Energy-Efficient Production of Natural Rubber Block Using Rotary Disc Granulator (RDG) with Improved STR Quality Characteristics

Akarapong Tuljittraporn[1], Karnda Sengloyluan[2], Andreas Limper[3], Ekwipoo Kalkornsurapranee[1]

e-mail: akarapong04@gmail.com

[1] *Division of Physical Sciences, Faculty of Science, Prince of Songkla University, Hat-Yai, Thailand*

[2] *Rubber Technology and Engineering Program, Faculty of Engineering, Prince of Songkla University, Hat-Yai, Thailand*

[3] *Institute of Plastics Processing (IKV), RWTH Aachen University, Aachen, Germany*

Abstract

Natural rubber (NR) has gained renewed attention amid growing global concerns regarding environmental and climate change. NR exhibits a significantly lower carbon footprint NR (at approx. 283 g CO_2e/kg) compared to synthetic rubbers. However, current production processes for NR block rubber from cup lumps involve multiple mechanical steps including slab cutter, wet pre-beaker, creper and shredder to remove impurities prior to drying and block formation. These processes consume substantial energy and water, leading to increased carbon emissions. [1]

This study presents a novel approach for modern natural rubber block production using a Rotary Disc Granulator (RDG) [2] as an alternative to conventional processing. The objective is to evaluate the effectiveness of RDG technology in reducing energy consumption while maintaining rubber quality in accordance with Standard Thai Rubber (STR) specifications. Natural rubber blocks were produced using both conventional and modern processes. The specific energy consumption (SEC) [3] of each process was evaluated and compared using Tecnomatix Plant Simulation. Additionally, key material properties were characterized, including dirt content, ash content, nitrogen content, volatile matter, initial plasticity (P_0), plasticity retention index (PRI), and Mooney viscosity. The results demonstrate that the modern process reduced SEC by approximately 30% compared to the conventional method. Improved cleanliness was observed, with dirt content decreasing from 0.0327 to 0.0235 wt.% and lower ash content. Other properties remained within STR requirements. Notably, PRI increased from 79.8 to 85.7, indicating enhanced thermal-oxidative stability. In conclusion, RDG technology offers a promising, energy-efficient alternative for NR block production, supporting sustainable and cost-effective industrial processing.

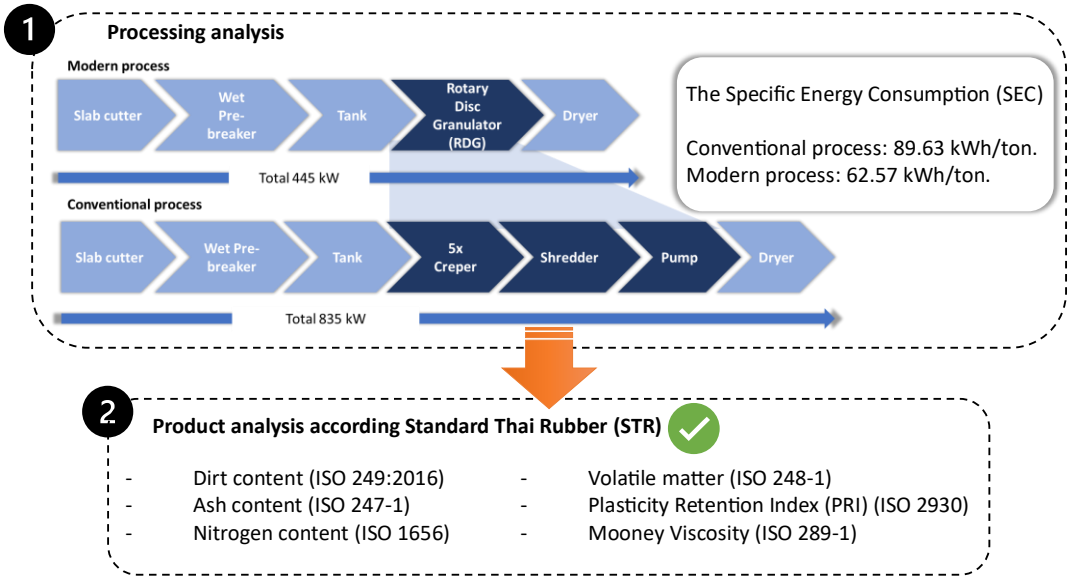
Research Keyword:
Natural rubber processing, Energy efficiency, Specific energy consumption (SEC), Rotary Disc Granulator (RDG)

References:

1) Thailand Greenhouse Gas Management Organization (TGO), Carbon Label Project: Carbon Footprint for Organization/Product; (2025)

2) Hoelschertechnic Gorator & Co KG GmbH, Crushing Device and Wet Crushing Device; German Patent DE202009006268U1, (2024)

3) Farla, J.; Blok, K.; Schipper, L. *Energy Policy*., *25*, 745–758, (1997)


1
Processing analysis
Modern process
Slab cutter
Wet Pre-breaker
Tank
Rotary Disc Granulator (RDG)
Dryer
Total 445 kW
Conventional process
Slab cutter
Wet Pre-breaker
Tank
5x Creper
Shredder
Pump
Dryer
Total 835 kW
The Specific Energy Consumption (SEC)
Conventional process: 89.63 kWh/ton.
Modern process: 62.57 kWh/ton.
2
Product analysis according Standard Thai Rubber (STR)
- Dirt content (ISO 249:2016)
- Ash content (ISO 247-1)
- Nitrogen content (ISO 1656)
- Volatile matter (ISO 248-1)
- Plasticity Retention Index (PRI) (ISO 2930)
- Mooney Viscosity (ISO 289-1)