Intermittent Impinging Jet Drying

Impinging jet drying

Impinging jet drying is one promising method to improve drying rate due to its higher heat and mass transfer rates. However, impinging jet drying has certain drawbacks: high energy consumption compare to traditional parallel flow drying and not suitable for highly sensitive materials due to over-heating.

Hence, it is necessary to match the energy demand for drying, as governed by drying kinetics, with the external supply of heat. It can be achieved by supplying heat to the drying process concurrently or sequentially according to the needs of the drying application; for example, pulsating and intermittent flow.

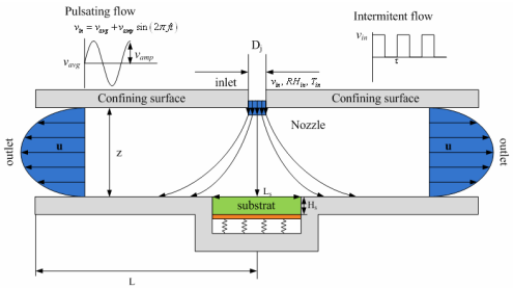

Figure 1. Schematics of impinging jet drying

This study investigate the performance of impinging jet drying using pulsating and intermittent flow rather than the conventional steady jets.

Mathematical model

A mathematical model for drying air and drying substrate is developed, taking into account the following mechanisms: moisture diffusion from the inner drying substrate towards its surface, conductive heat transfer within the drying substrate, evaporation and convection of the vapor from the surface of the drying substrate into the drying air, convection heat transfer from drying air to the surface of the drying substrate.

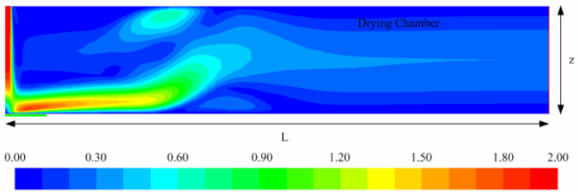

Figure 2. Velocity contour of impinging jet drying chamber

Drying kinetics

For the particular cases, the effect of inlet velocity is not significant. It is most likely due to the small thickness of the drying substrate. Similarly, pulsating frequency has minor effect to the drying kinetics. Moreover, implementation of pulsating and intermitent jet slightly extend drying period. It should be noted, however, that this method requires only half of the energy consumed by steady jet.

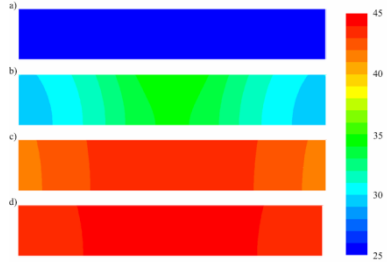

Figure 3. Temperature contour of impinging jet drying substrate

Overall, pulsating and intermittent impinging jet offer energy saving as compared to steady jet and it provide sufficiently good drying kinetics

Further study is underway to investigate various parameters; i.e., substrate thickness, effect of flipping, utilization of phase-change material thermal storage, waste heat recovery, multi-jet impingement, hybrid parallel and impinging jet, etc.

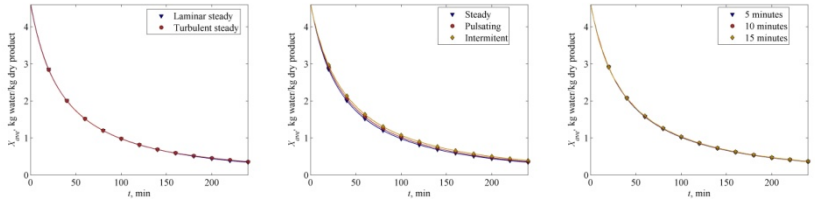

Figure 4. Effect of: a) inlet velocity, b) impingement and c) inlet frequency to the drying kinetics

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