

LOW CARBON EMISSIONS REVIEW IN AVIATION ENGINE TECHNOLOGY FOR ASEAN AIRSPACE: A PROPOSAL

Nithia Kumar Kasava^a, Noordin Mohd Yusof^a, and Muhamad Zameri Mat Saman^a

^a Faculty of Mechanical Engineering, Department of Manufacturing and Industrial Engineering,
Universiti Teknologi Malaysia (UTM)
81310 UTM Johor Bahru, Malaysia.

Corresponding Author's E-mail: nithia78@gmail.com

Keywords: Emission; gas turbine engine; carbon reduction.

EXTENDED ABSTRACT

Air transportation has been major mode of connecting role player in business supply chain and catalyst for tourism industry. Emission from aircraft engines do produce various gasses as by product of combustion. Thus in this paper the authors focus on gas turbine engine emissions in accordance to ICAO Annex 16 emission protection recommendations. Majority of the aircraft are fitted with gas turbine engines for propulsion. The United States Federal Aviation Administration (FAA) and European Aviation Safety Agency (EASA) emission documents were studied. Carbon in this context is CO₂ directly related to fuel consumption by the engine. The engine emission consist of NO_x, HC, CO₂ and smoke. However with various initiatives aircraft today 15 percent reduction in fuel burn, 40 percent lower in emission compared to a decade ago (ICAO Environmental report 2010)

The FAA have launched the continuous lower energy, emissions and noise (CLEEN) program in 2010. The goal of the CLEEN program is to noise and emissions reduction by aircraft and engine technology. Another improvement was the alternative fuel deployment and development project. This project known as "Farm to Fly" and base on this initiative development three alternative jet fuels approved for aviation use by ASTM standards. FAA also developing a proposed Global Market Based Measure (GMBM) for metrics of measurement. These holistic program known as "Next Generation Air Transportation System" or NextGen. NextGen has five pillars of strategy. (US Aviation GHG reduction plan 2015).

- I. Aircraft and engine technology improvement
- II. Alternative jet fuels development and deployment
- III. Policies, standards and measures
- IV. Air traffic management operation improvement
- V. Scientific understanding and modelling/analysis

Under the CLEEN project the FAA have collaboration with five manufacturers which are Boeing, General Electrics, Honeywell, Pratt & Whitney and Rolls Royce. The goal is to develop technology that reduces noise, emissions and fuel burn. CLEEN specializes improvements on the airframe, engine and flight controls. The total investment was USD 117 million to achieve this project goal.

The authors have used data from ICAO Annex 16 emission protection databank. The data was selected into old engines and new generation engines. The older gas turbine engines emission data was compared to new gas turbine engines. Sixteen types gas turbine engines

data was selected from various engine manufacturers. The engine manufactures are SNECMA-GE, General Electrics, Engines Alliance, Pratt & Whitney and Rolls Royce. The variable of bypass ratio, engine power in kN (kilo Newton), ratio of hydrogen atoms to carbon atoms in the fuel, smoke number at take off and emission index of carbon oxide at take off. A comparison analysis carried out among the old and new engine versions. The validation to the reduction of smoke and emission index were based on manufacturers engine emission control technologies. The authors reviewed EASA regulation on emissions, FAA regulation on emission and ASEAN aviation authorities policies and regulations in emissions management.

Based on comparative analysis from data, the authors expected to show that there was positive changes in emission of gas turbine engines from old engines to new engines with improvement in combustor design and combustion process. Base on this result a qualitative paradigm illustration will be developed to indicate emissions of carbon versus Airspace carbon tax. The higher carbon emitted by the engine thus higher the carbon tax in that airspace rule.

The authors propose that the ASEAN countries may capitalize these analysis result to implement a low carbon emission airspace policies. The proposal for local aviation authorities only to allow low carbon emission airplane into ASEAN airspace and to impose carbon emission tax to airlines that operationg aircraft engines with high carbon emission. The airlines may also use the analysed data to make decision prior purchase or lease any aircraft in order to comply the law carbon emission regulation if implemented in ASEAN airspace.

Acknowledgements: The authors would like to that to Malaysian Department of Civil Aviation for sharing their knowledge and plan in emissions. I would like to thank both my doctoral supervisors Prof Dr. Noordin Mohd Yusof and Assc. Prof Dr. Muhamad Zamari Mat Saman for the guidance and support in this research paper.

References

1. ICAO Environmental Report, Chapter 2, *Aircraft Technology Improvement*, 69-94, 2010.
2. United States Aviation Green House Gas Emissions, *Reduction Plan*, 12-42, 2015.