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## Woodgas CHP units: an efficiency and system comparison of the dual-fuel and gas-otto engine combustion process

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A system comparison involving two gasifier-CHP systems (Dual Fuel and Gas-Otto) was conducted, with an emphasis on the efficiency of the complete systems. A complete system consists of a biomass gasifier and a CHP unit. The gasifier is composed of a wood pellet storage, a gasification chamber, a gas cooler, a gas filter and dust removal, as well as a condensing unit. The system is a direct-current fixed-bed gasifier with a localized fluidized bed. Wood pellets and gasification air are introduced into the gasifier from below in direct current. The gasification process is autothermal, meaning the thermal energy required for the gasification process comes from the partial combustion of the pellets during the process. After the gas has formed, the wood gas emerges at about 800°C at the upper end of the gasifier. It is cooled to about 125°C by means of a gas cooler. A downstream fabric filter cleans the raw gas of dust and ash particles. Downstream, the raw gas is cooled to 40°C by condensation of water. In Dual Fuel operation the CHP system works with a compression rate of 14:1. The electrical efficiency of the complete system at full load (180 kW<sub>el</sub>) varies from 34.4 % (heating oil/wood gas), (biodiesel/wood gas), (rapeseed oil/wood gas) to 33.3 % (palm oil/wood gas) and (soybean oil/wood gas) dependent on the used pilot fuel. The thermal efficiencies vary from 44.4 % to 48.7 %. As a result, the power coefficients amount from 69.8 % to 75.2 %. The  $\lambda$  values are constant with 1.53 to 1.57 and independent of used pilot fuels. Considering the additional heat output from the gas cooler of 75 kW, the gasifiers total efficiency is 91.2 %. For the gas-otto operation the CHP system has been modified to a reduced compression rate of 12.6:1. The whole injection system and cylinder head has been replaced to a cylinder head with ignition coils and spark plugs, so that the 100 % woodgas operation without any pilot fuel comes possible. The maximum electrical power was limited to 165 kW. The wood pellet mass flow has been constant with 108.7 kg/h, which correlates to a wood pellet combustion heat performance to 532.7 kW. The electrical efficiency of the wood gasifier CHP system is 29.9 %. Its thermal efficiency is 52.3 %. As a result, the power coefficient amounts to 0.57 ( $\lambda$  value of 1.55). The reduction of the compression ratio and the conversion to the gas-otto combustion process shows a decrease in electrical efficiency and power coefficient.



Figure 1: The installation of the test bed for the experimental procedure

### Recent Publications

1. Bocci E et al. (2014) State of art of small scale biomass gasification power systems: a review of the different typologies. Energy Procedia. 45:247-256.
2. Moriconi N et al. (2015) Design and preliminary operation of a gasification plant for micro-CHP with internal combustion engine and SOFC. Energy Procedia. 81:298-308.

### Biography

Brautsch Markus is a Full Professor for thermodynamics, energy technology and renewable energies at the Technical University of Applied Sciences Amberg-Weiden, Germany since 1998. He is the Founder of the Institute of Energy Technology and the Bavarian Center of Excellence for Combined Heat and Power Generation. In 2014 he was appointed as Guest Professor at the Jiangsu University of Science and Technology in China. He is a Guest Lecturer at the Renewable Energy Center in Mithradam (India) and the University of Santa Caterina (Brazil).

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