The Ohio State University, Ohio Agriculture and Research Development Center – Food, Agricultural and Biological Sciences

Guayule Natural Rubber Latex Condom Production Optimization

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OBJECTIVE

Determine the protocol and process input parameters to manufacture guayule latex film condoms adhering to international standards and specifications.

INTRODUCTION

Guayule natural rubber latex GNRL), derived from the shrub *Parthenium argentatum*, is an alternative material to natural rubber latex (NRL) from *Hevea brasiliensis,* which is commonly used to create latex based products. Hevea NRL contains proteins that can induce dangerous Type I allergic reactions or sensitize exposed individuals. Unlike the Hevea tree, guayule plants have different proteins, in very low amounts, which have not been shown to sensitize people or induce Type I allergic reactions. Guayule also tends to grow well in arid climates like that in South Africa, rather than more wet and temperate climates like that of Southeast Asia where Hevea is grown. Once processed to retrieve the latex from its bark, the emulsion can be further used to manufacture products, like condoms, by dipping molds into the latex. The condoms are made using a novel compounding recipe which also avoids the Type IV allergies and other contact reactions commonly caused by conventional rubber chemicals. The use of this alternative latex may encourage use of condoms and help diminish the spread of sexually transmitted diseases (STDs). Developing the production of guayule condoms in sub-Saharan Africa, and specifically South Africa, can develop a new and stable economic industry for the nation, while combating one of the world's foremost infection rates of STDs including HIV/AIDS. This research is focused on determining the standard process and parameters to manufacture guayule latex film condoms.

This research was conducted by using latex dipping technology such as molds, machinery, dipping containers, and ovens for heating and curing. Once the single dip process was improved to produce stable, defect-free condoms, experiments were conducted to examine the relationship of the initial mold temperature, curing temperature, curing time, and leaching time to physical and mechanical properties. Condoms were dipped, dried, cured, cooled, leached, and finally stripped from formers. The condom's dimensions, tensile strength, elasticity, and barrier integrity were tested to ASTM standards similar to current commercial practices. The results were compared to the South African specifications, and provide a starting point in perfecting the process of making guayule-based condoms.

Knowing how these input parameters affect the final product is critical to developing a protocol to produce safe, high quality, and commercially viable guayule latex condoms.

METHOD

1. Mix a guayule NRL compound (constant recipe)
2. **Heat glass mold to a *predetermined temperature***
3. Dip mold into the latex dispersion
    1. Record solution temperature
4. Dry latex film at room temperature
    1. Use program adjusted to create correct dimensions and minimize defects
5. **Cure latex film at a *predetermined temperature and length***
6. Cool latex film in filtered water
7. Roll integral bead by hand
8. Strip latex from the mold by hand
    1. Use copious amounts of talc
9. Measure dimensions Length x Width x thickness
    1. lay-flat, single layer
10. Test barrier integrity to Guayule Condom Standard
11. Test mechanical properties using tensiometer to ASTM D412 - D

Figure 1 – Glass Molds

Figure 2 – Dipped Former

Figure 3 – Stripped Latex Film

Figure 4 – Finished Condom

RESULTS

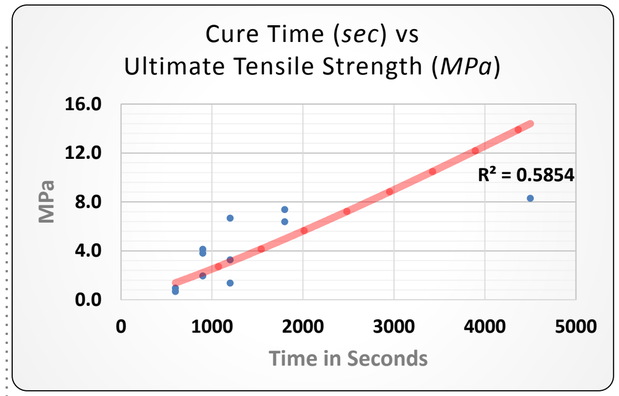

Figure 5 – The graph indicates a slight positive correlation between cure time and tensile strength.

Figure 6 – A Tensiometer. Used according to ASTM Standard D412 to measure mechanical properties.

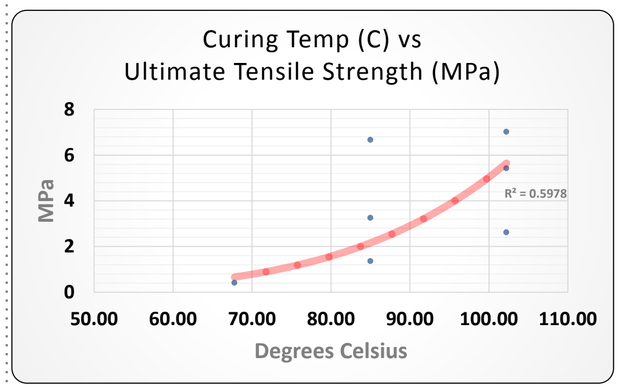

Figure 7 – Appears to be a direct relationship between curing temperature and tensile strength

SUMMARY AND CONCLUSIONS

This work has provided the starting point for subsequent experiments relating to the manufacture of guayule latex film condoms. It's identified relationships between mold temperatures and thickness, as well as correlations between curing temperatures and curing times to mechanical properties of unaged condoms, such as tensile strength and modulus of elasticity. Further work will be necessary to determine more precise parameters and to model the relationship between variables more effectively.

This research has developed a program to be used with a Diplomatic dipping machine that forms and dries a latex compound into a condom. The current operation has an issue where the process allows wet latex to pool on the closed end tip of the mold, so that a slightly thicker tip is formed during drying. Other occasional, but recurring, defects include permanent distortions of the film such as pleats and creases caused during hand-stripping, and discoloration of the film after the cure. Further improvement to the dipping and stripping process will be required to eliminate visible defects and adhere to desired specifications.

Continuing this work will provide a more substantial and accurate knowledge base so that the manufacturing of guayule condoms for commercial and humanitarian purposes can be improved.

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