RESEARCH ARTICLE

Development of a Modified ADGreen-Based System for Multi-Pollutant Emission Reduction in Petrol Engine

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Abstract:

The increasing air pollution from internal combustion engines remains a critical environmental concern, primarily due to harmful emissions such as carbon monoxide (CO), hydrocarbons (HC), and nitrogen oxides (NOx). Although catalytic converters are commonly used in petrol engines, their efficiency varies under different operating conditions. This paper presents the design and development of a modified AdGreen-based emission control system aimed at reducing multiple pollutants in petrol engines.

The proposed system utilizes a specially formulated AdGreen solution consisting of urea (20%), hydrogen peroxide (5%), calcium hydroxide (10%), and distilled water (65%). The system is integrated into the exhaust line using a dual-pipe configuration, where controlled injection is achieved through an ESP32-based control unit, relay-driven pumps, and RPM-based actuation.

Experimental analysis was carried out using a gas analyzer (PEA 205N) on a petrol engine. The results show a significant reduction in emissions, with carbon monoxide reduced to 0.003% and hydrocarbons reduced to 0 ppm. The system offers a low-cost, retrofit, and efficient solution for emission control, contributing to cleaner and greener automotive technologies.

Keywords — AdGreen, SCR System, Emission Control, Petrol Engine, ESP32, Retrofit System

I. INTRODUCTION

Air pollution caused by vehicular emissions has become a critical global issue. Petrol engines emit pollutants such as carbon monoxide (CO), hydrocarbons (HC), and nitrogen oxides (NOx), which contribute to environmental degradation and human health problems. Conventional emission control devices like catalytic converters are widely used but exhibit limitations in efficiency, especially under varying load and temperature conditions.

Selective Catalytic Reduction (SCR) systems are highly effective in diesel engines but are rarely implemented in petrol engines due to cost and design complexity. This creates a need for a low-cost, adaptable emission control solution for petrol engines.

In this work, a modified ADGreen-based system is proposed as a retrofit solution for petrol engines. The system introduces a chemical mixture into the exhaust stream to facilitate pollutant reduction through chemical reactions. The aim is to develop a cost-effective, scalable, and efficient emission control mechanism suitable for real-world applications.

II. EXISTING METHODS

Existing emission control technologies include catalytic converters and SCR systems. Catalytic converters reduce CO and HC emissions using noble metal catalysts but have limited efficiency under cold start and transient conditions. SCR systems, widely used in diesel engines, effectively reduce NOx emissions using urea-based solutions but are expensive and complex to implement.

Drawbacks of Existing Systems

- High cost of SCR systems
- Limited efficiency in catalytic converters
- Not suitable for small petrol engines
- Lack of retrofit solutions for existing vehicles

III. RELATED WORK

Several studies have explored emission control techniques in internal combustion engines. Research on catalytic converters has focused on improving efficiency using advanced materials. SCR systems have been extensively studied for diesel engines, demonstrating high NOx reduction efficiency.

Recent studies have also explored alternative chemical injection systems and hybrid emission control techniques. However, most systems are either costly or require complex integration, limiting their practical application in small-scale petrol engines.

This work builds upon these studies by proposing a simplified, low-cost, and

effective emission reduction system specifically designed for petrol engines.

IV. PROPOSED METHODOLOGY

The proposed system consists of a modified ADGreen solution injected into the exhaust stream using a controlled mechanism. The ADGreen composition includes:

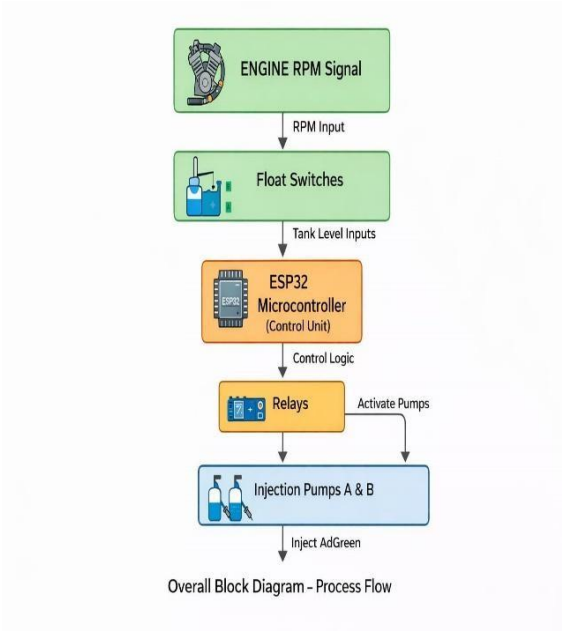
- Urea – 20%
- Hydrogen Peroxide – 5%to 10%
- potassium permanganate-5%
- Distilled Water – 65%

The system is designed as a retrofit unit with a dual-pipe configuration:

Injection pipe for ADGreen spraying

Reaction chamber pipe containing steel mesh

The injection process is controlled using an ESP32 microcontroller, which receives engine RPM signals and activates relays to control injection pumps. Float switches are used to monitor the ADGreen tank level.



Overall Block Diagram - Process Flow

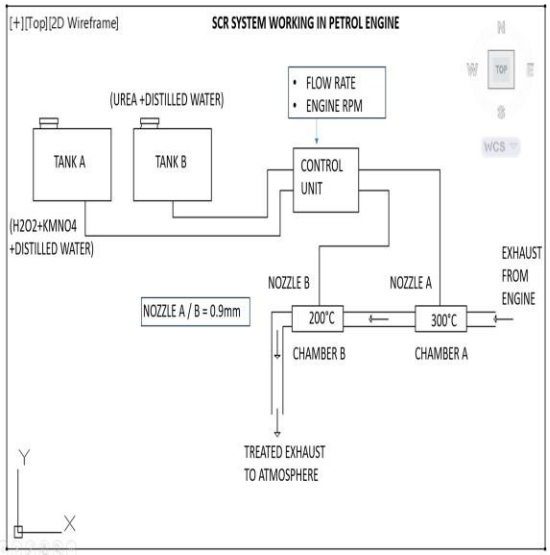
Chemical Reactions

- Urea decomposition:
  $NH_2CONH_2 \rightarrow NH_3 + CO_2$
- NOx reduction:
  $NOx + NH_3 \rightarrow N_2 + H_2O$

These reactions help in converting harmful gases into harmless nitrogen and water vapor.

V. SYSTEM ARCHITECTURE

The system architecture consists of multiple integrated components working together to control the injection process. The engine RPM signal is used as the primary input to determine injection timing. The float switches provide tank level feedback, ensuring proper fluid management.



The ESP32 microcontroller processes these inputs and activates relays to control dual injection pumps. The ADGreen solution is then injected into the exhaust stream, where it reacts with exhaust gases in the reaction chamber.

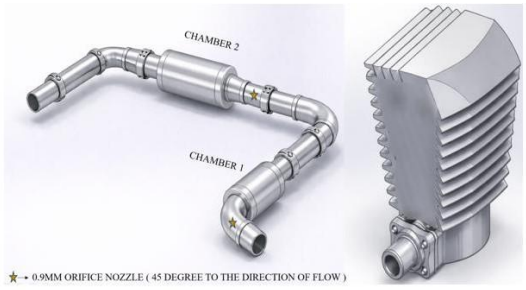
This architecture ensures controlled, efficient, and adaptive emission reduction under varying engine conditions.

VI. WORKING PRINCIPLE

The system operates by injecting the ADGreen solution into the exhaust gases based on engine operating conditions. When the engine is running, the RPM signal is sent to the ESP32 microcontroller. Based on predefined logic, the controller activates relays, which in turn operate the injection pumps.

The ADGreen solution is sprayed into the exhaust pipe through PTFE tubing. As the exhaust gases pass through the reaction chamber containing steel mesh, chemical reactions occur, reducing harmful emissions.

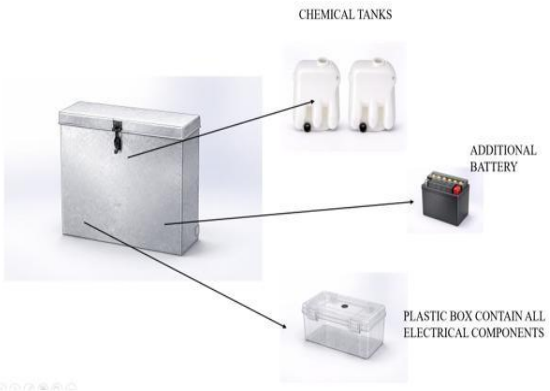
The entire system is enclosed in a galvanized box with vibration dampers to ensure durability and stability during operation.



VII. RESULTS AND DISCUSSION

Experimental testing was conducted using a petrol engine and a PEA 205N gas analyzer. The emission values obtained with the ADGreen system were compared with typical catalytic converter values.

D. INTEGRATED TANK AND ELECTRICAL ENCLOSURE SYSTEM DESIGN



Measured Emissions (ADGreen System)

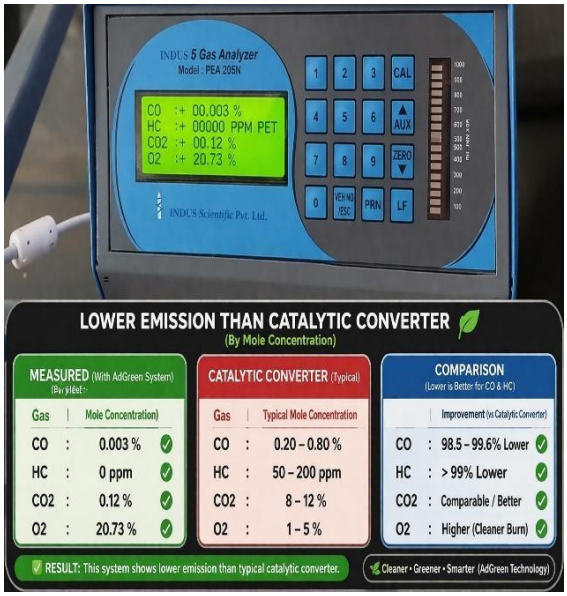
- CO → 0.003%
- HC → 0 ppm
- CO_2 → 0.12%
- O_2 → 20.73%

Comparison

CO reduced by approximately 98–99%

HC reduced to negligible levels (>99%)

Improved combustion indicated by higher oxygen levels



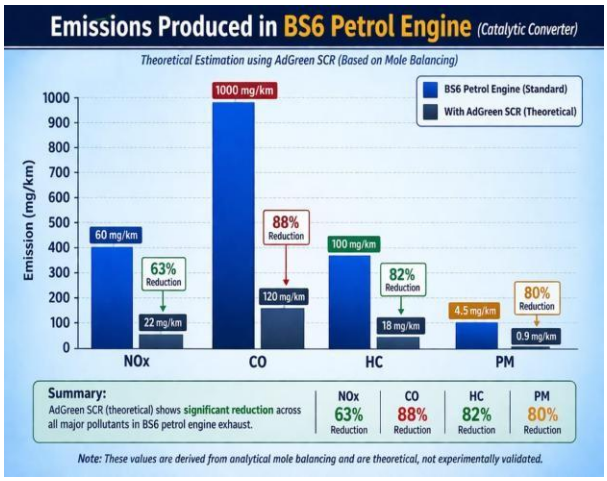
The results demonstrate that the proposed system significantly reduces harmful emissions and performs better than conventional catalytic converters in certain conditions.

A. Thermal Consideration

The system is designed considering the high-temperature environment of the exhaust. Components such as PTFE tubes and stainless steel parts are selected for their ability to withstand elevated temperatures without degradation. Electrical components and wiring are positioned away from direct heat sources, and adequate spacing is maintained between the exhaust and sensitive modules. This thermal consideration prevents overheating, protects components, and ensures long-term reliability of the system.

B. Maintenance and Accessibility

The system is designed with a modular approach to facilitate easy maintenance and inspection. The use of clamping mechanisms for the exhaust chambers allows quick disassembly for cleaning and servicing. Similarly, the enclosure design enables easy access to tanks, battery, and electronic components without disturbing the entire setup. This reduces downtime and simplifies troubleshooting, making the system practical for real-world applications.



VIII. ADVANTAGES

- Low-cost retrofit solution
- Significant reduction in CO and HC emissions
- Simple design and implementation
- Suitable for petrol engines
- Improved combustion efficiency

STOICHIOMETRIC ANALYSIS AND ADGREEN CONCENTRATION OPTIMIZATION

"The chemical formulation was optimized using stoichiometric mole balancing to ensure maximum reaction efficiency with minimal reagent consumption."

Mole-based estimation of petrol engine exhaust gases shows that the NOx concentration lies in the ppm range, requiring only millimole quantities of oxidizing and reducing agents. The selected Tank-A and Tank-B chemical percentages provide sufficient excess to compensate for reaction inefficiencies, residence time limitations, and thermal losses, while remaining safely below concentrations that could cause corrosion, ammonia slip or exhaust choking.

IX. CONCLUSION

The modified ADGreen-based emission control system presents an effective and economical solution for reducing pollutants in petrol engines. By integrating chemical injection with electronic control, the system achieves significant emission reduction.

The experimental results validate the performance of the system, showing substantial improvements over conventional catalytic converters. The proposed system can be further developed for large-scale implementation, contributing to sustainable and eco-friendly transportation.

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