Popular Science Summary: Electricity and Process Heat Generation from Rice Husk Utilizing Technology of Separate Reactors for Pyrolysis and Gasification Focused on a Rice Mill.

As the world's energy needs grow, Sri Lanka faces the challenge of reducing its reliance on imported fossil fuels. While the country has made progress with wind and solar power, using agricultural waste for energy is still at beginning stage. Rice milling is the major agricultural industry in Sri Lanka, produces large amounts of rice husks as waste. This study explores converting rice husks into energy using advanced technologies at a rice mill, highlighting benefits for sustainability and waste reduction.

The goal of this study is to use rice husk waste to generate electricity and heat by using special reactors for two processes: pyrolysis and gasification. The study aims to convert rice husks into useful products like biochar and syngas. Syngas derived from biomass is a mixture of hydrogen, carbon monoxide, and carbon dioxide produced by gasifying organic materials such as agricultural waste. Field studies, computer modelling, and analysis of rice husk properties show that it can be a valuable energy source. The research demonstrates that syngas from rice husks can power a gas turbine to generate electricity and process heat, enhancing energy security and reducing waste. The study focused on a rice mill in the Polonnaruwa district. Data were collected through interviews about rice production in the area, the milling process, and the mill's energy requirements and rice husk production. Aspen Plus, a commercial software used to model and optimize chemical processes including biomass conversion was used to model and simulate the conversion process and the power and heat generation cycle to understand how rice husks can be converted into energy.

Pyrolysis at lower temperatures produces more char, which helps boost syngas output in the gasifier. However, it also means less fuel for the combustor, affecting heat production. The combustor is crucial for maintaining process heat by burning air, pyrolyzed gas, and bio-oil. Adjusting airflow ensures efficient combustion and heat generation. Syngas production requires careful balancing of char, flue gas, and temperature. The pyrolysis reactor is key to converting biomass into biochar, bio-oil, and gas. Operating at an optimal temperature provides a good balance of biochar and gas. Precise control of the combustor's air-fuel mixture ensures effective combustion. The integrated system of pyrolysis, combustion, and gasification adapts to power demands, achieving efficient conversion of rice husks to syngas. The cleaned syngas fuels a turbine to generate electricity. Simulations showed that increasing airflow to turbine compressor improves cooling but reduces power output. The system can produce steam from turbine exhaust without affecting the hot air output required for the mills. Proper management of feed water flow is essential for optimal steam generation.

This approach achieves 22.6 % conversion efficiency of rice husk to electricity and combustion efficiency with 28.3 %. Additionally, generating steam and hot air from waste heat significantly enhances energy efficiency. This study highlights the potential of sustainable energy from rice husks, promoting optimized biomass utilization and reliable power supply.