

Computational fluid dynamics of low temperature furnace for continuous carbonization of carbon fiber

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Carbon fibers (CF) are often produced from polyacrylonitrile (PAN) fiber precursors with several heating processes such as stabilization, carbonization, and graphitization. The PAN fiber is first stabilized by oxidation in a temperature range of 200–300 °C (Rahaman et al., 2007). Then, the fiber is carbonized in an inert ambience with two steps: low (400–900°C) and high (900–1500 °C) temperature carbonizations. The low temperature furnace (LTF) comprises electrically heated multi-zone slots, purged with N₂ to prevent ingress of air and providing sufficient N₂ flow to remove exhaust gases. The flow uniformity and consistent temperature over the CF tows play an important role in the low temperature carbonization process. This work aimed to understand hydrodynamics of the continuous CF carbonization process, using a three-dimensional computational fluid dynamics (CFD) model with the porous moving reference frame. Hydrodynamics of LTF were identified in terms of the velocity, pressure and dead-zone of gas flow inside the furnace. The CFD model was further used to investigate operating conditions which reduce dead zones of gas flow and achieve a uniform temperature distribution.