The Throughflow Principle - the Efficient Way of Heatsetting Felts and Fabrics

There are two different principles in use today for heatsetting of felts and fabrics by hot air:

- Impingement
- Throughflow

In impingement systems, air is blown on to the surface of the product from linear slots. The air flows along the surface for some distance before being evacuated through exhaust ports. Impingement systems may treat just one face of the product, or both. In the latter systems, air will be provided symmetrically to both faces of the product. Due to the symmetry, the air flows will balance each other, and there will be no flow of air through the product.

In throughflow systems, as Air Through and Air Through Compact, the pressure difference generated by the opposing pressure and suction zones forces air through the product. The amount of throughflow will depend on the permeability of the product, but even for the densest pick-up felts some air will flow through. Our customers have reported that felts having a permeability as low as 6 cfm have been treated successfully in these systems.

Laboratory research, and tests in actual heatsetting systems treating permeable products, have shown that throughflow systems achieve higher production capacity than impingement systems, given that the pressure slot patterns and the air velocities are equal. There are two reasons for this capacity increase.

The most obvious is that air flowing through the fabric increases the contact surface between the air and the fibres, as the air passes through.

The increase in surface exposed to heat transfer results in a faster heating of the fabric, and thus increased capacity.

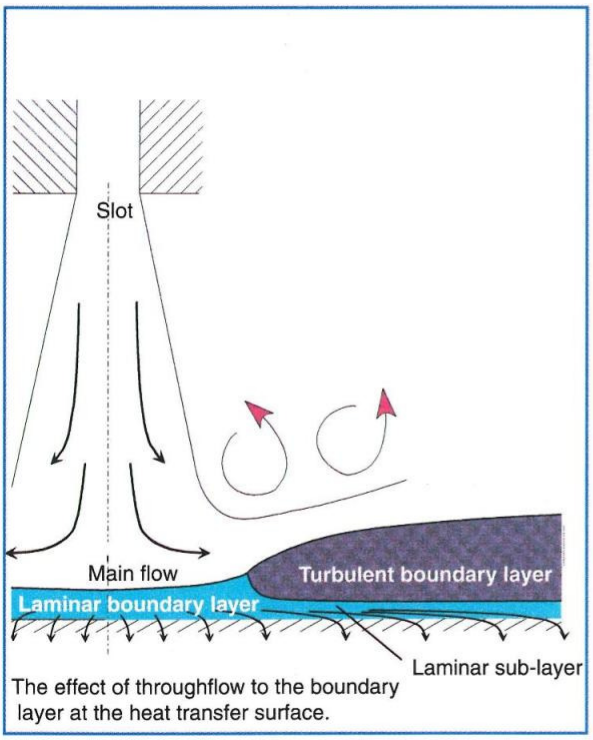
The second reason has to do with the flow pattern at the surface of the product, as shown in the figure below. When the jet of air from the slot hits the surface of the fabric, it is deflected and flows sideways.

The air closest to the surface, known as the boundary layer, will flow linearly along the surface without any turbulence (laminar flow).

The heat transfer rate to the fabric depends strongly upon the thickness of this laminar boundary layer, because the heat from the main flow of air can only reach the surface by thermal conduction through the boundary layer. So, the thicker the layer, the lower the heat transfer to the product, and the lower the capacity of the heatsetting system.

The thickness of the boundary layer is reduced if the air velocity in the main flow increases. Thus, a reduction in the slot/fabric distance, or increased air flow through the slot, results in increased heatsetting capacity.

If the fabric is permeable, and if a pressure difference is generated through the product by the heatsetting system, air will flow through the fabric. The air which penetrates the fabric will be the air which previously flowed along the surface of the fabric. This implies that air from the boundary layer will pass through, enabling hotter air from the main flow to reach the surface. In this way, the throughflow will reduce the thickness of the laminar boundary layer, and increase the heat transfer to the fabric.



The effect of throughflow to the boundary layer at the heat transfer surface.