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Design & Development of Novel Solar Still for Production of Potable Water

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Solar Distillation

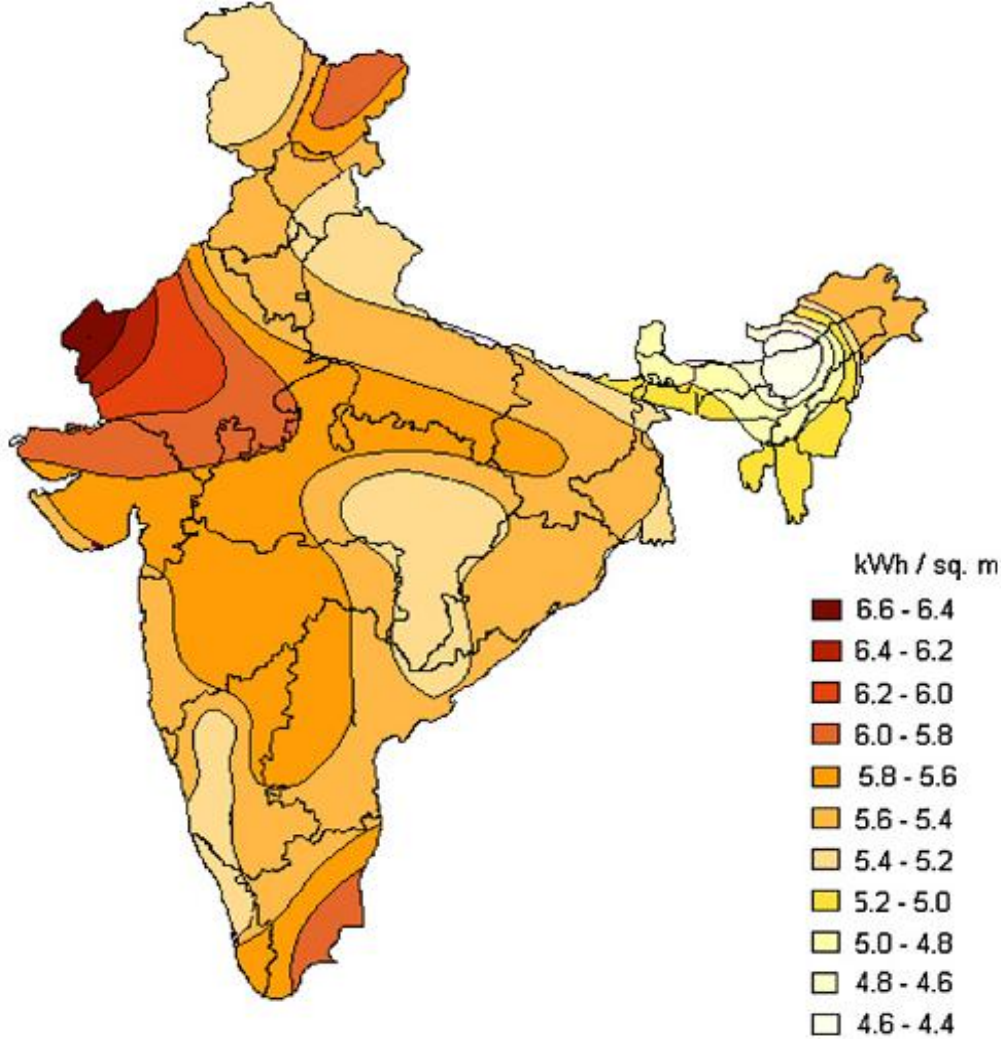
- *Water is an essential element for human survival.*
- *Around 99% of the total water present on Earth is found in oceans and seas. However, due to their extremely high salinity levels, they are not potable.*
- *Many processes have come into existence to tackle this issue, 'distillation of water' being one of those.*
- *Converting brackish/saline water to distilled water and then re-mineralizing it so that it becomes potable.*
- *A Solar still converts high TDS (Total dissolved solids) water into distilled water and later necessary minerals can be added to it*

Optimal Quantities of Ions in Water

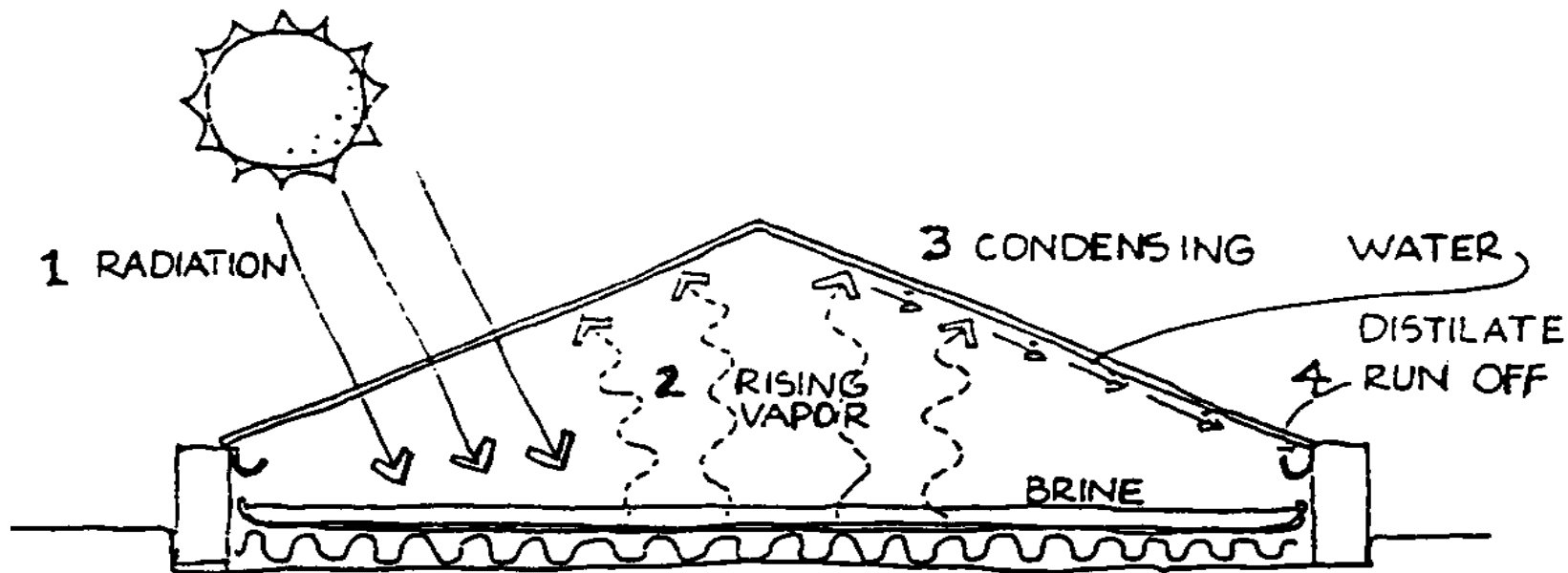
Ion/Molecule	Quantity (mg/l)
Chloride	150 – 200
Sodium	100 -150
Magnesium	25 – 50
Bicarbonate	30
Calcium	30
Potassium	8
Fluoride	1.5

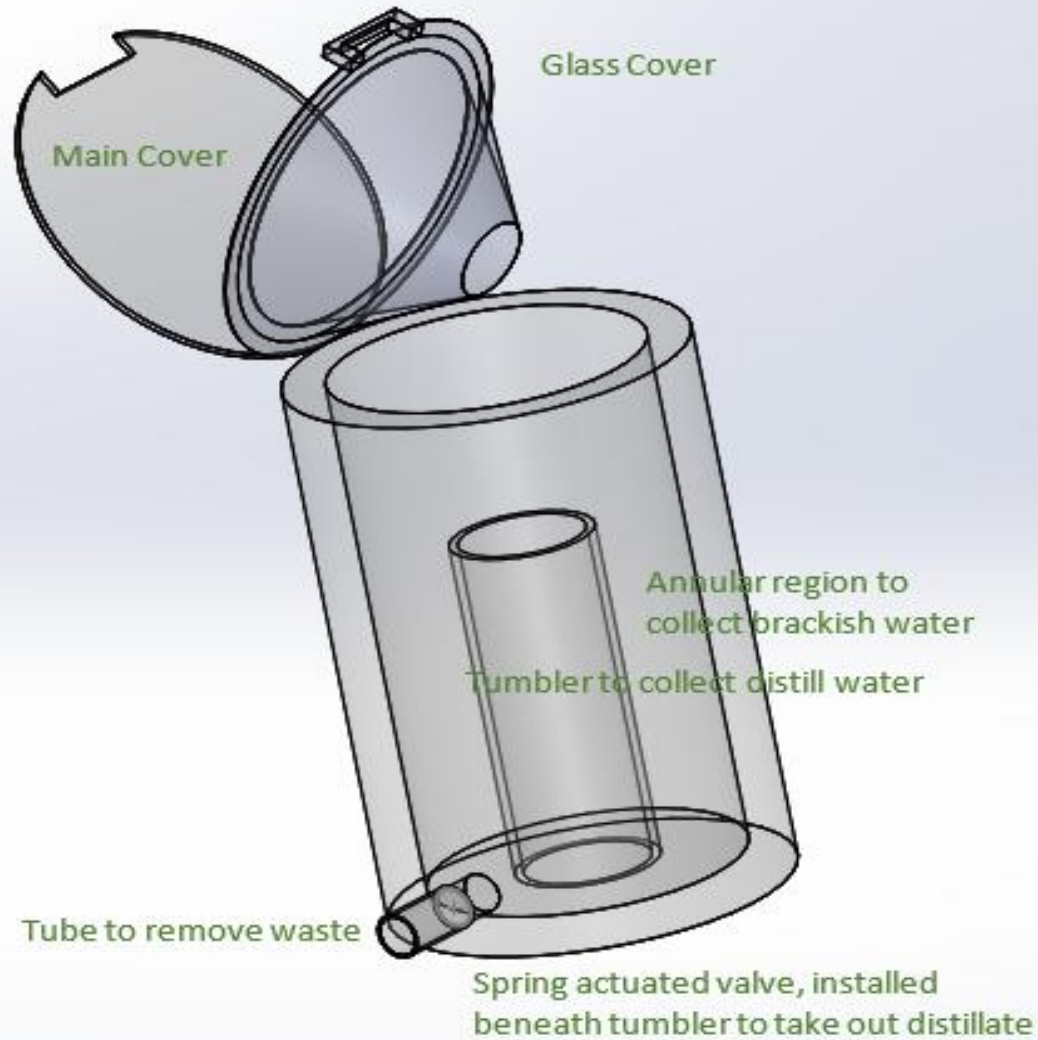
Source: [4-6]

Solar Energy Map of India



Solar Distillation





Design of the Novel Still

Analysis and Calculations

For calculations, solar insolation levels in the Bikaner district of Rajasthan, India has been selected as water available is brackish and have good insolation

Following assumptions are made to do the calculations:-

- No vapor leakage in the solar still.
- Basin is insulated from bottom so no heat loss from bottom.
- Heat capacities of other parts are assumed to be negligible except water.
- There is no temperature variation across the gap between water and glass cover.
- Thickness of cylinder is assumed to be negligible.

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Solar Insolation Data

Time	Solar Radiation (W/m ²)
07:00	71
08:00	232
09:00	442
10:00	616
11:00	733
12:00	819
13:00	824
14:00	838
15:00	425
16:00	477
17:00	122
18:00	114

Source [10]

Variables used

$I(t)$	Solar irradiation for 1 hour
T_w	Temperature of water in ($^{\circ}\text{C}$)
T_g	Temperature of glass cover ($^{\circ}\text{C}$)
P_w	Partial pressure at water temperature (N/m^2)
P_g	Partial pressure at glass cover temperature (N/m^2)
h_{cw}	Convective heat transfer coefficient from water to cover ($\text{W}/\text{m}^2\text{^{\circ}\text{C}}$)
h_{ew}	Evaporative heat transfer coefficient from water to cover ($\text{W}/\text{m}^2\text{^{\circ}\text{C}}$)
m_{ew}	Distil water output ($\text{kg}/\text{m}^2\text{h}$)
h_{fg}	Latent heat

Results

T (h)	I(t) (W/m ²)	T _w (°C)	T _g (°C)	h _{cw} (W/m ² °C)	h _{ew} (W/m ² °C)	m _{ew} (kg/m ² h)	h _{fg} (kJ/kg)
09:00-10:00	442	28.6	26.9	1.04	3.53	0.01	2437.60
10:00-11:00	616	38.2	31.7	1.67	8.15	0.08	2426.47
11:00-12:00	733	43.3	33.7	1.91	11.07	0.16	2421.70
12:00-13:00	819	47.1	35.2	2.06	13.52	0.24	2418.18
13:00-14:00	824	47.4	35.3	2.07	13.74	0.25	2417.88
14:00-15:00	838	48.3	35.7	2.11	14.42	0.27	2416.91
15:00-16:00	425	27.5	25.9	1.02	3.31	0.01	2440.05
16:00-17:00	477	30.7	28.6	1.15	4.34	0.01	2433.90

Conclusion

- The novel solar still is designed and analysed for Bikaner city of Rajasthan, India.
- It can produce up to 4.01 liters of mineralized water every day (given the same insolation levels as taken for the analysis).
- The water can be mineralized by addition of a Celtic salt pill of 5.2 grams for 4.01 liters of distilled water.
- This design can be scaled up to produce sufficient amount of water for a small family.
- Such a solar still would be best suited for arid areas where potable water is scarce, especially in developing countries.

References

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Thank You!!