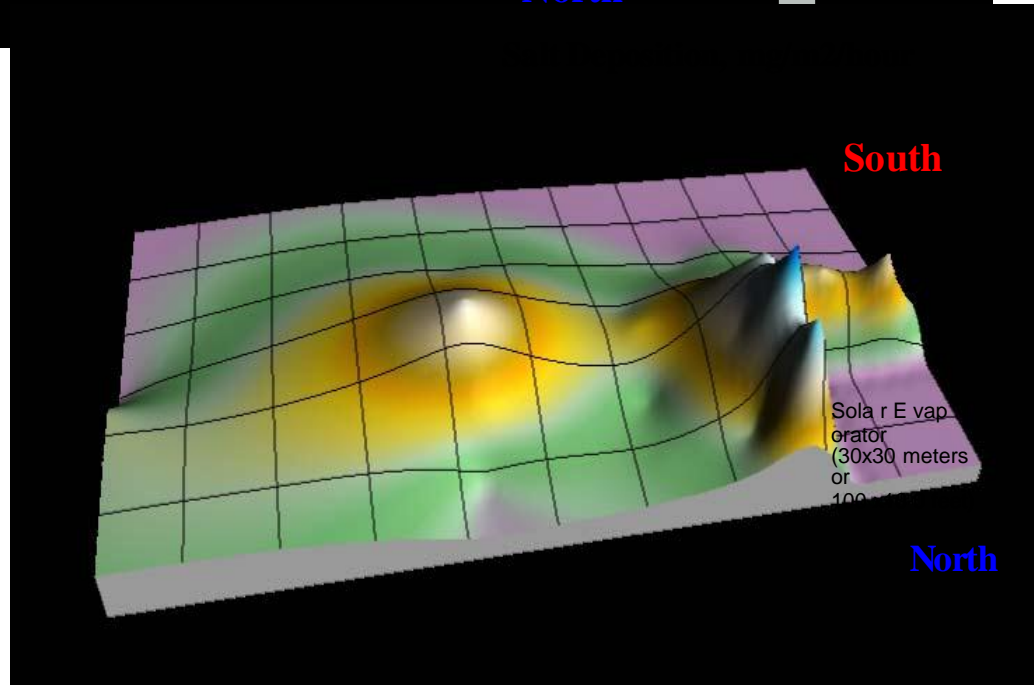
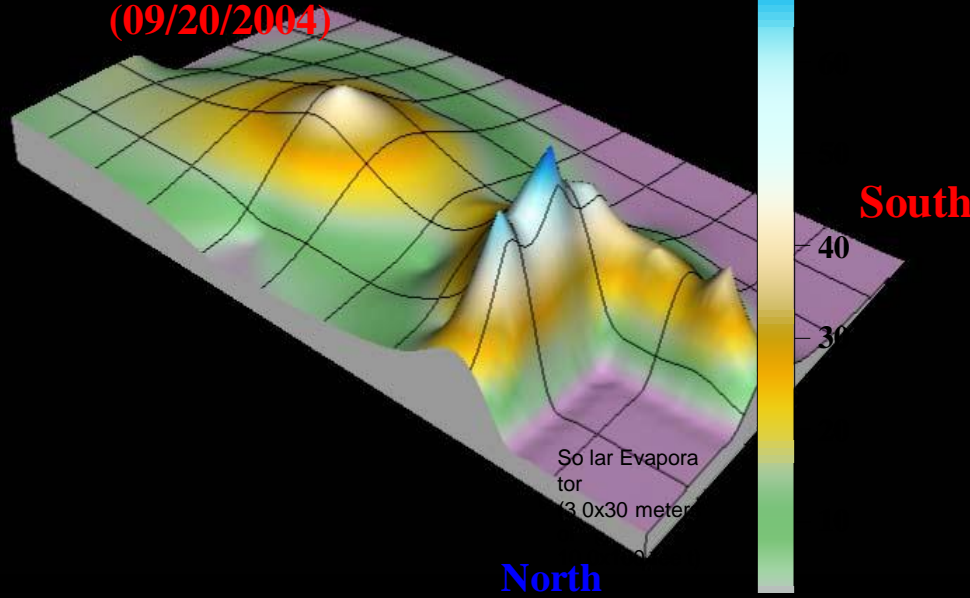


Nozzle riser= 1.5 ft,

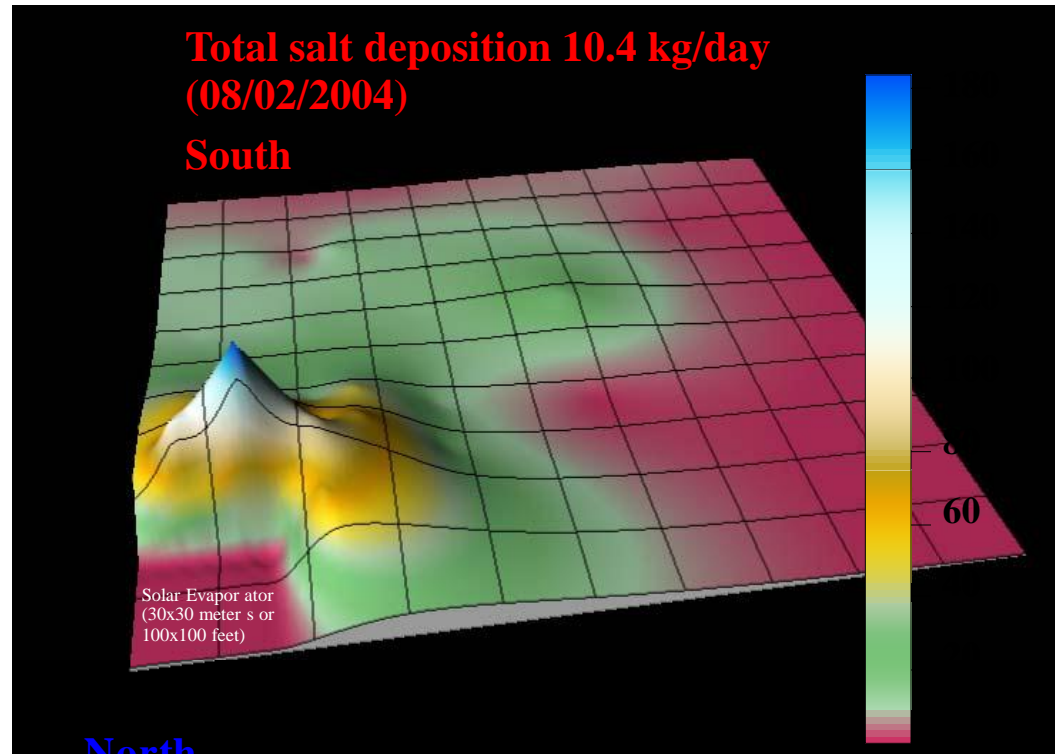


Nozzles raised at 0.5 ft

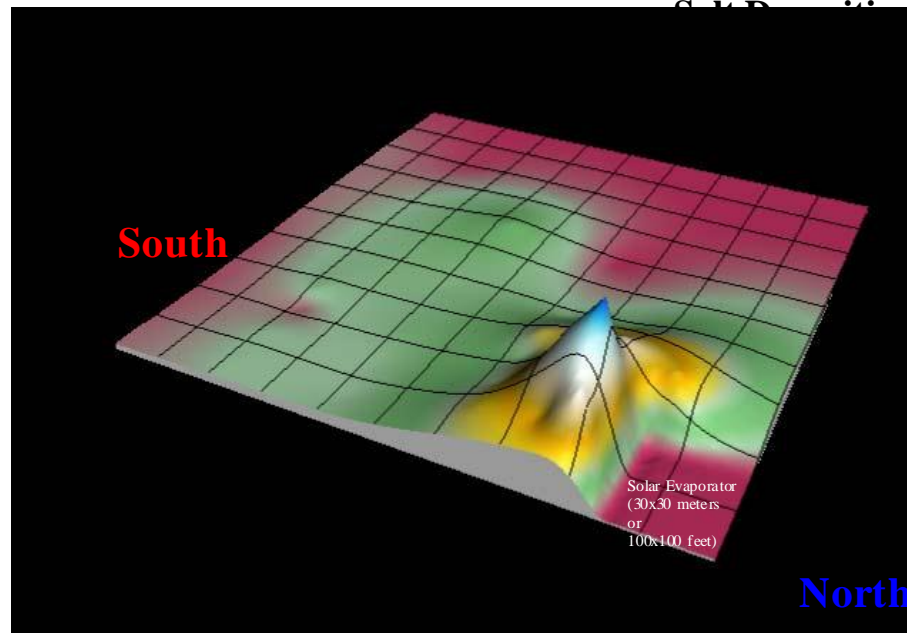
**Total salt deposition 5.9
kg/day
(09/20/2004)**



Nozzles raised at 1.5 ft

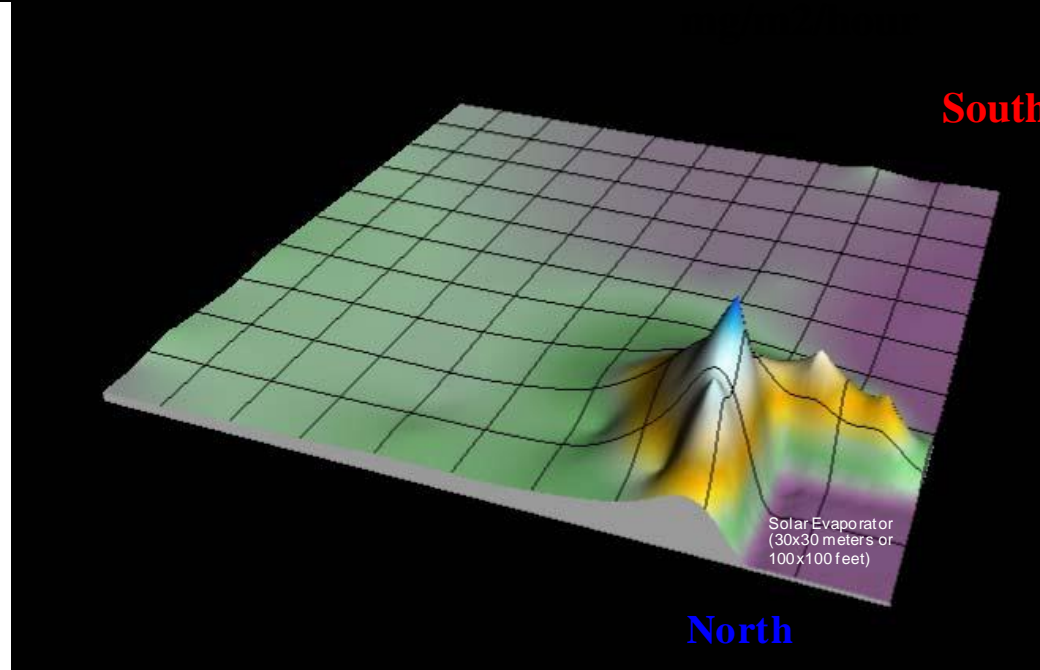
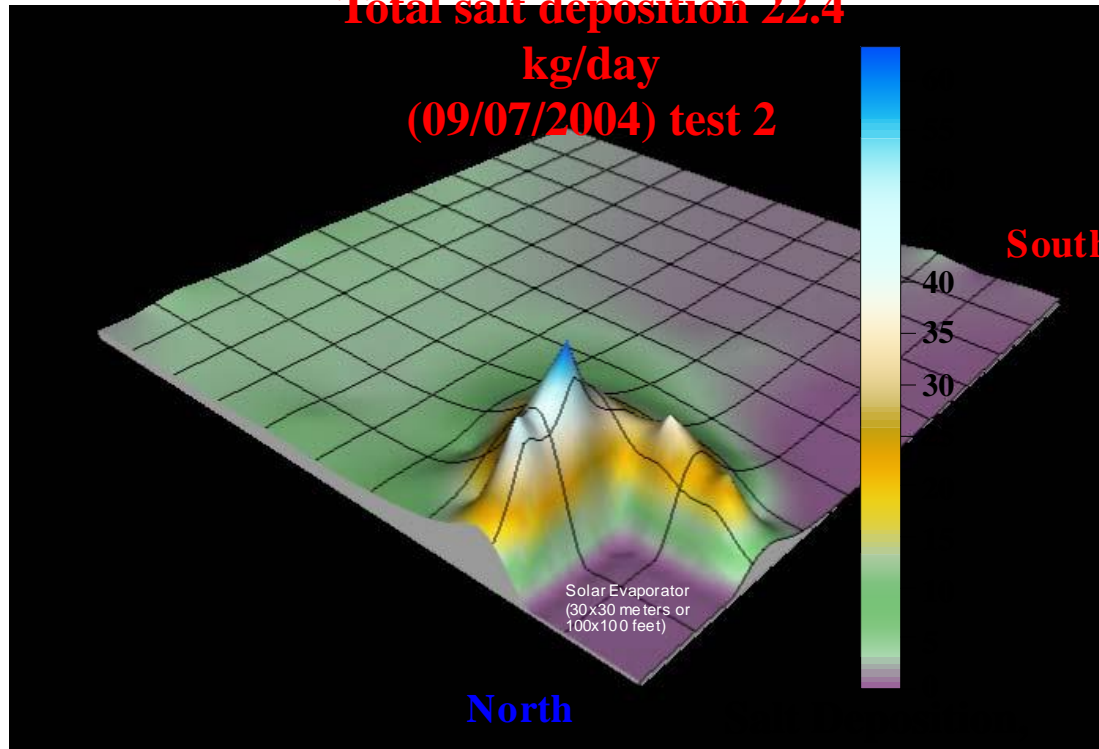


North



Nozzles raised at 2.0 ft

**Total salt deposition 22.4
kg/day
(09/07/2004) test 2**



Protection from Rain



Pond Size: 50 m x 30 m (1500 sqmts)









APPLICATIONS



Evaporator rejects



Power plants



Oil mills



Oil and gas



Refineries



RO rejects



Steel industries



Fertiliser plants



Sugar industries



Pharmaceuticals



Textile industries



Mining industries



DM plant & softener
regeneration wastes



Automobile and
ancilleries



Distilleries and
breweries



Food processing
industries



Sea food processing
industries



Cooling tower
blowdowns



Poultry



Slaughter houses



Dairy



Sewage

Acknowledgement:
Watrix Corporation-
Mr.Meenakshisundaram

Thank you