Supplementary material

Experimental investigation of hydrogen-intensified synthetic natural gas production via biomass gasification: A technical comparison of different production pathways

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A Bed material composition

Table A1 Typical composition of the used bed materials

Parameter	Olivine	Limestone
$CaCO_3$ (wt.-%)	<0.1	95-97
CaO (wt.-%)	<0.4	-
Fe_2O_3 (wt.-%)	8.0-10.5	0.1-0.3
$MgCO_3$ (wt.-%)	48-50	1.5-4.0
SiO_2 (wt.-%)	39-42	0.4-0.6
Hardness (Mohs)	6-7	3
Particle density (kg/m^3)	2850	2650 (1500[a])

[a] After full calcination

B Temperature trend in the gasification reactor

Fig. B1 depicts the temperature trends in the lower (GR1, GR6) and upper (GR15) gasification reactor during the DFB gasification test campaign. Fig. B2 shows the same trends for the SER test campaign.

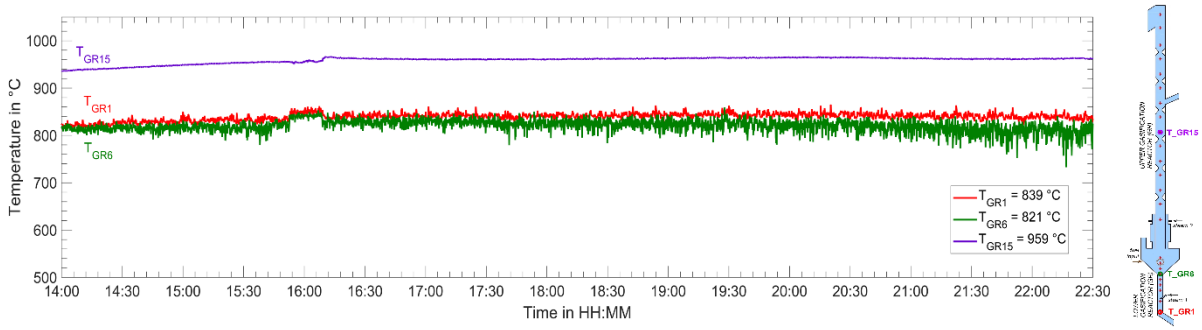

Fig. B1 Temperature trends in the gasification reactor for DFB gasification

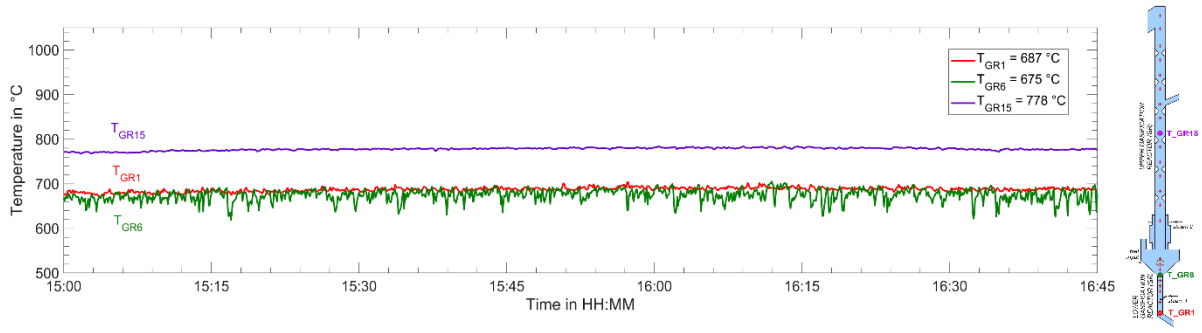

Fig. B2 Temperature trends in the gasification reactor for the SER process

C GCMS tar concentrations

Table C1 lists the single GCMS tar components measured after the gasifier (stream no. 2) and after the RME-scrubber (stream no. 5) for the DFB gasification and the SER process test campaigns. The components that could not be detected are indicated by the respective limit (<2 mg/Nm^3 and <15 mg/Nm^3 after the gasifier and <6 mg/Nm^3 and <4 mg/Nm^3 after the scrubber). The GCMS tar concentrations after the activated carbon beds (stream nos. 7 and 8) are below the detection limit for every measured component (<4 mg/Nm^3) and therefore not displayed. Isopropanol (IPA) is used as solvent for the samples.

Table C1 GCMS tar concentrations after the gasifier and after the scrubber for the DFB gasification and the SER process test campaigns

		DFB Gasification		**SER process**	
Stream number		2	5	2	5
Description		After gasifier	After scrubber	After gasifier	After scrubber
Solvent		IPA	IPA	IPA	IPA
Single GCMS tar components					
Pyridine	mg/m^3_N	<2	<6	<15	<4
2-Methylpyridine	mg/m^3_N	<2	<6	<15	<4
Phenylacetylene	mg/m^3_N	<2	<6	**34**	<4
3- und 4-Methylpyridine	mg/m^3_N	<2	<6	<15	<4
Styrene	mg/m^3_N	**53**	<6	**627**	**36**
Mesitylene	mg/m^3_N	<2	<6	**18**	<4
Phenol	mg/m^3_N	<2	<6	**1890**	<4
Benzofuran	mg/m^3_N	<2	<6	**76**	<4
1H-Indene	mg/m^3_N	**109**	<6	**1346**	**19**
2-Methylphenol	mg/m^3_N	<2	<6	**68**	<4
4-Methylphenol	mg/m^3_N	<2	<6	**356**	<4
2-Methylbenzofuran	mg/m^3_N	<2	<6	**17**	<4
2,6-Dimethylphenol	mg/m^3_N	<2	<6	<15	<4
2,5- und 2,4-Dimethylphenol	mg/m^3_N	<2	<6	<15	<4
3,5-Dimethylphenol	mg/m^3_N	<2	<6	**29**	<4
2,3-Dimethylphenol	mg/m^3_N	<2	<6	<15	<4
3,4-Dimethylphenol	mg/m^3_N	<2	<6	<15	<4
2-Methoxy-4-Methylphenol	mg/m^3_N	<2	<6	<15	<4
Naphthalene	mg/m^3_N	**2332**	<6	**1786**	**19**
1-Benzothiophene	mg/m^3_N	<2	<6	<15	<4
Quinoline	mg/m^3_N	<2	<6	<15	<4
2-Methylnaphthalene	mg/m^3_N	<2	<6	**510**	<4
Isoquinoline	mg/m^3_N	<2	<6	<15	<4
1-Methylnaphthalene	mg/m^3_N	<2	<6	**288**	<4
1-Indanone	mg/m^3_N	<2	<6	<15	<4
Eugenol	mg/m^3_N	<2	<6	<15	<4
Indole	mg/m^3_N	<2	<6	**17**	<4
Biphenyl	mg/m^3_N	**30.**	<6	**92**	<4
1-Vinylnaphthalene	mg/m^3_N	<2	<6	**34**	<4
2-Vinylnaphthalene	mg/m^3_N	<2	<6	**87**	<4

Isoeugenol	mg/m^3_N	<2	<6	<15	<4
Acenaphthylene	mg/m^3_N	**456**	<6	**377**	<4
Acenaphthene	mg/m^3_N	**18**	<6	**22**	<4
Dibenzofuran	mg/m^3_N	**43**	<6	**151**	<4
Fluorene	mg/m^3_N	**50**	<6	**219**	<4
Dibenzothiophene	mg/m^3_N	<2	<6	<15	<4
Anthracene	mg/m^3_N	**491**	**28**	**443**	**12**
Phenanthrene	mg/m^3_N	**84**	<6	**120**	<4
Carbazole	mg/m^3_N	<2	<6	<15	<4
4,5-Methylenphenanthrene	mg/m^3_N	**36**	<6	**34**	<4
9-Methylanthracene	mg/m^3_N	<2	<6	<15	<4
Fluoranthene	mg/m^3_N	**270**	**44**	**85**	**9**
Pyrene	mg/m^3_N	**255**	**43**	**75**	**8**
Benzo[a]anthracene	mg/m^3_N	**18**	<6	<15	<4
Chrysene	mg/m^3_N	**25**	<6	<15	<4
Benzo[b]fluoranthene	mg/m^3_N	**12**	<6	<15	<4
Benzo[k]fluoranthene	mg/m^3_N	**5**	<6	<15	<4
Benzo[e]pyrene	mg/m^3_N	**10**	<6	<15	<4
Benzo[a]pyrene	mg/m^3_N	**19**	<6	<15	<4
Perylene	mg/m^3_N	**4**	<6	<15	<4
Dibenz[a,h]anthracene	mg/m^3_N	<2	<6	<15	<4
Benzo[g,h,i]perylene	mg/m^3_N	**8**	<6	<15	<4
Indeno[1,2,3-cd]pyrene	mg/m^3_N	**9**	<6	<15	<4
Anthanthrene	mg/m^3_N	**4**	<6	<15	<4
Coronene	mg/m^3_N	<2	<6	<15	<4
Sum of GCMS tar	**g/m^3_N**	**4.340**	**0.115**	**8.80**	**0.10**