

Executive Summary



Shantanu Bhattacharya
Professor, IIT Kanpur, Kanpur, India.

1. Title of the Project: Disruptive Nanotechnology driven innovation for Treatment of Textile Wastewater through Automated Interventions

2. Date of Start of the Project: October 01, 2020, and 1st of initial 3 years tenure

3. Aims and Objectives:

- 1) Industrial wastewater remediation through a novel Advanced Oxidation processes (AOP) based integrated pre-treatment and photocatalysis technique [1], [2].
- 2) Development of an Automation framework and Controller design through an IoT-enabled platform with a cloud-based decision support system [3], [4]

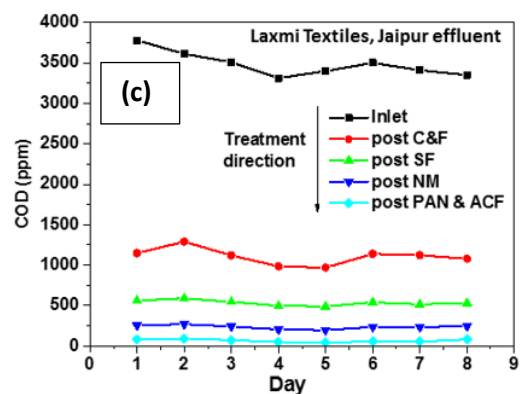
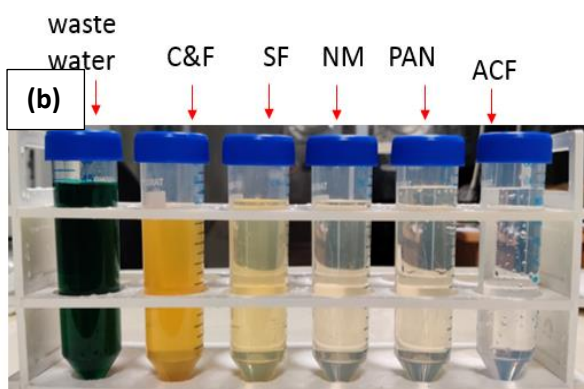
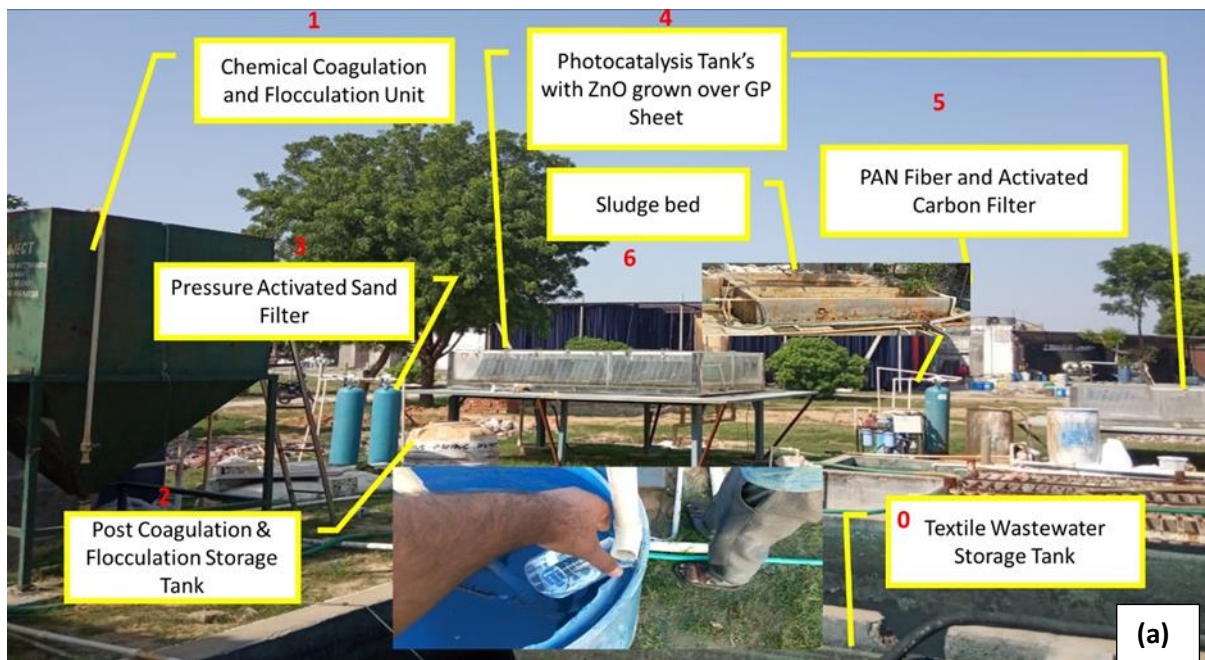
4. Significant achievements (not more than 500 words to include List of patents, publications, prototype, deployment etc)

A photocatalytic remediation method for the treatment of industrial wastewater using detailed steps on a pilot scale (10 KLD) plant with performance metrics as represented in figure 1 (a)-(d) below, is fully commissioned and is being optimized/ automated with decision support system. The plant does the following processing steps in order as mentioned below:

- a) Pre-treatment of the wastewater through coagulation / flocculation steps for removing the scum and large particles

- b) Sand filtration of effluent discharged from step (a) wherein the sand is modified by the treatment/activation of acid and absorbs basic dyes from effluents.
- c) Advance oxidation of the effluent discharged from step (b) using ZnO/GO nanostructures coated in stainless steel sheets assembled into a well-designed flow reactor working through photocatalysis process reducing the COD level and color of the wastewater in the presence of sunlight.
- d) Removing the contaminants through PAN hollow fiber/ activated carbon filters as an end of process effluent polishing method.

Various steps as above with large scale synthesis and characterization of various photo-catalyst materials of Zinc Oxide nanowires, Vanadium oxide, Graphene oxide films, ZnO/GO and V2O5/rGO nanocomposites have been completed, along with sand acidification method for large scale deployment have been achieved over coagulated/ flocculated effluents [5], [6], [7].



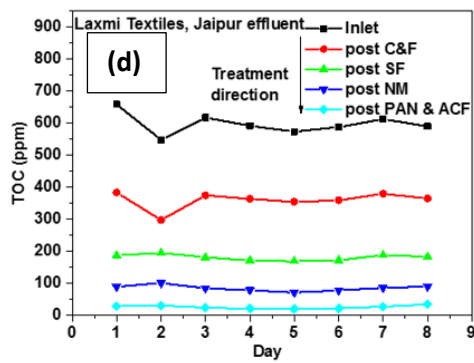


Figure 1 (a): Commissioned Plant at textile park, Jaipur (b) Dye degradation depicted by change in colour of effluent with each process (left to right) (c) and (d) Sectional daily performance of the plant in respect of COD, TOC etc.

The proposed activities are completed with positive results in the first year despite the lockdown situations in academic places as well as site of implementation (Jaipur).

Publishing's:

- [1] Chauhan P. S., S. Bhattacharya, and U. Brighu, "Industrial wastewater remediation technique by integrated pre-treatment and photocatalysis," 202111015994, 2021.
- [2] P. S. Chauhan, K. Kumar, K. Singh, and S. Bhattacharya, "Fast Decolorization of Rhodamine-B dye using novel V 2 O 5 -rGO photocatalyst under Solar Irradiation.", *Synthetic Metals*, Elsevier (**Communicated, Under Review**)
- [3] P. S. Chauhan, K. Singh, and S. Bhattacharya, "Modified Advance Oxidation Process based Design and Development and Data-driven Predictive Performance Modelling of Industrial Waste-water Treatment Plant," *Scientific Reports*, (**Communicated, Under Review**).
- [4] P. S. Chauhan, A. Choudhary, K. Saxena, and S. Bhattacharya, "MEMS Devices for the Measurement of Wastewater Parameters," in *MEMS Applications in Biology and Healthcare*, AIP Publishing, 2021 (**Book Chapter, Publication In Process**).
- [5] DST, "Novel water management system developed to treat toxic textile effluents," *Chemical Weekly*, 2021. .
- [6] DST, "Improved water management system for toxic textile effluents developed," *The Hindu*, 2021. <https://www.thehindu.com/sci-tech/energy-and-environment/improved-water-management-system-for-toxic-textile-effluents-developed/article36404525.ece>
- [7] DST, "The 'much-improved' AOP technology targeting zero discharge water management system," *National Herald*, 2021. <https://www.nationalheraldindia.com/national/indian-researchers-develop-wastewater-treatment-solution>

5. Concluding remarks:

The author deeply acknowledges the support provided by the Indian National Academy of Engineering through the Abdul Kalam Technology Innovation Fellowship which has been very helpful in carrying out the following activities.

- 1) AOP based pilot plant commissioned at Textile Park Jaipur with process optimization and automation steps underway.
- 2) Detailed study of breakdown products of photocatalysis being analyzed through HPLC/MS for initiating predictive control.
- 3) Research on the effect of various material systems and process parameters for various sections of the plant is underway.
- 4) Automation/Controller design of the pilot plant through an IoT-enabled platform with a cloud-based decision support system to monitor the efficient operation and performance of processes of the plant is underway. Detailed lab-based studies have been carried out and the system is pending deployment at the field level.
- 5) Formulation of startup entity with involvement of all stakeholders in underway and deep interest has been expressed by various industrial verticals and divisions in the effluent remediation business to collaborate to initiate a higher TRL through user intervention.