MRC Global Funding for Rubber Innovation

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Nurturing Ideas for the Rubber Industry Globally

DOWNSTREAM RUBBER SECTOR

MRC MALAYSIAN RUBBER COUNCIL

DRY RUBBER PRODUCTS

DOWNSTREAM [DRY RUBBER PRODUCTS]

1. Introduction of Automation to the current processing line

- There are three common manufacturing methods/processes of dry rubber products which are extrusion, moulding and calendering.
- Depending on the processes, products, tooling and process designs, they can be very labor-intensive either Pre, During or Post-production.
- To be competitive, manufacturers need to simplify methods, improving cycle or handling time, reduce wastages, reduce dependence on manual & foreign labour => improve productivity, efficiency, process, cost, quality and also safety.

2. Exploration of new method, parameters and technologies

- Over the years, dry rubber manufacturers in Malaysia has develop and implemented various types of new method, parameters and technologies to enhance and control each aspects of the processing line
- Need unconventional perspective to identify new fundamental parameters or methods that can strengthen the manufacturing process of dry rubber in terms of productivity, cost and quality

DOWNSTREAM [DRY RUBBER PRODUCTS]

3. Data Collection and Analysis

- Data collection & analytics are basically essential in improving each aspects of dry rubber products manufacturing
- However, currently, the knowledge for data collection among dry rubber manufacturer is very limited
- Need out of the box outlook to improve data collection by introducing efficient data collection & data analysis system that can identify bottlenecks in each process involves in the dry rubber manufacturing operation, reducing human error

4. Synthetic Rubber

- Most dry rubber products are utilizing Synthetic rather than Natural Rubber
- Highly dependent on overseas source for polymer and chemicals used
- Generally, cost being subjected to demand vs supply and Forex

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5. Recovery of Heat Energy

- Heat is used in the dry rubber manufacturing process usually for rubber softening and rubber crosslinking
- Electricity usually used to heat up the devices for the softening and crosslinking process
- However, quite often that the heat energy is loss to the surrounding due to installation of weak insulation system => high heat containment leads to bad working environment (hot)
- Heat loss may be due to workers slow to load the material, leading to prolong curing and possible manufacturing defects => high rejects
- Energy loss => leads to high energy consumption

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6. Nanotechnology

- Currently graphene is widely used in rubber products as filler.
- It can improve the electrical, thermal, chemical and mechanical properties of rubber products
- New type of nanomaterial to further enhance the properties of rubber products is highly sought

7. Use of Thermoplastic Elastomers (TPEs) for Product Substitutions

- Generally, most rubber products are thermoset elastomer
- Once cross-linked, the thermoset elastomer will maintain its shape permanently opposite to thermoplastic where the process is reversible
- With that, reject cannot be rework in thermoset elastomer cases

DOWNSTREAM [DRY RUBBER PRODUCTS]

8. Innovations of New Products

- Epoxidized Natural Rubber (ENR) has not yet been explored
- Lithium-ion battery made from rubber
- Generating energy using rubber

9. Products with Green Contents

- Green materials as raw ingredients
- Recyclable & Reusable
- Compliance to SVHC, REACH, ROHS

LATEX-BASED PRODUCTS

DOWNSTREAM [LATEX-BASED PRODUCTS]

1. Online hole detection & “hole repair”

- ❑ Currently the glove in-process inspection involves the water leak or air inflation method
- ❑ The process is labour-intensive and slow
- ❑ Only few gloves are inspected for the whole batch. Not all gloves are tested in the batch
- ❑ A system to detect holes online will save time and tests all gloves.
- ❑ Furthermore, if an online method to patch up the holes is available, it will improve the product quality significantly

DOWNSTREAM [LATEX-BASED PRODUCTS]

2. Curing system

- Generally, for natural rubber & polyisoprene gloves, accelerator & sulphur are used for crosslinking/curing process
- Due to no functional group at the mainchain molecules, the accelerator-free curing system for natural rubber & polyisoprene cannot be easily achieved
- Residual accelerator in glove may cause skin reactions, such as Type IV allergy
- It also leads to the formation of nitrosamines, which are suspected to be carcinogenic
- Accelerator is cytotoxic, unable to meet ISO10993 Part 5, which is one of the requirements for in vitro cytotoxicity test for medical device

DOWNSTREAM [LATEX-BASED PRODUCTS]

3. Powder-free System

- Coagulant contains power (calcium carbonate) to produce powdered gloves.
- The powder is removed in post processing followed by chlorination to produce power-free gloves.
- Alternatively, metal stearates, e.g. stearates of potassium, calcium and zinc are added to the coagulant to replace the powder
- Stearates not good enough for double gloving of surgical gloves due to the tacky surface
- Former contamination/staining by stearates leads to holes formation
- Stearates are not suitable for cleanroom gloves due to the particle's formation

DOWNSTREAM [LATEX-BASED PRODUCTS]

4. Thin Natural Rubber (NR) Examination Gloves

- Currently, nitrile rubber gloves can be as thin as 0.04mm while only 0.06mm for NR examination gloves
- NR condoms can be thinner compared to NR gloves due to the symmetrical shape
- Thinner gloves reduce material consumption and provide good sensitivity to use
- Thinner NR examination gloves are good for both the manufacturers and users

5. Polymer Coating for Cleanroom Gloves

- Polymer coating is applied to rubber gloves for anti tack and easy donning
- However, gloves with the current polymer coating may generate fine particles during offline washing.
- Since cleanroom gloves require extensive offline washing, the current polymer coating is not suitable for the production of cleanroom gloves which require low particle counts

DOWNSTREAM [LATEX-BASED PRODUCTS]

6. Efficient Leaching System

- Leaching is a cleaning process to remove residual non-rubber materials such as chemicals and proteins from the glove using heated water
- This step is crucial in minimizing the risk of causing skin reactions to the user
- Leaching can also improve the glove's tensile properties
- Leaching process requires continuous heating and addition of fresh water to maintain the leaching efficiency.
- A better leaching system could reduce water and energy consumption.

DOWNSTREAM [LATEX-BASED PRODUCTS]

7. Energy Recovery System

- Energy used at glove manufacturing plant mainly for heating water and drying glove.
- Steam, hot water or thermal oil is used as heating media to heat up the water used mainly in leaching.
- Boiler consumes natural gas, fuel oil, LPG or biomass to heat up the heating media
- Continuous supply of heating media is required to maintain the optimum leaching water temperature
- Electricity or natural gas is utilized for generating heat in the drying oven
- Both processes of heating water heating and glove consume substantial quantity of energy.
- As such, energy cost constitutes about 11% of the total glove production cost.
- A cheaper source of energy and efficient utilization of energy is highly desirable.
- Besides that, a better insulation system and heat integration or recovery system are also highly appreciated by the industry

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8. Porous Glove Former Restoration, Former Protection

- Glove former normally lasts for several months to several years, depending on the glove thickness
- Over time, the former will become porous due to its weak corrosive resistance against alkalis
- Currently, there is no known method to restore the porous former
- Cost for former replacement exercise is quite high
- If porous former can be restored, or good former can be protected from corrosion, these will reduce production cost as well as maintain the glove quality

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9. Better Breach Detection

- This system functions to alert the wearer in case of glove perforations
- Currently, to detect a glove breach, a darker colour under glove and a brighter colour outer glove are used.
- Breach will be detected when liquid penetrates through the hole and the colour of the wetted under glove become more visible
- A better breach detection to alert the wearer of glove could improve the safety and thus provide a better protection

DOWNSTREAM [LATEX-BASED PRODUCTS]

10. Chemical Permeation for Personal Protective Equipment (PPE)

- Majority of rubber gloves (nitrile, polychloroprene and natural rubber) are weak against to the permeation of several chemicals when tested according to EN16523-1.
- These chemicals are:
  - 96% Sulphuric Acid
  - 65% Nitric Acid
  - Tetrahydrofuran
  - Dichloromethane
  - 40% Hydrofluoric Acid
- A glove with the resistance against the above chemicals is expected to be well received by the user

DOWNSTREAM [LATEX-BASED PRODUCTS]

11. Bone Cement (Acrylic Monomer) Resistance

- Currently, no medical gloves can prevent the permeation of the bone cement
- Normally the bone cement permeates through the glove less than 10 minutes
- Wearer who is allergic to bone cement will normally wears 2-3 gloves simultaneously or regularly change the glove to prevent contact
- Regular changing of rubber gloves during a procedure might cause interruption
- A bone resistant glove will meet the requirement of user

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12. Glove Manufacturing Process Improvements

- To better enhance the through put and production capacity of glove manufacturing process by inserting more automations and new technologies.
- Production of better-quality gloves by reducing human errors and footprint through on-line automated quality inspection
- To reduce the cycle time the manufacturing process by simplifying the manufacturing line by skipping few processes but still producing same quality of rubber gloves
- Reduce the cost and down time in the manufacturing line by introducing cheaper, lighter and more durable mechanical parts that last longer
- Further enhancements needed in robotic glove stripping.
- The automation on “100 piece glove stacking and insertion into the dispenser box and eventually into the carton” needs further fine tuning, to make it more cost competitive.

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13. Glove with Super Hydrophobic Surface

- During a procedure, e.g. stitching, the visibility of the wearer's gloved fingers might be obstructed by liquids such as blood on the surface of glove
- A superhydrophobic glove will repel liquids and keeps the gloved fingers visible
- Besides that, the transfer of pathogen from surface to surface can also be prevented
- Therefore, a super hydrophobic glove improves safety and infection control

14. Improve Comfort

- It is common for surgical gloves to be worn for a long period of time.
- However, this will lead to sweaty hands which can cause discomfort
- A glove with the ability to remove or reduce sweat of wearer either through absorption or transmission during use is expected to delight the user

DOWNSTREAM [LATEX-BASED PRODUCTS]

15. Sustainable or Biodegradable Materials

- Bio-monomers for the rubber synthesis, chemicals such as surfactants, curing agents

16. Less Materials

- Soap-free latex, dispersing agents free compounding ingredients