

Optimized Fuels for Sustainable Transport

Public

All rights reserved by CHOREN Industries GmbH

Project co-funded by the EUROPEAN COMMISSION FP7 Directorate-General for Transport and Energy Grant No. 218890

Deliverable

Deliverable 3.1

Report of test run of the PRO/II and DYN-SIM model of the Carbo-V biomass gasification process of the beta plant consisting of the four sub-processes

Public Summary

Work package: Deliverable Nº: Reviewer: Due date of deliverable: Actual date of delivery: Version: Responsible: Author: Contact: Dissemination level: WP 3 D 3.1 Gregor Fernholz / Invensys M 21 30.09.2010 Final CHOREN Dr. Fred Compart fred.compart@choren.com PU



Deliverable 3.1 For Public Information

Table of Contents

1	Publisha	able Summary	3
2	Introduc	tion	4
3	Referen	ce Documents	4
4	Introduc	tion: Carbo-V biomass gasification process	4
5	Model D	Description and test runs	6
Ę	5.1	Implementation of reactions for steady state PRO/II simulation	7
Ę	5.2	Implementation of reactions for dynamic simulation (DYNSIM)	7
Ę	5.3	Details of UNIT 1.1 modeling: Low temperature gasifier (LTG)	11
Ę	5.4	Implemented overall PRO/II and DYNSIM model for the low temperature	
Ç	gasifiers (LTĠs)	12
Ę	5.5	Steady state test runs of UNIT 1.1: Low temperature gasifiers	16
Ę	5.6	Dynamic test runs of UNIT 1.1: Low temperature gasifiers	25
Ę	5.7	Steady state test run of complete Carbo-V biomass gasification process	26
Ę	5.8	Dynamic test run of complete Carbo-V biomass gasification process	30
6	Summa	ry	32

Revision	0								
Purpose	For Public Information								
Date	9/30/2010								
CHOREN Industries GmbH									
Author	DrIng. F. Compart								
Checked									
Approved									
QA Mangr									



1 Publishable Summary

Invensys Systems GmbH and Choren Industries GmbH together developed integrated and complete steady state and dynamic models for the core Carbo-V gasification process of the Biomass-to-Liquid Plant (CHOREN) located in Freiberg, Germany. This development is part of the tasks of the working package 3 within the EU Project OPTFUEL 218890 (Project co-funded by the EUROPEAN COMMISSION FP7, Directorate-General for Transport and Energy Grant No. 218890).

For steady state simulation the engineering software tool PRO/II is used. For the dynamic simulation the software DYNSIM is utilized. Both tools are products of Invensys System, Inc. The steady state PRO/II model was created by CHOREN; the dynamic DYNSIM model was created by the OPTFUEL project partner Invensys.

The gasification processes comprise gas - solid reactions, gas - gas reactions and unconventional composite materials not encountered in typical petrochemical processes (p. e. wood, coal, ash, slag). Wood and coal are complex materials. Their characterization and the handling of these biomaterials and the gas - solid reactions are some of the specific challenges within this project development.

The CHOREN Carbo-V biomass gasification process addresses the tar issue of biomass gasification by using the three-stage process. In the first stage the biomass is pyrolysed with an $O_2/CO_2/H_2O$ gas mixture. A following high temperature gasifier with O_2 - input effectively destroys the tars contained in the pyrolysis gas. In a subsequent third stage (endothermic reactor) the pyrolysis coke from the 1st stage is processed together with the hot gas of the 2nd stage in order to elevate the overall gasification efficiency which is important for the yield of biofuel out of this biomass.

These different gasification process stages required different modeling strategies (kinetic models respectively chemical equilibrium models, the latter with optionally tunable temperature approaches if required in order to take into account kinetic effects).

The effective workability of the developed steady state gasification model was investigated by parameter studies. Tuning parameters for the models of the 1st and 3rd gasification stages were chosen. The suitability of this set of tuning parameters was validated by a fit to some operation outcomes of the Beta Plant (normal operation point and operation points during the ongoing plant commissioning). Tuning of these parameters is already done and will be furthermore done with the help of Beta plant experimental data. The prerequisites are successfully created for fitting further experimental Beta plant operation results to the PRO/II simulation outcomes – a contribution to a thorough understanding of the specific chemistry of the CHOREN beta plant gasification processes.

These results of the steady state parameter fitting will be translated into a fit of the kinetic parameters of the dynamic simulation models with DYNSIM. Parallel to this dynamic case studies of the behavior of the 1st gasification stage and the complete Carbo-V biomass gasification process were already done by Invensys and CHOREN. Disturbance scenarios as well as smaller deviations from normal operation and respectively the controller behaviors were investigated by way of selected examples. The workability of the dynamic models was validated. The dynamic simulation runs are computer challenging. After the mentioned fine tuning of kinetic parameters the study of transient dynamic plant behavior (disturbance compensation, fine - tuning of controller parameters, shut down scenarios) will be further intensified.