Journal of Air Transport Management 58 (2017) 176–182

Contents lists available at ScienceDirect

Journal of Air Transport Management

journal homepage: www.elsevier.com/locate/jairtraman

Emissions from passenger aircrafts at Kayseri Airport, Turkey

İlker Yılmaz

Erciyes University, Faculty of Aeronautics and Astronautics, Dept. of Airframes and Power Plants, 38039, Kayseri, Turkey

ARTICLE INFO

Article history:
Received 1 February 2016
Received in revised form
1 November 2016
Accepted 4 November 2016
Available online 9 November 2016

Keywords:
Aviation
Landing and take-off
Aircraft emissions
Pollutants

ABSTRACT

This paper presents the estimation of pollutant gas emissions including nitrogen oxides (NO_x), hydrocarbons (HC), and carbon monoxide (CO), from aircraft during landing and take-off (LTO) cycles for the year 2010 at Kayseri Airport in Turkey. Emission calculations were carried out using the flight data recorded by the State Airports Authority and International Civil Aviation Organization (ICAO) - Engine Emission Data Bank (EEDB) used for calculations. The total landing and take-off pollutant emissions from aircrafts were calculated as 177.90 t/y (8.4 t/y for HC, 66.90 t/y for CO, and 102.64 t/y for NOx) at Kayseri Airport in 2010. It is estimated that a decrease of 2 min in taxiing time causes a decrease of approximately 4% in LTO emissions. An increase of 25% in landing and take-off cycles causes an increase of around 11% in pollutant emissions. Domestic flights were responsible for 68% of the total LTO emissions from all flights at Kayseri Airport in 2010.

1. Introduction

Aviation plays a key role in the economic improvement and daily life. It contributes to our quality of life by enabling the movement of people and products all over the globe quickly and safely. The air transport industry has grown rapidly over the years, and this growth is expected to continue. Turkey, which is the third largest country in Europe and positioned at the crossroads of Europe, Asia and Africa, has been one of the fastest growing markets of the world (Ozgur et al., 2015). Fig. 1 shows growth of air passenger traffic between 2002 and 2010 years. Roughly, total country's passenger traffic has grown at a rate of 317% from 34 million to over 166 million in the last 9 years. Air transportation is an important source of pollutant emissions in the atmosphere. For this reason, it is important consideration in the environmental impact of aviation with regard to pollutant emissions.

Emissions from aircraft originate from the fuel burned in aircraft engines. Aircraft gas turbine engines like many other vehicle engines produce nitrogen oxides, hydrocarbons, carbon dioxide, water vapor, sulphur oxides, particulates, and other trace compounds. Carbon monoxide is formed due to the incomplete combustion of the carbon in fuel. Nitrogen oxides, nitrogen oxide and nitrogen dioxide, are produced when fuel is burned at high temperatures, as in the combustion process. Hydrocarbons are emitted due to incomplete fuel combustion by an engine. Carbon dioxide is the product of the complete combustion of hydrocarbon fuels like kerosene, gasoline, and diesel. Carbon in fuel combines with oxygen in the air to produce carbon dioxide. Water vapor is the other product of complete combustion as hydrogen in the fuel combines with oxygen in the air to produce water vapor. Sulphur oxides are produced mainly from the combustion of fossil fuels that contain sulphur like gasoline, coal etc. Particulates form as a result of incomplete combustion. The negative external effects of aviation exist at both local and global levels (Penner et al., 1999; Environmental Protection Agency, 1992). The environmental impacts of atmospheric emissions from aircraft have been examined in two separate ways; aircraft pollutant emissions occurring during the LTO cycle (local pollutant emissions) which are the focus of the present study, and these that occur during the non-LTO cycle (global pollutant emissions). Pollutant emissions from aircraft at airports are important sources of air pollution and directly or indirectly have a harmful effect on human health, ecosystems and cultural heritage.

There have only been a few studies on aircraft pollutant emissions at airports. There has been no detailed study to determine the pollutant emissions from aircraft gas turbines at Airports in Turkey. Only two studies have been conducted on the estimation of aircraft emissions at Turkish airports. In the first of these, the estimation of aircraft emissions during the LTO cycle at Turkish airports was carried out using flight data recorded by the State Airports Authority (Kesgin, 2006). Using flight data from the State Airports Authority, the second study examined the estimation of

E-mail address: iyilmaz@erciyes.edu.tr.

http://dx.doi.org/10.1016/j.jairtraman.2016.11.001
0969-6997/

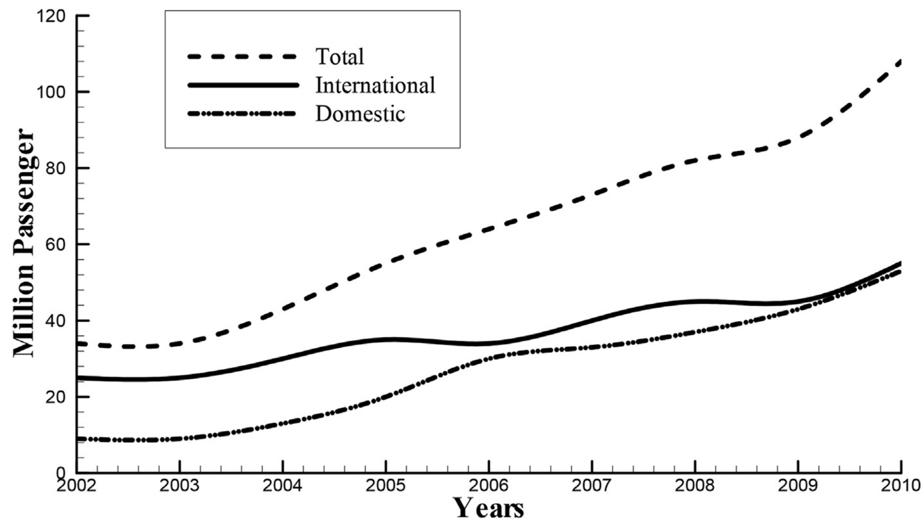

Fig. 1. Growth of air passenger traffic between 2002 and 2010 years. (Derived from the State Airports Authority (DHMI), 2011).

atmospheric emissions of aircrafts with gas turbine engines during the LTO cycle at Adnan Menderes Airport, Turkey (Elbir, 2008). In the literature, many studies focused on the estimation of pollutant emissions from aircraft at airports. Kurniawan and Khardi (2011) evaluated some of the methodologies used in aircraft pollutant assessment by focusing on some of the projects and studies available in the literature. In one study a city-pair gravity model was presented to project domestic US passenger air traffic through to 2030 (Jamin et al., 2004). The model predicted future levels of domestic US air passenger mobility and generated a simplified three-dimensional emissions distribution. The estimating of temporal and spatial contributions to NOx concentrations from aircraft and traffic around a local airport in London was studied by Farias and Apsimon (2006). In their study special attention was devoted to the modeling of aircraft releases at different altitudes. At Dallas/Fort Worth International Airport, a detailed estimation of fuel consumption and emissions during taxi operations was investigated using aircraft position data from actual operations (Nikoleris et al., 2011). The authors of the study concluded that taxiing and idling are the two largest sources of fuel burn and emissions. In other study aviation emissions based on actual 4D trajectories including flight routes and radar data were calculated (Pham et al., 2010). In that study, the estimation of information about flights was also performed to improve the accuracy of emission computation. Comprehensive modeling to assess the impact of aircraft emissions on air quality at Hartsfield–Jackson International Airport was performed (Unal et al., 2005). The authors of the study used the emission rates which are a function of smoke number and fuel flow rate for different engine types. In another study, different methodologies proposed for estimating aircraft emissions were compared (Romano et al., 1999). The cost of air pollution from aircraft at Lyon Satolas Airport was investigated by Perl et al. (1997). An inventory model for air transport fuel consumption and pollutant production was reported by Stefanou and Haralambopoulos (1998). The model was developed to determine the annual fuel consumption and emissions for an airline company. Atmospheric emissions from aircraft at airports were measured by non-intrusive measurement methods and compared to the values

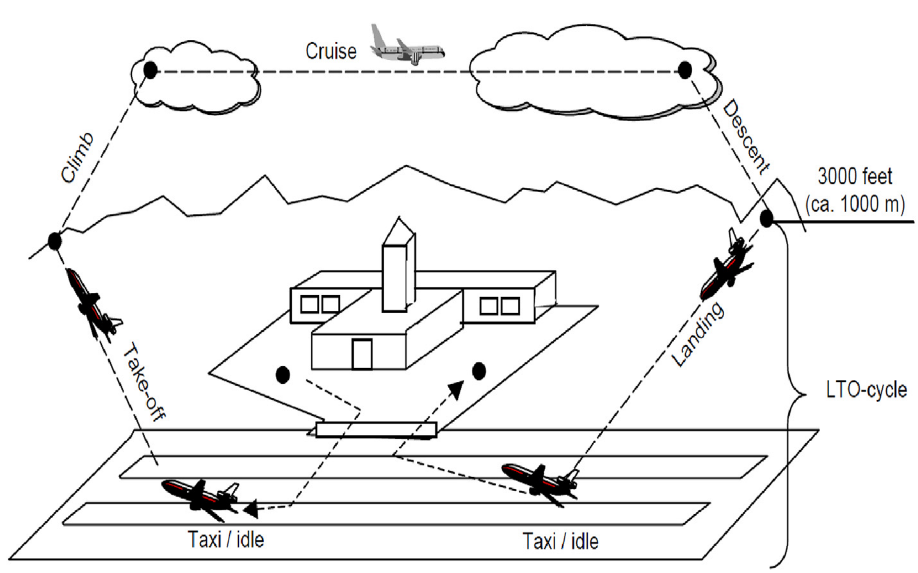

Fig. 2. LTO cycle described by ICAO.