

Fluidized Wireless LED Reactor

(Wastewater Treatment and Hydrogen Production)

Investigator: **Muhammad Nur Hafid, Ph.D., Assoc. Prof.**
 FACULTY OF INDUSTRIAL AND BIOTECHNOLOGICAL ENGINEERING
 UNIVERSITI PUTRA MALAYA
 41060 UPM Serdang, Selangor, Malaysia
 E-mail: hafid@upm.edu.my
 Prof. Dr. Elva Sze Yee
 Prof. Dr. Mohd. Asyraf. Yusoff, Dr. Tengku Nur Hafidz
 Fund:
 • Sponsorship No. P027000025



Photoreforming

Conventional photoreforming systems

- Affected by uneven variation of solar radiation
- Limited photon/light transfer efficiency

Product Benefits

- Efficient and sustainable artificial lighting solution
- Uniform light irradiation with minimum shadow
- Ease in upgrading and downscaling
- Customizable spectral response and regulatable light radiation intensity

Novelty, Originality/Inventiveness

- New approach in photoreforming technology
- Visible-light active system with regulatable intensity
- Higher freedom in reactor design
- Easy scalability
- 22.7% PTE at 2 apparatus scale ratio
- Isolated triple Halohydrin pair driven by an improved class-E inverter

Benefits/Usefulness/Applicability

- Improve reactor design freedom, photon transfer efficiency and reaction rates
- Photoreforming treatment of petrochemical wastewater
- Green energy production (hydrogen)
- Photobioreaction process
- Mercury/hydrogen free and Electromagnetic safe

Status of Innovation

- First scale prototypes
- TRL 6

Achievements/Award

- CITREX Medal, 2023

Product Issue and Characteristics/Results

Overall System Results



State of the Art Methods

- New method for reduced light source
- New technology for wastewater treatment and hydrogen production
- Easily scalable with load requirement
- Optimal transmitter coil design for minimal inductance and uniform light
- Broadband load feature with isolated field coil

Marketability & Commercialization

- Wastewater treatment
- Sustainable energy production
- Photobioreactor

Cost Analysis

- Based on reaction volume
- Cost: RM 25k (Complete 10L system)
- Other Devices: -RM50k (Scale-Up/light 7 L reactor)

Publication

- Hydrogen production via photoreforming of wastewater under LED light-driven case: Cd@ZnO/nano-ZnO
- Chemosphere, 19th Journal (2022)
- Improved wireless LED based light process for photobioreaction in a slurry reactor
- Progress Electromagnetics, 19th ECEIT Journal (2022)
- Multi-Inductance estimation for electrical coupling with multiple reactant coils
- 2022 IEEE 19th International Conference on Signal Processing, Intelligent Processing and Signal Processing (ICSP-IPSP)
- Enhancing a Low-cost Coupled Inductive Wireless Power Transfer System for LED-Driven Slurry Photobioreaction
- Journal of Microwave Power and Distributed Energy (2023, Journal 12, Under Review)

Environmental Impact/Sustainability Development Goals

- Fulfills SDGs 8 and 7
- Revitalizes photoreforming approach in wastewater treatment
- Provides green energy production from wastewater (petrochemical)

Block of Fund

- Trapa-Discovery Project Grant
- Belgian Ministry of Higher Education (FRS-FNRS/RSO1181924)
- UPM Research Grant

www.upm.edu.my





[General](#)

Associate Professor Dr. Mohd Mawardi uses LEDs to develop photocatalytic reactor as source of white light (photon)

17 September 2024

PEKAN, 25 June 2024 – Researcher and lecturer of the Faculty of Electrical and Electronic Engineering Technology (FTKEE), Universiti Malaysia Pahang Al-Sultan Abdullah (UMPSA), Associate Professor Dr. Mohd Mawardi Saari, 37 designed a photocatalytic reactor using LEDs as a source of white light (photons).

According to this Kelantan-born lad, the LEDs are powered by a wireless power transfer system and move freely within the reactor area to activate the photoreforming process by the photocatalyst.

“Through my research titled Fluidized Wireless LED Reactor (Wastewater Treatment and Hydrogen Production), this product works by converting DC electrical energy to AC at high frequencies using an inverter developed specifically for this project.

“This AC electrical energy is then transmitted to the transmitter coil on the outside of the reactor to uniformly convert electrical energy into magnetic energy within the reactor area.

“Then, through the concept of induction, this magnetic energy is received by the receiving coil and converted and returned to electrical energy to turn on the LEDs,” he said, who has a Doctorate (Engineering) from Okayama University, Japan.

Associate Professor Dr. Mohd Mawardi said these LEDs will then convert electrical energy into light (photons) to activate the photocatalyst for the photoreforming process.



“The five-year research, which began in 2018, was a spark of original ideas from a group of researchers led by the lecturer of the Faculty of Chemical and Process Engineering Technology (FTKPP), Professor Ir. Dr. Chin Sim Yee aimed to overcome problems in conventional photoreactors.

“Among the problems are the inconsistent dependence of the sunlight source and the weak penetration of light into the reactor when the light source is placed outside the reactor.

“These problems sparked the idea to use a light source inside the reactor and move freely to achieve a more even photoreforming process.

“Our group progressed from that point and was given the responsibility to produce a photoreactor based on these characteristics,” he said.

The research was conducted under a subproject of the 2018 TRGS Grant in collaboration with Professor Ir. Dr. Chin Sim Yee (FTK KP) and two PhD students, namely Zulkifly Aziz (FTK EE) and Thurga Devi Munusamy (FTK KP).

He further explained that the end goal of this product is to be one of the technologies that can be used for the water treatment process by petrochemical plants using photoreforming methods.

“At the same time, it helps the production of hydrogen.

“This is in line with the Sustainable Development Goals (SDG) 6 and 7 for water treatment innovation and producing clean energy.

“In fact, we will promote and open for any discussions and collaborations related to this product technology to the industry and research institutions,” he said, who specialises in the field of magnetic sensor instrumentation.

This research also involves collaboration between industries, namely UPC Chemicals (M) Sdn. Bhd., and technically on the instrument side, the collaboration is carried out with Adv. Electro Measurement Technology Laboratory, Okayama University in Japan.

“The estimated cost is around RM25,000.00 for 10 litres of reactor volume.

“In the future, we plan to expand the use of the concept of wireless energy transfer technology and hope that the products developed can be applied in industry and research institutions.

“Our research group at FTKEE also has expertise in the study and production of probes for nondestructive testing of iron components.

“In addition, our group has expertise in producing prototypes based on magnetic sensors and sensing instruments,” he said.

For the record, this research won a silver medal at the 2023 Creation, Innovation, Technology & Research Exposition (CITREX), a gold medal and also a Special Award from the Union of Arab Academia at the 2024 Malaysia Technology Expo (MTE).

By: Safriza Baharuddin, Centre for Corporate Communications

Translation by: Dr. Rozaimi Abu Samah, Faculty of Chemical and Process Engineering Technology

[View PDF](#)

