THE COVID-19 DILEMMA: Personal Protective Equipment vs Pollution

LOOK AT THIS...



This is a recent photograph taken at Soko Islands, Hong Kong. A noticeable amount of surgical masks scattered among the myriad of marine debris. These masks are **harmful** to aquatic life which will affect the food chain and finally lead to chronic health problems to humans.

WHAT IS PERSONAL PROTECTIVE EQUIPMENT?

Personal Protective Equipment, abbreviated as PPE, includes face masks, protective clothing, gloves, and other single use equipment. China personal protective equipment market size, by product, 2012 - 2022 (USD Billion)



← This graph shows an increasing trend on the usage of personal protective equipment (PPE) in China.

In Hong Kong, it is estimated that around 4 to 6 million face masks are used in Hong Kong daily. The face masks disposed at landfills every day will weigh up to 10 to 15 tonnes.

WHY IS PPE SO PROBLEMATIC?

PPE provide sufficient protection against pathogens, however their disposal can be devastating to environment.

1. Chemical component of PPE

The polymer that is largely used in making of PPE is Polyproylene (PP):



PP is a saturated carbon chain with a methyl group (-CH₃) attached to alternate carbon atom. It is:

- Hard, light in weight (density of 0.90 g/cm³), flexible, with high strength to weight ratio, suitable for various industrial applications.
- Resistant to high temperature and various chemicals, acid, alcohols, bases, aldehydes, esters, aliphatic hydrocarbons, ketones, etc.
- Non-biodegradable, takes hundreds of years to be broken down by micro-organisms.

2. Environmental damage of PPE

Microplastic pollution occur when plastics (PPE) are fragmented into tiny pieces (less than 5 mm in length) and released to the environment. This results in:

- Respiratory and gastrointestinal obstructions
- Death by starvation, entanglement and ingestion
- Affect the food chain
- ⇒ And finally: **chronic health problems** to humans





"A single disposable plastic mask could end up floating in the ocean for four and a half centuries before it finally begins to decompose."

Geochanvre, an industrial manufacturer in France, has made the Europe's first compostable face mask, which is made of hemp fibre and corn blend, with a recyclable elastic band.

🔊 Oil-bas oil

- Non-re readily
- Takes of decom

Pyrolysis is the cracking of long chain hydrocarbons. It involves thermal degradation of long-chain polymer molecules into simple, smaller molecules, in the absence of oxygen in a closed thermal reactor between **300-400 °C** for **60 min**. Steps are:



Propagation: free radicals may disproportionate forming an olefinic hydrocarbon chain and a small chain free radical.



Pyrolysis does not require prior separation of different types of waste plastics, thus a mixture of plastics can also be converted into liquid fuel, which have properties similar to fossil fuels.

ARE THERE ANY SUSTAINABLE WAYS TO USE MASKS? THE ANSWER IS ... YES! **HERE ARE SOME SOLUTIONS:**

1. Biodegradable face masks



PP surgical mask	S Biodegradable hemp mask
ed, extracted from crude	Plant-based, grown on fields
newable – cannot be replaced	Renewable – can be regrown
over 450 years to pose	Takes only 6 months to decompose

2. Cracking of Polypropylene

"The liquid fuel produced from plastics is clean and can be used for the generation of energy for any industrial applications."

Initiation: under high temperature, PP chain undergoes homogenous fission to generate free radicals.

Termination: The free radicals are unstable and undergo coupling and disproportionation to form stable molecules.



3. Recycling face masks

"Plaxtil has been recycling thousands of face masks, turning the potentially hazardous face masks into useful products."

The mechanism:





ultraviolet light

Masks are collected and 'quarantined' for 4 days to liminate most o the microbes

These steps would ensure the plastic product to be safe for use and sustainable while also fighting the waste problem caused by the pandemic.

- for fighting against COVID-19.
 - Plastic visors or face shields
 - Mask strap extenders

4. Reusable face masks Hong Kong **Polytechnic University**

Launched a mask PU30, with polytetrafluoroethylene filter, which can be reused after being disinfected

TO CONCLUDE...

Despite knowing that the production and usage of PPE is hard to avoid during this pandemic, alternatives are everywhere! As shown above, all these could compensate the environmental destruction caused by PPE.

References links:

- https://www.france24.com/en/20200827-face-mask-recycling-french- 11. firm-finds-way-to-re-use-covid-waste
- recycling-moving-towards-new-sustainable-normal/
- https://www.info.gov.hk/gia/general/202005/20/P2020052000560.htm 13. https://www.sciencedirect.com/science/article/pii/S0025326X20306354
- https://www.weforum.org/agenda/2020/09/hemp-france-face-maskscoronavirus-covid-pandemic/
- https://oceansasia.org/beach-mask-coronavirus/
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7543915/#!po=29.0000
- https://creativecommons.org/licenses/by-sa/3.0/
- http://www.businesskorea.co.kr/news/articleView.html?idxno=42805
- 10. https://ruvid.org/ri-world/researchers-develop-biodegradable-and-



Properties of transformed plastic – Plaxtil:

plastics

• Can be pressed and molded like normal plastic

• Used to produce personal protective equipment especially

• Door-openers for nursing home residents.



A project developing biodegradable antiviral filters made of polyhydroxyalkanoates (PHAs)



product **Plaxtil**



Announced in March 2020, that it had succeeded in creating reusable nano-fibre filters



https://www.bbvaopenmind.com/en/science/environment/face-masks-12.

viricidal-antiviral-filters-for-pro https://www.dw.com/en/covid-19-recycling-pollution-trash-pandemic/a-55707817

https://recyclinginternational.com/gallery/plaxtil-puts-single-use-facemasks-back-in-the-loop/32591/

https://www.pinterest.ca/pin/787074472366950111/

https://www.plaxtil.com/?lang=en

https://www.polyu.edu.hk/fast/research/PU30_t/

Research articles:

Strategy for repurposing of disposed PPE kits by production of biofuel: Pressing priority amidst COVID-19 pandemic

Sapna Jain, Bhawna Yadav Lamba, Sanjeev Kumar & Deepanmol Singh (2020)