

TUBITAK Marmara Research Centre - Turkey

TUBITAK Marmara Research Centre (MRC) Energy Institute conducts applied research on advanced energy technologies; namely pyrolysis, gasification and combustion of solid fuels and syngas utilization. The institute specifically has expertise on biomass characterization, gasification and biomass to liquids technologies.

Within the BRISK project TUBITAK contributes to the development of new methodologies for the characterization of 2nd generation biofuels, focusing on Fischer-Tropsch (FT) liquids and attrition phenomena on catalysts in slurry bed reactors. Advanced sulfur and tar measurement methods in thermochemical biomass conversion are the other areas that the institute is involved with. The gasification infrastructure at TUBITAK MRC is open to Transnational Access activities within the BRISK project.

The following infrastructures have recently been revamped and are ready to accommodate the European research community for hands-on experience:

Pilot Scale Bubbling Fluidized Bed Gasifier

This test rig is composed of an allothermal bubbling bed gasifier with a thermal capacity of 50 kWth and gas clean-up reactors (see Figure 2). The gasifier can be operated at a maximum temperature of 850°C under atmospheric pressure. The average particle size of the solid fuel feed is 500 µm with an upper limit of 2000 µm. Minerals such as dolomite, olivine, limonite can be used as the bed material. Air is used as the gasification agent. Tar is measured according to the two different methods, SPA (Solid Phase Adsorption) and CEN/TS 15439 (conventional gravimetric method).

Tar samples are quantitatively characterized by a gas chromatograph equipped with a flame ionization detector (FID). A T-junction is set at the cyclone outlet pipe and assembled with Tedlar Bags for gas sampling. This line is used to monitor the composition of syngas via an on-line infrared and thermal conductivity detector gas analysis system. Gas samples in bags are connected to gas chromatographs (GC) for further gas analysis, namely total S, H₂S, carbonyl sulfide (COS), methyl mercaptane (MeHS) and C1 to C5 hydrocarbons.



Figure 1: A general view taken from the pilot plant site of the TUBITAK MRC Energy Institute.



Figure 2: Pilot Scale Bubbling Fluidized Bed Gasifier.

The H₂S amount is detected by the GC equipped with a thermal conductivity detector. The amounts of other sulfur compounds, i.e. COS, MeHS and thiophen are determined by another GC equipped with a flame photometric detector (FPD). The gasifier is integrated with a gas clean-up unit, which consists of reactors and columns, namely a sand bed filter, COS hydrolysis, shell and tube heat exchangers, caustic scrubbers and a ZnO bed.

Bench Scale Bubbling Fluidized Bed Gasifier

The bench scale gasifier which is available through BRISK is an atmospheric allothermal, bubbling fluidized bed gasifier and has a thermal

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capacity of 20 kWth (see Figure 4). The operation temperature is 750°C. The bed material is sand. Coal/biomass in sizes of 0.5-1.0mm can be fed through a series of attached screw feeders. Air, steam or CO₂ are the alternative gasification agents.

Tar is measured according to the two different methods, SPA (Solid Phase Adsorption) and CEN/TS 15439 (conventional gravimetric method). Tar samples are quantitatively characterized by gas chromatograph equipped with a flame ionization detector. Syngas is measured via an online gas analyser.

The gas sampling part has been revamped in terms of on-line gaseous sulfur measurement according to the US Environmental Protection Agency (EPA) Method 15 'Determination of H₂S, COS and CS₂ emissions from stationary sources'. A calibration gas generator is used for the calibration of gas chromatograph (GC) equipped with pulse flame photometric detector (PFPD). Online benzene, toluene and xylene analysis is possible via the second channel of this GC connected to a flame ionization detector.



Figure 3: Gas analysis system equipped with gas chromatograph (GC) with pulse flame photometric detector (PFPD) and calibration gas generator.



Figure 4: Bench scale bubbling fluidized bed gasifier.



www.mam.gov.tr

www.briskeu.com

Contact



Hakan Karatas

T: +90 262 677 27 92

E: hakan.karatas@tubitak.gov.tr



Alper Sarioglan

T: +90 262 677 27 06

E: alper.sarioglan@tubitak.gov.tr



Ozlem Atac

T: +90 262 677 27 29

E: ozlem.atac@tubitak.gov.tr