On-board hydrogen generation using heat recovered from the exhaust of a 4-stroke diesel engine for HHO-assisted combustion

A THESIS

submitted by

M. Nikhil Mathew (Roll No. S18008)

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of

MASTER OF SCIENCE

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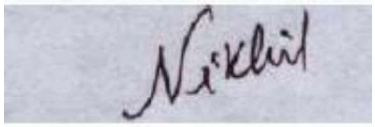
DECLARATION BY THE RESEARCH SCHOLAR

This is to certify that the Thesis entitled **"On-board hydrogen generation using heat recovered from the exhaust of a 4-stroke diesel engine for HHO-assisted combustion"**, submitted by me to the Indian Institute of Technology Mandi for the award of the Degree of **Master of Science (by research),** is a bonafide record of research work carried out by me at the School of Engineering, Indian Institute of Technology Mandi, under the supervision of ***Dr Atul Dhar***. The content of this Thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any Degree or Diploma.



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DECLARATION BY THE RESEARCH ADVISOR

This is to certify that the Thesis entitled **"On-board hydrogen generation using heat recovered from the exhaust of a 4-stroke diesel engine for HHO-assisted combustion",** submitted by ***M. Nikhil Mathew*** to the Indian Institute of Technology Mandi for the award of the Degree of **Master of Science (by research)**, is a bonafide record of research work carried out by him under my supervision at the School of Engineering, Indian Institute of Technology Mandi. The content of this Thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any Degree or Diploma.

Signature

Dr Atul Dhar
Associate Professor
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Date:

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ABSTRACT

IC engines have played a vital role as the most favoured prime mover and have helped the world reach where it is today. The reciprocating type of IC engines can be classified into two based on the most popular fuels they consume to produce power, which are gasoline or spark ignition (SI) engines and diesel or compression ignition (CI) engines. Of the two, diesel engines are more efficient (due to their capabilities of working at higher compression ratios), use the cheaper fuel and have better mileage. These qualities unanimously make them the most desired choice in the long run. But on the downside the diesel engines are also the most polluting in the lot. Diesel powered engine emissions amount to a major part of the Particulate Matter (PM) emissions globally.

Addition of Hydrogen or Brown's gas (HHO) as an auxiliary fuel is a widely studied area of research with promising results to substantially reduce the PM emissions, but the storage of hydrogen or the onboard production of HHO have always been daunting issues. In this project dual fuel combustion of diesel with HHO gas as an auxiliary fuel is studied. The HHO gas is produced on-board by a HHO generator utilising the power extracted from the engine exhaust. A Thermoelectric Generator (TEG) based exhaust heat recovery setup and an alkali based HHO generator were designed and manufactured to suit the requirement of the project. The produced gas is purified and sent into the intake manifold of the engine with the dryer tank acting as an intermediate storage unit. A maximum power of 44.98 W was generated from the exhaust heat recovery unit, which in turn produced 584.74 ml/min of HHO when the engine was operating at 1500 rpm and 45 N-m. Combustion with and without the HHO gas was studied, the soot particulate number reduces from 1.44×10^8 to 0.84×10^8 and the Total Hydrocarbon (THC) content in the exhaust reduces from 81.36 ppm to 48.36 ppm at 1500 rpm and 45 N-m load.

KEYWORDS

Electrolyser, Compression Ignition, Dual Fuel Combustion, HHO Fuel, Regulated Emissions, Particulate Matter, Particle Number, Exhaust Heat Recovery, Thermoelectric Generators, Scanning Electron Microscopy, Energy Dispersion Spectroscopy, Cyclic Voltammetry, Linear Sweep Voltammetry, X-ray Photoelectron Spectroscopy, X-ray Diffraction Spectroscopy.

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