Institute of Fluid Mechanics
Research Group B2
Flows with Chemical Reactions
- Combustion technology -
Cauerstr. 4, 91058 Erlangen

MA/BA Thesis Title: 22.07.2019

Development of a Hot-Gas-Treatment (HGT) system for the ALLOTHERM-Converter

Introduction:

Despite recent developments in biomass gasification (nearly 500 decentralized wood-gasifiers installed in the last 10 years in Germany), the thermochemical conversion of biomass into syngas (mainly H2-CO mixture) by commercially available technologies is only possible for well-defined wood-chips or wood-pellets, while alternative biomasses remains largely unused.

That is the case of residual straw. Even if unused straw has a potential to provide nearly 4,5 GW of electric capacity to the German grid or replace nearly 9 big coal power plants, its use is restricted to only 1,4% of this potential due to the limitations of commercially available technologies.

The challenges in overcoming the biomass limitation and the approaches adopted by the LSTM team in its innovative ALLOTHERM-Converter (and to be addressed by 2 Master students) can be so described:

Theme	Addressed Issue	*ALLOTHERM Approach*
1	High inorganic content of straw (around 6%) leads to sintering and vaporization of some species (ex. KCl, KOH, NaCl) and subsequent blockages and deposits respectively. In addition, the high concentration of acidic compounds (ex. HCl, H2S) increases the risk of metal corrosion.	The ALLOTHERM concept adopts a Hot Gas Treatment System for the removal of inorganics and acid compounds from the syngas stream in a downstream filter with adsorbents. An indirect heating system (based on volumetric ceramic burners) reduces the maximal temperature and the sintering risk.
2	The presence of condensable organic compounds in the syngas (tar) prevents the use of advanced energy systems like gas engines and fuel cells for the decentralized heat and power supply.	By applying recent developments in Hot-Gas-Treatment, autogenous char is used for removing tar still inside the reactor at the process temperature (~900°C). The expected result is a high-quality syngas.

Description of the work:

The student will take part in the development of a test set-up of the ALLOTHERM Converter. Manufacture of the reactor will be done in the department workshops and the produced test set-up will be then experimentally tested and its performances under different working conditions evaluated and improved.

Following the **Theme 1** above, the student will take part in the development of a Hot Gas Treatment (HGT) system for the removal of alkali and acidic compounds from a syngas stream. The student will simulate chemical reactions between these compounds and absorbers at high temperature (500 – 900 °C) using for example a dedicated simulation software (Chemkin) and considering different syngas composition. The student will also investigate the parameters for the construction of a High Temperature Gas Cleaning reactor, like geometry and fluid dynamics properties.

Tasks:

- Evaluate the suitability of different absorbers at the process conditions in a simulation software (Chemkin);
- Test set-up mounting and commissioning;
- Create control and measurement sequences in LabView,

- Parametric study of the reactor performance at different flow volumes and temperatures,
- Detailed analysis of obtained experimental results,
- Optimization and further development of the proposed concept.

Requirements:

- Proficient use of German and/or English language,
- Interest in the research topic and commitment to the research,
- Ability for independent work in the laboratory,
- Advanced knowledge of thermodynamics and fluid mechanics,
- Advanced knowledge of inorganic chemistry,
- Basic knowledge of combustion technology and systems.

Study subjects: CE, CBI, ET, MB or LSE

Start: From September 2019.

Contact:

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