

Experimental study of the effects of steam injection on the quality of syngas from two-stage downdraft wood gasification

Arnaud Rouanet¹, Hervé Jeanmart¹

EXPERIMENTAL CONDITIONS

Experiments were performed on air-steam gasification of wood chips in a pilot-scale two-stage downdraft gasifier of 200 kW_{th}.

Low (LT) and High (HT) temperature steam (100-250°C) was injected at the secondary stage at steam to biomass ratios (SBR) between 0 and 0.6.

Tar sampled with the tar protocol was analysed by GCMS.

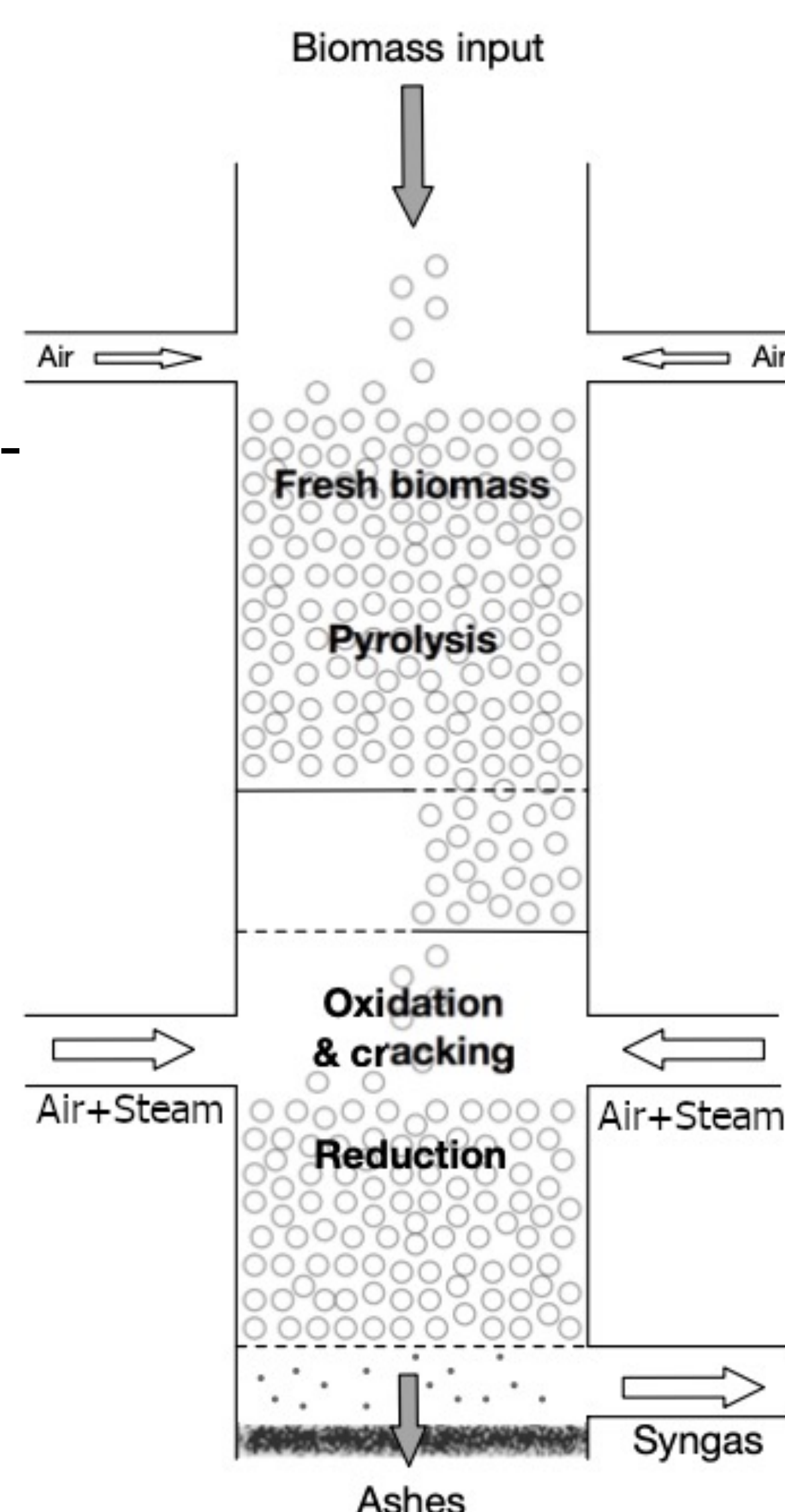


Figure 1: two-stage downdraft gasifier

Run ID	Air flow Nm ³ /h	Air ratio sec./prim.	Steam flow kg/h	Steam T °C	Wood flow kg/h	ER	SBR
air60	59	2.3	0	-	39	0.36	0.00
air60_st10LT	60	2.2	10	103	35	0.40	0.31
air60_st20LT	59	2.0	20	103	38	0.37	0.57
air60_st20HT	59	2.0	20	260	37	0.38	0.59
air70	69	2.4	0	-	46	0.35	0.00
air70_st10LT	69	1.9	10	104	44	0.36	0.24

Table 1: experimental conditions

SYNGAS COMPOSITION AND H₂/CO RATIO

Steam injection strongly shifts the syngas composition from CO towards H₂. The H₂/CO ratio increases from 0.9 to 2.0 at SBR=0.6.

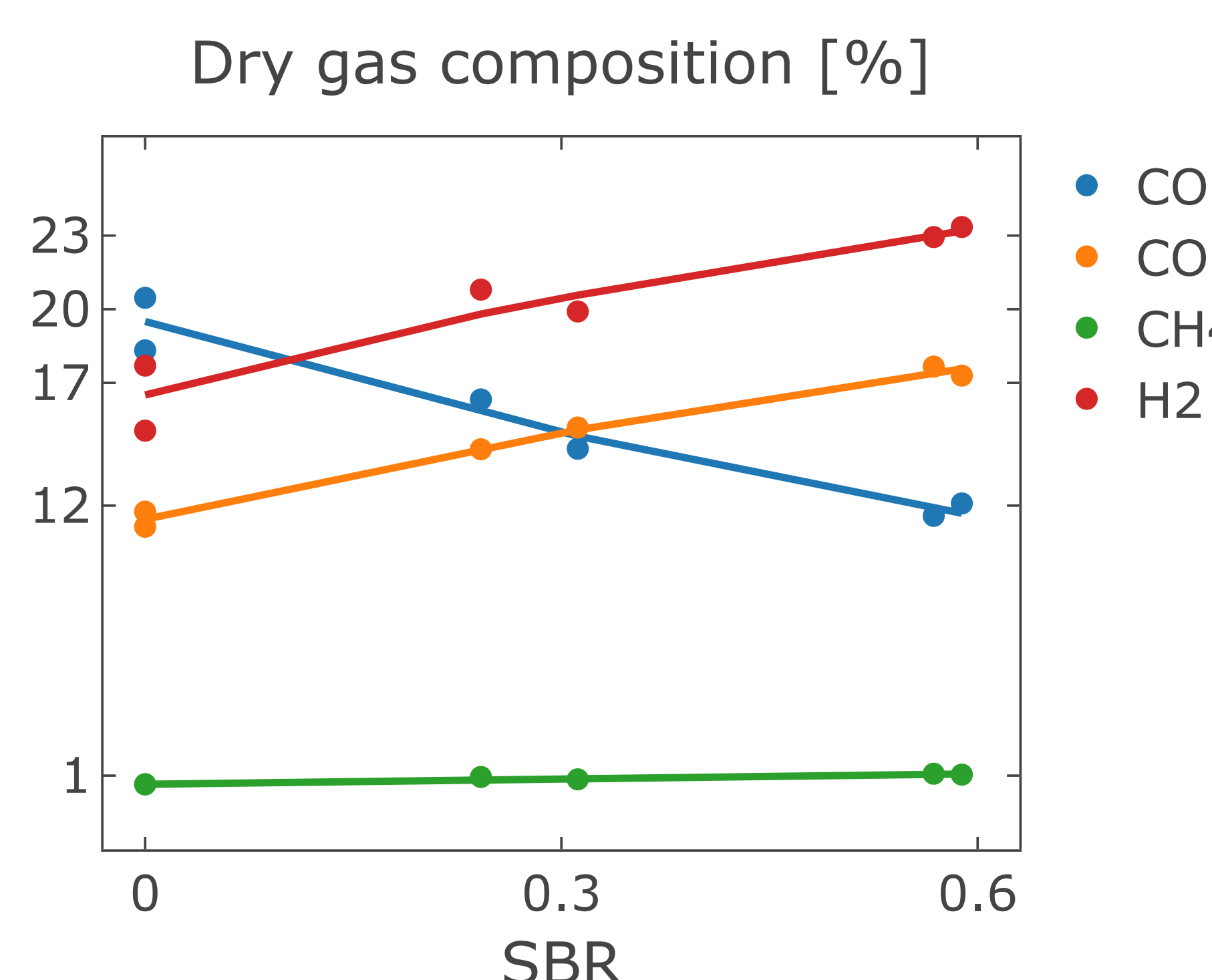


Figure 2: effect of the SBR on syngas composition

SYNGAS LHV AND CONVERSION EFFICIENCY

The impact of steam on syngas LHV is small: +6% compared to the reference run with 20 kg/h HT steam. Comparatively, the increase of air flow from 60 to 70 Nm³/h yields a +13% gain.

Cold gas efficiency is enhanced by steam injection, thanks to an improved carbon conversion in the reduction bed.

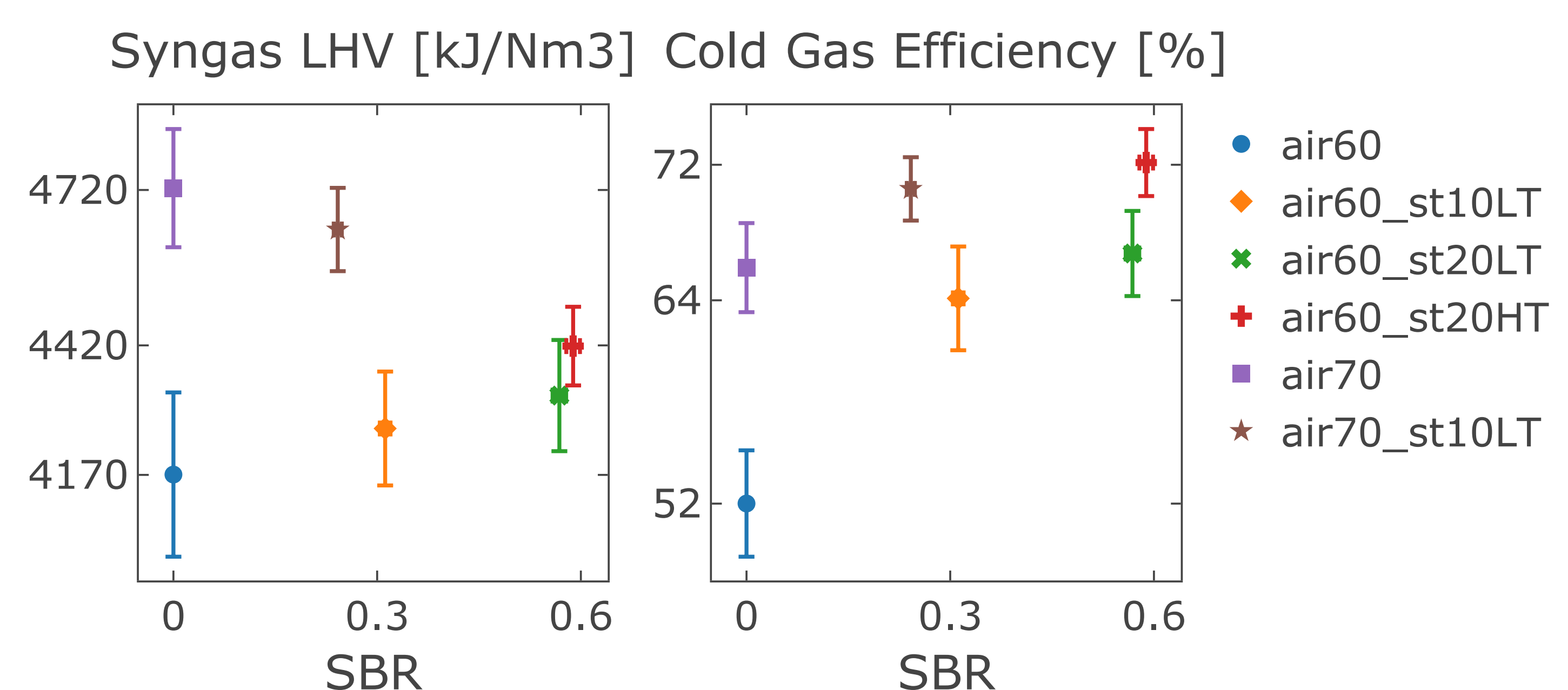


Figure 3: effect of the SBR on syngas LHV and gasification efficiency

TAR COMPOSITION AND DEW POINT

Steam injection remarkably enhances the conversion of secondary tar (phenolic compounds) and PAHs into benzene, lowering the Tar dew point.

Run ID	Total mg/Nm ³	Benzene mg/Nm ³	>Benzene mg/Nm ³	Secondary mg/Nm ³	PAHs mg/Nm ³	Dew point °C
air60	140	84	57	43	14	87
air60_st20LT	189	154	35	29	6	67
air60_st20HT	180	152	28	23	5	68
air70	112	52	60	50	10	109
air70_st10LT	149	122	27	22	5	72

Table 2: tar content and tar dew point

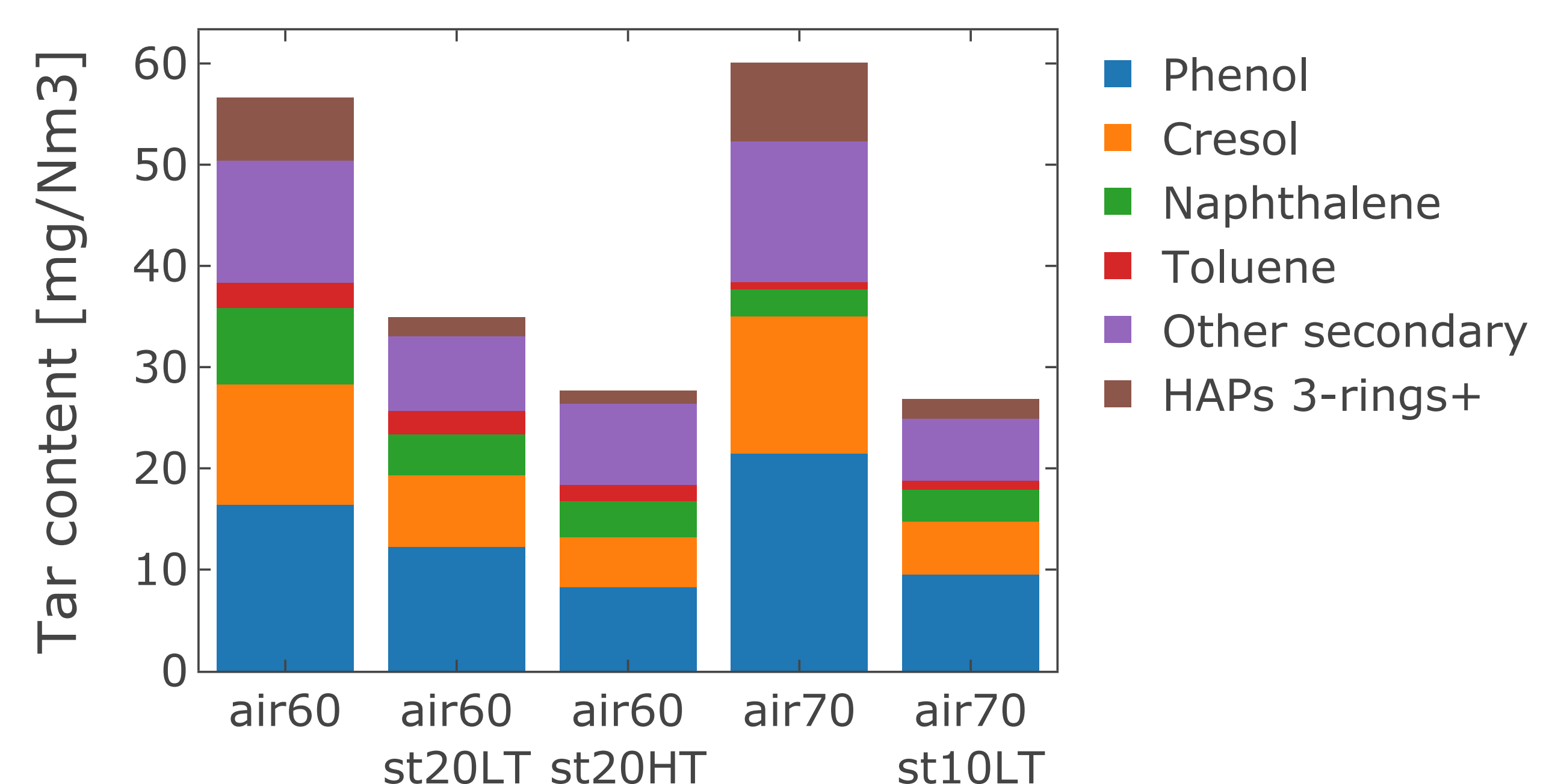


Figure 4: composition of tar species heavier than benzene