# THE FACE MASK WASTE RECYCLING GENERATED DURING COVID-19 PANDEMIC IN INDONESIA

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***ABSTRACT***

*In Indonesia, the COVID-19 disease has developed rapidly as found on April 20, 2021, there were 1,614,849 positive cases of Covid-19. The increase in cases of the coronavirus has resulted in an increase in the amount of medical waste during the Covid-19. The most common medical waste is face masks, both from hospitals and households. This increase in medical waste will cause environmental damage or health problems. "A viable solution for reducing the impact of face mask waste on health and the environment is to recycle the face mask mechanically, chemically, and thermally. The proximate, ultimate, FTIR analysis and hardness testing have been carried out to obtain the potential for recycled products. The test results show that carbon ( C ) and volatile matter (VM)are found in large quantities; polypropylene content is a detected type of plastic. Thus, recycled products can generate potential as a source of renewable energy, cement replacement materials, pipes, packaging materials.. Besides being able to produce new products, this process can also eliminate viruses.*

**Keyword**: medical waste, covid-19, face mask, environmental damage, recycling,

## INTRODUCTION

To prevent more widespread transmission or spread of the corona-19 virus in Indonesia, the Indonesian Health Ministry RI, has announced to implement the 3M Health Protocol. namely using masks properly, maintaining distance from crowds, and washing hands with soap or hand sanitizer in every activity. In addition, local institutions recommend all parties to do their activities in public spaces to wear face masks, both medical and non-medical masks, gloves. Therefore, it will cause an increase in infectious waste due to the Covid-19 outbreak which has the potential to cause harm to public health and the environment (Fabiula, 2020; Sarawut, 2020). At this time in the market many types of face masks are sold that are tailored to the needs of the community and social class; some consist of type 2 PFM to 4 ply face mask (4PFM)

Recapitulation of face mask waste during the Covid-19 outbreak in Indonesia from the pandemic start to the latest data as of April 20, 2021, was recorded at 21,768 tons; and possibly more related to the vaccination plan in Indonesia in 2021-2022 which is estimated to use 329.5 million doses of vaccine; will produce 7,578,800 kilograms of waste or 7,578 tons..

Mostly the face mask used polypropylene (i.e. plastic) (Huang , 2007). The high heat, can cause malfunction of the mask due to its sensitivity to heat. and the lifespan using for reuse is only 72 hours (Chua et al., 2020; SAGES, 2020). To reduce and eliminate viruses caused by face mask contamination, recycling of the waste is carried out. The three main recycling methods are mechanical, chemical, and thermal. (Kahlert and Bening, 2020; Ragaert et al., 2017; Mohammad et al., 2021. A number of studies on the process of recycling face masks using the pyrolysis method can produce oil and gas products with high calorific value (Jung et al., 2021; hu et al., 2008)

The aim of this research is to find a solution to manage the waste of infectious covid-19, such as face masks during the COVID-19 pandemic, which are mostly made of plastic into useful materials.

## RESEARCH METHODS

In this research, the 4PFS face mask type was selected from various types of face masks that exist in the community for experiment. Samples were taken from landfills in Jakarta, as well as from a number of hospitals..

### Coronavirus Face Masks Material

- Color: White
- Material: 4 ply non-woven fabric and melt-blown fabric (Fig. 1)
- Size: 17.5cm x 9.5cm

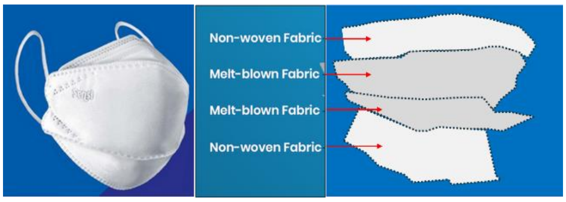


**Figure 1.** The picture of 4PFM with details of face mask composing



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There are four layers that make up the 4 PFMs; as follows: the first and second layers are non-woven fabrics made from polypropylene/polyethylene; as well as the third and fourth layers made of polypropylene but with melt blown fabric.

**Preparation of Coronavirus Face Masks**

- Separate non-woven materials from rope and metal on the face mask.
- Next, make these materials into small sizes using scissors or cutter.
- Crushed using an electric grinder into fine particles (powder size)
- Pyrolysis experiments conducted

**Characterization of Coronavirus Face Masks**

- A Proximate analysis of the sample was carried out to determine moisture, volatile matter, fixed carbon and ash.
- The ultimate analysis; to analyze the amount of carbon, hydrogen, oxygen, nitrogen, sulfur, and other elements in the sample.
- The FTIR Analysis: determine functional groups and chemical structure (Martin and Loder, 2015; Minteing, 2017). The solid sample to be analyzed is mixed with KBr powder (5 – 10% of the sample in KBr powder), then placed in a sample pan; then the spectra were determined using Bruker Appr

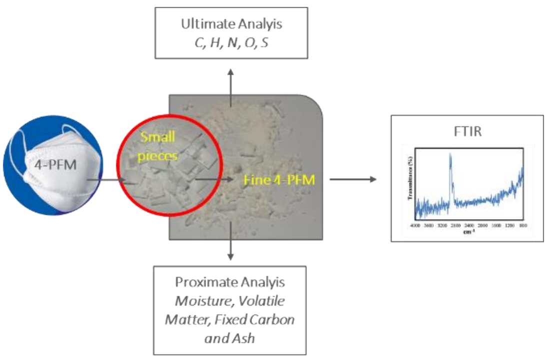


**Figure 2.** The flowchart the research

**RESULT AND DISCUSSION**

**PROXIMATE AND ULTIMATE**

The elemental analyses all the samples were tabulated in Table 1. The dominant chemical elements are carbon (average 85.25 wt.%), and hydrogen (average 12.95 wt.%). Other chemical elements such as oxygen and nitrogen are found in small amounts; while sulfur is not detected.. The proximate measurements indicated of high content of VM up to ~98 wt.% with low ash (mean 1.17 wt.%)

**Table 1.** Elemental Analysis of Face mask.

| No. | Moisture | Volatile Matter | Fixed Carbon | Ash | |
|---|---|---|---|---|---|
| Proximate Analysis | | | | | |
| FM1 | 0.08 | 98.6 | - | 0.94 | |
| FM2 | 1.2 | 97.1 | - | 1.4 | |
| Ultimate Analysis | | | | | |
| FM 1 | Carbon | Hydrogen | Oxygen | Nitrogen | Sulfur |
| FM 2 | 86.2 | 12.4 | 0.6 | 0.8 | - |
| FM1 | 84.1 | 13.5 | 1.5 | 0.6 | - |

**FTIR CHARACTERIZATION**

The structure and molecule compound the grinded face mask were identified using FTIR measurement. From the figure 2, the FTIR spectra contains the strong peaks at 2955.21 and 2871.70 cm$^{-1}$ are identified to the asymmetric and symmetric stretching vibrations of –$CH_3$.

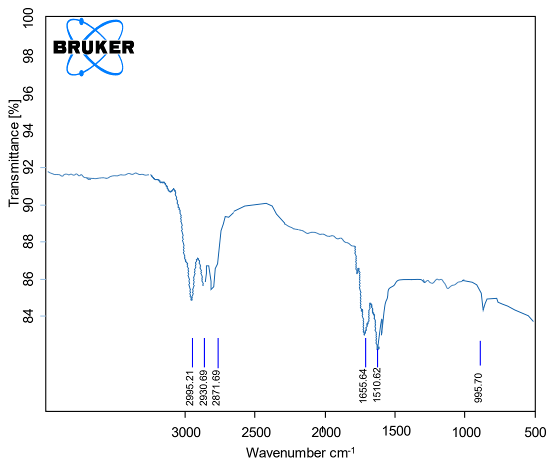


**Figure 1**. FTIR spectra of the FM 1.

The other peaks are stretching vibration $CH_3$-$CH_2$ (2930.69 cm$^{-1}$), the peak bending vibrating $CH_2$ (1655.64 cm$^{-1}$), $CH_3$ bending vibrational peaks (151062 cm$^{-1}$). Based on references from McDonald, MP, Ward, IM: (1961) most of the face mask materials are composed of polypropylene polymer which is charactezied by strong $CH_2$/$CH_3$ stretching vibrations at wavenumbers around 2900-3000 cm$^{-1}$ and bending vibration pairs $CH_2$/$CH_3$ at wavenumbers. 1510 -1655 cm$^{-1}$ as well as five peaks characteristic of polypropylene (PP)

The peak assignment in fig. 1 was presented in table 2.



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**Table 2.** FTIR spectrum for polypropylene

| WN($Cm^{-1}$) | Assignment |
|---|---|
| 2995.21-2871.70 | Asymmetric and symmetric Stretching vibration of $CH_3$ |
| 2930.69 | C–H stretching vibration in $-CH_2$ |
| 1655.64 | Bending vibrating $CH_2$ |
| 1510.62 | Bending vibration $CH_3$ |
| 995.70 | $-CH_3$ rocking |

WN : wave number in $cm^{-1}$

## DISCUSSION

In this research, mechanical, chemical and heat (pyrolysis) recycling methods were carried out to separate plastic particles and eliminate viruses in mask waste.

Elemental analysis shows that high levels of carbon indicate that face masks are a promising carbon source. A very small amounts (below detection limit; 0.01 wt.%) of nitrogen and sulfur in samples, will ensure that there are no toxic emissions in the pyrolysis recycling process on a large scale. The high concentration of volatile matter results from the proximate The analysis shows great potential for the process of changing and increasing the calorific value of recycled face masks into fuel.

The kinetics research on 3PFM conducted by Sami et al., (2021) using the iterative linear integral iso-conversional method and the iso-conversional KAS method showed the same average activation energy value of about 237 kJ mol-1.. Indicates that this face mask material has great potential as a renewable energy.

Easy to mold, lightweight, water resistant, recyclable, durable and hard; are a characteristic found in recycled face mask recycled products. Based on safety and performance aspects, a recycled face mask can be used as packaging material; pipe; replacement materials of the construction materials (cement, binder), and renewable energy.

## CONCLUSION

From the research results, it is known that the face mask recycling process can be concluded that the recycled product has the potential to reduce pollution due to covid-19 waste; can also produce new products with higher added value. The process of developing recycling this mask waste can be involved in construction materials such as artificial aggregates, concrete, new renewable energy, and new materials for packaging are a way that is appropriate and feasible at this time to prevent the spread of the Covid-19 outbreak which has a negative impact on health and the environment.

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