PARALLEL NUTRIENT REMOVAL AND BIOMITIGATION OF CO2 BY PURE (*CHLORELLA VULGARIS*) AND MIXED ALGAL CULTURES

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ABSTRACT

Microalgae are one of the most important bio-resources that are currently receiving a lot of attention due to a number of reasons. For example, they have diverse applications in the field of waste management such as removal of nutrients, organic contaminants, heavy metals, etc. Microalgal cultures can also be used for the treatment of olive oil, pulp and paper, and iron and steel industry wastewaters. Photosynthetic oxygen production by microalgae reduces the need for external aeration, which means lower energy requirement in the field of aerobic treatment technology. This process is advantageous, in particular, for the treatment of hazardous pollutants to be biodegraded aerobically and might volatilize during mechanical aeration. Moreover, the harvested microalgal biomass, itself, constitutes a raw material for the production of different high-value chemicals and bio-fuels such as biodiesel and bio-ethanol.

Nutrient discharges to natural waters have contributed to an increase in many problems such as eutrophication. Water quality legislation has increased the standards regarding nutrient removal in order to overcome eutrophication problems in receiving waters. With more stringent standards imposed regarding nutrient removal, processes have been developed to remove compounds containing nitrogen and phosphorus. However, nutrient removal from wastewaters is still a significant concern in many countries due to its high cost. Therefore, effective and low cost technologies for nutrient removal from wastewaters are in great demand.

Due to the fast-growing concern about global warming, which can be attributed primarily to the elevated CO2 level in the atmosphere, the United Nations promoted the Kyoto Protocol (1997) and more than 170 countries have ratified the protocol. Various CO2 mitigation strategies have been investigated, which can be generally classified into two categories: (1) chemical reaction-based approaches, and (2) biological CO2 mitigation. Chemical reaction-based methods for capturing CO2 are relatively costly and energy-consuming, therefore, the mitigation benefits become marginal. Biological CO2 mitigation has attracted much attention as an alternative strategy because it leads to the production of biomass energy in the process of CO2 fixation through photosynthesis. It can be carried out by microalgal cultures in addition to the other plants. The microalgae-for-CO2-mitigation strategy offers numerous advantages especially when it is combined with other processes such as wastewater treatment.

Therefore, this study investigated coupled nutrient removal and greenhouse gas mitigation by

using microalgal cultures. This innovative configuration does not only tackle with waste management issues (wastewater treatment and CO2 mitigation) but also generate bio-fuel (biogas, biohydrogen) and bio-product (fertilizer) if the produced algal biomass is further processed. Moreover, the parallel waste management and bio-energy/bio-product generation which constitutes another dimension of our work, is a novel example of waste valorization and sustainable waste management approach.

Within the scope of this study, a wastewater from steel-making industry wastewaters was treated by a photo-reactor containing both pure and mixed microalgal cultures. The reactors which were operated at three different solids retention times, were fed with a gas mixture containing 4% CO2 simulating the iron and steel-making industry exhaust gases. The results indicated that the parallel nutrient removal and bio-mitigation of CO2 is possible by using microalgal cultures.

Keywords: Algae, Chlorella vulgaris, nutrient, bio-mitigation, CO2, iron and steel-making.