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 4th year of tenure of 2020-25
3. **Aims and Objectives:**
   1) Industrial wastewater remediation through novel Advanced Oxidation processes (AOP) photocatalysis techniques for integrated pre-treatment system.
   2) Development of an Automation framework through an IoT-enabled platform with a cloud-based decision support system.
4. **Significant achievements (including patents, publications, prototypes, 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 [9-12]. The following processes:
      a) provide a micro-effluent treatment alternative with zero-level discharge with commensurate capacity through the reuse of treated water,
      b) introduces a disruptive change to the existing treatment processes through combined treatment processes.
   2) Design and Development of a Combined Advanced Oxidation Process Industrial Dye Wastewater Treatment Plant with Data-driven Predictive Performance Modeling has been undertaken and completed [1].
   3) 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 [2], [3], [4].
   4) 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].

5) Bayesian inferential modeling and multivariate curve resolution techniques using mid-level data fusion to facilitate the retrieval of intermediate samples' concentration and spectral estimation profiles. Development of a Data-driven Predictive and Automation framework for Treatment Process Operations through an IoT-enabled platform [5,6,13,14].
6) A stepwise inexpensive process for treatment and Advanced neutralization technique for the treatment of highly acidic wastewater from Steel rolling mills of western Rajasthan [7,8].

5. Concluding remarks

The author profoundly 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) The AOP-based pilot plant was commissioned at Textile Park Jaipur, and the process optimization steps were completed.
2) A detailed study of breakdown products of photocatalysis was analyzed through HPLC and LC-MS/MS to generate predictive models.
3) Research on the effect of various material systems and process parameters for various plant sections using different synthesized materials is presented.
4) Research on Bayesian inferential modeling and multivariate curve resolution techniques to facilitate the retrieval of uncertainty quantified reaction rates for the solar-induced hydroxyl attack mechanism on industrial dyes.
5) 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, pending deployment after simulations and experimental investigation.
6) Formulation of the startup entity with the involvement of all stakeholders is completed, and various industrial verticals and divisions have expressed deep interest in the effluent remediation business to collaborate for initiating a higher TRL through user intervention.

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