Wastewater treatment with mixotrophic microalgae for high-efficiency nutrients removal and circular economy

Jo-Shu Chang$^{1,2,3}$ and Chun-Yen Chen$^4$

$^1$Department of Chemical Engineering, National Cheng Kung University (NCKU), Tainan, Taiwan
$^2$Research Center for Circular Economy, NCKU, Tainan, Taiwan
$^3$Research Center for Energy Technology and Strategy, NCKU, Tainan, Taiwan
$^4$University Center for Bioscience and Biotechnology, NCKU, Tainan, Taiwan

Specific mixotrophic microalgae are able to grow on varieties of wastewater with the capacity of COD reduction and nutrients (N and P) removal. The strength of using microalgae for wastewater treatment mainly relies on their excellent ability to remove N and P from wastewater even in the absence of COD. For the wastewaters containing high content of antibiotics or other micro-pollutants, microalgae-based treatment could be more effective than the conventional bacteria-based activated sludge systems. The microalgal biomass produced during wastewater treatment could be utilized as fertilizers or animal/aquacultural feeds after proper treatments to gain additional benefits via circular economy concepts. The performance and characteristics of using microalgae to treat a variety of wastewaters (e.g., livestock wastewater, fishery wastewater, municipal wastewater, and so on) will be presented. The feasibility and challenges of the microalgae-based wastewater treatment will be discussed. A novel circular economy technology that combines flue gas CO$_2$ fixation, wastewater treatment with microalgae cultivation, and the follow-up high-value algal biomass utilization and refinery will also be introduced.

**Keywords:** Microalgae, Wastewater treatment, Mixotrophic growth, Nutrient removal, Flue gas CO$_2$ fixation, Circular economy, Animal feed, Aqua-feed, Biorefinery