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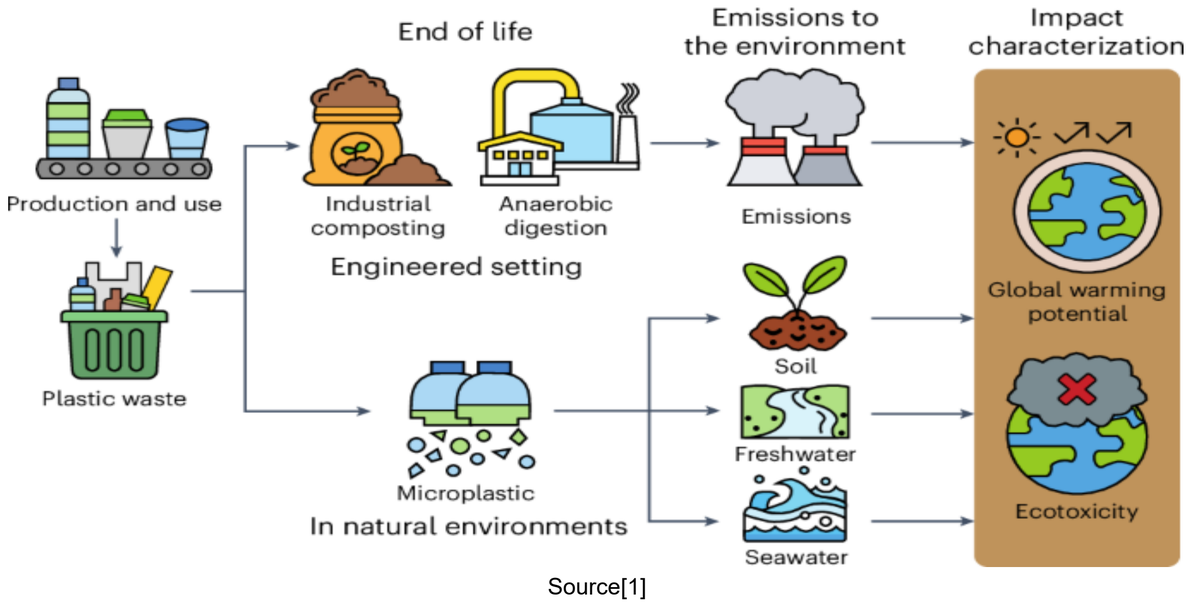
Design and Fabrication of a Biodegradable Plastic-Making System Using Starch-Based Polymers

Nasreen Bano[1], Tanzila Younas[2] , Huda Jan[1] , Mariya Murtaza[1] , Syeda Wania[1]
[1] Department of Mechatronic Engineering, SZABIST University, Pakistan
[2]School of Chemical and Biomolecular Engineering, The University of Sydney, Australia

INTRODUCTION & AIM



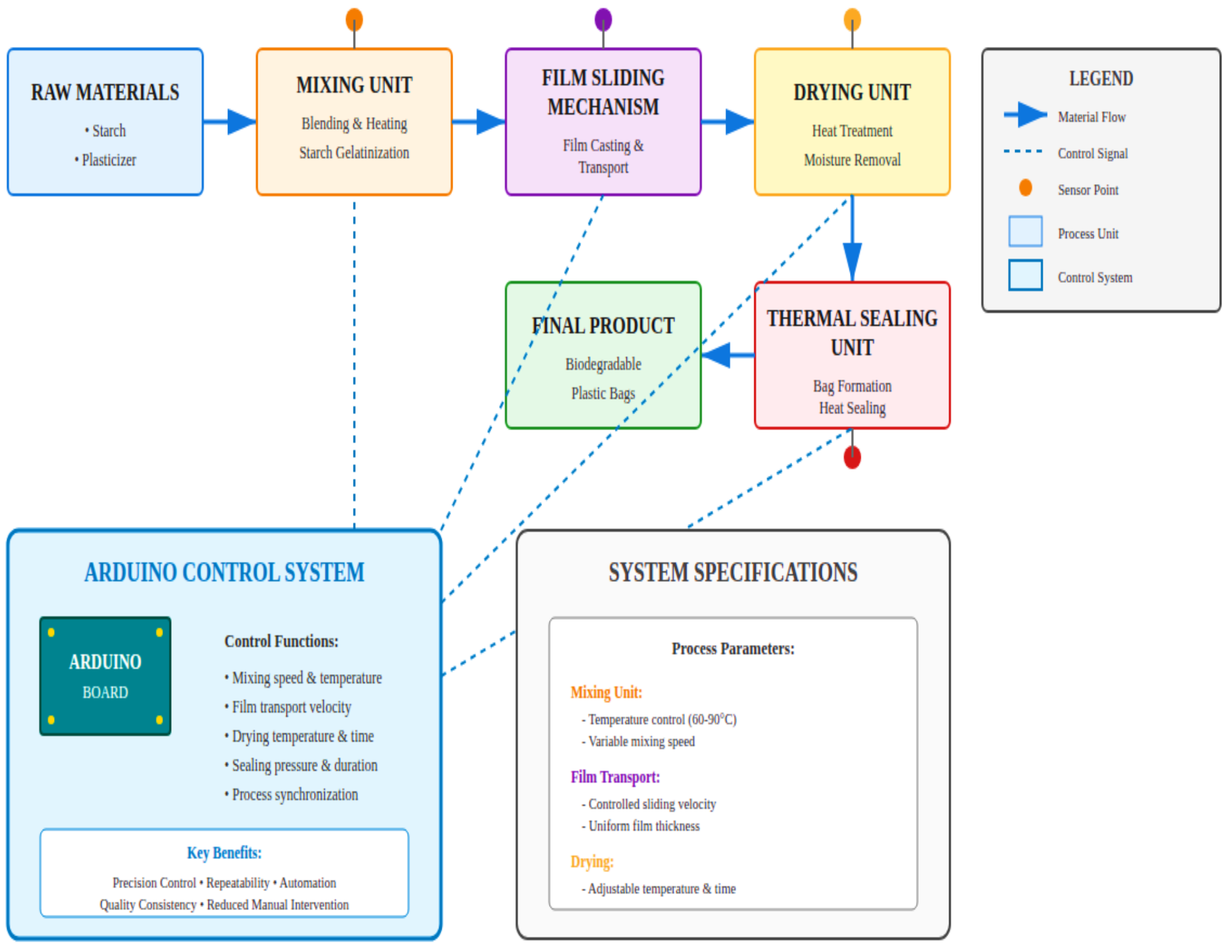
Source[1]

The system objectives encompass:

- ✓ Synthesis and characterization of starch-glycerol biopolymer formulations,
- ✓ Design and fabrication of an Arduino-controlled automated production system integrating mixing, film formation, drying, and thermal sealing modules, and
- ✓ Demonstration of a scalable, energy-efficient methodology for manufacturing sustainable packaging materials.

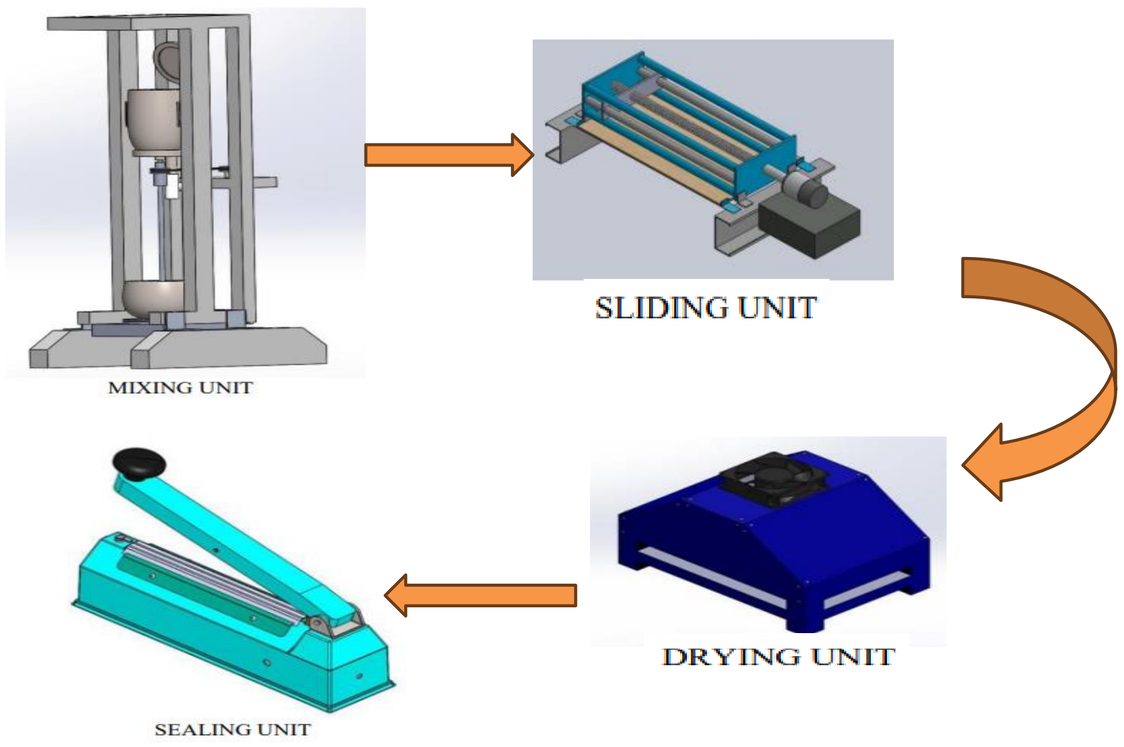
METHOD

- ✓ Biopolymer Synthesis: Corn starch (polymer matrix), glycerol (plasticizer 30% w/w), distilled water heated at 85°C with continuous stirring until complete gelatinization achieved.
- ✓ Film Fabrication: Solution cast onto flat plates, dried at 60°C for 24h.
- ✓ Automated System: Arduino-controlled modules (mixing unit with temperature control 60-90°C, film sliding mechanism, drying chamber with sensors, thermal sealing unit: 120-140°C, 0.5 MPa, 3s).
- ✓ Testing: Tensile properties (ASTM D638), biodegradation (soil burial, 28-day monitoring).



RESULTS & DISCUSSION

- ✓ Mechanical characterization revealed
  - Starch-glycerol films exhibited tensile properties comparable to low-density polyethylene (LDPE)
  - The flexibility retention across typical ambient conditions
- ✓ Biodegradation kinetics under controlled soil conditions demonstrated
  - Complete decomposition within 4-6 weeks
  - The soil microbial activity facilitating enzymatic hydrolysis of the polymer matrix
- ✓ The automated fabrication system achieved
  - Consistent throughput with 35% reduced energy consumption relative to conventional thermoplastic processing
  - It attributed to lower processing temperatures required for starch gelatinization
- ✓ Process optimization through Arduino-based parameter control resulted:
  - Enhanced film uniformity (±5% thickness variation)
  - Reproducible mechanical performance across production batches.
- ✓ Findings validate the technical feasibility of starch-based biopolymers viable substitutes for petroleum-based single-use packaging applications without compromising functional performance.



CONCLUSION

- ✓ Biodegradable bags were successfully produced using starch-based polymers.
- ✓ The system operates efficiently with low energy consumption and natural materials.
- ✓ The prototype demonstrates strong potential for scalable, eco-friendly manufacturing.

FUTURE WORK / REFERENCES

Enhanced polymer formulations for improved water resistance, integration of renewable feedstocks, scale-up optimization, life-cycle assessment, and cost-benefit analysis for industrial implementation.

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[2] Tang, X., & Alavi, S. (2011). Recent advances in starch, polyvinyl alcohol based polymer blends. Carbohydrate Polymers, 85(1), 7-16.
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