Solutions on Problems Due To The PPE Kits

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Abstract- *The purpose of this research is to identify effective strategies for dealing with the problems in PPE kits faced by health care workers. Based on the analysis conveyed, we came up with few modifications such as usage of silica gel packets and PLA for overcoming the problems like excessive sweating and biodegradability. We have adapted the strategy of using vest belt and leg beltfor positioning the silica gel packets. It not only absorbs moisture but also is light to carry on. Even by replacing polypropylene by PLA, we can make it more eco-friendly by resolving the biodegradability problem.*

Keywords- PPE kit, Silica gel packet, Polylactic acid, Excessive sweating, Biodegradable, Vest belt, Leg belt

I. INTRODUCTION

(COVID-19) pandemic in India has been raging at a rapid pace, posing a formidable challenge to the healthcare system in the country. The personal protective equipment (PPE) provides a shield of protection for the healthcare workers (HCWs). However, there have been various problems associated with the PPE such as increase in biomedical waste due to single use of PPE, excessive sweating, suffocation, headache, pressure marks on skin, etc. There is a need to assess these problems faced by HCWs both qualitatively and quantitatively.

• ***This research paper mainly focuses on two simultaneous solutions.***

II. TECHNIQUES USED TILL NOW

Some of them are as follows:

- DRDO has developed a personal air circulator system which can be used inside PPE kit as a small backpads of 500 gm.
- The device draws outside air with the help of a filter and moist air goes out from front face opening thereby, cooling neck and head area.
- Face visor made up of paper/wood pulp.
- Use of hydrophobic and well ventilated and disposable PPE kits.
- A compact ventilation system called as cov-tech that provides fresh air by using lithium ion batteries which still have many disadvantages such as:

o High Upfront Costs:- Lithium-ion Batteries cost 3x more than their lead-acid counterparts on average.
o Need for Increased Monitoring:- Lithium batteries require a Battery Management System (BMS). Lithium batteries can become damaged if they aren't properly monitored and can create more potential issues.
o Costly Recycling:- Lithium batteries have no commodity value and are harder to recycle.
o Battery Weight & Counterbalance:- Lithium batteries weigh less so additional counter weight may need to be added to compensate for the loss in weight.
o Aging effect - Lithium-ion battery will naturally degrade and will only be able to with stand 500 - 1000 charge and discharge cycles before their capacity falls to 50%.
o Deep discharge - Lithium-ion battery has low self-discharge. The general integrity of this battery remains intact even if partially discharged. However, deep discharge or when the voltage of a Lithium-ion cell drops below a certain level, it becomes unusable.
o Safety concerns - Lithium-ion battery may explode when overheated or overcharged or internal short circuit can cause fire.

III. SOLUTIONS

Case-1 : Silica gel bags as absorbent

- Silica gel layer can be used inside the PPE kits so that it can absorb the moisture and keep the wearer cool.
- A sole containing silica gel will have the property that the moisture arising from the user's sweat in boots and shoes, in particular those which have impervious over-material of rubber and synthetic substances such as PVC.
- Leather materialcovered with a coating of such a substance, will be absorbed in the silica gelthus preventing the user's feet from becoming damp.
- The same can be applied in PPE kits.

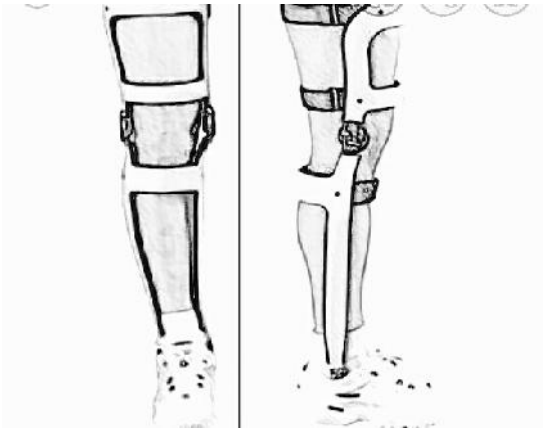
IV. COMPONENTS AND ITS USAGE

Vest belt :

The vest belt made up of nylon can be used. A vest belt will have some space for keeping the silica gel packets. This ensures that silica does not come in direct contact with the skin. We can wear this vest belt inside PPE kit for the protection of upper body.

Leg belt :

In case of lower body, we can use leg belt. Silica gel packets can be attached to the leg belt. We can wear this leg belt inside the PPE kit.



Silica gel packets :

Silica gel is made from silicon dioxide, which is a component naturally found in sand. It has small particles that can absorb significant amounts of water. The gel acts as a desiccant, which means that it pulls water out of the air to reduce the likelihood that moisture and mold will damage an item.

Advantages of silica gel :-

- Non-flammable
- Reused by regenerating–heating the gel will stave off absorptions
- Can absorb up to 40% of its own weight
- Shelf life is indefinite–if stored air tight
- It is inert and will not corrode or disrupt materials.
- A molecular sieve can absorb approximately 22% of moisture, while silica gel can absorb approximately 32% of moisture at the same condition.

V. WORKING

Average weight of silica gel packet is 5 gm each and last long till 4-12 months. This whole equipment weighs from 245 to 265 gm. Attaching 5 packets to upper body, one on each shoulder, 3 on waists. On the other hand, attaching 4 packets on leg belt, 1 each on backside of both the knees and two near limbs.

Once saturated with water, the silica gel can be regenerated by heating it to 120 °C (250 °F) for 1-2 hours. The easiest way to regenerate the silica gel is the microwave oven. While using the PPE kit, heat will be generated inside it. The generation of heat increases the moisture. Silica gel then absorbs the generated moisture and hence keeps the wearer cool.

Case-2:- PLA (Polylactic Acid)

PPE kits made up of PLA (Polylactic Acid) polymer instead of polypropylene can beused. PLA plastic or polylactic acid is a vegetable-based plastic material, which commonly uses cornstarch as a raw material. PLA is a fully biodegradable thermoplastic polymer consisting of renewable raw material.

Biodegradation of PLA:-

PLA can be naturally degraded by the simple hydrolysis of ester bonds. After exposure to suitable conditions that consist of a combination of moisture, oxygen, and naturally occurring microorganisms, PLA will decompose to water, carbon dioxide, and a minor quantity of nontoxic surplus materialwhich is the major advantage of the use of PLA. Under industrial composting conditions (58 °C), PLA can partly (about half) decompose into water and carbon dioxide in 60 days, after which the remainder decomposes much more slowly, with the rate depending on the material's degree of crystallinity.

A variety of different mechanisms will degrade PLA. These include hydrolytic, oxidative, thermal, microbial, enzymatic, chemical and photodegradativemechanisms.

Disadvantages of Polypropylene :-

1) Polypropylene is highly flammable. It will melt when exposed to heat and has a flash point of 260 degrees Celsius.
2) Polypropylene tends to be affected by UV degradation. Hence, it will not be preferable in high altitude areas and geographies where UV penetration is high.
3) Polypropylene has limited high-temperature uses because it has a high thermal expansion co-efficient.
4) In temperatures above 100 degrees Celsius, polypropylene tends to suffer from chain degradation which leads to oxidation. Oxidation results in cracks and crazing.

To overcome disadvantages of Polypropylene, we are using Polylactic acid(PLA).

Advantages of PLA:-

1) PLA has a reduced carbon footprint compared to fossil based plastics.
2) PLA is compostable.
3) PLA is made from renewable raw materials.
4) PLA melts more easily because it has a lower melting point than many fossil-based plastics.
5) It's easy to work with PLA and it requires less energy to transform.
6) When PLA is Incinerated, it emits less toxic fumes than oil based plastics
7) In case of biomedical use, PLA degrades into non-toxic acid.

VI. CONCLUSION

This research aims to bringattention towards the problems faced by our hard working HCWs while working in the PPE kits. The problems like excessive sweating can be reduced by using our equipment consisting of silica gel packets. Hence eliminating the problem of excessive sweating. Also the problem of generation of waste due to single used PPE kits is eliminated by using biodegradable fibre of PLA. Thus the above two problems are taken under consideration and solved effectively. These solutions will definitely help the HCWs to deal with and solve the problems arising out of PPE use.

REFERENCES

[1] https://patents.google.com/patent/WO1996002158A1/en
[2] https://en.wikipedia.org/wiki/Silica_gel
[Above given links are the references for silica gel.]
[3] https://www.fibre2fashion.com/industry-article/6028/pla-polylactic-acid-new-era-of-textiles
[Above given link is the reference for PLA (PolylacticAcid)]