



On the Perspective of Applying of a New Method for Wastewater Treatment Technology: Modification of the Third Traditional Stage with Two Units, One by Cultivating Microalgae and Another by Solar Vaporization

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Abstract

This Short Communication presents the concept of a new method for water/wastewater treatment technology using microalgae cultivation in effluents with the aims to treat, clean, and recycle waters using two units: the first one for cultivating microalgae and the second one through using sunlight and other types of renewable energy (wind photoelectric phenomena) modifying the physicochemical properties for vaporizing water that resulting from microalgae cultivation. The combined production of biomass by microalgae cultivation in polluted waters can allow achieving two main objectives: first, generate clean water and reuse it, and second, producing biomass, which may be used as resource for biofuels. Alternatively, it can be grown the microalgae using the CO₂ produced by anaerobic digestion, while methane (CH₄) as fuel after separation of biogases. The research objectives will be attained by setting up a device for wastewater treatment, microalgae cultivation, and cleaning water from wastewater by a solar unit. This process will reuse the effluent for growth of microalgae in photo-bioreactor and open system (outdoor pond). A global process study should also be performed with the aim of establishing the feasibility of scale-up application.

Keywords: Wastewater Treatment; Water Recycling and Reuse; Equilibrium; Vaporization; Microalgae Cultivation; Bioenergy; Photo-Bioreactor; Biogas

Introduction

There are several technologies for the treatment of water/wastewater, but the available methods depend on their availability and economic factors Al Arni S [1], Ghernaout [2-4], Amous [5]. In this regard, the biological removal of contaminants by microalgae is one of the most promising because it utilizes contaminants, as nutrients to culture biomass, and sunlight as the energy source for photosynthesis, both being free Souza [6]. Today microalgae have shown to have considerable potential as raw material in many applications such as a biomass feedstock for production of renewable energy Ghernaout [7], Solisio [8]. Microalgae, like plants, use sunlight to produce hydrocarbons and oils but they do so more efficiently than higher plants Frumento [9,10], Ghernaout [11]. Microalgal biomass production can potentially make use of some of carbon dioxide released by burning fossil fuels in power plants, which is one of the main contributors to the global greenhouse effect. Therefore, using microalgae to remove contaminants from waters from different origins would be an excellent solution from both environmental and economic viewpoints Converti [12]. Some types of microalgae are able to reduce chemical oxygen demand (COD) and biochemical oxygen

demand (BOD₅) of wastewaters by more than 98% Majone [13], Liu [14], Mata [15].

In this research-project, researchers will investigate (1) the capability of microalgae to remove contaminants from water and (2) the capacity of sunlight to vaporize water. There are three main stages of traditional wastewater treatment systems, namely: (a) physical treatments, mainly settling and screening to remove solids, (b) biological treatments to remove oxygen and suspended solids, and (c) chemical treatments to remove nitrogen, phosphorus, and other chemical compounds in the effluent coming from the second stage. The original idea here is to use the cultivation of microalgae in a broth from contaminated wastewater, with the aim of cleaning and recycling these treated waters Frumento [9,10] and the produced biomass as a feedstock for production of biofuels. Our idea is modifying the traditional wastewater treatment system by changing the third stage with two units. One unit for cultivating microalgae and the second one using sunlight to vaporize the rest of water after microalgae cultivation with the aim to save, recycle and reuse this water. Researchers also attempt to modify the biological treatment stage to capture biogas and save bioenergy.

This research-project will offer a sustainable solution to well-known environmental problems such as the domestic drinking water-supply and sewer systems associated with the rapid population growth Amous [5]. Besides the obvious benefit of cleaning, recycling of waters and biomass production, this research-project will pursue a number of other sub-objectives that are also important for the biotechnology sector. First, the project will investigate the usefulness of reutilizing contaminated

water/wastewater from local municipal wastewater treatment plants and industries Manouchehr [16]. The second aspect of the research is to investigate the growth of local microalgae in photo-bioreactor and open pond production systems using contaminated water and internal carbon dioxide from biogas externally produced. The results of this step are quite important for either the environmental and renewable energy fields.

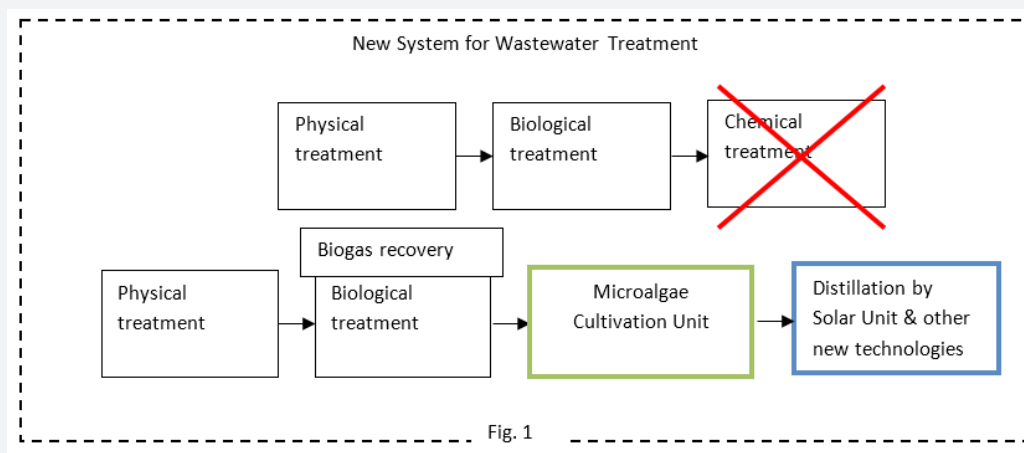


Figure 1: Modification diagram of the traditional wastewater treatment stages and proposed integrated process of biomass production with water cleaning by solar unit.

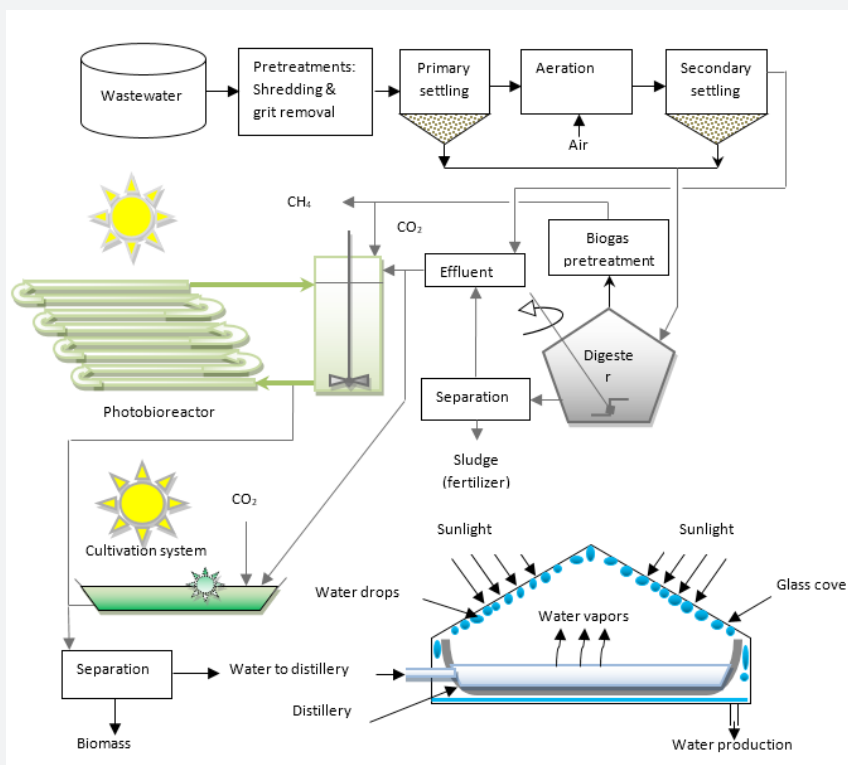


Figure 2: Schematic diagram of the proposed integrated process of biomass production, biogas and water cleaning by solar unit.

The proposed work is based upon modifications of the traditional wastewater treatment systems by changing the second and third stages. The former modification deals with the biological treatment stage to allow for capture of biogas, energy savings and use of biogas CO₂ for microalgae cultivation. The latter

modification of chemical treatment implies the two units: one unit for cultivating microalgae and the second unit using sunlight to vaporize the rest of water after cultivation (Figure 1), with the aim to save, recycle and reuse this water. For this, researchers will set up an experimental bench-scale plant with 50-L wastewater

capacity. The plant is expected to perform simultaneous production of biomass and water cleaning in a combined and innovative process, which is schematically represented in the attached scheme (Figure 2). The effluent from this stage, still containing nutrients such as nitrogen, phosphorous, heavy metals and other chemical compounds, will be used after some treatments for cultivation of local microalgae such as *Ankistrodesmus*, *Chlorella*, *Chlamydomonas*, *Euglena*, *Oscillatoria*, *Golenkinia*, *Micractinium*, *Nitzschia*, *Navicula*, *Stigeoclonium* or *Scenedesmus spp.* Palmer [17,18], González [19], De-Bashan and Bashan [20], Ghernaout [21], Ghernaout and Ghernaout [22], Attilio 2013, Ghernaout [23], Frumento [7,8]. Such approaches are included in the new trend conducted by researchers and engineers for green processing in a sustainable production system Mazzei [24], Furlong [25].

Conclusion

This Short Communication shows the idea of a fresh technique for wastewater treatment technology employing microalgae cultivation in effluents in order to treat and recycle waters throughout two units: the first one for cultivating microalgae and the second one for using sunlight and other technologies based on renewable energy resources, with relying on deeper investigation between vaporization and physicochemical properties, such as surface tension, composition and parameters that affecting on the heat of vaporization of wastewater which resulting from microalgae cultivation. The combined production of biomass by microalgae cultivation in polluted waters can allow achieving two main objectives: 1) generate clean water and reuse it, and 2) producing biomass, which may be used as resource for production of biofuels. Alternatively, it can be grown of microalgae using the CO₂ produced by anaerobic digestion as nutrients, while methane (CH₄) as fuel after separation of biogases. The research objectives will be attained by setting up a device for wastewater treatment, microalgae cultivation, and cleaning water from wastewater by a solar unit. This process will reuse the effluent for growth of microalgae in photo-bioreactor and open system (outdoor pond). A global process study should also be performed to establish the feasibility of scale-up application.

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