OPINION ARTICLE

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Phycoremediation – Present and the future

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Phycoremediation refers to the technology of using algae for the remediation of wastes, predominantly in the treatment of wastewaters as a part of the secondary treatment. The term ‘phycoremediation’ is in vogue for more than a decade, and of late the technology has begun to taste commercial success. A number of articles have been published on phycoremediation research and many authors have successfully established the fact that treatment of wastewaters using algae, microalgae in particular, leads to remarkable reduction of an array of organic and inorganic nutrients, including some of the toxic chemicals (Beneman et al., 1980; Gantar et al., 1991; de-Bashan et al., 2002; Queiroz et al., 2007; Thomas et al., 2016). With the support of the voluminous research data available, successful pilot-scale/field-scale studies have been on the rise (Aziz and Ng, 1993; Sivasubramanian et al, 2010; Rao et al, 2011). Needless to say, implementation of phycoremediation as a technology at a larger scale/mass-scale is being/has been successfully attempted across the globe (Oswald and Golueke, 1960; Sivasubramanian et al, 2009). Aside from its good bioremediation efficiency, use of microalgae offers lots of other advantages too. Although conventional biological treatment systems such as activated sludge process is highly efficient in terms of removal of organic load, major drawbacks such as sensitivity towards pH are inevitable; even small changes in pH will lead to crashing of the reactor. On the other hand, microalgae are robust enough to withstand extreme pH values ranging from highly acidic to alkaline. Moreover, most microalgal species upon growth stabilize the pH in the alkaline range but not exceeding 9, which is the upper limit standard for discharge of treated industrial wastewaters. Thus use of microalgae technology will help reduce the use of pH-correcting chemicals thereby leading to ecofriendly approach and in turn cost incurred for the same.

The other major benefits that can be reaped by implementing the above technology are effective carbon sequestration, oxygenation of the environment due to photosynthetic activity, and generation of biomass for production of carbon-neutral biofuels. Hence this technology offers one of the promising solutions for tackling global climate change and acidification of oceans thereby offering extreme environmental sustainability. In the recent past, there have been innumerous constraints and bottlenecks impeding its commercial deployment. However, the scenario is changing very recently; backed by the data at pilot-scale levels, many industries have begun to accept this novel technology. The success story of commercialization of phycoremediation technology started with the implementation of world’s full-scale phycoremediation plant at SNAP Alginate Pvt. Ltd., India, by Sivasubramanian and his co-workers (2009). Subsequently, India-based Phycospectrum Environment Research Centre (PERC) has installed full-scale plants in numerous industries across India as well as in many other countries. Very recently, the algal technology company has installed/is in the process of installing large-scale plants in reputed industries such as Brintons carpets, UK, Pacific Rubiales oil-drilling site, Colombia, KH exports, India, Ranitec CETP, India, etc.

Infrastructure development, modification of existing infrastructure, educating and training the operators, and biomass separation are other some of the minor hurdles in implementation.To overcome the above constraints, amalgamation of algal technology with the existing conventional treatment facilities is a wise option, where algae will help in removing some of the nutrients and also help stabilizing the pH for

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effective bacterial treatment. For some industrial waste treatment, phycoremediation alone will suffice. However, for this technology to be taken to a still higher level,, the awareness of using phycoremediation and its importance have to be disseminated by the scientific community with respect to environment sustainability, gaining carbon credits, and creation of wealth from waste. The integrated approach of waste remediation and generation of biomass is being talked about in recent times. With the fluctuating fossil fuel prices and sudden surge in the use of fracking technology, there is an urgent need for sustainable generation of biomass at a very cheaper cost. This can be achieved by proper and planned management of this technology such as effluent pooling for bioremediation and biomass generation for producing value-added products as well as commodity products. Such innovations will for sure help overcome the comparatively slower treatment rates by providing greater commercial gains. In addition, revisions of policies by the government pertaining to environment management and industrial waste mangement will certainly facilitate implementation of such ecofriendly technologies without any difficulty. For example, providing technical as well as financial support, subsidies, tax benefits, etc., will encourage both the start-up and already-existing industries to implement new bioremediation technologies with multiple benefits. To conclude, complete replacement of existing secondary treatment systems with more environment-friendly and profitable phycoremediation technology depends on the joint effort by the policymakers, entrepreneurs and the scientific community.

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