Utilizing simulations to guide furnace designs for the E-Iron™ Nugget process

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Need

- **Carbontec Energy Corporation** has developed a novel iron smelting process that, as proven in an extended pilot operation, can produce high quality pig iron nuggets on a continuous basis
  - Can convert both iron ore and steel mill wastes into low sulfur iron nuggets
  - Utilizes biomass reductants in place of coke
- Carbontec is moving forward to construct a plant that will produce 100,000 tonnes/yr of pig iron grade nuggets
  - We are modeling the core nugget process to provide a tool to assist in the final design of the production plant by avoiding pitfalls in the joining of the core process with production infrastructure

Approach

**Carbontec E-Nugget Process**

- Iron ore and biomass are blended and pressed into briquettes
- Briquettes are fed through multiple temperature zones of a linear furnace
- The iron ore and biomass run through a series of chemical reactions and the iron ore is reduced to iron
- The metallic iron then flows from the briquettes and pools into nugget sized pieces
- The resulting material is cooled tumbled and the iron nuggets are magnetically separated

**E-Nugget Process Simulations**

- Star CCM model of experimental process
  - Models include multiphase solid/gas flow, radiative and convective heat transfer, and 16 reaction chemistry model
  - 2D and 3D simulations on up to 512 CPUs
  - Temperature varied for different furnace zones
- Model validated against experimental data

Results (continued)

- Simulations were run on 4 experimental cases
  - M-11 was run at higher temperatures (1600K) and had a full yield of Fe
  - S-02 was run at higher temperatures (1600K) and utilized different ore and flux conditions and yielded ~50%
  - M-12 and S-04 were run at lower temperatures (1300K) failed to yield Fe did not yield metallic Fe

**Benefits**

- Process replaces coke in iron smelting
  - First plant will displace 90M lbs coke/yr*
  - Converting coal to coke requires 1.75-2.5 MJ/lb**
  - If 5% of US iron production were produced with this approach, 2 PJ/yr of energy could be saved by reducing coke needs by 1 billion lbs
- E-Iron™ nuggets are good feedstock for electric arc and BOF furnaces
  - 96.5% Fe, 2.9% C, 0.017% S

*2014 AIST average coke rate is ~900lbs/NTHM
**2007 IEA Tracking Industrial efficiency... p110

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