Thermal Contact Resistance of Metal Roller to Plastic Web Interfaces

by

EDWARD D. LIGHTBOURN

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ABSTRACT

Heated rollers are used in the forest product, printing and plastic processing industry to regulate product temperature during web processing. Improved regulation of product temperatures during processing results in a higher quality product as well as reduced waste and energy usage. This project leads to better understanding of the thermal contact resistance and the thermal interactions between heated plastic webs and rollers.

A new experimental method to measure the contact resistance between the two surfaces of one rigid and one pliable material is developed and used to measure the thermal contact resistance of a different plastic web to roller interfaces. Two blocks, initially at different temperatures, are brought together with the sample being studied between the blocks. The resulting time temperature profile can be used to determine the joint contact resistance. The physically static, thermally transient technique allows joint resistance measurements to be made quickly and easily using minimal equipment. The average joint resistances measured for the polyester, polypropylene and embossed polyethylene samples were 0.0006, 0.0007 and 0.0028 m^2-K/W respectively over a pressure range of 0.25 to 6 kpa.

A finite difference model of the web and roller system was used to model the heat transfer between rollers and webs. Given the required roller and web inlet conditions, the program could calculate the web outlet temperature and power draw from the roller.
The roller model was developed with following intentions and results:

1. To simulate an internally heated roller as well as a roller having surface heat generation. Little difference was found in the surface temperature profiles of the differently heated rollers, but for the internally heated roller case, the hot fluid supply temperature needed was substantially higher than the actual roller surface temperature.
2. To develop a simple algebraic correlation that predicts the web heating effectiveness for thin webs accurately. This was achieved for plastic webs of less than 0.30 mm thickness over a wide range of processing conditions.
3. To calculate the roller to web interface contact resistance based on measured web inlet, outlet and roller surface temperatures. A series of tests with a pilot scale facility was used to determine the effect of air entrainment on the contact resistance.

The contact resistance measured in the static tests was then used to predict the web heating found in dynamic tests cases using the pilot scale facility. Infrared pyrometers were used extensively in the experiments and were the limiting factor in experimental accuracy. Good agreement was found for the opaque PVC sample within the experimental margin of error. For the highly translucent plastics, the static and dynamic tests did not show a good match, and the high error in the infrared temperature measurements was apparent.

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'Genius is 1 % inspiration and 99 % transpiration.'

-Lars Vicum.

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