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INTERNATIONAL TINKER INNOVATION & ENTREPRENEURSHIP CHALLENGE (i-TIEC 2025)

"Fostering a Culture of Innovation and Entrepreneurial Excellence"



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23 January 2025
PTDI, UiTM Cawangan Johor
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Electrical Engineering Studies, College of Engineering
Universiti Teknologi MARA (UiTM) Cawangan Johor
Kampus Pasir Gudang
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A-ST133: GREENDRIVE EV: AN INNOVATIVE PALM OIL ESTER BLEND FOR EV TRANSMISSION FLUID

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ABSTRACT

The growing adoption of electric vehicles (EVs) has driven significant advancements in sustainable and efficient technologies. This rapid development highlights the increasing need for specialized lubricants designed to enhance EVs performance and durability. The sustainability of EVs closely related to the efficiency and environmental impact of their mechanical systems, including lubricants. Conventional petroleum-based transmission fluids commonly used in internal combustion engine (ICE) vehicles are unsuitable for EVs due to their inability to meet the requirements of electrical insulation properties and environmental sustainability. To address this challenge, an innovative transmission fluid for EVs based on palm oil ester blends has been developed, specifically tailored to meet the special requirements of EV transmissions. The formulation of this product involves blending palm oil ester base oil, mineral base and specialized additives. This innovative approach emphasized on the unique properties of palm oil esters to provide superior lubrication, enhanced thermal stability and reduced wear. Moreover, it improves efficiency and minimize environmental impact. The results demonstrate that the blends of palm oil ester, mineral oil and additives effectively reduce wear rates. Furthermore, this innovation aligns with Sustainable Development Goals (SDGs) by reducing dependency on petroleum-based fluids and promoting the sustainable use of palm oil derivatives. This novel formulation also holds significant socio-economic potential by contributing to circular bioeconomy and supporting palm oil industry stakeholders. GreenDrive EV Transmission Fluid presents a viable solution for eco-conscious manufacturers, by balancing high performance with environmental responsibility. It is specifically designed to meet the needs of automotive OEMs and lubricant manufacturers.

Keywords: biolubricant, EV transmission fluid, palm oil esters, sustainability, lubrication, thermal stability

1. Product Description

GreenDrive EV Transmission Fluid is specialized formulation designed to meet the unique demand of EV transmission by leveraging the advantageous chemical properties of palm oil esters. These esters are recognized for their excellent lubrication, low volatility, high thermal stability and high viscosity index. The formulation incorporates high quality palm oil ester base oil, mineral oil and advanced additive, optimized to deliver superior anti-wear performance. The rigorous formulation process as illustrated in **Figure 1**, highlights the systematic approach undertaken to design and optimize GreenDrive EV. It is specifically

engineered to manage the high-speed, high-torque operations of EV transmissions, minimizing friction and energy loss. Compared to conventional transmission fluids, GreenDrive EV enhances thermal management and improves durability, making it particularly suitable for high-efficiency electric drivetrains. The formulation demonstrates superior performance compared to both mineral oil and its parent material, as shown in **Table 2**. It is cost-competitive and aligns with global trends favoring green automotive technologies for extended transmission service life and smooth driving experience, supporting transmission to sustainable mobility.

2. Diagrams

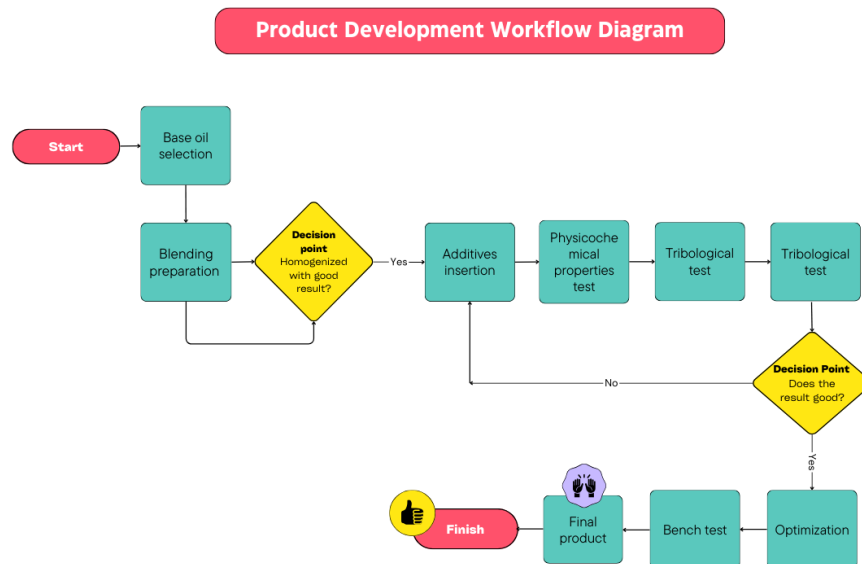


Figure 1. Scheme of work in formulating the GreenDrive EV transmission fluid.

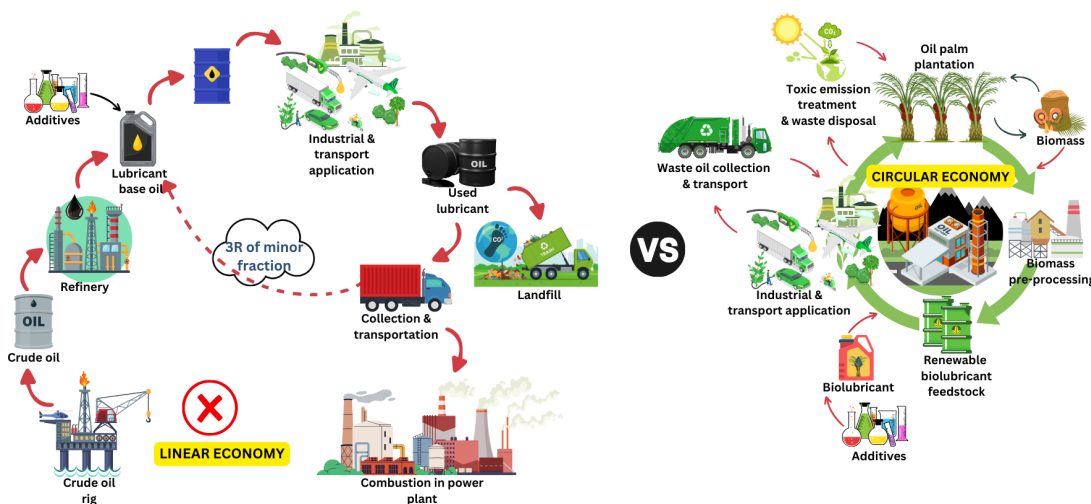


Figure 2. The use of palm oil ester base oil contributes in advancing the circular bioeconomy.

Table 1. Wear scar diameter (WSD) and coefficient of friction (CoF) for the formulated GreenDrive EV compared to the single base oils and their blends without additives

<i>Formula</i>	<i>WSD (mm)</i>	<i>CoF</i>	<i>Pour Point (°C)</i>
<i>Palm oil ester base oil</i>	1.176	0.087	-45
<i>Mineral base oil</i>	1.231	0.107	-9
<i>Palm oil ester + Mineral oil</i>	0.857	0.099	-20.5
<i>GreenDrive EV</i>	0.542	0.077	-34

3. Novelty and uniqueness

GreenDrive EV introduces the first palm oil ester-based transmission fluid specifically tailored for EV applications. Unlike traditional fluids, it addresses both the operational needs of EV transmissions and the demand for sustainable automotive solutions. The product's formulation optimizes wear resistance, thermal stability, and biodegradability, creating a significant competitive advantage. GreenDrive stands out as innovative solutions due to its unique features and benefits. Its biobased composition derived from renewable palm oil esters, significantly reducing environmental impact while aligning with sustainable practices. The formulation offers enhanced thermal stability, making it highly suitable for the high-temperature operations typical in EV systems. Additionally, its low wear rate extends the lifespan of EV transmission components, ensuring durability and reliability. Designed with eco-conscious lifecycle, GreenDrive EV minimizes its carbon footprint and contributes to the principle of a circular bioeconomy, making it a good choice sustainability-focused market.

4. Benefit to mankind

GreenDrive EV aligns with Sustainable Development Goal (SDG) 12 - Responsible Consumption and Production and SDG 13 – Climate Action. It provides notable benefits by reducing carbon footprints, enhancing energy efficiency and promoting a circular bioeconomy through utilization of renewable resources. **Figure 2** illustrates how GreenDrive EV supports the principle of circular bioeconomy in contrast to conventional mineral lubricants, which follow a non-circular economic model. Additionally, it supports stakeholders in palm oil industry while mitigating environmental harm and addressing global challenges related to industrial waste and pollution. This innovative solution demonstrates the integration of sustainability and technological advancement in automotive sector.

5. Innovation and Entrepreneurial Impact

This innovation promotes eco-friendly entrepreneurship and supports the principle of circular bioeconomy principle by encouraging sustainable practices within the automotive and lubricant industries. GreenDrive EV provide a renewable, sustainable

and high-performance lubricant tailored to the need of the growing EVs industry, meeting growing demand for EVs product. This product presents new business opportunity focusing on biolubricants and hold significant potentials for collaboration with green initiatives and government policies that promote biobased industries. It shows the integration of sustainable innovation in automotive engineering which can inspires collaboration between academia and industries to adopt green technologies through knowledge transfer, skill development and industrial partnership.

6. Potential commercialization

GreenDrive EV demonstrates a strong commercialization potential, with primary focus on EV manufacturers, lubricant suppliers and industry prioritizing green energy and sustainability. By catering to the eco-conscious market, this product aligns with the increasing global adoption of EVs and the demand for high-performance and sustainable automotive solutions. The emphasis on achieving SDGs and meeting regulatory requirements further enhances market demand, which can expedite market entry and scalability. Additionally, the modular nature of the product's formulation allows it to be adapted for use in other industries, broadening its applicability and market reach while reinforcing its value as versatile and sustainable solutions.

7. Acknowledgment

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8. Authors' Biography



Samihah Mustaffha is currently on study leave to pursue her PhD in Agricultural Mechanization Engineering at Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA (UiTM) Malaysia. Her areas of expertise include agricultural facilities technology, farm mechanization, and environmental engineering. Her current research is focusing on advancing palm oil ester as potential base oil for electric vehicle transmission fluid. Samihah's academic contributions demonstrate her dedication to improving agricultural practices and environmental sustainability.



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A-ST139: INNOVATIVE API NITRATE TEST KIT VORTEX MIXER FOR ENHANCED AQUAPONIC WATER QUALITY MANAGEMENT

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ABSTRACT

Monitoring nitrate levels is essential for maintaining water quality in aquaponic systems, as excessive nitrate levels can harm aquatic life and promote algae growth. This work proposes the API Nitrate Test Kit (API-NTK) Vortex Mixer, a device designed to simplify nitrate testing for aquaponic farmers. The system employs a Raspberry Pi Pico microcontroller to control a motor for mixing nitrate test solutions, improving consistency and ease of use compared to manual mixing. Users can set a countdown timer using tactile switches, which initiates the mixing process. The countdown is displayed on a 20 × 4 LCD screen for clear user feedback. Safety is prioritized with the inclusion of an emergency stop function activated by the final LED. By automating the mixing process, the API Nitrate Test Kit Vortex Mixer reduces user effort while ensuring accurate test results.

Keywords: Nitrate Vortex Mixer, Water Quality, Aquaponic, Raspberry Pi Pico.

1. Product Description

The proposed prototype is a user-friendly device designed to streamline nitrate testing in aquaponic systems. Built around a Raspberry Pi Pico microcontroller, it automates the often tedious and time-consuming task of solution mixing required for the API-NTK. Users can set predefined timers, as specified in the test kit's procedure, including 10 seconds, 30 seconds, 1 minute, and 5 minutes, via intuitive toggle switches. Each timer initiates the motorized mixing process, ensuring thorough and consistent blending of the nitrate test solution. The countdown timer is displayed on a 20 × 4 LCD screen for easy monitoring. The prototype features an emergency kill switch, which immediately halts all operations, prioritizing safety. The motor, driven by a motor driver to power a 12V DC motor, is capable of maintaining consistent performance even under varying loads. A buzzer alerts the user when the mixing is complete for each set time. Encased in a compact, clear casing, the mixer is designed for durability and portability, making it suitable for both small-scale and industrial aquaponic systems. By automating the traditional manual process of the API-NTK procedure, this prototype reduces the time, effort, and potential inaccuracies associated with nitrate testing. Its innovative design ensures affordability and accessibility for both aquaponic farmers and aquarium hobbyists, promoting better water quality management.

2. Block diagrams of API-NTK Vortex Mixer System

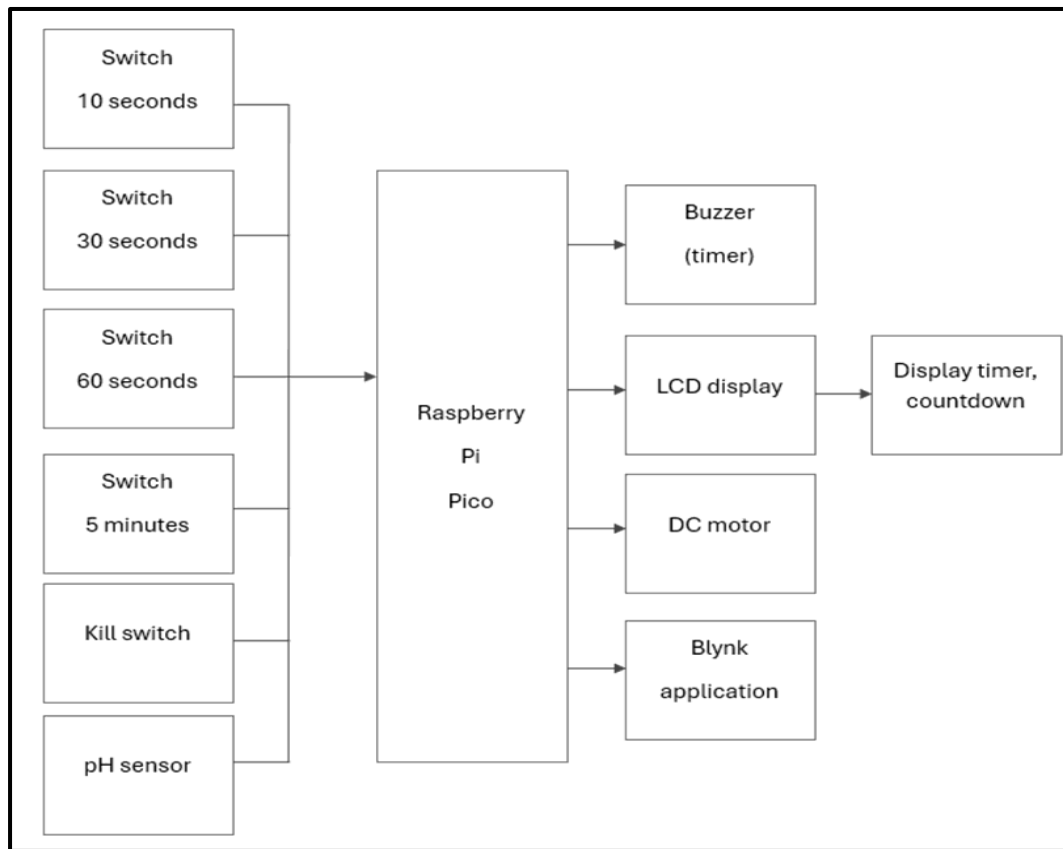


Figure 1. Block Diagram of API-NTK Vortex Mixer System

Figure 1 illustrates the operation of the system through a block diagram. It provides an overview of how the components in the API-NTK Vortex Mixer work together, from activating the switches to the automated mixing process, making the system easier to understand. The system initiates by operating the four toggle switches accordingly, with user activity starting only if the kill switch is off. Once a timer switch is turned on, the timer starts, and the motor spins. The timer countdown (10s, 30s, 60s, 1min, 5min) is displayed on the LCD, and the buzzer sounds for 5 seconds when the countdown ends. The motor driver controls the DC motor direction and speed. The timing options are based on the current market API Nitrate tester procedure, which requires specific mixing durations to ensure accurate nitrate level readings. Because the switching arrangement was developed according to the procedure of the API-NTK, it aligns with the standard test requirements for consistent results. Additionally, a pH sensor is integrated into the system to monitor water pH levels, with the data accessible through the Blynk application on the user device for convenient monitoring.

3. Novelty and uniqueness

The prototype of API-NTK Vortex Mixer offers a novel approach to water quality testing by automating the solution mixing process, traditionally done manually. The system integrates motorized mixing, automated countdown timers, and user-friendly safety features, all powered by the Raspberry Pi Pico microcontroller. The key advantage of this device is its precision and consistency, eliminating variability in results caused by human error or inconsistent mixing. The user interface, with toggle switches and an LCD screen, ensures ease of use even for those with limited technical expertise. An emergency kill switch adds an extra layer of safety, a feature not often found in similar devices. Its compact design allows for use in various settings, from home aquariums to large-scale aquaponic farms. Unlike other nitrate test kits, which are time-consuming and labor-intensive, this system prioritizes efficiency without sacrificing accuracy. By using cost-effective components, the mixer offers a unique balance of affordability and high performance.

4. Benefit to mankind

This prototype contributes to Sustainable Development Goal 6: Clean Water and Sanitation, which focuses on sustainable water management. Aquaponic systems rely on maintaining optimal water quality for the health of both aquatic organisms and plants. High nitrate levels can harm water quality, aquatic life, and promote algae blooms. This device enables users to monitor and control nitrate levels more effectively, leading to healthier ecosystems. By automating nitrate testing, the mixer reduces human error, ensuring accurate results that support better decision-making and increased sustainability in aquaponics. It also promotes efficient resource use by allowing early detection of water quality issues, reducing waste, and minimizing corrective actions. On a larger scale, the prototype supports environmentally responsible farming practices, contributing to food security, environmental conservation, and sustainable agriculture. Its affordability and ease of use make it a valuable tool for both small-scale farmers and hobbyists, enhancing global water management efforts.

5. Innovation and Entrepreneurial Impact

The API-NTK Vortex Mixer aligns with Industry 4.0 by using automation and smart technology to improve efficiency in aquaponic and aquarium systems. With the Raspberry Pi Pico microcontroller and motorized mixing, the device automates the traditionally manual nitrate testing process, ensuring more consistent and accurate results while reducing human error. This innovation supports sustainable agriculture and water management by making the nitrate testing process faster and more reliable. The affordable design makes it accessible to both small-scale hobbyists and large aquaponic farmers, meeting the demand for smart solutions in the agriculture industry. The potential for

commercialization through future upgrades, such as IoT integration for remote monitoring, enhances its relevance in the Industry 4.0 landscape. Overall, the device promotes efficient resource use, supports environmentally responsible farming, and contributes to smarter, data-driven decision-making in aquaponics and water management.

6. Potential commercialization

The API-NTK Vortex Mixer has strong commercialization potential due to its practicality, affordability, and innovative features. Designed for aquaponic farmers and aquarium hobbyists, the device automates the nitrate testing process, reducing manual labor and improving accuracy. Its modular, cost-effective design appeals to a broad audience, offering small-scale farmers an affordable alternative to expensive testing equipment. Hobbyists benefit from its user-friendly interface and compact size, while industrial users can integrate it into larger setups. Safety features, such as the emergency kill switch, enhance reliability. With the growing global focus on sustainable agriculture and water management, the mixer market potential increases. As aquaponics become more popular, demand for tools that support water quality management rises. With effective marketing, partnerships, and potential upgrades, such as IoT integration or faster motors, the device could capture a significant share of the market, making it commercially viable for global distribution.

7. Acknowledgment

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8. Authors' Biography



Arisa Mustafa is a final-year student pursuing a Diploma in Electrical Engineering (Electronics) at Universiti Teknologi MARA UiTM Sarawak Branch, Kota Samarahan Campus. Her final year project, titled "Sustainable Aquaponics: Automated API Nitrate Vortex Mixer with pH Measuring Using Raspberry Pi Pico," focuses on creating an innovative solution for water quality management in aquaponic systems. This project combines automation, sustainability, and technology to improve water management in agricultural practices.



Hadi Jumaat received the B. Eng. in engineering electronics and M.Sc. degree in electrical engineering from the Universiti Teknologi MARA (UiTM), Selangor, Malaysia in 2012 and 2015. He is currently working towards the Ph. D. degree in electrical engineering at Antenna Research Center (ARC) in Universiti Teknologi MARA. Since 2015, he joined UiTM as a young lecturer. His research interests are in communication antenna design, biomedical antenna and electromagnetic wave propagation.



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