INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student	:	**Wittison Kamei**
Roll Number	:	126103040
Programme of Study	:	Ph.D.

Thesis Title: Experimental investigation of a dual-fuel compression ignition engine for improvement of emissions and thermal efficiency

Name of Thesis Supervisor(s)	:	Prof. Niranjan Sahoo (IIT Guwahati), & Dr. V.V.D.N. Prasad (IIP Dehradun)
Thesis Submitted to the Department/ Center	:	Department of Mechanical Engineering
Date of completion of Thesis Viva-Voce Exam	:	26 June 2021
Key words for description of Thesis Work	:	Dual-fuel engine, combustion, performance, emissions, oxidation catalyst, exergy, liquefied petroleum gas, dimethyl ether.

SHORT ABSTRACT

Dual-fuel engines fumigated with gaseous hydrocarbon fuels such as natural gas or liquefied petroleum gas (LPG) face the challenges of low thermal efficiency and high emissions of carbon monoxide (CO) and unburnt hydrocarbon (HC) at low engine loads. In the present research, two alternative gaseous fuels - dimethyl ether (DME) and liquefied petroleum gas (LPG) - are studied as fumigants in a dual-fuel compression ignition engine. LPG is a widely used alternative fuel, and DME is a promising alternative fuel that can be produced from feedstocks such as coal and biomass. In the present research, the LPG fumigation and DME-LPG co-fumigation are studied for engine performance, emissions, and combustion characteristics, with emphasis on thermal efficiency improvement and reductions of CO and HC at low loads. Two different oxidation catalytic converters (OCCs) – a commercial OCC and a customized OCC - are used for the reductions of CO and HC emissions, from low-load conditions to 70% load. The LPG-diesel

dual-fuel mode suffers from poor combustion characteristics, low brake thermal efficiency (BTE), and high emissions of CO and HC at below half-load operations. However, at 70% load, the engine performance of the LPG-diesel dual-fuel mode is the same as that of the diesel mode. While CO emissions are readily oxidized by either of the OCCs at all the tested loads, the dual-fuel mode HC conversion efficiencies with the commercial OCC are limited to about 60% at low-load operations. The customized OCC performed significantly better when compared with the commercial OCC. The addition of DME as a co-fumigant with LPG results in significant improvement of BTE. The DME-LPG-diesel dual-fuel mode BTEs and exergy efficiencies are higher than those of the LPG-diesel mode and the baseline diesel mode. With the combined approach of using the DME-LPG co-fumigation and the customized OCC, HC emissions are 85-89% lower, and CO emissions are 89-94% lower as compared to the diesel mode. Further, smoke opacity values are 78-94% lower than those of the diesel mode. Therefore, the DME-LPG co-fumigated dual-fuel engine, equipped with the customized oxidation catalyst, outperforms the diesel mode and achieves lower emissions.