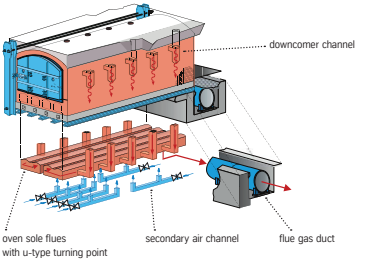
Research on Process Technology of Heat Recovery-Coke Ovens

Dr. Ronald Kim[1], Dr. Patrick Schwöppe[1], Dr. Rafał Buczyński[2]

1) ThyssenKrupp Industrial Solutions AG (TKIS), BU Process Technologies, Coke Plant Technologies/Coke Oven Plants, 44141 Dortmund, Germany
2) Technical University Clausthal, Institut für Energieverfahrenstechnik und Brennstofftechnik, , 38678 Clausthal, Germany

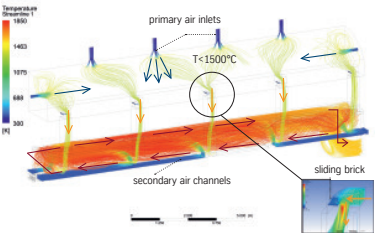
Objektives

TKIS-PT has decided to validate and broaden the design criteria for heat recovery-technology with an in-depth theoretical investigation of the process using various mathematical models [1]. In order to achieve short gross coking times and optimized design regarding cross sections/location of air inlets as well as downcomer channels with respect to an even surface heating of the cake, a complex 3D-flow and staged combustion model was designed based on a Computational Fluid Dynamics (CFD)-Analysis using FLUENT-software.

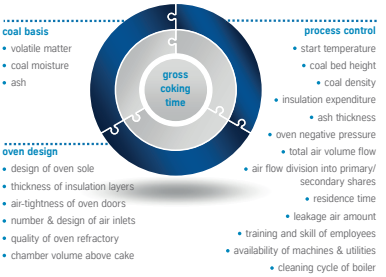


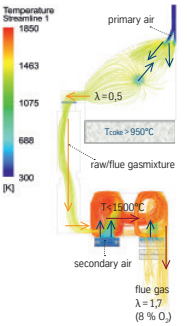
Results

The CFD-Analysis enabled the mixing and combustion process within the oven chamber and sole flues to be observed through graphical animation and led to an evolutionary improvement in understanding of mixing and combustion laws within the combustion chambers of the oven. The model enable the limits of application for this coking technology to be worked out with respect to important process parameters like gross coking time and characteristic temperature/pressure profiles in the upper and lower parts of the oven, taking into account full process and geometric coupling between the upper and lower oven parts.



Influences on gross coking time





CFD - Simulation and parameter variations result in optimization of:

- position of downcomer channels in oven length direction
- design and cross section of primary and secondary air inlets
- design and arrangement of secondary air channels beneath ovens sole flues
- design and cross section of U-type turning point of sole flue channels
- position of sliding bricks
- required negative pressure within the flue gas duct in front of the ovens to avoid emissions out of the primary air inlets
- instruction for adjustment of primary/secondary air flow quantities at the correct points in time

Conclusions

Based on the investigations described TKIS-PT has optimized the overall design and process control of its heat recovery-coke oven technology, evolutionally, resulting in uniform heat flux distribution both above and below the coal/coke-charge. It is associated with short gross coking times of less than 58 hours using compacted coal charges of 1 m height with a density of ≈1100 kg/m^3, thus guaranteeing high process efficiency and low investment costs, simultaneously. In addition, the optimized design and the adjustment of cross sections of secondary air inlets at correct points in time avoid melting processes of refractories within the oven sole flue channels, ensuring long oven life time without repairs. Moreover, the new door design certifies air-tightness, thus avoiding door-resealing of gaps between door and oven front after charging and, therefore, loss of process control caused by unwanted primary combustion just behind the oven doors. Furthermore, linked to a three-shift operation and a distinctive pushing schedule the new duct design promises low flue gas flow fluctuation at the boiler inlet of < ± 5%, respect. high steam production.

Reference: [1] Ronald Kim, Ein Prozessmodell zur Kokserzeugung mit direkter Beheizung, Ph.D. Thesis, Clausthal University of Technology, 2010