# Heat Transfer Characteristics of Industrial Drying Systems for Roll-to-Roll Converting Processes

**Vivek Dhaka and Florian Lemm**

*Kroenert GmbH & Co KG, Hamburg, Germany*

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Impinging jets of hot air are widely used in convection dryers for efficiently transferring thermal energy to the coating system and transporting evaporated solvent away from the product. The jet flow is achieved by supplying an array of nozzles with a high-pressure blower system. The present study investigates into the local heat transfer characteristics and visualization of submerged jet flow formed under an array of floatation nozzles with two slot openings inclined towards each other. The measured heat flux data is utilized to correlate local Nusselt number (Nu) to the geometrical parameters associated with the nozzle system at Reynolds number (Re) ranging from 3500 to 15000. It is concluded that an increment of Re leads to a higher Nusselt number. The similar trend in Nu is observed with a lower pitch and a wider slot. Furthermore, the flow behavior is simulated with 2D SST (steady), 3D $v^2f$ (steady) and 2D LES (transient) turbulent models. A good agreement is found between the experimental local Nu profile and that predicted by SST and $v^2f$. However, among the three models only transient LES seems to present a realistic flow pattern as the other two are unable to fully capture turbulence. According to Zuckerman et al. [1] the jet flow is comprised of three main regions, i.e. the free (core) jet, stagnation region and wall jet, which is confirmed by flow measurements performed using particle image velocimetry (PIV) technique as shown in Figure 1. The flow is perceived to possess significant turbulence even at Re 3500.

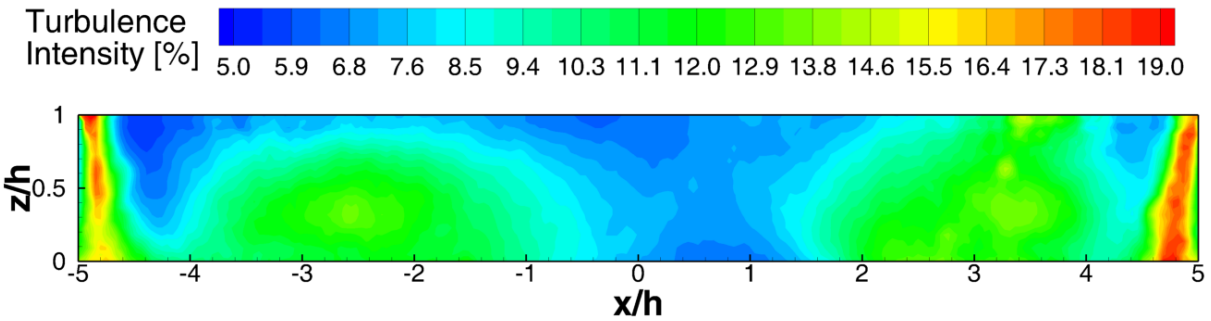


*Fig. 1: Turbulence field under the nozzle at Re 6200. The left and right slot jet are located at x/h = -5 and 5*

**References**

1. N. Zuckerman and N. Lior, *Adv. In Heat Transfer* **39**, 565-631 (2006)

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