Numerical Modeling of Char Particles Segregation in Entrained-Flow Slagging Gasifiers

Fiorenzo Ambrosino[a], Andrea Aprovitola[b], Francesco Saverio Marra[b], Fabio Montagnaro[c], Piero Salatino[d]

[a]*ENEA - Agenzia Nazionale per le Nuove Tecnologie, l'Energia e lo Sviluppo Economico Sostenibile, CR Portici, Piazzale Enrico Fermi 1, 80055 Portici (Italy)*

[b]*Istituto di Ricerche sulla Combustione, Consiglio Nazionale delle Ricerche, Via Diocleziano 328, 80124 Napoli (Italy)*

[c]*Dipartimento di Chimica, Università degli Studi di Napoli Federico II, Complesso Universitario del Monte di Sant'Angelo, 80126 Napoli (Italy)*

[d]*Dipartimento di Ingegneria Chimica, Università degli Studi di Napoli Federico II, Piazzale Vincenzo Tecchio 80, 80125 Napoli (Italy)*

This work illustrates how different numerical modeling approaches can be complementarily adopted to gain the knowledge necessary to explain the observed segregation/entrapment of char particles on/into the molten slag layer in full-scale entrained-flow slagging coal gasifiers *[1–6]*. A multi-level approach is being developed: RANS-based simulations of the full-scale geometry with coal particle injection and tracking aims to obtain the general features of the flow field and the particle trajectories, allowing to estimate the effect of swirl and turbulence on the char particle deposition rate *[7]*.

These results are adopted in two different subsequent models: a reduced plug-flow based model of the full-scale geometry and a more detailed model of a particle-laden channel flow confined by a slag layer. This last model, based on the solution of the filtered Navier-Stokes equations, is solved with the adoption of the OpenFOAM toolkit *[8]*. An LES approach for the turbulent Eulerian gas phase is applied *[9]*. The equations of particles motion are solved via a Lagrangian particle tracking algorithm with the TrackToFace method *[10]*. Simulations have been performed involving a number of particles from 10^5 to 10^6, which is considered sufficient to obtain a clear picture of the multiphase flow behaviour responsible for char deposition phenomena *[11,12]*. This multi-level approach allows to assess the char particle deposition rates and the nature of char/slag interaction (segregation/entrapment) that are likely to occur in full-scale slagging gasifiers.

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