- **2.4 Gasification for synthesis gas production**
  Fundamentals and studies, technologies and reaction for syngas production, syngas cleaning from particles and inorganics.

Steam Gasification of Olive Oil Pomace Investigated with Thermal Analysis Coupled with Mass Spectrometry

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Steam gasification of biomass is one of the promising technologies towards thermochemical hydrogen rich gas and/or hydrogen production from biomass.

Thermal analysis coupled with mass spectrometry (TA/MS) has been applied to investigate steam gasification of olive oil pomace. The utilized device is NETZSCH F3 JUPITER coupled with AELOS403. During the experiments, ~10 mg pomace with a particle size of < 250μm has been used in the TA/MS system in order to reduce mass and heat transfer limitations. The sample has been heated up to 1000°C at several heating rates from 5 to 20°C/min. Different Argon-steam mixtures at a flow rate of 50 mL/min have been used in experiments. Olive oil pomace has been gasified in pure Argon (99.9995%) as well to create a reference case. The results provided here are for a heating rate at 20°C/min and 20% steam.

The major gasification products identified are H2, CH4, H2O, CO, H2S, CO2, COS and SO2 along with several minor ones. Their evolution profiles with respect to temperature developed by using on-line MS enable a realistic evaluation of weight loss results.

Olive oil pomace first loses inherent moisture during gasification in TG. Release of volatile matter sets on in Argon atmosphere at around 200°C and ends at 600°C. Further weight loss observed up to higher temperatures in Argon atmosphere is rather insignificant.The remainder is carbon rich char and mineral matter. There are two major weight loss regions in Argon-steam gasification of olive oil pomace after the loss of the inherent moisture. The first one that corresponds to the release of volatiles is similar to that with Argon. The second one occurs at higher temperatures due to the reaction of the pomace char with steam. H2, CO and CO2 emissions at higher temperatures increase with the presence of steam indicating various reactions of the char with steam such as water gas shift reaction producing hydrogen.

Keywords: Biomass, Steam Gasification, Hydrogen Production

TG-DTG results of olive oil pomace gasification in Argon and Argon-steam atmosphere at 20K/min is presented in Fig. 1. The major weight loss observed to around 600°C is quite similar for both atmospheres. No further weight loss occurs for Argon gasification while an additional weight loss takes place in the 600-850°C region in Argon-steam atmosphere.

The lower temperature (200-600°C) weight loss, corresponds mainly to the decomposition of hemicellulose and cellulose, is about 66% in Argon atmosphere and 68% in Argon-steam atmosphere. Higher temperature (600-850°C) weight loss related to char steam reactions is 23%.

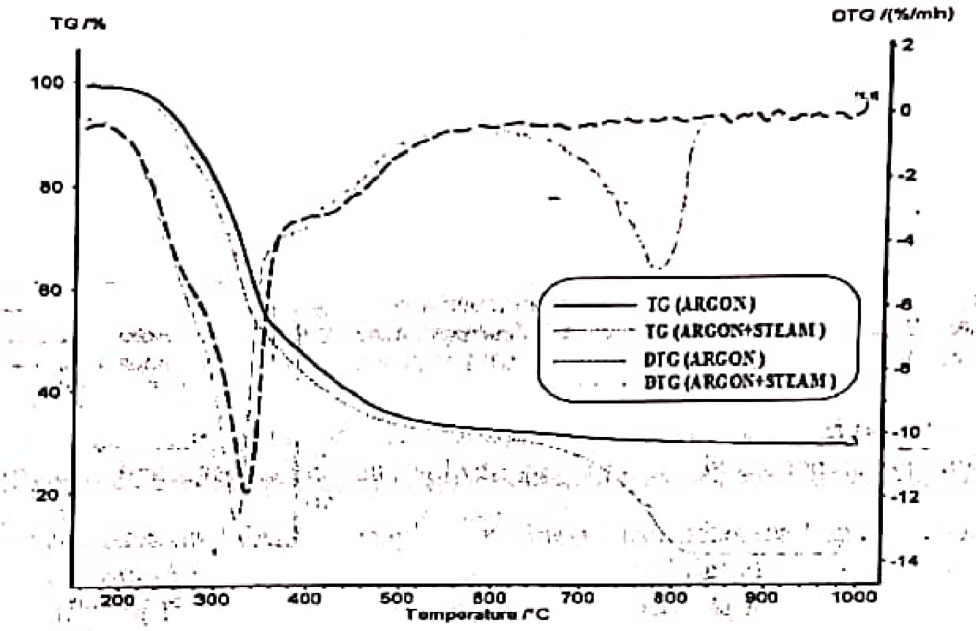

Figure 1. TG-DTG results for olive oil pomace under Argon and Argon-steam atmosphere

Figure 2 presents H2, CO and CO2 evolutions during Argon and Argon+steam gasification of olive oil pomace up to 1000°C. It is observed that steam gasification enhances char/steam reactions resulting in higher temperature (>600°C) H2, CO and CO2 formations.

Hydrogen formation between 200-450°C mainly depends on the decomposition of cellulose and hemicelluloses ; hydrogen formation from 450°C to 600°C is primarily due to the occurrence of aromatization and structural rearrangement within lignin. Higher temperature (>600°C) H2 evolution in Argon-steam atmosphere is a consequence of the steam induced char reactions.

Carbon monoxide produced from the degradation of cellulose is formed mainly at low temperature region in Argon and Argon-steam atmospheres. In the latter atmosphere further CO evolution occurs at higher temperatures. A similar trend is observed for CO2.

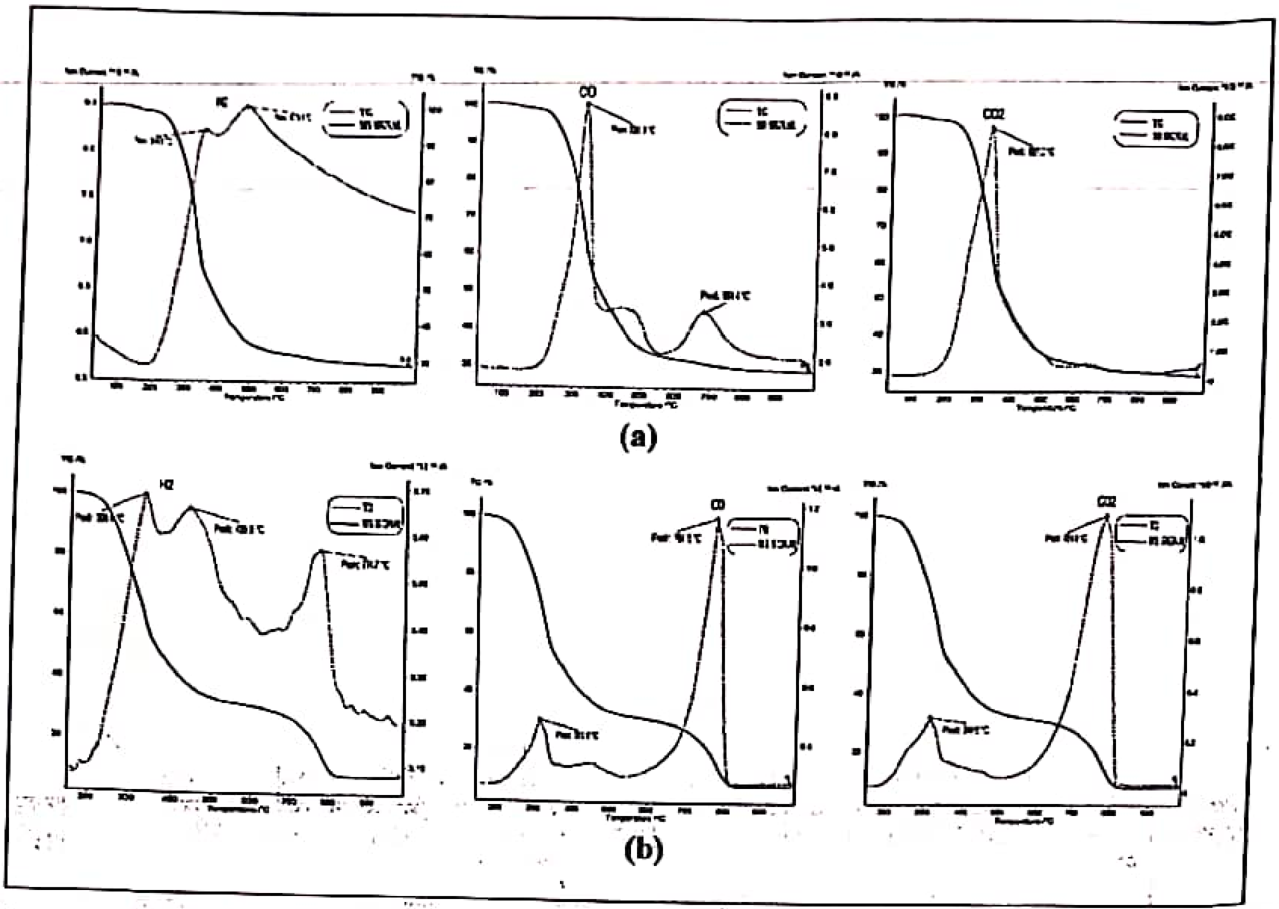

Figure 2. H2, CO and CO2 evolutions during Argon pyrolysis (a) and steam gasification (b) of olive oil pomace

Concluding Remarks

TA/MS enables the identification of gaseous species formed during thermolysis; experiments can be designed to interprete the kinetics of thermolysis processes as well.

H2 production is desired for both energy and chemical synthesis related applications. This study indicates the importance of steam gasification to produce higher yields of H2 from biomass.

Data taken for several biomass samples and their mixtures with Turkish lignites and biomasses at various heating rates and reactive atmospheres including steam, CO2 and O2 are being developed and kinetically analyzed (iso-conversion , model fitting and regression). Results are to be /published in the near future.

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