Executive Summary

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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 3rd of initial 3 years tenure in 2022-23
3. **Aims and Objectives**:
   1) Industrial wastewater remediation through a novel Advanced Oxidation processes (AOP) based integrated pre-treatment and photocatalysis techniques.
   2) Development of an Automation framework through an IoT-enabled platform with a cloud-based decision support system.
4. **Significant achievements (not more than 500 words to include List of patents, publications, prototype, deployment etc)**

1) The main objective of the proposed work is to replace the existing methodology of effluent treatment of textile industries using multiple steps like Advanced Oxidation Processes (AOP) (visible light photo-catalysis), absorption on acid modified soil bed and hollow fiber filters. The following processes:

   a) provide a micro-effluent treatment alternative with zero level discharge with commensurate capacity through reuse of treated water,

   b) introduces a disruptive change to the existing treatment processes through combined treatment processes.

Design and Development of a Combined Advanced Oxidation Process based Industrial Dye Wastewater Treatment Plant with Data-driven Predictive Performance Modeling has been undertaken and completed [1].

2) Research in domains related to photo-catalyst materials (Zinc oxide, Graphene oxide films coated ZnO, vanadium pentoxide–reduced graphene oxide (V_2O_5-rGO) nanocomposite, TiO_2, Boron Doped TiO_2 using various precursors) synthesized for advanced treatment of industrial dyes wastewater. [1-3, 6-7, 9]

3) Detailed study on the Effect of Standardized ZnO/ZnO-GO FES driven Advanced Oxidation Process on Textile Industry Effluent Stream: Detailed Analysis of Photocatalytic Degradation Kinetics through AOP-mediated formation of intermediaries and degradation products using High-Performance Liquid Chromatography/Mass Spectrometry (HPLC/MS) which generates results on specific fragment-ion characterized using QTOF-MS/MS) [4].

4) A stepwise inexpensive process for treatment and Advanced neutralization technique for the treatment of highly acidic wastewater from Steel rolling mills of western Rajasthan [5,8]

5) Development of a Data-driven Predictive and Automation framework for Treatment Process Operations through an IoT enabled platform [10]

References:

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[5] S. Tatiya, S. Maurya, and S. Bhattacharya, "Advanced neutralization technique for the treatment of highly acidic wastewater from Steel rolling mills of western Rajasthan", under review, Nature Water.

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[8] S. Tatiya, L R Tatia, R K Gattani, S Bhattacharya, S Maurya, “A stepwise inexpensive process for treatment and neutralisation of highly acidic wastewater and material recovery from stainless steel industries.”, Invention Disclosure filed @ IITK, 2022.

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[10] 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.

[11] Shantanu Bhattacharya, “Improved water management system developed can treat toxic textile effluents facilitating its reuse in households and industry,” DST, Government of India, India, New Delhi, Sep. 2021.

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 and will be very helpful in carrying out the following activities:

1) AOP-based pilot plant commissioned at Textile Park Jaipur with process optimization steps completed.
2) Detailed study of breakdown products of photocatalysis analyzed through HPLC and LC-MS/MS for generation of predictive models.
3) Research on the effect of various material systems and process parameters for various sections of the plant using different synthesized material is presented.
4) Data-driven Predictive and Automation framework for Control design of the pilot plant through an IoT-enabled platform with a cloud-based decision support system. To monitor efficient operation and performance of plant processes through detailed lab-based studies, which is pending deployment after simulations and experimental investigation.
5) Formulation of startup entity with involvement of all stakeholders is completed and deep interest has been expressed by various industrial verticals and divisions in the effluent remediation business to collaborate for initiating a higher TRL through user intervention.