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Adverse effects of Aviation Industry in Global Warming

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ABSTRACT

The burning of aviation fuels produces greenhouse gases such as CO_2, CO, SO_x, NO_x and water vapors which lead to global warming. Earth's environment, ecosystems and human health is continuously damaging due to the hazard of global warming. Although, the overall contribution of aviation industry is less in global warming as compare to other transport modes but emission from aircrafts are of great concern due emission of GHG at higher levels of the atmosphere. The present study briefly reviews the various aspects of emission caused by aviation industries and their contribution in global warming. Few approaches requiring technological amendments and/ or advancements to curve the release of harmful gases and particulates in the atmosphere by aviation industries has also been briefly discussed.

Keywords: *Global warming, greenhouse gases, carbon dioxide, oxides of nitrous, water vapor.*

I. INTRODUCTION

Global warming is defined as an increase in the average temperature of the Earth's atmosphere, greenhouse gases (GHG) in the earth's atmosphere, leading to entrapment of more and more solar radiations, and thus increasing the overall temperature of the earth.

In 2013, IPCC stated that emission of greenhouse gases such as carbon dioxide, methane and nitrous oxide has been the dominant cause of the observed warming since the mid-20th century. indicated that during the 21st century, the global surface temperature is likely to rise a further 0.3 to 1.7 °C (0.5 to 3.1 °F) in the lowest emissions scenario, and 2.6 to 4.8 °C (4.7 to 8.6 °F) in the highest emissions scenario.

Average temperatures around the world have risen by 0.75°C (1.4°F) over the last 100 years about two thirds of this increase has occurred since 1975. In the past, when the Earth experienced increases in temperature it was the result of natural causes but today it is being caused by the accumulation of greenhouse gases in the atmosphere produced by human activities. The natural greenhouse effect maintains the Earth's temperature at a safe level making it possible for humans and many other life forms to exist. However, since the Industrial

Revolution human activities have significantly enhanced the greenhouse effect causing the Earth's average temperature to rise by almost 1°C. To put this increase in perspective it is important to understand that during the last ice age, a period of massive climate change, the average temperature change around the globe was only about 5°C, the 25 warmest years have all occurred within the last 28 years. Scientists know with absolute certainty that the observed dramatic increase in the atmospheric concentrations of greenhouse gases since preindustrial times (to levels higher than at any other time in at least the last 420,000 years) has been caused by human activities, mostly the burning of fossil fuels (coal, oil, and natural gas), and to a lesser extent, deforestation.

The aircraft engines consume hydrocarbon as fuel and produce CO_2, CO, SO_x, NO_x, water vapors and other traced particulates. Consumption of fuel in aircraft is relatively smaller than the consumption of fuel in automobile industry and power generation sector but study of emissions from aircraft is of great concern as they are deposited at higher altitude where they can affect the environment entirely different than the other modes of emissions.

Increment in CO_2 levels causes increase in overall temperature and Ocean acidification. Increments in temperature lead to heightened evaporation of oceans which further leads to an increase in global averaged precipitation causing more extreme storms, floods and hurricanes. Accumulation of CO_2 on ocean results destruction of food sources, in turn decreasing biodiversity levels. The IPCC stated that aviation is likely responsible for 3.5% of climate change and could grow to 5% if no action is taken by 2050.

Over the years, new technologies have been introduced to reduce the amount of emissions but with the technologies the demand of transportation is also increasing and these advances have not kept pace with the increased demand for air transportation. The intent of this study is to review the emission of GHG from aircraft and their effect on human health and environment.

II. CONTRIBUTION OF AVIATION INDUSTRY IN GHG EMISSION

Over the years, emissions from aviation industry has grown significantly as shown in Figure 1.

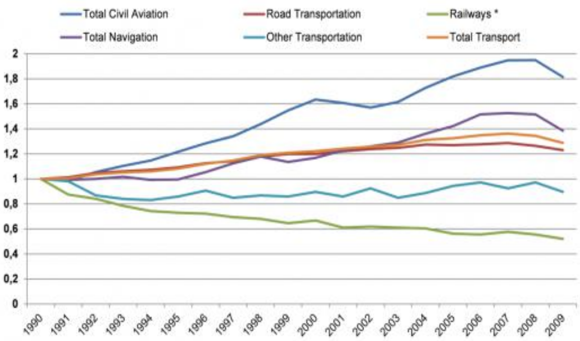

Figure 1: GHG emission trends of various transport modes

Kirby (2008) stated that road transport contributes in 80% of greenhouse gas emissions, railway transport emits 46% GHG, 7% comes from sea transport and 0.5% from rail. Civil aviation sector is the second largest contributor with 13% greenhouse gas emissions as shown in Figure 2.

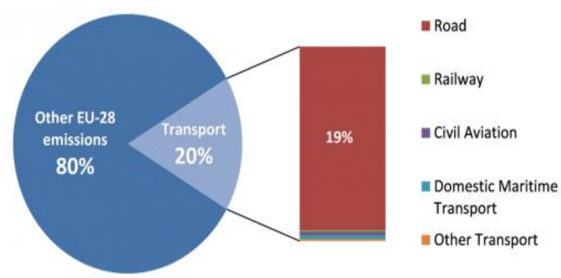

Figure 2: Breakdown by emission sectors

Environment impact is also associated with the altitude at which aircraft is flying as shown in Figure 3 and emitting carbon dioxide, higher altitude cause greater damage to ozone layer and most of the flights fly at an altitude between 9-12km.

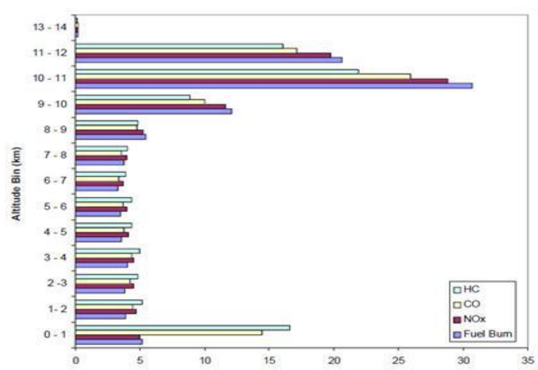

Figure 3 Altitude distribution of fuel burn and emissions

III. EFFECT OF AVIATION EMISSION ON CLIMATE AND HEALTH

The major concerns with emissions are the global warming, alteration of the concentration of ozone and the effects on human health due to air pollution.

Impact on health

A journal of Environmental Science and Technology stated that cruise altitude of about 35,000 feet release pollutants that cause about 8,000 deaths globally per year. People in areas where flights are very frequent are affected by varied diseases due to presence of more emission.

Carbon monoxide: causes headaches, nervous system impairments, and nausea.

Nitrogen oxides: can damage immune system cells and capillaries, aggravates asthma, increase susceptibility to infection, critical health of the heart, acute respiratory problems. Ozone increases susceptibility to infection, reduces lung function, and aggravate allergy.

Particulate matter: causes respiratory problems, colds, decreased lung capacity and emphysema. Long term exposure can also be responsible for heart and lung disease and cancer.

Sulfur dioxide: causes chronic bronchitis, breathing difficulties, lung irritation, preterm birth in humans and possible death when mixed with particulate matter.

Water vapors: imposes great risk on lungs if ingested as they contain unburned hydrocarbons.

Impact on Environmental

Pollution caused by aviation harms not only climate but it affects aviation industry itself. High temperature rise caused storm on ground which damages the aircraft controls and equipment during take-off and landing that reduces the frequency of flight as well as operational time. Warm climate reduces the capability of load carrying capability of aircraft and its performance. To operate in severe turbulent weather new sensing, communication and navigation technology is required to maintain the safety of passengers and crew.

Effects of Carbon Dioxide

Carbon Dioxide is a greenhouse gas which is by-product of the combustion of fossil fuels due to incomplete combustion. Increased amount of CO_2 causes melting ice caps and rising ocean levels and it remains in atmosphere for 100 to 200 years which traps additional heat and causes the average temperature on Earth to rise and the results would be floods, heat waves, droughts and tornadoes. Figure 4 and Figure 5 represents increase in CO_2 and change in global temperature respectively.

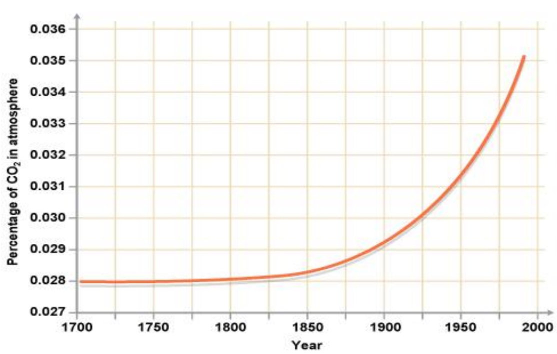

Fig. 4 Increase of carbon dioxide

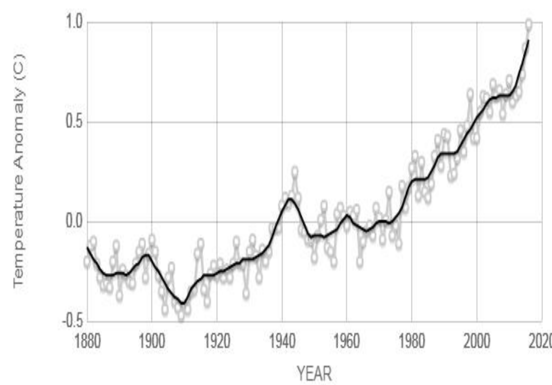

Fig. 5 Increase of global average temperature.

Effects of Water Vapor, Contrails, and Cirrus Clouds

Cirrus clouds conceal to 25% of the Earth and have a net warming impact. At the point when clouds are meager and translucent, they productively retain active infrared radiation while just insignificantly mirroring the approaching daylight. At the point where clouds are 100 m thick, they reflect just around 9% of the approaching daylight anticipate practically half of the active infrared radiation from getting away, in this way raising the temperature of the environment underneath the mists by a normal of 10°C .

Because of their warming impacts when moderately slender, cirrus clouds have been embroiled as a potential fractional reason for an unnatural weather change. Researchers have theorized that a dangerous atmospheric deviation could cause high thin overcast spread to increment, in this manner expanding temperatures and moistness. This, thus, would build the cirrus overcast spread, successfully making a positive criticism circuit. A forecast of this theory is that the cirrus would move higher as the temperatures rises, expanding the volume of air underneath the clouds and the measure of infrared radiation reflected down to earth.
The impact of aeronautics incited cirrus clouds is exceptionally dubious. They may have next to no or no impact or they may influence the worldwide radiation spending more than CO2. The impact may likewise differ with scope and season. Regardless of whether the impacts of contrails and aeronautics incited cirrus mists are little when arrived at the midpoint of all around, they may have noteworthy climatological impacts in certain areas.

Effects of Oxides of Nitrogen (NOx)

NO_x emissions in the upper troposphere increase the amount of ozone. This increase may have decreased UV radiation at the Earth's surface by 1% at 45 degrees latitude and growth in aviation could double the effect by 2050.

IV. CONCLUSION

GLOBE-Net (2007) stated that with development and improvements in airframe and engine technology, better traffic management systems and with alternative energy sources, emission of GHG can be reduced drastically.
Aviation emission can be reduced by increasing fuel efficiency. Higher fuel efficiency can be achieved by increased pressure ratio within engine but increased pressure ratio also increases nitrogen oxide content. So there must be some improved control techniques for NO_x to get better fuel efficiency at higher pressure ratio. Improvements in Aircraft Efficiency can be achieved by latest fuel efficiency technology, better aerodynamic shape and use of light weight material (composites) to reduce aerodynamic drag, flexible wing, winglets, fuselage airflow control devices and weight reductions. Efficient current flight patterns at optimized aircraft speed with less consumption of fuel reduces the impact of CO_2 emissions which is an imperative approach to reduce aircraft emission.
Alternative energy solutions will lead to reducing greenhouse gas emissions such as fuel cells, biofuels, solar cells etc.

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