Dynamic modeling and simulation of membrane wall of Shell entrained flow gasifier in IGCC

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The Shell coal gasification system is a single-stage, up-flow, and dry-fed gasifier, which adopts an entrained-flow mechanism. Moreover, it operates in slagging model, and its wall comprises a membrane wall structure. In this work, a dynamic model of Shell gasifier is developed as a part of an IGCC process simulation. The model is simplified with several sub-models, such as volatilization zone, reaction zone, slag zone, and membrane wall zone. Especially, a new form of wall structure was applied in order to outline its structure and heat transfers between wall layers in membrane water tubes. Membrane wall zone model is an important part in the gasifier, since MP steam is generated as saturated water at 54 bar. Therefore, the model was divided into three sub-models: castable refractory wall, the membrane tube wall, and the water wall. In case of the two solid walls, a model with 1-D and 1-phase was used for simulation, whereas the water wall considered 1-D and 2-phase to calculate vapor fraction profile from the heat gain. All the equations describing each zone were solved simultaneously with gPROMS software. The vapor fraction in the simulated membrane wall was 0.2, which agreed well with reference values.