Supplementary Materials

1. Comparison of DO Radiation Model with P-1 Radiation Model

The DO radiation model and P-1 radiation model with WSGG model have been widely used in gasification studies. For comparison, we performed additional calculations for Drayton coal using the P-1 radiation model. Table S1 below shows the results.

Table S1. Comparison of the CFD result by DO radiation model with P-1 radiation model.

Contents	Considering DO Radiation Model	Considering P-1 Radiation Model
CO (%)	62.96 (34.19 kg/s)	62.95 (34.14 kg/s)
H_2 (%)	29.23 (1.10 kg/s)	28.96 (1.09 kg/s)
CO_2 (%)	2.62 (2.23 kg/s)	2.60 (2.21 kg/s)
N_2 (%)	4.35 (1.13 kg/s)	4.31 (0.99 kg/s)
Others (%)	1.84 (1.72 kg/s)	1.93 (1.93 kg/s)
Temperature (K)	2068.65	2078.73
CGE %/CCE %	78.29/99.63	78.28/99.32

For Drayton coal with meshes considering the 1/4 periodic geometry of the gasifier, CFD calculations were carried out using the DO radiation model and P-1 radiation model. The comparison was made in Figures S1–S3 for distributions of temperature, H_2 molar concentration, and CO molar concentration.

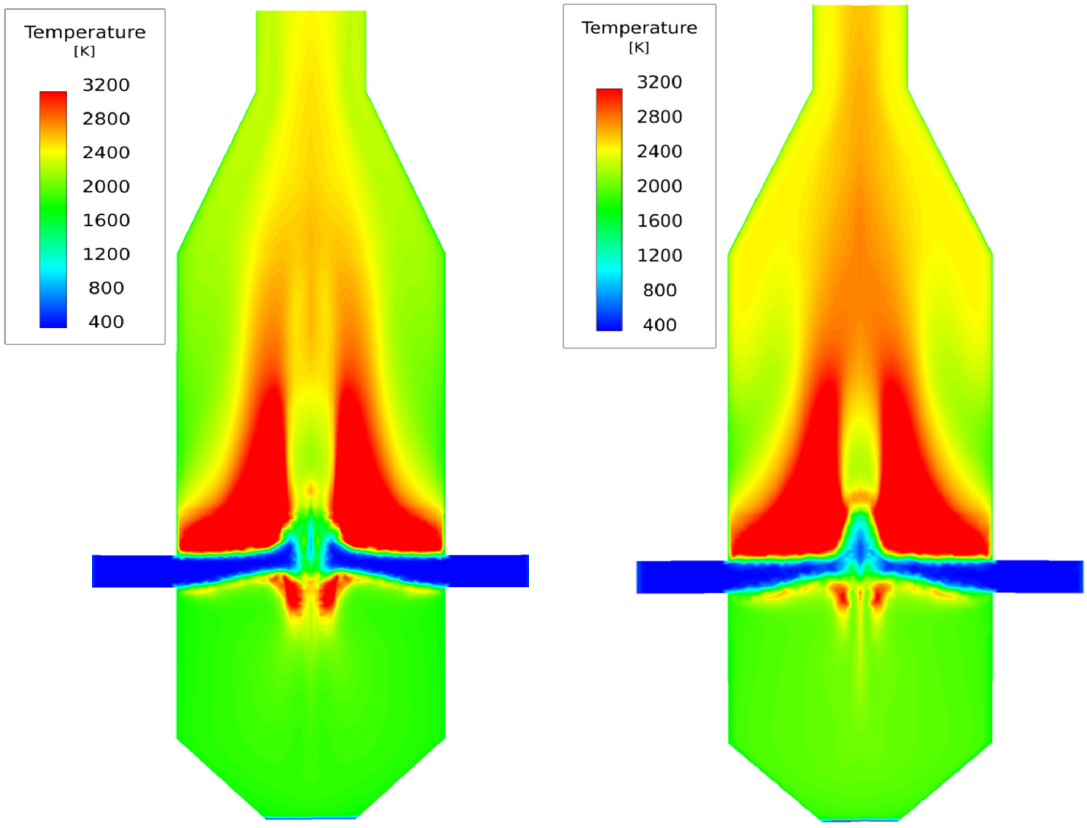
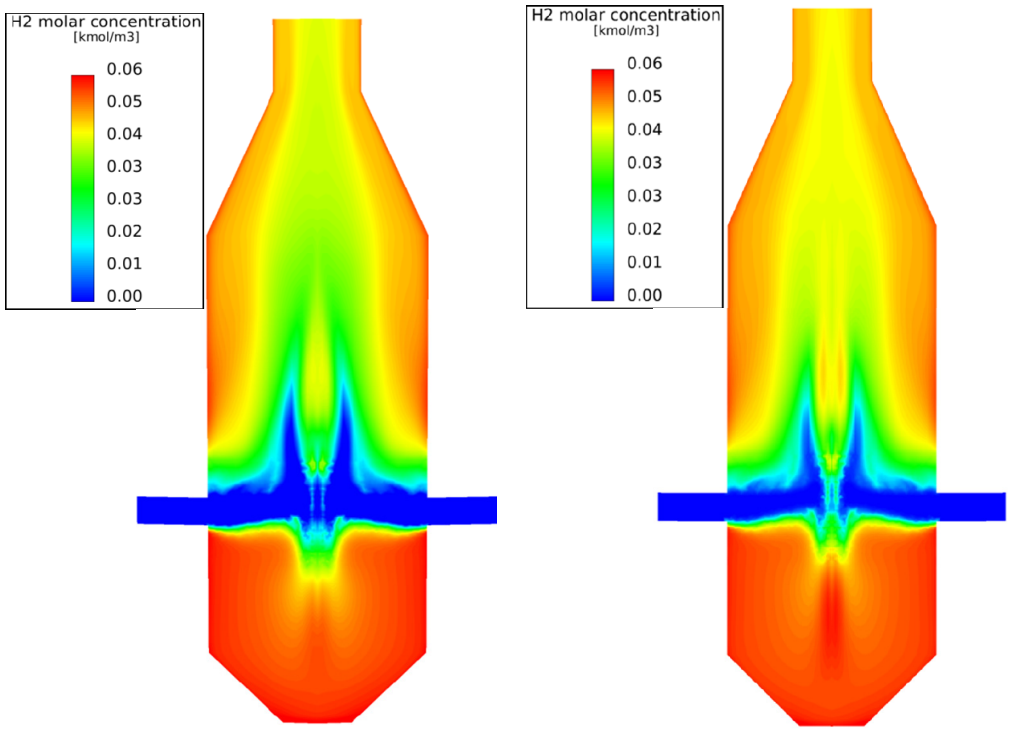
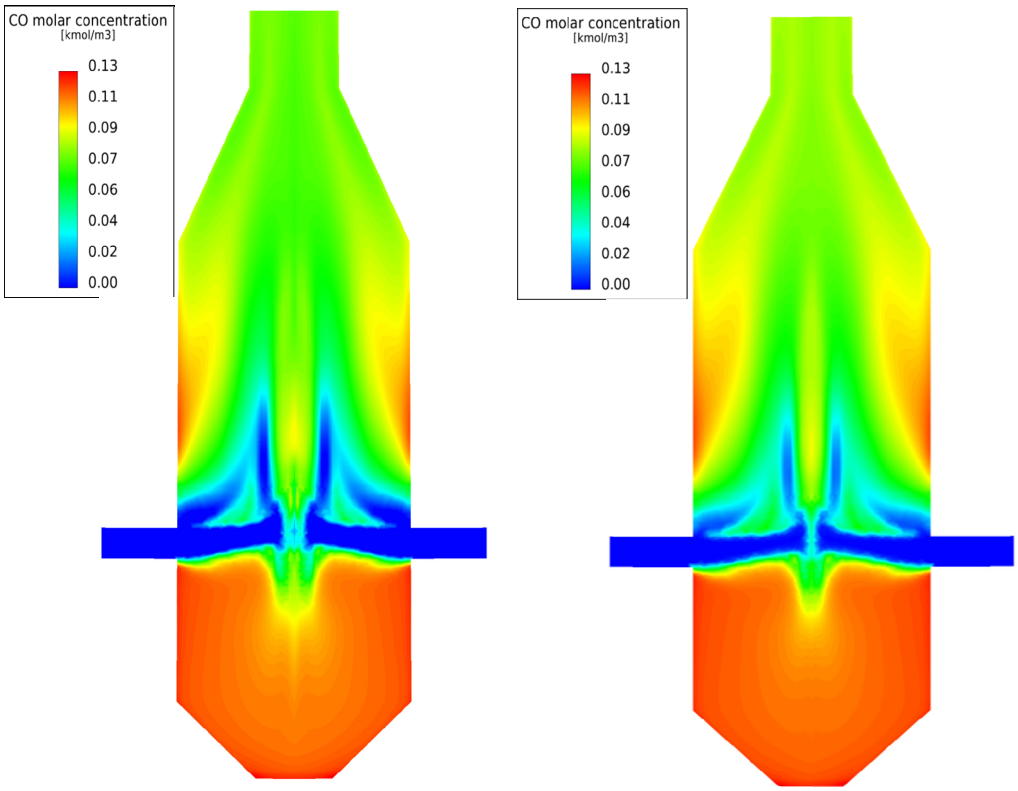


Figure S1. Distribution of temperature for DO and P-1 radiation model. (**a**) DO radiation model; (**b**) P-1 radiation model.



(**a**) (**b**)

Figure S2. Distribution of H2 molar concentrations for DO and P-1 radiation model. (**a**) DO radiation model; (**b**) P-1 radiation model.

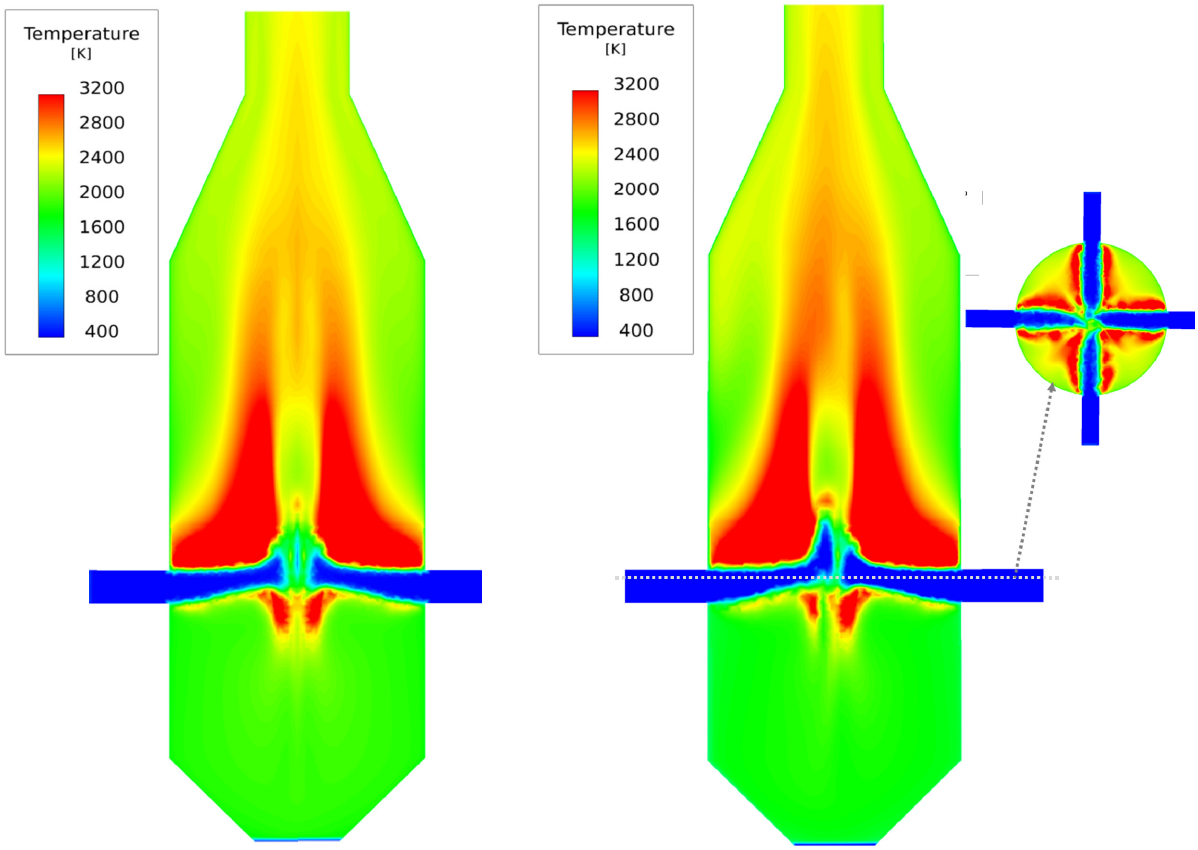


(**a**) (**b**)

Figure S3. Distribution of CO molar concentrations for DO and P-1 radiation model. (**a**) DO radiation model; (**b**) P-1 radiation model.

2. Drayton Coal

For Drayton coal, CFD calculations were carried out using meshes considering the 1/4 periodic and whole geometries of the gasifier. The DO radiation model was used. For example, the comparison was made in Figures S4–S6 for distributions of temperature, H2 molar concentration, and CO molar concentration.



(**a**) (**b**)

Figure S4. Distribution of temperature for 1/4 periodic and whole geometries. (**a**) 1/4 periodic geometry; (**b**) Whole geometry.

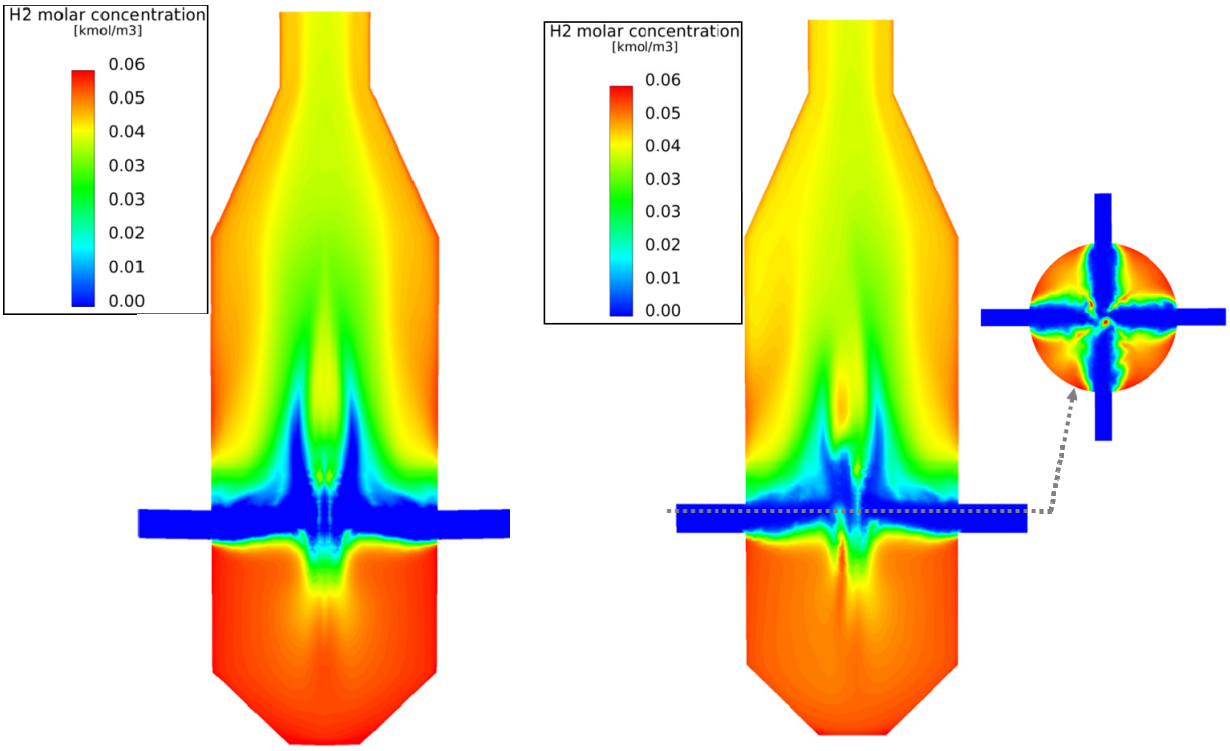


Figure S5. Distribution of H_2 molar concentration for 1/4 periodic and whole geometries. (**a**) 1/4 periodic geometry; (**b**) Whole geometry.

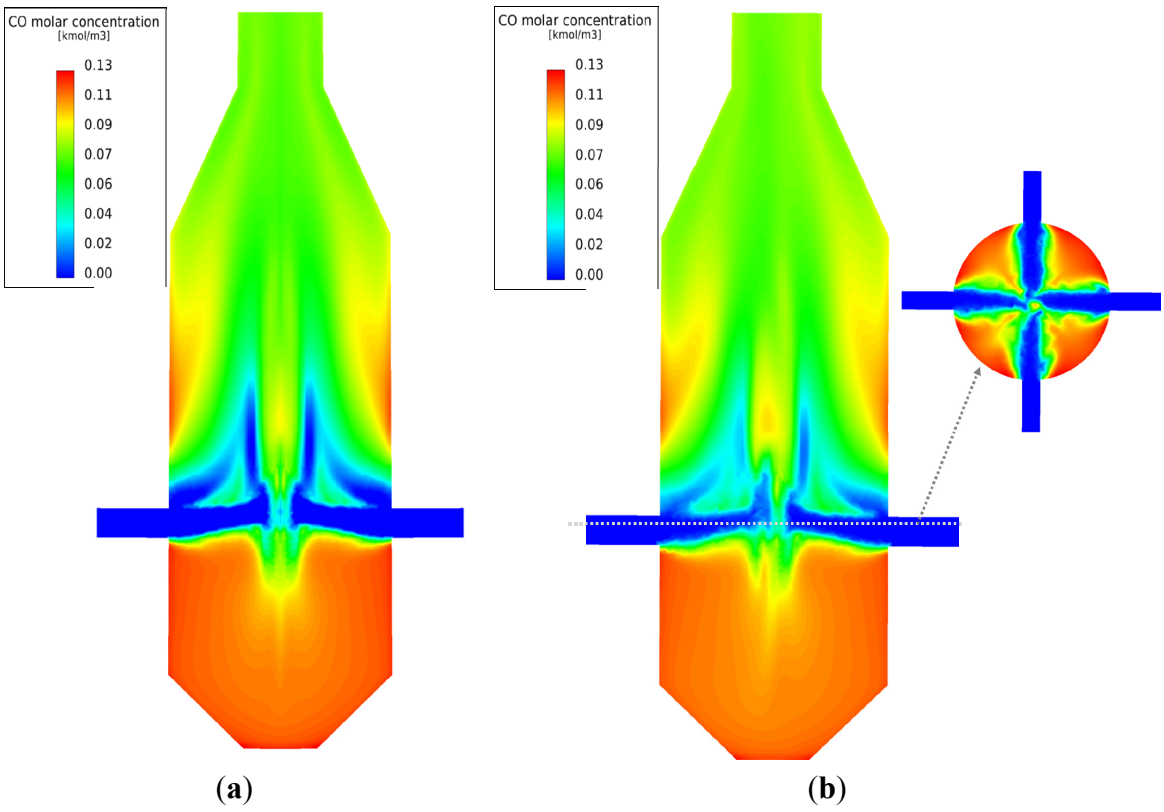


Figure S6. Distribution of CO molar concentration for 1/4 periodic and whole geometries. (**a**) 1/4 periodic geometry; (**b**) Whole geometry.

Table S2. Comparison of the CFD results of 1/4 Periodic geometry with CFD analysis result of whole geometry.

Contents	CFD Calculation Results (1/4 Periodic Geometry)	CFD Calculation Results (Whole Geometry)
CO (%)	62.96 (34.19 kg/s)	62.09 (34.08 kg/s)
H_2 (%)	29.23 (1.10 kg/s)	29.54 (1.24 kg/s)
CO_2 (%)	2.62 (2.23 kg/s)	2.38 (2.20 kg/s)
N_2 (%)	4.35 (1.13 kg/s)	4.29 (1.08 kg/s)
Others (%)	1.84 (1.72 kg/s)	1.71 (1.68 kg/s)
Temperature (K)	2068.65	2089.79
CGE (%)	78.29	78.21
CCE (%)	99.63	99.59
Operating conditions	Feed rate of coal: 21.86 kg/s O_2/coal ratio: 0.885 Steam/coal ratio: 0.071 N_2/coal ration: 0.044	

3. Illinois #6 Coal

For Illinois #6 coal, CFD calculations were carried out using meshes considering the 1/4 periodic and whole geometries of the gasifier. The DO radiation model was used. For example, the comparison was made in Figures S7–S9 for distributions of temperature, H_2 molar concentration, and CO molar concentration.

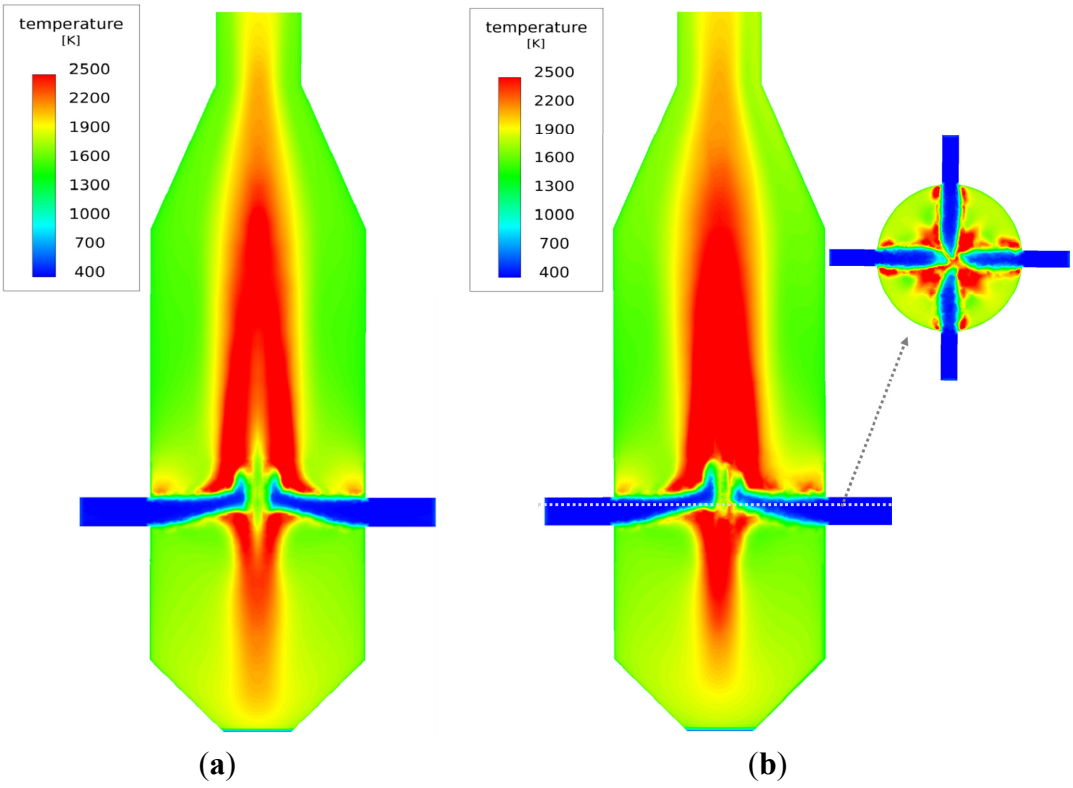


Figure S7. Distribution of temperature for 1/4 periodic and whole geometries. (**a**) 1/4 periodic geometry; (**b**) Whole geometry.

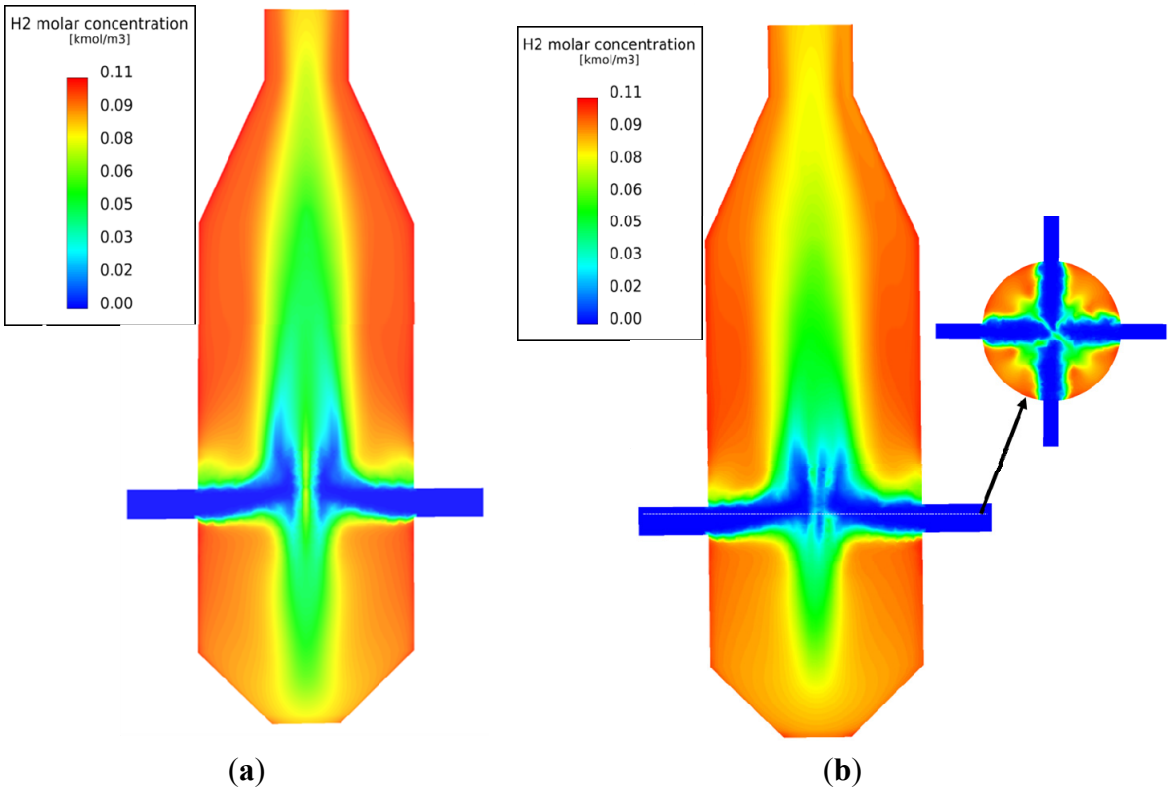


Figure S8. Distribution of H_2 molar concentration for 1/4 periodic and whole geometries. (**a**) 1/4 periodic geometry; (**b**) Whole geometry.

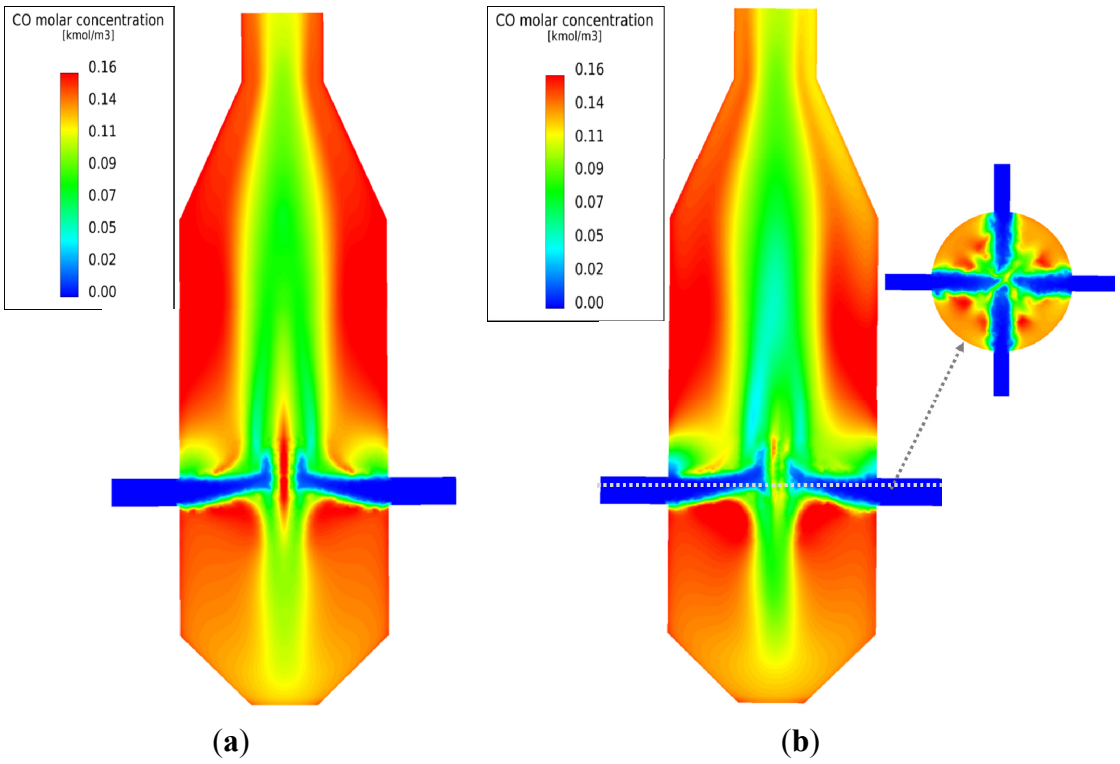


Figure S9. Distribution of CO molar concentration for 1/4 periodic and whole geometries. (**a**) 1/4 periodic geometry; (**b**) Whole geometry.