



**Center for Global & Strategic Studies  
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## **Use of Bio-Solar Reactor for Pond Water Treatment in Pakistan**

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Adequate access to water and sanitation is one of the basic human rights. The burgeoning population growth coupled with the concepts of urbanization and industrialization in the 21<sup>st</sup> century calls for an improvement of the current water and sanitation systems. Urbanization and Industrialization are the two phenomena

that have disturbed the balance between the demand of water and the natural recharge. Water resources are becoming scarce, and the ones that are available have been contaminated, rendering them unfit for human consumption. Therefore, gaining equitable and affordable access to clean water has become one of the biggest challenges for the humanity. According to the United Nations Environment Program, the predicted strife between the water demand and supply could be as high as 40% by 2030. About 2.6 billion people in the world do not have adequate access to sanitation facilities whereas around 900 million people live without having access to clean drinking water (UN-Water, 2010). With the provision of adequate water and sanitation facilities, lives of around 2.4 million people could be saved (Pr ü ss-Üst ü net al., 2008).

In many developing countries, centralized treatment systems are quite expensive and involve complex sewerage networks in the urban areas where, at the same time, a large number of houses do not even have sewer systems (Crites and Tchobanoglous, 1998). Therefore, it is imperative to adopt decentralized treatment solutions which are congruent to the needs of a particular locality and environment.

Among a plethora of on-site treatment systems, one of the most feasible and pragmatic approaches is to develop a Bio-Solar Reactor (BSR). BSR is a novel technology where rainwater or municipal wastewater can be stored in ponds, reservoirs, and dams. Such a system can be completely mechanized and is fully capable of utilizing solar energy for biological treatment of the sewage water. The operation of this system using solar-powered microcontrollers allows it to meet energy needs even in remote areas where electricity is not accessible. It makes use

of the microbial consortium which is a community of different species of microorganisms living together. The core of this system involves alum as a coagulant (an adhering material) and aerators for treating wastewater present in the pond.

### *A Practical Approach to Bio-Solar Reactor for Water Treatment*

Each year during the monsoon season, Pakistan is vulnerable to floods. These floods at one hand, cause catastrophic impacts on the life and property of country's inhabitants, at the same time, result



in deterioration of the water quality mostly in the rural areas. Water from these regions is frequently contaminated with nitrogenous waste, algal bloom, and eutrophication which results in high turbid water. The inefficiency and the difficulty associated with the application of conventional treatment methods like Activated Sludge Process (ASP), trickling filters and Oxidation ponds in these remote areas have vexed the research community to search for sustainable solutions to this problem. The prevalent water and energy crisis in Pakistan necessitates the development of a technique that holds the ability to not just treat wastewater but also to treat it in the most energy-efficient manner – Bio-Solar Reactor seems to go well in this regard. Keeping the rural areas of Pakistan in perspective, *Institute of Environmental Sciences and Engineering (IESE) at National University of Sciences and Technology (NUST)* developed this technology which, unlike conventional

water treatment plants, does not have a huge land or energy requirement and can effectively treat municipal wastewater. Wastewater coming from the residential areas, particularly rural, where appropriate treatment facilities are lacking, can be collected in ponds with Bio-Solar Reactor installed within the pond for the treatment of wastewater. Treated wastewater from this pond can be reused for horticulture and agricultural purposes.

A self-contained system, BSR has been primarily designed for treating greywater (a terminology used to refer to the relatively clean wastewater coming from baths, sinks, and kitchens, etc.) The treatment is carried out by virtue of microbes, which decompose the organic material present in the wastewater. A coagulant such as alum can be used which would cause the suspended particles to adhere together and eventually settle down – a process called sedimentation of the suspended particles. Microcontrollers, run on solar energy, are used for the aeration of the pond water which is important to maintain a certain dissolve oxygen (DO) level.

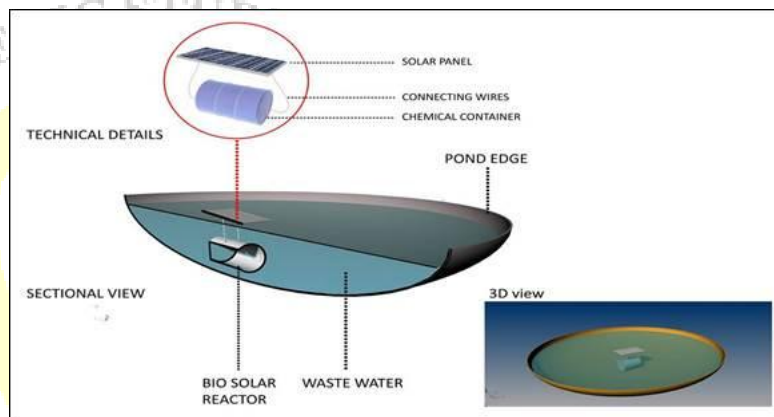
#### *The Underlying Mechanism of Bio-Solar Reactor (BSR)*

Treatment of the pond wastewater starts each day when the solar radiations first strike the pond. To ensure homogenous conditions throughout the pond, mechanical pumps are used which circulates the wastewater in the whole pond. Two pumps are used for aeration of water. When the pond water comes into contact with the atmospheric air, oxygen gets dissolved in it. A Floater



Unit Pump is installed which causes jets of water to originate from the surface of the pond. These jets of water results in ripples on the water surface which further increases the dissolved oxygen. Therefore, the presence of oxygen-dissolved water in the top layer of the pond water do not allow anaerobic digestion (breakdown of organic matter in the absence of oxygen) to take place.

This BSR is a submersible unit which has been provided with the mechanism to release water jets which help in maintaining the flux in water which, in turn, enhances the aggregation process. This submersible BSR unit has in-built ability



to release a prescribed dosage of precipitant which aids the process of aggregation. During night time, the water jets stop which leads to the settling of organic pollutants to the bottom.

The consortium of the effective microorganisms are placed in the BSR unit, and the moment this BSR unit gets submerged and water contacts with these microbes it activates the capsuled microorganisms. The Bio media provided in the BSR unit is the source of nutrients and food to microbes for their nourishment in a safe environment. These bacteria feed onto the organic pollutants which get entrapped to the media. One type of bio media used to achieve the desired goal is *Macaroni*, which can be used as a supplement to provide all the essential nutrients to the microbes including proteins, fats, and carbohydrates. These bacteria then find their



way out of the submersible BSR unit and start making colonies in the rest of the pond. Using the phenomena of aeration at the surface and aggregation of pollutants at the bottom helps to ensure that the anaerobic digestion (digestion taking place in the absence of oxygen) is restricted only to the bottom of the pond. This is an effective way to control the odor problem as anaerobic digestion involves the release of pungent smelling gasses.

### Way Forward

Given the current scenario in the country on the degraded water quality and contamination of the previously clean water resource, we should be mindful of the alarming situation that we have put ourselves into. There are only two ways emerging from this standpoint. Either we continue the business-as-usual pathway and call for our demise, or we take a tilt towards sustainable development and base our actions on the following guidelines:

- a. The effectiveness of the technique of Bio-Solar Reactor for treating wastewater can be enhanced by using it in conjunction with the water disinfection methodologies.
- b. Villages and small towns without any appropriate wastewater treatment facilities must adopt this system to collect their wastewater in a pond and treat it to reuse this water for useful purposes. This can help in meeting the local irrigation needs of the village farms.
- c. This system is driven by solar energy which precludes its dependence on electricity. Such an aspect of this system coupled with the rest of the components makes it fit for usage in any remote area. Therefore, rural areas

and suburbs of cities that are not yet connected to the national grid system should take maximum benefit from the adoption of this technology.

- d. To further increase the efficiency of the BSR system, algal bloom appearing on the surface of the pond should be cleared out simultaneously.

### Conclusion

Use of BSR for the treatment of wastewater collected in a pond, from a group of houses in a rural setting is an effective way of reclaiming and reusing wastewater for agricultural and horticultural purposes. For a country like Pakistan which is on the verge of becoming an absolutely water scarce country, reclaiming greywater can be the most plausible way out in the given circumstances. This Bio-Solar Reactor (BSR) was designed and tested by the *Institute of Environmental Sciences and Engineering (IESE)* at *National University of Sciences and Technology (NUST)* which has been a success. The algal blooms that may appear at the initial stages of the test run eventually get cleared out once the consortium of bacteria (a community of multi-species microorganisms living together) gets activated. According to the study conducted at IESE, such a system holds the ability to purify 85% of the pond water within 10 to 15 days. Owing to the solar-powered microcontrollers, this system is fully capable of providing treated water in remote areas, and this treated water can then be disinfected by desired use of the effluent.