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Review of Aircraft Emission Reduction

Ankit Kumar and Pramod Bhatia

Department of Mechanical Engineering, The NorthCap University, Gurgaon 122017, Haryana, India

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Abstract

Aviation sector is one of the fastest growing industries which include both combat and transportation. Aviation sector is a major industry with world GDP contribution of $973 billion. By 2026, expected contribution of $ 1.1 trillion indirectly, and $ 1.5 trillion through direct support of global tourism is expected. For next two decades this sector is expected to grow at the rate of about 4%-4.5%. Global aviation sector accounts for 2% of global GHG (greenhouse gas) emission. Aviation industry's waste product like non-CO_2 gases [NOx and SOx] emissions at higher altitude increase effect global warming. This value is much higher than that of CO_2. According to ICAO, in 2010 aviation industry consumed 65% fuel and resulted in 448 MT of CO_2 emissions. This valued will to 682-755 MT by 2020. This can lead to global warming and global temperature increase of 2 C. It is known that at higher altitudes, vehicular emissions are three to four times more than ground levels. The proposed work of this research paper is to reduce aircraft emission by improving technology, air traffic management and by use of alternative fuels.

Keywords: *Technology improvement, air traffic management, alternative fuel*

Introduction

GHG (greenhouse gas) emission is a serious problem in all transport systems including passenger and combat aircraft. Aviation industry transports about two billion passengers yearly and it generates about 27 million jobs globally. Aviation industry is responsible for about 2 present of global carbon dioxide (CO_2) emissions [1]. International Civil Aviation Organization and NASA are working towards reduction of aviation emissions. By 2050, International Civil Aviation Organization has decided to increase fuel efficiency annually by 2 percent. This will be made possible by use of CNG and biofuels [1]. ICAO has laid down guidelines for reduction of aviation greenhouse gas by using alternative fuel (CNG, biofuel). They have also made the guidelines for airport and for maintenance schedule requirements. According to Intergovernmental Panel on Climate Change (IPCC), aviation sector currently accounts for approximate 2% of human-generated global CO_2 emission. CO_2 is the most important greenhouse gas (GHG) and is responsible for about 3% of the potential warming.. According to IPCC's medium-range estimate forecast, by 2050, the global aviation sector, including air- craft emissions, will emit about 3% of global carbon dioxide and will be responsible for about 5% of the potential warming effect of all global human-generated emissions. During flight operations, aircrafts emit various types of GHG (greenhouse) and other gases. Some of these harmful gases are: carbon dioxide, nitrogen oxides, soot and water vapour. These gases directly affect the earth's climate [1-5].

Importance of Aviation Sector

Aviation industry is a fast growing sector and it contributes world GDP through business, tourism and defence. Numbers of airlines have double in the past few years. In future more and more passenger will travel through air. In past few years aviation sector has grown fastest in countries like India, Brazil, China, France and Japan. In these countries, this sector has generated 8.7 million direct jobs and its growth will be booming in future.

Background History of Aviation Emission

In 1903, Wright brother's, for the first time used propulsive device in an airplane. This airplane was a reciprocating engine airplane. In 1940 jet engines were revolutionized continuously. 1903 was the starting point of aircraft emissions and these emissions are continuously growing every year. In present times, aircraft sector contributes to approximate 2% to 3% worldwide CO_2 production. This sector accounts for approximately 13% to 15% of fossil fuels consumed by transportations.

Aircraft Emission Reduction Planning, Effect analysis and Matrix development

Aircraft emission reduction planning is very important from all points of view like environment, climate change, human impact, cloud formation, ozone layer depletion and contribution of 2 C temperature change. The aircraft emission reduction plan should have three key features: (1) Process, (2) Matrix and (3) Goals. The process is very important for achieving the goals and for scheduled inspection of the matrix. The metrics is defined by human health and welfare risks due to domestic air quality. Matrices also involve the number of pollutants. An efficient matrix helps to reduce global warming and uncertainty in climate; it is also helps in domestic and international air quality improvement. Third important point is the goals. Goals should be technically and economically achievable. They should be simple, accurate and meaningful. Aviation emission reduction plans are of three types: (1) Short term, (2) Medium term and (3) Long term; all of three are very important.

Guide Line for Reduction Negative Impact of Environment by Aviation Sector.

The three main guidelines are:

(a) Communication and Coordination

First is communication and coordination among stockholders. Second is development of more effective tools and metrics for planning research investment and for policy decisions. Third is develop technologic and policies for long time environment improvement. The third is recommendations are very important because without third, first and second are meaningless.

(b) Tools and Metrics

Assessment of human health and welfare effect using metrics is important. These metrics represent impact of aircraft emission on human health, climate change, cloud formation and ozone depletion. A tool represents aviation impact on economic cost analysis, benefits analysis, policy analysis and research & development. The evaluation of benefits of research include: operational advancement and source simplification technology. Analysis of damage cost, mitigation cost, air quality and climate changes are also important. It also evaluates research opportunities.

One has to create new analytical tools which should help us in better understanding of emissions and the types of aircraft emission, as well as to analyse the total cost, advantages & disadvantages of different technology, operations, policy option for moderation.

Earth systems observation, modelling and analysis is a new technique. It should be integrated to atmosphere observations with domestic, national & international modelling for reducing uncertainty in global and local climate change, cloud formation, domestic air quality, international air quality, national air quality, whether by technology improvement or by operational modernisation.

Characterization of aviation air toxics and particulate matter is another technique developed for measurement of toxic air pollutants (hazardous) and particulate matters from aircraft and to collect data for classifying the aircraft emission for current fleets, and to perform research work on emission pollutant effect on environment, climate change, cloud formation and also for engine design and for finding operation effect, for local air quality monitoring, and to inform the stockholders. We have to develop a road map, models and policies for emission reduction. These road maps and model are highly reliable and protect human from harmful aviation emission. These are the very important

Assessing impact and development of more effective matrices of aircraft particulate matter (PM) and climate changes, human health effect risk and cost is very important. These techniques help in aviation emission effect analysis and also help formulate policies of emission reduction. Matrix is very important for developing new policies, climate changes, and local air-quality improvement

We have to develop new plans for giving information to public and to educate them about aviation emission effect on environment change, global warming, climate change, ozone depleted, cloud formation, human health etc.

(a) Recommendation technology, operations, and policies

This is a new approach for developing new policies for operation management and decrease the effect of aviation emission. Here we have to develop new policies for ground time reduction and develop policies for local air quality improvement. We should also develop new policies for technology improvement and also ensure that they are reliable and environment friendly.

Aircraft Emission Control

Aviation emission and traffic doubles every 15 years. This increases aviation emissions which consist of carbon dioxide (CO_2), hydrocarbon (HC), nitrogen oxide (NOx), soot (aerosols), water vapour (H_2O) and Sulphur dioxide (SO_2). These pollutants impact cloud formation and human health. They lead to climate change and ozone depletion. Airlines generate 13% CO_2 emission by transportation and hence lead to global climate change and deteriorate local air quality. We must to reduce aircraft emissions by short term, long term and medium term actions plans. These policies reduce fuel consumption by aircraft technology improvement, improve air traffic by management, improve operations, develop new technology and alternative fuels, and

compensate aircraft emission by market based measurements (MBM).

The short term actions plans are of three types: (1) Management of CNS-ATM Systems, (2) Flight operations and (3) Aircraft maintenance. These are important for local air quality, reduced fuel consumption by flight operations management, maintenance.

CNS-ATM system is very important for aircraft because without it airline industries may not exist. Operation possible by CNS-ATM System are: ground clearance, runway information, time of take -off and landing. All these are controlled by CNS-ATM Systems without increasing the possibility of fatal accident. We should develop new CNS-ATM system for reducing fuel consumption by reduced ground clearance distances, by improving communication information about runway and by controlling location of aircraft between transponder and receiver during flight. Effective and efficient use and planning of airport capabilities, construction of new runway and taxiway to relief traffic congestion must be implemented. Improvements in air traffic management (ATM) and other operational procedures could reduce aviation fuel burn by between 8 and 18% by direct routings optimum altitude and speed.

Focus should be on improvement of flight operations for reducing fuel consumption. Aircraft emission reduction is possible by controlling phase of flight, optimal use of fuel reserves, proper airplane landing, proper route selection, proper altitude selection, speed control and flap deflection. At landing time main engine is off and flap is deflected for reducing fuel consumption and batter landing; which in turn for improves the local air quality. We should not select long route. We have to go from Delhi to Goa but route we take delhi-kanpur-patna-goa route. This obviously increases aircraft emissions. At higher altitude emissions are more than three to four times higher than ground level.

Maintenance is an important factor to minimised emissions by Ram check-1 (after landing), Ram check -2 (after 100h of flight hour), Ram check -3 (200 flight hour), Service check-1 (after 6 six month of service periods), Service sheck-2 (2 year of service) and Service check-3 (5 year of service).

Alternative fuel trial to reduced fuel consumption and emission reduction is very important. During last five years major work on the alternative aviation fuel aimed at identifying new aviation alternative fuel which will increase fuel efficiency and reduce aviation emission was done.

Market-Based Measures (MBM) policy tools that are designed to achieve environmental goals at a lower cost and in a more flexible manner than traditional command are required.

We have to upgrade policies for emission reduction. This is required from time to time. Analyzing policies and upgrade or develop new policies for emission reduction and efficient working is extremely necessary.

Long term police are developed for approximately 10 to 15 year. In these policies working on technology development, aerodynamic technology improvement, new alternative fuels, new design of aircraft for solar driven etc. are ensured. These policies require heavy investment.

Technology development is made possible through following:

a) Weight reduction using advanced materials, structural layout and manufacturing methods
b) Aerodynamic improvements by reducing drag, design of flap and design of aircraft shape.
c) Propulsion system and power generation developments for developing new engine for using alternative fuels

We must develop advanced CNS-ATM system and develop policies to control GHG emission

Conclusion

Aviation sector is one of the fastest growing industries which is expected to contribute to GDP of world directly USD 973 billion, another USD 1.1 trillion indirectly, and USD 1.5 trillion through direct support of global tourism. This industry will grow at the rate of about 4%-4.5% next two decades. Global aviation sector accounts for 2% of global GHGs (greenhouse gases). They are responsible for global warming and climate change. At high altitudes aviation greenhouse gas emission and other pollutant directly lead to global warming. It is very difficult to reduce aviation GHG emission but immediate action on aviation emission controlling are required. NASA is working with 32 organizations on aviation emission reduction technology ATM system improvement, design improvement and research on alternative aviation fuel to increase efficiency and reduced aviation greenhouse gas emission is must. ICAO (international civil aviation organization) plans to reduce up to 50% aviation greenhouse gas emission and other pollutant in next few years. According to ICAO all aviation fuels (example-ATF, AVG) must be replaced with alternative fuel (CNG, Biodiesel) by 2050. All the policies, guideline given by NASA, ICAO, etc are long term measures.

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