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Department of Chemical Engineering

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Review Articles

An open review on air pollution monitoring systems

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&

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ABSTRACT

Air pollution poses a serious threat to public health and urban environments worldwide. Despite the growing number of air pollution monitoring systems, there is a lack of comprehensive comparative studies that systematically evaluate their components, methodologies, and performance. This survey addresses that gap by analyzing 50 peer-reviewed research papers focused on air quality monitoring technologies. The papers were selected from reputable scientific databases, including IEEE Xplore, ScienceDirect, and SpringerLink, using defined criteria such as publication within the last seven years. This review provides a structured overview of the technologies currently used in air pollution monitoring, highlighting their strengths and limitations. Technologies such as the Internet of Things (IoT), Long Range Wide Area Network (LoRaWAN), and Wireless Sensor Networks (WSNs) are reviewed in the context of their effectiveness, scalability, and real-time capability. Hardware components such as microcontrollers, sensors, actuators, integrated circuits, Wi-Fi modules, and cloud services are evaluated across various implementations. The review reveals trends such as the increasing use of low-power wide-area networks and cloud integration, but also identifies persistent challenges, including high energy consumption, limited data security, and scalability issues. In addition, programming models and performance metrics (e.g. Mean Absolute Percentage Error (MAPE), Root Mean Square Error (RMSE)) are compared to assess system reliability and accuracy. The review concludes that while significant progress has been made, further development is needed in areas such as secure communication protocols, energy-efficient system design, and the integration of intelligent algorithms.

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Discharge of spheres and dumbbells mixed with fine grains from a 3D silo

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Abstract

The flow of mixtures of non-spherical particles from silos is extensively observed in various industries. In this paper, we study the flow of binary mixtures of large grains mixed with fine spherical particles during the discharge of a silo with a circular orifice in its base. In particular, we focus on the effect of the shape of the large grains by using either spheres or dumbbell-shaped grains (mung beans). The flow rate is measured for various diameters of the orifice (D) and mix ratio of small and large particles (χ). The pure systems (no added fine grains) show equivalent flow rates for spheres and dumbbells. When fine grains are added to a sample of large particles, the effective flow rate of the big grains (diameter d_b) can increase. We observed that this is the case for both spheres and dumbbells. We propose a scaling of the flow rate, for binary mixtures, that allows us to assess the effect of the particle shape by removing the particle size

contribution. The results suggest that for $D/d_b \lesssim 6.0$ the shape of the large particles does not affect its flow rate for these low aspect ratio dumbbell shapes. However, for larger orifices and intermediate mix ratio, the spheres flow faster than the dumbbells.

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Experimental investigation for twisted tape as an augmentation device in plain tube

- Published: 10 June 2025
- Volume 50, article number 120 (2025)

Sāadhanā

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- [Sudesh Ayare](#),
- [Sonali Jadhav](#) &
- [Jayesh Mapara](#)
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Abstract

The heat exchanger plays a vital role in every thermal system. The growing emphasis on enhancing heat transfer augmentation techniques has sparked increased interest in the advancement of high-performance thermal systems. The present article describes how the modified twisted tape insert will affect the Nusselt number and the friction factor. The study was carried out to resolve the heat transfer coefficient for the tube side and the friction factor using inserted twisted tape. Twisted tape finds extensive application in improving heat transfer within heat exchangers, as it boosts heat transfer through the creation of a swirling flow in the flow channel. Numerical analysis was conducted under turbulent flow conditions, employing twisted tape inserts with various ratios twist ($\gamma = 5$) while maintaining a constant flow rate. The Nusselt numbers were determined to be 2.88, 2.78, 2.5, 2.36, 2.39 and 2.29 times better than the values observed for plain tubes when using V-cut and rectangular-cut twisted tape, perforated stainless steel twisted tape, copper, aluminum and stainless steel respectively. The obtained results have been authenticated using conventional correlations existing in the literature.

Research article

Degradation of sunset yellow dye using hydrodynamic cavitation and ultrasonic horn assisted by UV irradiation and chemical additives

Sonali P. Jadhav ^{a b}, [Parag R. Gogate ^b](#)

[10.1016/j.jics.2026.102404](https://doi.org/10.1016/j.jics.2026.102404)

Degradation of sunset yellow dye using hydrodynamic cavitation and ultrasonic horn assisted by UV irradiation and chemical additives

Article preview

- [Abstract](#)
- [Introduction](#)
- [Section snippets](#)
- [References \(71\)](#)

Highlights

Hydrodynamic cavitation and ultrasonic horn applied for Sunset Yellow dye removal.

Optimal conditions identified as 20 ppm dye, pH 10, and 2 bar input pressure for HC.

Addition of TiO₂, H₂O₂, and KPS enhanced degradation efficiency using cavitation.

HC + UV + KPS achieved 99.88 % dye degradation and 72.22 % COD reduction.

Combination of HC, UV, and oxidants elucidated as most effective.

Abstract

The current study explores the treatment of Sunset Yellow dye using hydrodynamic cavitation (HC), ultrasonic horn (US), and their combinations with UV light and different oxidants. Experiments showed that the best operating conditions for HC were a dye concentration of 20 ppm, pH 10, and an inlet pressure of 2 bar. Under these settings, HC alone removed 56.09 % of the dye and achieved a 12.48 % reduction in COD, while the US alone was less effective, reaching only 29.25 % decolorization. The addition of oxidants and catalysts noticeably strengthened the process. Titanium dioxide (TiO₂) at 0.8 g/L as optimum loading led to 78.25 % removal, and hydrogen peroxide (H₂O₂) at 1 g/L resulted in higher degradation as 84.44 %. Among all additives, potassium persulfate (KPS) (1 g/L) delivered the best performance, reaching 97.31 % removal when combined with HC. Overall, systems coupling HC with UV and suitable additives performed far better than cavitation alone, with the HC + UV + KPS setup

achieving complete colour removal and a 72.22 % in COD reduction. Overall, results clearly show that combining cavitation with UV irradiation and oxidants in optimum amount results in a much more effective treatment route for Sunset Yellow degradation than any single technique used independently.

Chapter

Emerging Strategies for Food Allergen Management: Innovation and Potential

- July 2025

DOI:[10.4018/979-8-3693-6432-1.ch007](https://doi.org/10.4018/979-8-3693-6432-1.ch007)

- In book: Holistic Approaches to Health Recovery, edited by Adérito Seixas, et al., (pp.181-218)
- Publisher: IGI Global
- Editors: Adérito Seixas, Rita Alegria, Daniela Vieira

Authors:

[Dr-Sunil Jayant Kulkarni](#)

[Sachi Dubey](#)

[Ajayagiri Goswami](#)

[References \(93\)](#)

Abstract

Food allergies are a major global health concern that affect millions of people. The intricacy of the food supply chain and the range of allergens cannot be fully accommodated by traditional methods, such as labeling laws and manufacturing procedures. In response, new approaches and cutting-edge technologies are being developed to improve the management of food allergies. By enhancing the identification, management, and dissemination of allergen risks, these strategies hope to boost consumer confidence and safety. This review examines recent developments in food allergen management, such as innovative food processing techniques, state-of-the-art detection methods, and regulatory advancements. In order to address the changing issues surrounding food allergies and safeguard the public's health, the review highlights how crucial it is for stakeholders to keep coming up with new ideas and working together.

Chapter

IoT/AI Based Solutions in Environmental Waste Management and Monitoring

- October 2025

DOI:[10.1201/9781003668961-17](https://doi.org/10.1201/9781003668961-17)

- In book: Sustainable Biotechnological Remedial Frameworks for the Rejuvenation of Heavily Polluted Environments (pp.344-365)

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[Sunil Kulkarni](#)

[Ajaygiri Goswami](#)

Chapter

Applications of Nanofluids in Energy Storage Devices

- February 2026

DOI:[10.1007/978-3-032-04008-4_15](https://doi.org/10.1007/978-3-032-04008-4_15)

- In book: Ionic Liquids, Nanofluids and Nanotechnology (pp.333-352)

Authors:

[Sunil Jayant Kulkarni](#)

[References \(111\)](#)

Abstract

Nanofluids are capable of increasing the transfer of thermal energy in storage systems, especially in solar energy applications. The capacity of the system to hold energy can be improved with the application of nanoparticles in fluid systems. In the case of solar collectors, heat absorption can be maximized by taking advantage of the conductivity of the nanofluids, leading to improved energy storage capacity. Faster melting and solidification can be facilitated in the case of the material that changes phase (phase change material) with the application of nanofluids. Improved energy transfer, energy storage and reduced size of the equipment are important aspects of the application of nanofluids in the energy storage system. This chapter summarizes the research in nanofluid applications in energy storage. It also underlines the advantages and limitations of the nanofluid application in energy storage.

The Detection Methods of Microplastics and Nanoplastics

- Chapter
- First Online: 19 May 2026
- pp 49–72
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Microplastics and Nanoplastics

- [Tamanna Chaturvedi](#),
- [Sunil Kulkarni](#) &
- [Ajaygiri Goswami](#)

Part of the book series: [Lecture Notes in Nanoscale Science and Technology](#) ((LNNST, volume 49))

- 145 Accesses

Abstract

Microplastics and nano-plastics have become a worldwide issue in the aquatic ecosystem. Microplastics contains particles of size ranging from 1 μm to 5 mm, while nanoplastics range from 1 nm to 1 μm . These materials are known to possess sophisticated elementary properties that affect their migration, toxicity, bioavailability, and interactions with surrounding pollutants. In this chapter, methods of analysis, chemical and physical, are discussed in detail. These methods of detection generally involve isolation of the particles from the habitat, and then the tests are run on them. It includes detection methods such as visual and microscopical techniques, spectroscopic techniques, receptor-based techniques, and thermal analysis. The technique involves various methods such as dissecting microscopy, polarized microscopy, fluorescence microscopy, scanning electron microscopy, and atomic force microscopy. Various methodologies are used to obtain images of the MPs and NPs. Spectroscopic technique involves studying the motion of molecular vibration for the detection of material. Another method of detection discussed is receptor-based detection, which provides high accuracy and precision in bio-applications. This method allows for the distinction of MPs and NPs present in the

surroundings, as well as the identification of the plastic's composition. Thermal Analysis involves the identification of MPs and NPs based on the products formed by the thermal degradation of the material. Thermal analysis techniques utilize the analysis of the material obtained from the thermal degradation of the sample to identify the MPs and NPs. Methods such as differential scanning calorimetry (DSC) and pyrolysis-gas chromatography-mass spectrometry (py-GC-MS) are used in thermal analysis. These methods can also be used in combination for the identification process. Recently, there has been a rising concern about the existence of MPs and NPs in the surroundings. This results in the need for standardization of detection methodologies, which can be achieved by creating combinations of available techniques. Additionally, this opens up a new space for research on standardizing detection methods.