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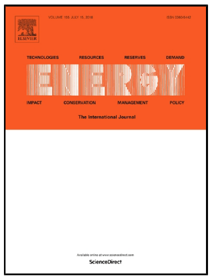

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# Oxygen-blown operation of the TwoStage Viking gasifier

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## Abstract
The TwoStage Viking gasifier from the Technical University of Denmark is being further developed for biofuel synthesis applications. In order to optimize the gasification process, it is suggested to apply an $O_2$-$CO_2$ gas mixture as gasification medium, instead of air, to limit $N_2$-dilution of the product gas. It is found through a modeling study that the system is expected to achieve operating conditions in the range of air-blown operation, when 21v% $O_2$ in $CO_2$ is applied, and nearly identical parameters as the concentration is increased to 30v%. An experimental campaign with the 80kW$_{th}$ Viking pilot plant using 21v% oxygen confirms this, as operation temperatures are seen to slightly decrease the partial oxidation (POX) temperature by 52-69°C and grate temperature by 31-36°C. Tests with 25v% oxygen were also carried out with slightly higher temperatures. Detailed gas analysis showed that $N_2$ had effectively been reduced to a few percent and that tar and sulphur levels were similar to the very high standards of the air-blown operation: only a few mg/Nm$^3$ of tar and <3 ppm sulphur were detected. The lone gas cleaning, a bag filter, was found to be virtually inactive for capturing these impurities. Hence, the gasifier had been successfully demonstrated with $O_2$-$CO_2$ mixtures and is expected to be able to maintain its simple design, whilst enabling very high system efficiency.

**Keywords**: Biomass gasification, Two-stage gasifier, Thermodynamic analysis, Experimental, Gas quality

## 1 Introduction
It is very cost-effective to use biomass-based energy to reduce the impact on climate change, because it to a large extent can be directly utilized into the current fossil infrastructure. Biomass as a flexible resource can be used for heat and power production, but is especially relevant as a carbon source for transport fuels. The fuels can be produced in a number of ways, but the thermal gasification platform offers maximum fuel and product flexibility along with very high conversion efficiency.

The production of biofuels via biomass gasification is a well-studied area and there are a number of limitations and challenges in this coupling of technologies which are namely associated with gas quality. Synthesis reactors are very sensitive to harmful gas impurities such as tars and inorganics and while no hard conclusions can be made on tolerances[1] some overall considerations can be made. These reactors utilize catalytic material at elevated temperatures of ≈200-700°C for synthesis [1][2][3], which are typically in the range of the dew points of tar species in the product gas at ≈200-500°C, which can cause fouling of

[1] Tolerances for gas impurities are set based on catalyst, operating conditions and economic analysis and will vary