Analysis of Harmful Chemicals Generated During Heat Treatment of Waste Masks

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폐마스크 열처리 시 발생하는 유해화학물질 분석

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Abstract

Lung masks have recently been mass-produced due to the corona virus and are being discarded as waste plastic. These waste plastics are expected to be washed and then treated with heat exceeding 200 degrees Celsius to be processed into construction materials, or mostly mixed with MSW (Municipal Solid Waste) and incinerated. Through this recycling process, we tried to find out the hazardous chemicals generated during the thermal decomposition process during heat treatment or incineration.

In this study, in order to measure and analyze hazardous chemicals generated during the thermal decomposition of waste masks, 6 types of masks were selected and analyzed using GC. A total of 11 hazardous chemicals (Acetone, Methyl acerate, 1,1,1-trichlorethylene, n-propyl acetate, trichlorethylene, 4-Methyl-2- Pentanone, Ethyl benzene, p-Xylene, m-Xylene, o-Xylene, Cyclohexanone) were detected.

Hazardous chemicals analyzed during heat treatment can directly or indirectly harm the human body, animals and plants. It is assumed that there are differences in hazardous chemicals generated depending on conditions such as materials used and heat treatment temperature for each mask manufacturer and grade. Therefore, in order to find out the characteristics of hazardous chemicals generated during heat treatment in waste masks, it is thought that a follow-up study on the characteristics of hazardous chemical substances for each material used is necessary.

1. Introduction

For more than two years, from the first outbreak of COVID-19 in December 2019 to now, wearing a mask has become a daily routine for many modern people. Currently, as masks produced in large quantities are indiscriminately disposed of, the amount of waste masks has increased significantly. Masks cannot be recycled, and masks used to protect the body from infectious diseases have no answer other than incineration. As a result, the amount of waste masks emitted by the public exceeds about 4 billion, which is about 16,780 tons.[1] The main component of the mask is polypropylene (PP), which causes serious secondary environmental pollution problems when discharged as domestic waste. The cause of the environmental pollution problem occurs in the process of incinerating the mask, and in this process, a huge amount of pollutants are generated, which harm our human body. Masks used to protect themselves are finally coming back as a bad influence.

Looking at the current number of waste masks and the actual situation of disposal methods, the number of disposable masks discarded after being used as an essential item for quarantine over the past two years is 1 per 2.3 days on average in Korea alone, according to data disclosed by the Anti-Corruption and Civil Rights Commission. When converted, it is estimated that 20 million waste masks are emitted per day, or more than 7.3 billion annually. The impact of these waste masks on environmental pollution is that considering that the weight of about 20 million masks is an average of 4g per day, the amount of disposable mask waste generated per day in Korea alone is 80t (ton), and the treatment method for this is 30% About 6 million phosphorus will be landfilled, and the remaining 70% will be incinerated. In other words, it is being treated in the same way as household waste that comes out of the volume-rate system bag.[2]

The purpose of this study is to measure and analyze the substances generated during the thermal decomposition of waste masks, as it is considered necessary to study hazardous chemicals generated during the thermal decomposition of waste masks, which are emerging as such environmental problems.

2. Method

2.1 Analytical instrument conditions

GC used CroZen GC, a 6th generation model from YOUNG IN Chromass. For the column, the HP-INNOWax column was used, and a PEG (Polyethylene Glycol) stationary phase characterized by high polarity and high temperature upper limit was used. Carrier gas was N_2 and the flow rate was set at 30.0ml/min. The flow control mode used pressure and was set to 110.0 kPa. The total flow was set to 50.0ml/min, of which the column flow was set to 1.67ml/min.

Temperature schedule was set as shown in <Table 1>.

[Table 1] The schedule of temperature.

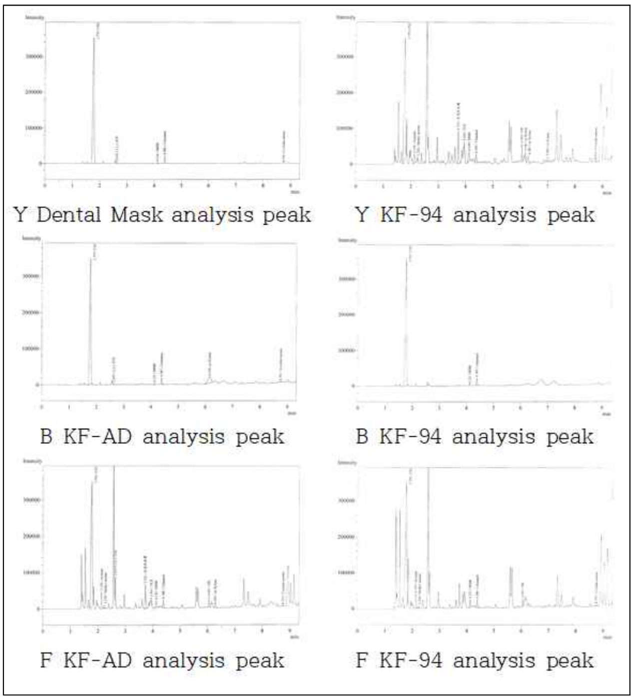
Rate	Temperature	Hold Time
-	40.0℃	2.00min
10.00 ℃/min	100.0℃	0.00min
15.00 ℃/min	120.0℃	0.00min

2.2 Preparation of analysis sample

In order to measure and analyze hazardous chemicals generated during thermal decomposition of waste masks, six types were selected for each mask manufacturer. As for the selection criteria, two types of masks were selected: a droplet blocking mask (KF-AD) and a health mask (KF-94), which were approved by the Ministry of Food and Drug Safety and whose performance and safety were verified according to the guidelines for compliance with the quarantine guidelines for wearing masks. A hot plate was installed inside the chamber to collect harmful chemicals generated during the mask pyrolysis process. The volume of the chamber is 550 mm wide, 455 mm long, 850 mm high and has a volume of approximately 0.21 m³. The mask was cut into chips about 3 mm in size in a 100 ml beaker, weighed and placed on a hot plate. The temperature of the hot plate was set to 300°C.

Before connecting the sampler to the chamber, it was connected to the flow meter and calibrated so that the flow rate was 0.2 L/min, and then installed. When the temperature of the hot plate reached 300 ° C., the sampler was operated to collect smoke in the chamber for 30 minutes, and then the sampler and the charcoal tube were separated, sealed with parafilm, and stored in a refrigerator.

Prior to analysis, the activated carbon tubes were desorbed using a diluted solution of 5% 2-butanol in CS2. The inlet of the front layer of the charcoal tube was broken with a tool, transferred to a vial, and 1 ml of desorption solution was added thereto.



[Fig. 1] Waste mask analysis Hazardous chemicals peak

3. Experimental results

In order to identify hazardous chemicals generated when the mask is thermally decomposed during incineration, 54 organic solvents were investigated among environmental measurement analysis items.

<Fig 1> shows the results of analyzing 6 kinds of masks by pyrolysis and sampling.

In this study, six types of mask manufacturers were selected and analyzed using GC to measure and analyze hazardous chemicals generated during the thermal decomposition of waste masks. A total of 11 types of chemicals were detected in 6 types of masks. Comparing the characteristic substances generated during pyrolysis by waste mask manufacturer and grade, company

Y's dental mask was analyzed for 1,1,1-TCE, MIBK, and cyclohexanone, and KF-94 from the same manufacturer was analyzed for acetone, TCE, EB, (o, m, p)-Xylene and the like were analyzed. Company B's KF-AD was analyzed for 1,1,1-TCE, p-Xylene, Cyclohexanone, etc., and MIBK was analyzed for KF-94 from the same manufacturer. Company F's KF-AD was analyzed for acetone, n-propyl acetate, TCE, and m-Xylene, and KF-94 from the same manufacturer was analyzed for EB and Cyclohexanone.

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