PREFACE

Textile and dyeing industries are considered the most polluting industries based on both the amount and the toxic content of effluents. Dye-contaminated effluents discharged from industries are considered one of the major concerns among environmentalists. The remediation and abatement of these toxic dyes from the environment is a serious concern since these pose adverse impacts on humans as well as on the aquatic ecosystem.

Several treatment techniques comprised of chemical, physical, and biological have been used over the past few decades for the degradation of dyes. These are adsorption, coagulation, membrane filtration, ozonation, etc. However, these techniques are associated with demerits such as high sludge production and expensive cost. The biological method has several merits such as low-cost, eco-friendly, and less harmful sludge production over conventional physicochemical processes. Various researchers adopted the free-cell technique for dye degradation, which involves the addition of free-cell microorganisms directly to the bioreactor. However, free cell processes often have limited application under a high inlet loading rate. To rectify the above problem, the immobilized cell technique has received major attention. In this technique, the microorganisms grow on a carrier surface, and subsequently, immobilized carriers are used as packing material in the bioreactor.

In the direction of the attached growth bioreactor, the packed bed bioreactor (PBBR) has been widely utilized for the biodegradation of various organic pollutants. Various packing materials such as sodium alginate, polyurethane foam (PUF), biochar, and polymeric support were used for the immobilization of microorganisms. In order to scale up these lab-scale reactors to industrial scale accurately for biodegradation, the role of mass transfer correlations is an important aspect of the effective operation of bioreactor.

However, several studies have shown the existence of non–biodegradable or low-biodegradable compounds in textile effluent. The existence of these non–biodegradable compounds causes a lower biodegradability index (BOD_5 : COD < 0.2) and makes biological treatment ineffective for the majority of industrial wastewater, including textile industry. The biological methods are typically effective for wastewater having BOD_5 : COD ratios greater than 0.4. In this context, new technologies for the treatment of textile wastewater have been developed. The principle of advanced oxidation processes (AOPs) is to produce strong oxidizing radicals, specifically the hydroxyl radical ($OH^{\bullet}$), which is having high oxidation potential ($E^{\circ} \cong 2.8\ V$) and is capable of oxidizing highly recalcitrant contaminants. Hydroxyl radical ($OH^{\bullet}$) can be generated by individual processes which include ozone (O_3), UV fenton, hydrogen peroxide (H_2O_2), UV/H_2O_2, $O_3/UV/H_2O_2$, and $O_3/TiO_2/H_2O_2$ system. Among all these existing advanced treatment processes, ozonation is preferred as a viable alternative for textile wastewater treatment owing to its high selectivity towards the chromophoric group of an azo dye, less sludge formation, and adaptability across a wide pH range.

In connection with the optimization and process designing of the bioreactor, RSM is one of the useful statistical experimental designs and provides information about the combined effect of various parameters. However, the major issue in the treatment of dye-containing wastewater by the biological process is the nonlinear nature of the process, modeling of such a complex process cannot be successfully done by RSM. To rectify these limitations, ANN can be used to approximate the functions.

ANN is a computational-based model which is influenced by biological neural processing, which can be used to model highly nonlinear processes. ANN has intrinsic characteristics like learning and works in two manners which can be classified as training mode and normal mode.. ANN could be advantageous over RSM as it does not require preparatory specification of fitting function.

The present thesis is categorized into **7 chapters**. **Chapter 1** embeds a general introduction (sources and toxic effect) of azo dye and its derivatives, treatment methods, various factors affecting the biodegradation process, and application of ozonation for textile effluent treatment. **Chapter 2** contains a detailed analysis of the literature review, research gaps, and objective of my research work. **Chapter 3** contains common materials and method used in biodegradation and hybrid treatment processes. In **Chapter 4,** Biodegradation study was performed for the degradation of Brilliant green dye in a packed bed biofilm reactor: Statistical modelling, kinetic evaluation, and toxicity assessment**. Chapter 5** focuses on mass transfer assessment for the biodegradation of brilliant green dye in PBBR using LDPE as bio carrier. In **Chapter 6** an attempt has been made for the development of a hybrid treatment technique for the complete mineralization of textile wastewater. The summary and scope of future work is described in **Chapter 7.**