17th International Conference on Environmental Science and Technology

Athens, Greece, 1 to 4 September 2021

DETERMINATION OF GREENHOUSE GASES EMISSIONS FROM PMDI PRODUCTS IN GREECE

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Abstract

The focus of the current study is on the estimation of greenhouse gases (GHG) emissions from pressurized Metered Dose Inhalers (pMDIs) products in Greece. The emissions are expressed as carbon dioxide equivalent (CO_2eq). The total emissions of the pMDIs were estimated at 47.53 kt CO_2eq and they represent the 0.052% of the total Greek GHG emissions. In addition, calculations separately for each pMDI category showed that short-acting β-agonist (SABA) pMDIs have the highest contribution on the total pMDIs emissions, due to higher annual sales. Two scenarios were implemented for evaluating possible reduction of the pMDI emissions in Greece. In scenario A, the replacement of the current propellants contained in pMDIs products, with HFA 152a which is a low Global Warming Potential (GWP) propellant was suggested. In scenario B, the emissions were estimated for the replacement of HFA 134a by the HFA 152a and the reduction of the amount of propellant contained in each pMDIs. It is concluded that implementing the above scenarios could result to a significant decrease (89-96%) of the CO_2eq emissions by pMDIs products.

Keywords: greenhouse gases, pMDI emissions, propellant

1. Introduction

The Montreal Protocol on Substances that Deplete the Ozone Layer is an international agreement designed to protect the ozone layer by phasing-out the production of substances responsible for ozone depletion. In particular, the Montreal Protocol, signed in 1987, banned and phased-out the use of chlorofluorocarbon (CFCs) gases for commercial use.

CFCs were replaced with alternative gases in many different industrial sectors. In the case of pharmaceutical products, including pressurized Metered Dose Inhalers (pMDIs), alternatives were found. With the entry into force of the Montreal Protocol CFC propellants contained in pMDIs were replaced by hydrofluorocarbons (HFAs). In addition, since then, also Dry Powder Inhalers (DPIs), not containing propellants, have been further developed and made available (Janson et al. 2020).

The pMDIs are used by asthma and Chronic Obstructive Pulmonary Disease (COPD) patients and are an essential therapeutic option for managing their disease and improving their quality of life (GINA report, 2020; GOLD report, 2021).

In industrialized countries the prevalence rate of asthma ranges from 2 to 10% of the total population (Morris and Pearson, 2020). In 2016, according to the Global Burden of Disease Study, 251 million cases of COPD were reported worldwide, while in 2015, 5% of the total annual deaths were caused by COPD (WHO, 2020).

The big number of patients worldwide and consecutively the big number of potential pMDI users, since not all patients, especially children and old people, are capable of using DPIs, show the importance to maintain on the market all the therapeutic options in order to preserve patients' health and choice (ERS, 2021). HFA 134a and HFA 227ea propellants, that are currently used in pMDIs, are not ozone-depleting substances, but are recognized as greenhouse gases with high or very high Global Warming Potential (GWP), (Murayama and Murayama, 2018; Janson et al. 2020) and therefore, they contribute to global warming (Hansel et al., 2019).

2. Materials and Methods

2.1. pMDIs CO_2 emissions estimation

The emissions of pMDIs, expressed as carbon dioxide equivalent (CO_2eq) were estimated using equation 1 (Hansel et al., 2019):

$$kg\ CO_2eq = \text{activity data} \times \text{emission factor} \times \text{GWP} \quad (1)$$

In order to calculate the pMDIs CO_2eq emissions, the amount of propellant used per device is needed. In the current study the amount of propellant contained in pMDIs was derived from the scientific literature (Jeswani & Azapagic, 2019; Murayama & Murayama, 2018;

Wilkinson et al. 2019). The amount of propellant in pMDIs depends on several parameters, like the size of inhaler, the number of doses contained, the type of the active ingredients and the type of propellant (Jeswani and Azapagic, 2019).

The amount of propellant ranges from 8.42 to 19.8 gr per device. The highest amount is contained in SABA pMDIs. It should be taken into consideration that SABA pMDIs has 200 actuations while the other products have only 120 actuations per device. Therefore, they need more propellant gas compared to the rest of the products.

In the case of two ICS/LABA and one ICS/LABA/LAMA products, the CO_2eq were not calculated and published data by Panigone et al. (2020) were used for the computations.

Calculations of the pMDI emissions were based on the annual sales in Greece and more specifically on the MAT 9/2020 pMDIs sales data. According to the above annual data, SABA dominates the market with 1,181,314 devices in 2020. Half of the sales in Greece are related to SABA products, following ICS (26.4%) and ICS/LABA (18.5%), while only 2% and 3% of annual sales are ICS/LABA/LAMA and LABA pMDIs, respectively. SABA pMDIs represent the largest percentage due to the use of salbutamol by both asthma and COPD patients as a reliever medication. Salbutamol works by relaxing the muscles of the airways, but also help patients to breathe easier (GINA, 2020; GOLD, 2021) and due to its dual application, it is the most frequently prescribed type of pMDI. However, most patients will need, additionally to SABA, another inhaler to control their disease. SABA overuse by asthma patients has been suggested to be associated with high risk of exacerbations and mortality (Nwaru et al., 2020; Suissa et al., 1994). Furthermore, according to GINA recommendations, high SABA use is considered to be a risk factor for poor asthma outcomes (GINA, 2020).

3. Results and discussions

2.1. Contribution to the total GHG emissions in Greece

The total GHG emissions in Greece for the year 2018 were equal to 92221.66 kt CO_2eq according to the National Inventory Report 2020 (MEEN, 2020). Based on the above calculations, the contribution of pMDIs to the total Greek GHG emissions is 0.052 % (Figure 1). Table 1 presents the contribution of each pMDI category to the total Greek GHG emissions.

Table 1. Contribution of each pMDIs category to the total Greek GHG emissions

pMDI Category	Contribution (%) of pMDIs to the total GHG emissions
ICS	0.009
LABA	0.001
ICS/LABA	0.009
ICS/LABA/LAMA	0.001
SABA	0.032
Total	0.052

2.1. Evaluating actions for reducing carbon footprint of pMDI products in Greece

Jeswani and Azapagic (2020) in their study, proposed two alternative scenarios for reducing the carbon footprint of pMDI products. The first option is to replace the current propellants with low GWP propellants while the second is besides the replacement of the propellant, to reduce also the amount of gas contained in pMDIs. Following Jeswani and Azapagic (2020) methodology, the emissions of pMDIs were estimated for these two scenarios. In Scenario A the HFA 134a (GWP 1,300) and HFA 227ea (GWP 3,350) propellants were replaced by HFA 152a (GWP 138) (same amount of gas with the one currently used in all products). This replacement would decrease CO_2 emissions by 89.4% and 95.9% for pMDIs containing HFA 134a and HFA 227ea respectively, leading to the reduction of the carbon footprint of pMDI products. In the case of two ICS/LABA and one ICS/LABA/LAMA products, the CO_2 emissions were reduced by 87.9% (Panigone et al., 2020).

The replacement of HFA 134a with HFA 152a will also lead to the reduction of the amount of propellant contained in pMDIs (Jeswani and Azapagic, 2019; Jeswani and Azapagic, 2020). Jeswani and Azapagic (2020) state that the equivalent amount of HFA 152a required in an inhaler would be 34% lower than that of HFA 134a. As a result, in Scenario B the emissions were calculated by replacing HFA 134a with HFA 152a, with the amount of the propellant reduced by 34% compared to the current amount used. In the case of Scenario B the emissions of pMDIs will be reduced by 93%.

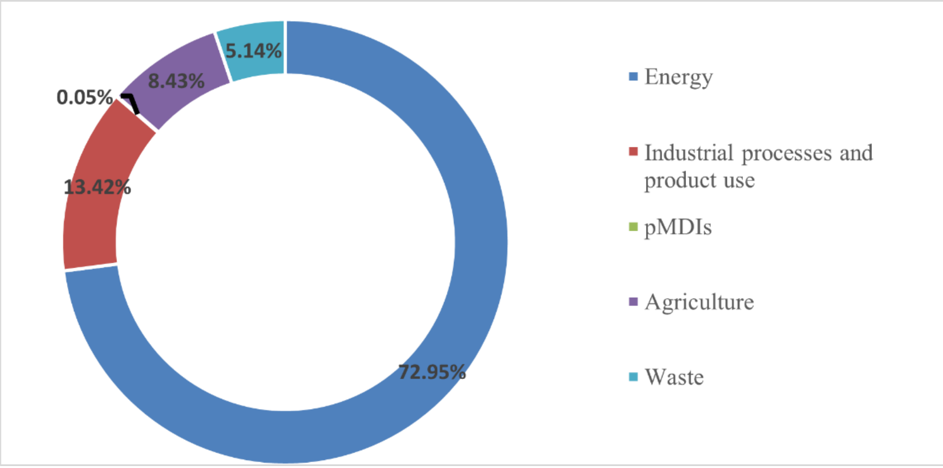

Figure 1. Contribution of pMDIs emissions to the total Greek GHG emissions.

4. Conclusions

The total estimated CO_2eq emissions of the pMDIs are 47.53 kt CO_2eq, representing the 0.052% of the total GHG emissions in Greece. Therefore, pMDIs contribution to the total GHG emissions can be considered negligible.

Furthermore, examining the replacement of the propellants HFA 134a and HFA 227ea, currently used in pMDIs, with the low GWP propellant HFA 152a, revealed a potential significant decrease (more than 90%) of the CO_2 emissions related to the use of pMDIs products.

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