Environment

Water & Environmental Sanitation Network (WES-Net India)

Solution Exchange for WES-Net India Consolidated Reply

Query: Desalination Techniques, from TERI, Bangalore (Comparative Experiences)

Compiled by Preeti Soni, Resource Person and Moderator; additional research provided by Ramya Gopalan, Research Associate
26 October 2005

Original Query: S.N. Srinivas, The Energy and Resources Institute (TERI), Bangalore, Karnataka

Posted: 6 October 2005

I work at the Southern Regional Center of The Energy and Resources Institute (TERI). We are collaborating on a project to explore the use of solar desalination devices to produce potable water from saline and brackish water.

My Query is, does anyone have experience in using solar stills to produce potable water? What are the other techniques and technologies that may be/are being used effectively to produce potable water from brackish and saline water?

Responses received with thanks from:

1. **Nafisa Barot, Utthan, Ahmedabad (Response 1, Response 2)**
2. **Dinesh Kumar, IWMI, Anand, Gujarat (Response 1, Response 2, Response 3)**
3. **Terry Thomas, Participatory Learning and Action Network (Planet Kerala), Trivandrum**
4. **Shirish Sinha, IWMI, New Delhi**
5. **Ravi Parthasarathi, Tata Projects Ltd, Hyderabad**

Further contributions are welcome!

Summary of Responses

This query seeks information and experiences on desalination techniques, particularly solar stills, to produce potable water from brackish and saline water. The responses received from the Network

members evoked a lively discussion (though at times it diverted from the main issue raised in the query).

Experience with solar desalination: Distillation through solar devices implies the use of solar heat to evaporate the saline or brackish water followed by its condensation. The water thus obtained is free from harmful salts. The experiences relating to solar stills cited by the Network members are: (a) in the saline areas of **Gujarat**, and (b) in the coastal areas of **Kerala**. The Gujarat initiative carried out in the early eighties showed that the successful operation of solar stills required a clear sky, high temperatures and absence of strong winds (to avoid accumulation of dust on the glass covering of stills). The process also demanded the availability of additional quality water for mixing with the distilled water to make it potable. In contrast, the more recent Kerala project provides a viable, replicable model for use of households at a low investment and minimal operational costs.

In addition to weather conditions and water requirements, effective solar desalination was dependent on:

- **Costs** – both initial and running costs, especially in the case of community-managed solar stills;
- **Complexity of operations**, the degree of labour needed, and reliability;
- **Disposal mechanism** for saline water;
- **Communities' attitude –** their understanding of the technology, trust and preparedness to take on the operation and maintenance; and
- **Availability and relative effectiveness of alternative desalination technology options**, including their acceptability, economics and scalability.

Other technologies: With reference to the last point, technologies suggested by members included:

- **Distillation** processes (other than solar) that require mainly heat plus some electricity for ancillary equipment. These include nuclear desalination, and flash distillation systems. The latter is currently being used by Reliance in Jamnagar.
- **Reverse osmosis** process, wherein pure water is forced to pass under pressure through special semi-permeable membranes, while salt is rejected. It is being used, for example, by Tata Chemicals and Tata projects (in Hyderabad and Kudankulam) and by private entrepreneurs in Gujarat.
- **Harvesting rain water** in lined ponds or roof rain water harvesting systems (RRWHS). The discussion and responses brought out the merits (such as reliability and security) and limitations (such as costs and labour) of the RRWHS systems.
- **Electro-dialysis**: This is similar to the RO process and makes use of membranes to filter water from the salts. The difference mainly lies in that, the ions in this process are transported through a membrane from one solution to another under the influence of a direct current electrical potential.

Comparative Experiences

Gujarat (*From Nafisa Barot, Ahemdabad*)
The experience of using solar stills in the saline areas which dates back to 1982, suggests that the area of implementation, temperature and weather conditions, availability of clean water capacity of communities and costs are all important for the success of solar distillation processes. It highlights the importance of communities' attitude and interest towards using this amongst other available techniques, and showed that the communities were less forthcoming in handling the technology until there was no other option for fresh water (even if bacteriologically unfit).

Kerala (*From Terry Thomas, Trivandrum)*

The experience involves developing a locally fabricated solar distillation unit outlining participatory technology incubation; and thus evolving a model after due experimentation. The unit can be installed for household needs at low investment, zero operational costs and is replicable. For further information see Locally fabricated solar distillation still for drinking water.

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Related Resources

Recommended Documentation

Locally fabricated Solar Distillation still for drinking water (*from Terry Thomas, Planet Kerala, Trivandrum)*
News on Concept in Community Practice, May 2005, Planet Kerala,
http://www.solutionexchange-un.net.in/environment/cr/res20100501.pdf (size: 153KB)

Provides an account of experiences gained and lessons learned in Kerala by the implementation of solar stills for desalination in households.

From Preeti Soni, Resource Person

Solar Distillation
Technical Brief, Practical Answers to Poverty, Intermediate Technology Development Group
http://www.itdg.org/docs/technical_information_service/solar_distillation.pdf (size: 88KB)

This technical brief by ITDG provides basic information on the treatment of polluted water using solar water distillation and directs the reader to more detailed sources.

An Improved Solar Desalination System
Energy for Sustainable Development, Volume I No. 5, January 2005, International Energy Initiative (IEI)
http://www.ieiglobal.org/ESDVol1No5/solardesalination.pdf (size: 41KB)

The unit described in this paper deals in detail with the desalination of saline water by distillation using solar energy by means of the solar still apparatus.

Desalination Plant in Chennai: A primer
Sundhar Parthasarathy, ORF Strategic Trends, Vol III Issue. 38; September 26, 2005, Observer Research Foundation
http://www.observerindia.com/strategic/st050930.htm#2

The article highlights in brief the Indian experience with regard to the setting up of desalination plants.

Desalination: India opens world's first low temperature thermal distillation plant
IRC, Netherlands, May 2005
http://www.irc.nl/page/24010

News article providing information on India's first low temperature thermal distillation plant set up in Kavaratti by the National Institute of Ocean Technology.

Desalination: Dutch firms develops high efficiency solar distillation unit
IRC, Netherlands, February 2004
http://www.irc.nl/page/8128

Reports on a prototype solar energy based desalination unit developed in Netherlands and installed in Bonaire island in Caribbean.

Upgrading Water Quality in **Source Book of Alternative Technologies for Freshwater Augmentation in some countries in Asia** *(From Ramya Gopalan, Research Associate)*
Prepared by the Danish Hydraulic Institute as part of the joint United Nations Environment Programme (UNEP) Water Branch and International Environmental Technology Centre (IETC),
http://www.unep.or.jp/ietc/publications/techpublications/techpub-8e/desalination.asp

Provides a technical description of desalination technologies designed to produce freshwater from brackish ground water or seawater, and the extent of usage and costs involved.

Recommended Organizations

Utthan, Ahmedabad *(from Nafisa Barot, Utthan, Ahmedabad)*
http://www.utthangujarat.org/

Utthan is recommended as an organization, which has some experience in using solar stills for accessing potable water in 1982, in some of the saline areas of Gujarat.

Recommended Websites

Solar Distillation at Participatory Learning and Action Network (Planet Kerala), *(from Terry Thomas, Planet Kerala, Trivandrum)*
http://www.planetkerala.org/links.htm

Solar Distillation technique as implemented by Planet Kerala is recommended for its community experimentation in providing potable water in the coastal areas of Kerala.

Desaline.com *(from Ramya Gopalan, Research Associate)*
www.desline.com
This online desalination directory provides information on organizations, publications and contacts in the field of desalination and the various technologies encompassed within.

Responses in Full

Nafisa Barot, Utthan, Ahmedabad

Utthan has some experience in using the solar stills for accessing potable water in 1982, in some of the saline areas of Gujarat.
Our experience then was as follows:
It is a technology which would work well depending on the clear sky/ high temperature. We found that in our areas, due to strong winds, the transparent cover (glass or other material) would soon be covered with dust and reduce the distillation rate.
Secondly, we needed some good quality water (even if saline) to mix with the distilled water to make it potable. This requires careful handling/ mixing mechanism, if done manually. Perhaps now those mechanisms might be in place.
Our experience showed that unless and until there was no other option for 'potable' - meaning fresh water (even if bacteriologically unfit), communities found it less interesting in handling it.
Hence, the important consideration is where it is being done? In the rural areas? Is community really prepared for its operation and maintenance? One should find out the latest costs/ technological options.

We had also tried out Reverse Osmosis for desalination. Though there are various improvements in the technologies one should again see whether it is required for industries or at the community level.

Cost is another factor that needs to be considered if to be maintained and managed by communities. Apart from this, disposal of saline water after desalination is another issue to be kept in mind.

Our experience in saline areas in Gujarat showed that it is possible to harvest rain water in lined ponds, and in roof top water collection in the tanks, if it is not possible to recharge the ground water.

Dinesh Kumar, IWMI, Anand, Gujarat

Your inputs on solar stills are extremely valuable. On a different note, when it comes to desalination, we seem to be quite concerned about the cost and economics. But that does not seem to be the case with Roof Rain Water Harvesting Systems (RRWHS). Why?

RRWHS in many situations cost around Rs. 30/m^3 of water (if it collects water!) after amortizing the cost over the 40 year life. Is it not expensive? I have come across tens of such structures built in Gujarat, but in many situations do not serve any purpose (this is not a commentary on any specific agency's work). On the other hand, desalination would cost only in the same range or even less for salinity in the range of 3000-4000 ppm. In many coastal areas, it is easy to get groundwater of this quality. This includes operation and maintenance costs. Of course, there are quite a few operation and maintenance issues involved in Reverse Osmosis (RO) as well apart from the cost part (power supply, availability of service engineer etc.).

We must remember that taking water from the RRWHS tank also costs labour and time. Efficacy (rainwater collection efficiency) of the system would depend on the quality of design and installation. Over and above, who is going to take care of the water quality, main threat to which is biological contamination (people try and lift water using buckets from the tank instead of using the hand pump)?

These are my quick reactions.

Terry Thomas, Participatory Learning and Action Network (Planet Kerala), Trivandrum

We would like to introduce our organisation Participatory Learning and Action Network. We are involved in community experimentation, where Solar Distillation is one component for providing potable water in coastal areas in Kerala. A prototype of a solar still is currently being evaluated, which is fabricated locally. Details regarding the same may be retrieved from our website (http://www.planetkerala.org/links.htm).

Nafisa Barot, Utthan, Ahmedabad

My comments on experiences in desalination are not limited to cost only. There are other factors which need to be taken into consideration.

We need to understand why there is such a huge demand for roof rain water harvesting as compared to desalination alternatives at the 'community' level? Question is about security, reliability and cost effectiveness. So even if in an economist perception roof water tank is more expensive, communities'

response, especially from the women is that they are willing to pay /bear the cost for maintenance. So they 'trust' systems which is more reliable.(dependency on others, electricity etc.)

Pumping water from the roof water tank would be much less laborious then bringing water home from a source away from home.

I would suggest that you may want to visit those places where women/ community members are using the tanks for long/ short time and are happy. If we can assure reliability and address all the other issues I have raised in my earlier mail, then perhaps community will have more choices and then let the community decide, if they would like to go for desalination.

Dinesh Kumar, IWMI, Anand, Gujarat

The "dynamics of the great community demand" needs to be understood. If the demand also means the willingness to pay, then the community should pay for it. At present, in almost all situations I know, RRWHS is being pushed as a heavily subsidized scheme. The community members are not paying anything significant from their pocket except taking care of the labour. This is not to underestimate the value of labour.

Secondly, the RRWHS are being used as intermediate storage system for the "water" being supplied through either long distance pipelines or tanker. Well: this is based on my observation from the field and women told me. First the water collected is too insufficient for domestic uses; then villagers do not find great merit in taking the pain in storing the roof water. So let us make a distinction between the "resource" and "supply/storage infrastructure".

When it comes to desalination, well if you are willing to run the system, they might be willing to use the water even by paying. But, then we want to pay the full O & M cost, which is quite significant. The problem is that we want the community to operate and maintain the system before they understand the technology itself.

Also, we underestimate the maintenance requirement in a RRWHS tank. The fact of the matter is that it is not maintained (cleaned; or protected in most situations). We also need to understand in how many cases people actually drink the water collected from roof top. In some villages, women expressed their resistance to use water stored in the tank for drinking either due to the social taboo or perhaps they know that it is contaminated.

I happened to see a case in a village in Kachchh, where tens of school children were fighting to collect water from a tap connected to a pipeline scheme, when just 10 metes away, there was a RRWHS tank (well constructed and collected a lot of water from the roof!!!) lying idle. Nobody touches water from this tank though there is a hand pump.

Shirish Sinha, IWMI, New Delhi

Economics of desalination units is critical, and it becomes even more critical in case of *solar* desalination units. I have a counter question for Srinivas, which is similar to the points raised by Nafisa in her first mail. The question for Srinivas is: what is the capacity and cost of the solar desalination units that you are considering under your project? Related questions: at what scale

would these be economically viable, and at what scale are you implementing the project? How does the "economics" and "scale" compare with other systems such as Reverse Osmosis.

I think the discussion should move beyond RRWHS. Certainly there are advantages, but there are also limitations which have been brought in exchange of emails.

What are the other technologies for desalination? What have been the experiences with them, including "economics" and "scalability"?

Dinesh Kumar, IWMI, Anand

I am not a specialist on desalination system. But whatever available data available with me says: there is economy of scale in most desalination systems. But the capital and the operating cost per unit volume of treated water reduces with plant capacity. There are three techniques which have industrial application, which I am quite aware of: 1] Reverse Osmosis plants; 2] flash distillation process; and 3] electrolysis. Those who are in the field should correct me if I am wrong.

From electrolysis, you get distilled water. RO is demineralization to almost 98 per cent. The Tata Chemicals had been using RO for quite some time. Reliance uses Flash distillation process to produce 7-10 million litres of water a day. They have been supplying water to Jamnagar city for municipal uses during droughts.

ROs are being used by private entrepreneurs for selling drinking water to towns and cities in north Gujarat which are affected by fluoride and high TDS in groundwater. The cost of production is around 12-15 paise per litre and they sell at 35 paise per litre. Well, it all depends on judicious selection of plant size and capacity utilization. But the cost could be brought down to 3-4 paise per litre for large plants.

Ravi Parthasarathi, Tata Projects Ltd, Hyderabad

Tata projects Ltd, Hyderabad have developed and deployed defluoridation plants using reverse osmosis in rural areas where water is being sold at 5 -7 paise per liter.

Many thanks to all who contributed to this query!

If you have further information to share on this topic, please send it to Solution Exchange for WES-Net at se-wes@groups.solutionexchange-un.net.in with the subject heading "Re: [se-wes] Desalination Techniques, from TERI, Bangalore (Comparative Experiences)".