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WATER AND SANITATION FOR ALL: PARTNERSHIPS AND INNOVATIONS

Pilot solar desalination plants in Bangladesh

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ACCORDING TO UNICEF and DPHE (1994), as of 1991, about 85 per cent of rural Bangladeshi households have access to safe drinking water within 150m and in urban slums 98 per cent households are within 150m of safe water sources. But in hilly areas and the coastal belt over 20 per cent people have to go more than 200m to get clean water. The main source of water for human consumption in Bangladesh is ground water. But the availability of ground water is however, not uniform throughout the country as various constraints prevent a more uniform development of ground water. In general, public tubewell coverage is very good, but in coastal belt, there are some pockets where people do not have good access to tubewell water. While in the high water table areas, there is one tubewell for 78 persons, the corresponding figure is 242 for the coastal belt where 11 per cent of the total population of the country reside. In the coastal belt major obstacle in the use of ground water has been identified as high salt content (in excess of 1000mg/1). It is however, been possible to pump sweet water from deep seated aquifers by the use of deep tubewell. Very shallow and deep shrouded tubewells have also been used to extract water from perched sweet water aquifer lenses found around the sweet water reservoir. These kinds of tubewells perform well but they can not completely solve the problem of sweet water shortage in the coastal areas since such aquifers are not always found at convenient locations. Even if available, pumping up ground water would be cost-prohibitive particularly for the rural areas of Bangladesh where per capita income is very low. Thus it appears that the desalination of brackish water could be an effective solution to the problem of water supply in the coastal areas if cost effective technologies can be adopted. The cost of conversion of brackish water to fresh water by the use of solar energy is still relatively high with the present state of knowledge and technology. However, solar energy is renewable, inexhaustible and free of cost but available only in a form of low heat. Again the application of solar distillation process has promising potential because solar stills possess the advantage of having the least possible moving parts, no requirement for specially trained personnel for maintenance and operation where conventional water treatment methods may not be feasible especially to meet small scale demands of villages or isolated communities, and most important of all, operation costs are low because the source of energy is free. Thus this action research has been undertaken with a view to studying the applicability of different types of solar distillation plants in the coastal areas of Bangladesh and recommending options for design, construction and operation of such plants.

Construction details of solar stills

In this study, different types of single basin solar stills were constructed. These designs differ in structure and material of construction, but basically, incorporate common elements for different functions. The principal criteria for selection of materials and developing the design of still was local availability of materials and cost involvement, efficiency, and ease of construction and maintenance. The stills are characterized by a single basin (base and wall) to store saline water and one or more transparent covers on top of the basin (Figs. 1 & 2). From a review of the literature, at first attempt was made to construct stills as shown in Fig. 1 that can be fabricated with skilled labour and shipped to the remote areas for use. It was decided that mild steel, wood and ferro-cement would be used to construct still basins. Experimental investigation with these solar stills indicate that their construction cost are much higher compared to their output (Mamtaz et al, 1996). Subsequently it was decided to construct still basins with brick and cement plastered clay. However, such type of still basins have a limitation that they have to be constructed at the site. This research has been implemented in two phases. In phase I, although different types of materials were considered for construction of still basins, only basins constructed with mild steel ferro-cement and brick were operated as these produced reasonable amount of yield. In phase II, field investigations were commenced in the coastal belt and at the same time laboratory investigations were also continued. On the basis of market survey and detail analysis, the cost involvement of different types of solar stills along with a brief description of materials used for the construction of still basins and transparent covers are presented in Table 1. However, detail description of these plants are available in Rahman. et al (1996).

Experimental work

In phase I, all experiments were conducted on the roof of the Civil Engineering Building of Bangladesh University of Engineering & Technology (BUET), Dhaka (the longitude latitude are 90°23’E and 23°46’N respectively). In phase II, some new plants were constructed and operated

Figure 1. Single basin solar still with inclined glass cover design

at BUET, Dhaka and at field, Kaligonj thana of Satkhira district which has a longitude and latitude of 89º01'E and 22º27'N respectively. The plants at the field were placed on the ground. The saline water was supplied to plants through their inlet pipes four times a day (at 9am, 12 noon, 3pm and 5.30pm) and the amount of the water supply was fixed based on the objective of maintaining 1 inch (25.4mm) depth of water in the basin. Distillate amount, air temperature outside the still and on the glass cover, and water temperature inside the still were measured for four times a day (at 9am, 12 noon, 3pm and 5.30pm). Schedule of data collection is shown in Table 2.

Result and discussion

Table 3 shows the maximum, minimum and average yields and the cost per litre of yield on the basis of initial investment cost of all plants during their respective time of operation. The water obtained from the plants was totally free from salinity. The salinity of water in the coastal areas of Bangladesh varies in general from 1,000 to 2,000 ppm and the acceptable limit for drinking purpose is 600 ppm. Therefore, an equal amount of tubewell water may be mixed with the output of the plants to increase the stock of water (considering salinity of 1,000 ppm). The lowest cost (TK. 621 (US$14), Table 3) per litre of yield is obtained from clay plant. However, the yield of Brick plant 1 (1.4 $lm^{-2}d^{-1}$) is much higher than the clay plant (0.7 $1m^{-2}d^{-1}$). Again the basin constructed with bricks have the advantage that these are safe against natural catastrophe and unfavourable climatic conditions. Its life time will be much higher than then the clay plant.

Table 1. Materials and cost involvement of different stills

The desalination plants with proper cleaning can also be used to collect rain water during the rainy season. Then a tap of TK.10 (US$ 0.23) has to be provided with the plant for collecting rain water to minimize contamination of storage water.

Recommendation

From the foregoing discussion, it appears that the Clay plant (cement plastered) performed well during the experimental investigation period, was easy to construct, operate and maintain and involved less cost. However, the yield was rather low. Brick Plant 1 involved higher cost when compared with the clay plant but provided higher yield as well. Although cost per litre was lowest for Clay Plant (cement plastered), the higher yield of Brick plant 1 made it a more convenient source of desalinated water. Further, clay as construction material si not as durable as brick and will therefore need more maintenance. Therefore, it can be recommended that, of all the plants studied under the project, B rick Plant 1 is the best suited solar desalination plant for Bangladesh. This type of plant was constructed, installed and operated both at BUET and at the field (Brick Plant 4) and it performed satisfactorily at both places.

References

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Figure 2. Single basin solar still with stretched double sloped plastic cover design

Table 2. Schedule of data collection

Table 3. Output of stills