

Recent Achievements of CSIR-NEERI

A. Full Scale Remediation of Mercury Contamination Site at Kodaikanal

This site is a closed thermometer manufacturing factory owned by Hindustan Unilever Ltd (HUL). Due to various reasons, the factory premise soil has been contaminated with mercury exceeding 5000 mg/kg at some places. Total area contaminated by mercury \approx 18,000 m². NGT has ordered to remediate the site to the target level 20 mg/kg.

This is the first large-scale remediation of contaminated site in India. CSIR-NEERI evaluated various technological options for soil mercury remediation and advised HUL a combination of two technologies viz. soil washing and thermal retorting. CSIR-NEERI conducted lab-scale and pilot scale studies, prepared detailed project proposal (DPR) and it was approved by Scientific Expert Committee (SEC) regulatory authorities. Soil washing selectively concentrates mercury in the fine soil fractions (<70 μ m) that constitutes about 30 % of the input soil.

The mercury enriched soil fraction is subjected to thermal retorting process i.e. heating the soil at 250° C under vacuum. The off-gas containing mercury is collected and condensed. Treated soil is removed and mixed with washed soil and native uncontaminated soil and backfilled.

CSIR-NEERI established a Site Laboratory and monitors the entire work for compliance to the “Soil remediation upscaling plan” approved by Tamil Nadu Pollution Control Board (TNPCB).

CSIR-NEERI provides technical advice and solutions to HUL on method of soil excavation, monitoring of mercury in different soil fractions, retort condensate samples and homogenized samples based on global best practices. Total area remediated till March 2023: 5836 m².

- Extent of Contamination – 3 acres of out total 20 acres
- Maximum Concentration of mercury – 9000 mg/kg
- Target Remediation Level - < 20 mg/kg
- Remediation Technology - Soil excavation, soil washing, thermal retorting, homogenization and backfilling
- DOC of Full scale remediation – March 2021
- Total area remediated till August 2023– 60 %



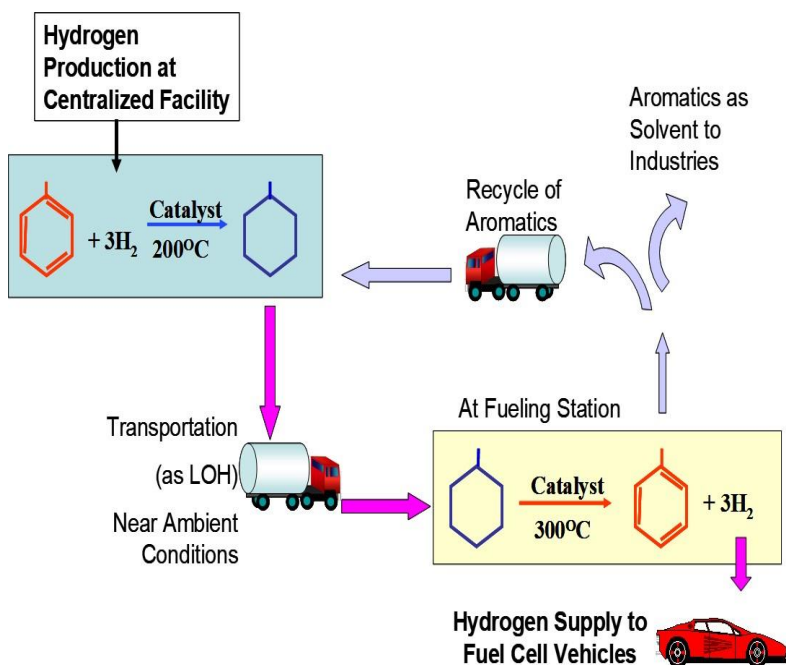
B. Stockholm Convention Regional Centre (SCRC) on Persistent Organic Pollutants (POPs) for Asia Region

- CSIR-NEERI has been recognized as “Stockholm Convention Regional Centre (SCRC) on Persistent Organic Pollutants (POPs) for Asia Region” since 2011 by UNEP.
- CSIR-NEERI with expertise in monitoring of POPs in environmental and products, is carrying out extensive sampling and analysis and create comprehensive database on POPs. The data is useful to understand the extent of contamination, possible human health effects.
- Improved policy decisions on chemicals and waste which contribute to protection of human health and environment.
- Major Projects undertaken under SCRC during 2020-2023
 - Institutional capacity building for the sustainable management of chemicals and waste with special focus on persistent organic pollutants.
 - Development and Promotion of Non-POPs Alternatives to DDT.
 - Review and updation of National Implementation plan on the management of POPs.



C. Hydrogen Storage and Delivery using Catalytic System (HyStoCat)

CSIR-NEERI has developed a technology on, “Hydrogen Storage and Delivery using Catalytic System (HyStoCat)”. The heart of the technology is catalytic dehydrogenation wherein process and catalysts are patented by of CSIR-NEERI The technology is very effective for long term and short period storage of hydrogen. It provides an efficient route with relatively higher gravimetric and volumetric capacities of hydrogen storage. The technology is based on a paired reactions of hydrogenation of aromatics to cycloalkanes and dehydrogenation of cycloalkanes to aromatics. Hydrogen is picked from hydrogen production facility by hydrogenation of aromatics to cycloalkanes and subsequently, delivered at required location via dehydrogenation of cycloalkanes to aromatics. Aromatics can be transport back to pick up hydrogen in next cycle. The candidate cycloalkanes including cyclohexane, methylcyclohexane, decalin etc. contains 6 to 8 wt% hydrogen with volume basis capacity of hydrogen storage of 40-60 kg/m³. In view of several advantages of the system such as transportation by present infrastructure of lorries, no specific temperature pressure requirement and recyclable reactants/products, the LOH definitely pose for a potential technology for hydrogen delivery.



Prototype with Capacity of 1 Nm³/h of hydrogen delivery @99.95% purity. Inset a novel

D. Large Scale Dissemination of Low Cost Improved Chulhas (Cookstoves) and Estimation of Health and Environmental Benefits

CSIR-NEERI in association with Glenmark Foundation has developed optimized models of “PAVAK” improved low-cost cookstoves (mud, clay and concrete based) via R&D efforts and testing in the laboratory. A small-scale pilot study was also conducted in a village of Khandwa district of Madhya Pradesh, to determine user’s perception of the developed cookstove models. Results showed that these cookstoves exhibited significantly lower emissions and fuel savings in the field, without compromising traditional cooking practices. All these studies were funded by the Glenmark Foundation.

Considering that CSIR-NEERI has successfully achieved development of modified low-cost cookstove, it is now proposed to attempt large-scale dissemination of these cookstoves in association with Glenmark Foundation, as envisaged in the original MoU and collaboration for societal benefits. It is therefore proposed to continue activities for large scale dissemination of the optimized cookstove models in identified rural villages and associated activities to promote adoption and ensure sustained usage of the improved low-cost cookstoves for widespread societal benefits.



Pavak - 3




Picture depicts usage of improved concrete stove given to five HH of Kotwariya village

Field based trials indicate that PAVAK-3 provides significant fuel savings and emissions reductions, resulting in mitigation of adverse health and climate impacts. A user perception survey shows that PAVAK easy to use, resembles traditional cooking practices and does not deteriorate the taste of food. CSIR-NEERI would be providing technical assistance and undertaking field-based studies to determine and quantify health and climate benefits.

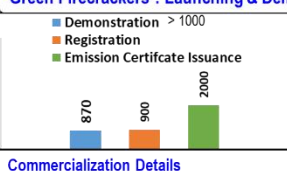
E. Green Firecrackers formulations:

Landmark technology popularly known as “Green Firecrackers” developed for addressing environmental issues and protecting dwindling economy of fireworks industry worth Rs. 6000 crores & job opportunities of more than 5 lakhs personnel have been saved.

New Published & Media Coverage



Green Firecrackers : Launching & Demonstration to FW manufacturers





Commercialization Details

Revenue Generation

- Technology transfer fees: Rs. 332 lakhs till date for licensing of firework formulations
- Revenue generation from spin-offs:
 - Emission Testing = Rs. 1.67 Crore
 - QR code = Rs. 15.0 Lakh envisaged
 - Raw materials / chemical characterization = Rs. 10.0 Crore per annum (expected)

Launched on 5th October, 2019

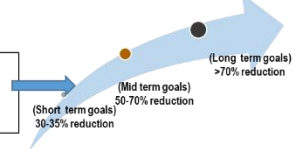



Future Perspectives:

- 1.Periodic review of emissions norms proposed by MoEFCC, CPCB & PESO
2. Raw materials and emission testing (RACE) facility launched in PPP mode- Total cost Rs 15 crores

• Landmark technology popularly known as “Green Firecrackers” developed for addressing environmental issues and protecting dwindling economy of fireworks industry worth Rs. 6000 crores & job opportunities of more than 5 lakhs personnel have been saved

• Green firecrackers are “environmentally benign by design” with reduced chemical and environmental footprint and the term gained formal recognition in October 2018 by the APEX court



New variants with 50-70% emissions reduction developed, third party testing in progress

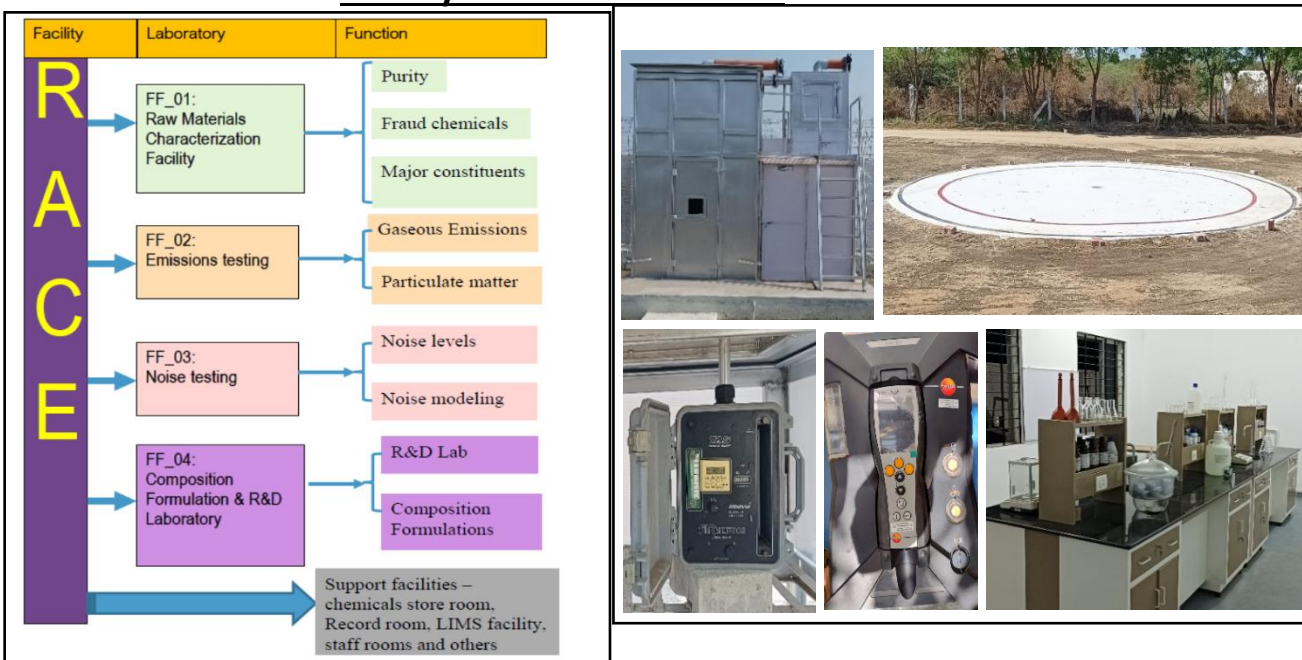


District collector, Virudhnagar operationalized RACE Facility at Sivakasi, one of the important milestones of the RACE project. The RACE facility is now operational at SIVAKASI.

F. Testing and Research and Development Facility for Firecrackers - Raw materials, Compositions and Emissions (RACE)

- Compositional analysis of firecrackers using X-ray (RIR method).
- Creation of emission testing facility for firecrackers at Chennai zonal center, CSIR-NEERI.
- Provide technical consultancy to firework industry to improve skill and training to manpower skill.
- Conducting awareness programs at Sivakasi.

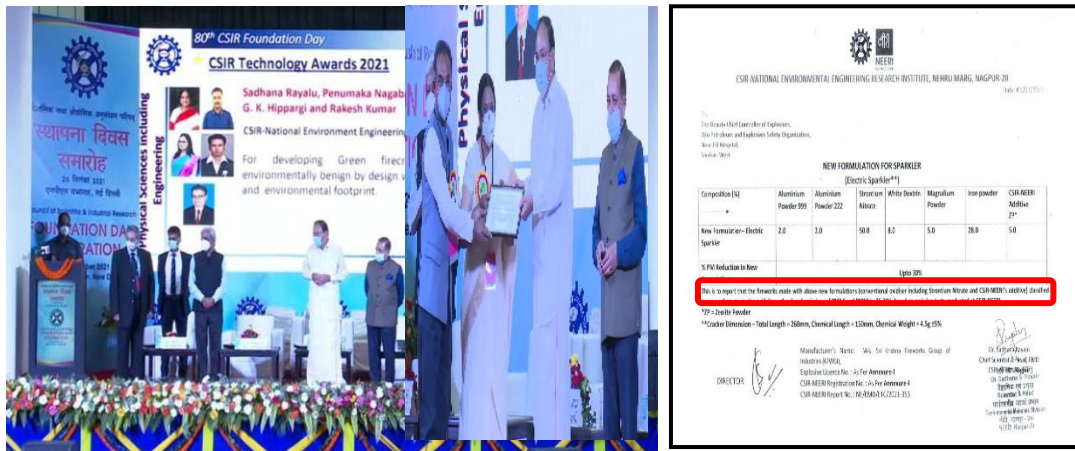
Facility creation at Sivakasi



I. GREEN Firecrackers (Reduced Emission Firecrackers)

- CSIR-NEERI awarded the CSIR Technology Award 2021 for developing “GREEN FIRECRACKERS” on 26th September 2021 at the hands of Hon’ble Vice President of India Shri M. Venkaiah Naidu.
- Pyrotechnic formulations meeting 30-35% emissions reduction licensed to 1200 fireworks manufacturers so far.....
- Total No. of Fireworks Manufacturers registered with CSIR-NEERI by signing NDA/MoU = 1200
- New pyrotechnic formulations meeting 60-75% emissions reduction developed.
- Demonstrations to more than 1500 FW manufacturers and dignitaries
- Distribution to CSIR-NEERI family in Diwali

- Emissions testing
- State of art facility developed
- Methodology for emissions testing developed and validated by CPCB and IIT-B
- BIS certification in progress
- Sample of Emission Testing Certificate (ETC)/Report issued to Fireworks. Manufacturers (Total No. of ETC issued so far: 2300)



Digital Management: Product Quality & Data

G. Development of Technologies for Himalayan Regions

Dry Bio Toilet

Low-temperature adapted methanogenesis for sustainable sewage treatment in Himalayan regions

- Applicable to liquid temperatures of 3-25 °C.
- COD removal efficiency of sewage > 80%
- Treated effluent characteristics COD ≤ 50 mg/L, BOD ≤ 10 mg/L, SS ≤ 20 mg/L
- No periodic addition of psychrophilic microbial consortia after initial seeding
- No external heating and aeration required



Dry Bio Toilet with complete onsite treatment and resource recovery for cold and arid Himalayan climates

- Waterless and odorless dry toilet.
- Dry flush system for covering the excreta
- Modified toilet seat with urine diversion
- Onsite containment and stabilization of human waste
- Mechanical ventilation from the storage bins for an odor-free experience
- Hands-free handling of compost

H. Full Scale Sewage Treatment Plant based Moving Bed Bio-reactor (MBBR) and submerged aerobic bio-reactor (SAFF) for sewage treatment and recycle & reuse for gardening

- Developed under Indo-EU Horizon 2020, DST Funded Project titled “Potential and Validation of Sustainable Natural & Advance Technologies for Water & Wastewater Treatment, Monitoring and Safe Water Reuse in India (PAVITR)”
- Implemented improved 100 m³/d capacity, Moving Bed Bio-reactor (MBBR) and submerged aerobic bio-reactor (SAFF) for sewage treatment and recycle & reuse for gardening in SIDCO Garden.
- Designed to comply with NGT norms



Raw sewage Sump; MBBR & SAFF Main Units;

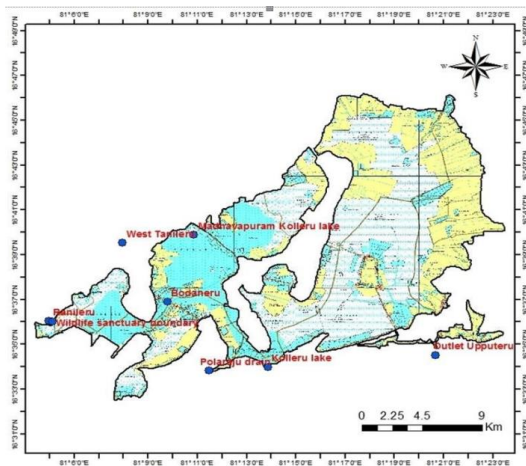


Multigrade Filter, and sludge Drying Reed Beds

I. Study on the assessment of eco-zones/distances for the establishment of Red, Orange, Green and White category industries within 10km radius from Kolleru lake

Andhra Pradesh Pollution Control Board (APPCB) has awarded the study to carry out the “Comprehensive scientific study to save Kolleru wildlife sanctuary and wetland of Kolleru” to CSIR-National Environmental Engineering Research Institute (NEERI) vide notification of award no. APPCB-12023/2/2021-SS-CL-APPCB-569 dated 09.11.2022 and amendment No. APPCB-12023/2/2021-SS-CL-APPCB-762 dated 07.12.2022. Accordingly, after acceptance of the work order, the reconnaissance survey was carried out during December 21-23, 2022 within the Kolleru wildlife sanctuary. Based on the reconnaissance, the detailed sampling plan has been prepared. The sampling of the drains (notified and non-notified) in study area started from February 4, 2023 and continuing.

Figure



Achievements

- Reconnaissance survey was carried out during December 2022
 - The post monsoon sampling of flora, water, sediment of notified and unnotified drains has been completed during March 2023 and the analysis is in progress
- Based on the sampling till date, the status of the drains are as follows:

Total no. of drains	No. of drains for which sampling has been completed	No. of drains for which sampling has to be carried out
NOTIFIED DRAINS		
67	57	10
NON-NOTIFIED DRAINS		
46	32	14
ADDITIONAL DRAINS SAMPLED: 10 Nos.		

Out of the 67 notified drains, the sampling has been completed for 57 drains and 10 drains sampling is under progress. Similarly, out of the 46 non-notified drains, the sampling has been completed for 32 drains and 14 drains sampling is in progress. Apart from the notified and non-notified drains, the team has also collected additional 10 drains, which are leading in to Kolleru wetland. The details of all the above drains are presented in Table 2. It was observed during the field survey that some of the drains become dry during the summer season. The lake sampling has already been started and it will be continued till the end of March 2023.

J. Source Apportionment, Emission Inventory and Carrying Capacity Studies for Guntur City under National Clean Air Program (NCAP)

- Reconnaissance survey w.r.t air quality monitoring was carried out during April 2023 and accordingly, five ambient air quality (AAQ) monitoring stations representing kerbside, control, residential, industrial and commercial areas selected for collection of primary air quality data for Guntur city.
- Phase-I air quality monitoring for summer season is carried out during April - May 2023 and analysis of samples is under progress for ions, elements, PAHs etc



Fig. AAQ Monitoring during summer (Phase I) in Guntur City

- Reconnaissance survey w.r.t air quality monitoring was carried out during 1st week of November 2022 and accordingly, five AQ monitoring stations representing kerbside, control, residential, industrial and commercial areas selected for collection of primary air quality data for Ongole city.
- Phase-I (Winter) and Phase-II (Summer) air quality monitoring is carried out for 15 days continuously during December 2022 - January 2023 and April - May 2023 respectively.
- Chemical Speciation of PM₁₀ and PM_{2.5} mass for elemental composition, ions, OC/EC and PAHs by analyzing different filter papers collected at all locations completed.

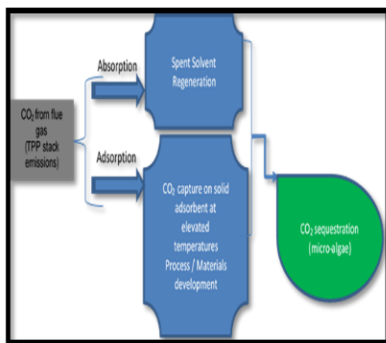
L. DST funded Centre of Excellence (CoE) entitled " Cross disciplinary, Emerging and Futuristic Carbon Capture Utilisation and Storage (CCUS) Technologies".

This Centre aims to develop materials and processes for capture of CO₂ from industrial emissions. Specifically, development of adsorption and adsorption pilot scale reactors for capture of CO₂ and regeneration of spent solvents using nanomaterials-based approach to reduce energy requirement during spent solvent regeneration. A pilot scale microalgal bioreactors are proposed in this project to address food-processing CO₂ emissions.

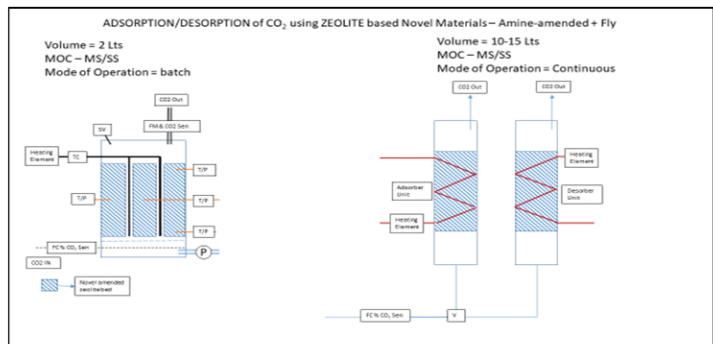
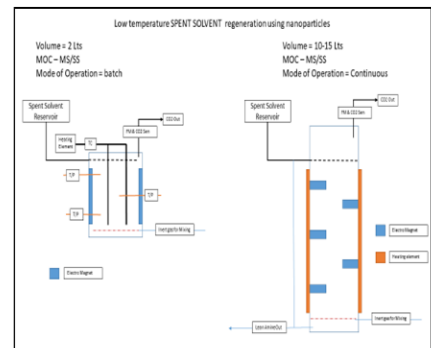
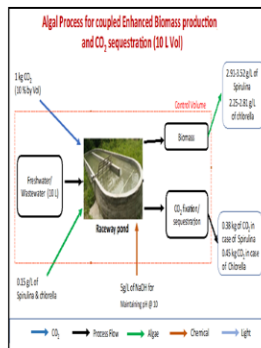
DST-Centre of Excellence for Carbon Capture, Utilization and Sequestration

Main Objective of the Centre: To develop new processes, materials and technologies to address CO₂ capture and sequestration relevant to Indian industrial needs (budget – Rs 583.2 lakhs)

Flow chart of Focus Areas



Planned Work Packages	
WP-I/A	Spent solvent regeneration using graphene nanocomposites to reduce parasitic energy penalty
WP-I/B (i)	CO ₂ capture at elevated temperatures by using zeolite and zeolite functionalized materials
WP-I/B(ii)	Development of process for synthesis of aminated zeolite and analogues with the capacity of 10 kg/batch for CO ₂ capture applications
WP-II	Algal-based CO ₂ sequestration for carbon capture and utilization



M. COVID-19 RT-PCR testing, Nagpur

- ~100,000 samples tested so far and Testing capacity: 500/day.
- ~17,207 positive cases reported from the facility.
- Crossed 1.8 million testing as DBT regional Hub.
- Saline Gargle[®] RTPCR commercialization to three industry partners.
- CCMB Developed Dry swab RT-PCR NEERI first lab to implement on 9th Sept 2020 ~45,000 nCoV samples tested.
- Trained 40 personnel with RT-PCR testing CDC-RTMNU center developed and guided by CSIR-NEERI.

COVID-19 RT-PCR testing, Nagpur

