

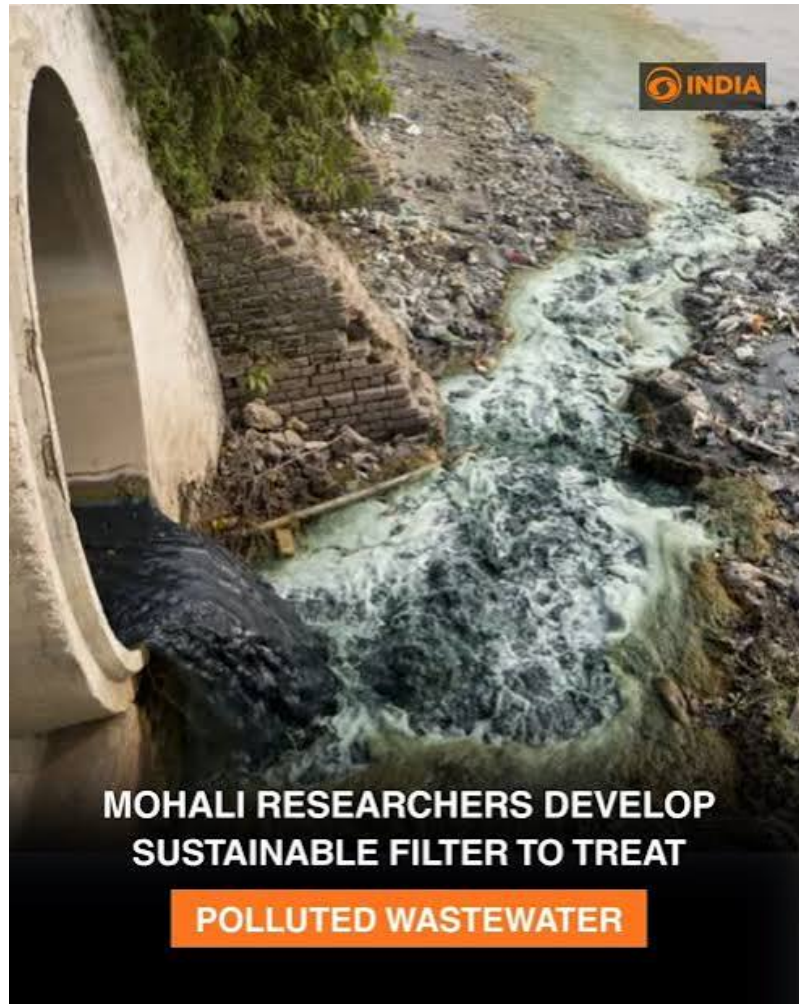
Nanofibre Filter for Dye-Contaminated Wastewater

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Why in news?

Researchers at the Institute of Nano Science and Technology (INST), Mohali, have developed a sustainable nanofibre filter to treat dye-contaminated wastewater.

- **Nanofibre Filter** – A sustainable, multifunctional machine learning-enabled filter that combines zinc oxide nanoparticles with biodegradable nanofibres to treat dye-contaminated wastewater.
- **Developed by** – Institute of Nano Science and Technology (INST), Mohali, an autonomous institute of the Department of Science and Technology (DST).
- **Need for development** – The material addresses persistent organic dyes discharged by industries, particularly textiles; these compounds can be toxic, chemically stable and resistant to natural degradation.
- **Conventional treatments vs new technology** – Conventional treatments such as adsorption, sedimentation and flocculation can separate pollutants without necessarily destroying them, while biological treatment may be slow for highly stable dyes.
- Photocatalysis offers an alternative by degrading pollutants under relatively mild conditions.
- However, conventional systems face difficulties in recovering nanoparticle catalysts, separating them from treated water and maintaining efficient contact with pollutants.
- Their performance can also be limited by light availability and electron-hole recombination.
- **Working** – To address these challenges, researchers use light and mechanical vibrations to enhance pollutant degradation, while machine learning helps predict its dye-decolourisation performance.
- Zinc oxide (ZnO) nanoparticles are immobilised within porous polylactic acid (PLA) nanofibres and introduced mechanical excitation alongside light.
- Mechanical vibrations generated piezoelectric polarisation, suppressing the recombination of light-generated electrons and holes and increasing the formation of reactive species involved in pollutant degradation.
- **Fabrication** – Uses electrospinning to produce a porous, high-surface-area and mechanically stable PLA-ZnO membrane instead of using freely dispersed ZnO powder.
- The integration of photocatalysis and piezocatalysis enabled pollutant degradation using both light and mechanical vibrations.



- **Nanoparticle Features** - ZnO nanoparticles were synthesised using turmeric extract.
- Naturally occurring compounds, including curcumin, flavonoids and phenolic compounds, acted as reducing and stabilising agents, avoiding synthesis methods involving harmful reagents.
- **Performance** - Under combined light and ultrasonic excitation, the nanofibres achieved 98.6% decolourisation of MB dye and 96.7% of CR dye within 120 minutes.
- The material also demonstrated antibacterial activity, inactivating approximately 75% of E. coli and 71% of S. aureus after six hours.
- Machine learning was integrated to predict dye-decolourisation behaviour using parameters including wavelength, treatment time, catalyst quantity, ultrasonic frequency, light intensity and dye concentration.
- **Applications** - Identified potential applications in treating textile and industrial wastewater containing persistent dyes and microbial contaminants, as well as in environmental remediation and antibacterial water-treatment membranes.

References

1. [PIB | New technology for treating dye-contaminated wastewater](#)
2. [DD News| New technology for treating dye-contaminated wastewater](#)



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