PILOT PLANT TRIALS USING INNOVATIVE IR DRYING TECHNOLOGY (STIR®)

Extensive pilot plant trials investigated the influence of an STIR® emitter on paper properties and possible energy savings.

Method and speed of thermal dewatering (drying) have significant effects on paper properties and production costs. Aqueous coatings applied on or outside the paper machine (by spraying or film /metering size presses) require additional drying capacity. For reasons of space and energy efficiency, this extra capacity is often ensured by pre-drying using IR emitters. Conventional IR dryers work with short-wave emitters at wavelengths between 1 and 1,4 µm. More than seven years ago, the company IBT.InfraBioTech started developing infrared dryers based on a new principle: STIR® - selective transformed infrared. By now, this technology has been successfully implemented in various industrial applications.

When using infrared systems for thermal processing, it is important to optimally adjust the emission bands of emitters to the absorption characteristics of products being processed. Water and many synthetic materials are known to have their typical and most effective absorption bands at wavelengths between 3 and 6µm. STIR® emitters working at an emitter temperature of approx. 600 °C match the absorption characteristics of water and synthetics best at these wavelengths. By means of these emitters, drying times of wet coatings and adhesives could be reduced by up to 25 % as compared to conventional methods or manufacturer specifications.

IBT.InfraBioTech offers infrared modules based on STIR technology tailored to the needs of customers, complete systems including emitter, regulatory and control unit, and engineering services. The company has indicated its interest in implementing this drying technology also in paper coating. Practice-oriented pre-tests for this are hardly possible in the laboratory, and full-scale trials would be too expensive and time-consuming. The fibre technology pilot plant at PTS Heidenau offers a viable alternative for performing near-practical studies at low cost. IBT.InfraBioTech has therefore assigned PTS to test an STIR® emitter as compared to a conventional IR dryer. Data of the IR dryers used se below:

	Wavelength	Power output	Power per unit area
Conventional emitter	short-wave 1 – 1.4 µm	62.5 kW/m²	
STIR emitter	medium-wave 3 – 10 µm	62.5 kW/m²	20 – 80 kW/m²

Aims of the pilot plant trials at PTS Heidenau

The trials were intended to identify possible advantages of STIR® technology over conventional IR drying in the paper industry, and the conditions required for achieving these advantages. More specifically, the following information was to be gained:

- comparative assessment of specific drying rates as a function of coating media (water, starch suspension, polymer dispersion),
- comparison of surface temperatures achievable in the paper web, and
- comparison of influences on paper properties.

This know-how will lower the risk and cost of full-scale trials.

Test programme and methodology

The test programme elaborated jointly with IBT.InfraBio-Tech was comprised of the following steps and procedures:

- base paper production from virgin fibres and broke
  - o grammage of 80 g/m² and
  - o filler content of 24%,
- spray coating at 45% dry content,
- spray coating at 90% dry content,
- determination of dry contents before and after (calculation) spray coating, after IR drying and after the subsequent drying cylinder,
- measurement of web surface temperature after IR dryers
- calculation of specific drying performance and
- testing of papers on
  - o water absorption (Cobb60) and
  - o surface strength (Dennison wax test).

Application weights amounted to 1.5 und 3.0 g/m²:

- starch suspension of 100g/l
- polymer dispersion of 100 g/l
- adequate amounts of water as a reference.

Results

The results in Figures 1 to 6 show the influences of IR emitter type, coating medium and application weight on specific drying rate, web surface temperature and paper properties. The following conclusions can be drawn:

The type of IR emitter influences the specific drying rate, surface temperature and film formation of coating media. For spray coating at 45% dry content (about the same dry content as after wet pressing), the STIR emitter gives a 20 - 25°C higher surface temperature of the web (Figure 2) leading to improved film formation of coatings and, thus, surface strength (Figure 5). In the case of latex, the improved film formation also results in reduced water absorption (Figure6).

Medium-wave IR radiation (STIR) acts predominantly on the surface of the web, whereas short-wave radiation penetrates deeper into the paper structure causing it to dry "from within". Specific drying rates of starch- or latex-containing coatings are therefore higher with conventional dryers, whereas STIR emitters are more advantageous in the case of water because the water film dries directly on the surface.

At 90% dry content, drying removes only the amount of water introduced by the coating. STIR emitters give higher

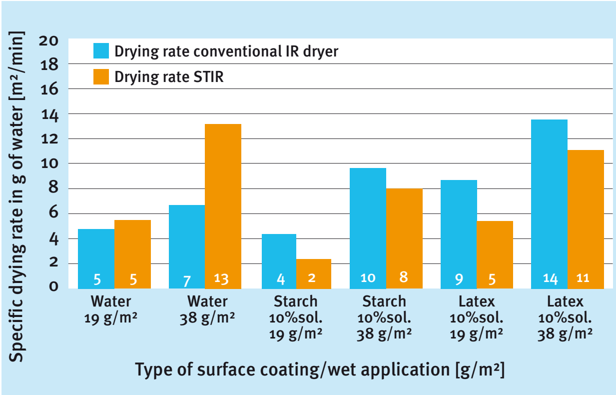

Figure 1: Specific drying rates of various types of surface coating at 45% dry content

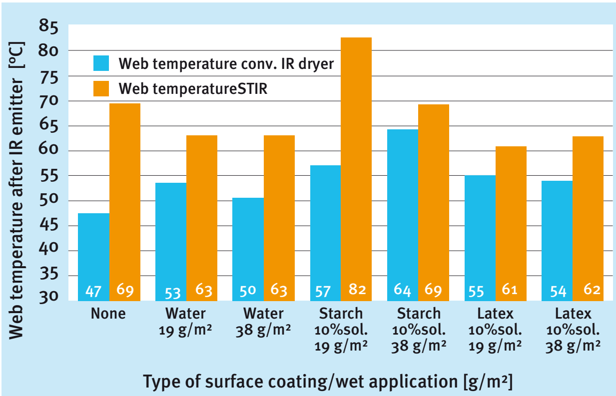

Figure 2: Web surface temperature of various types of surface coating at 45% dry content

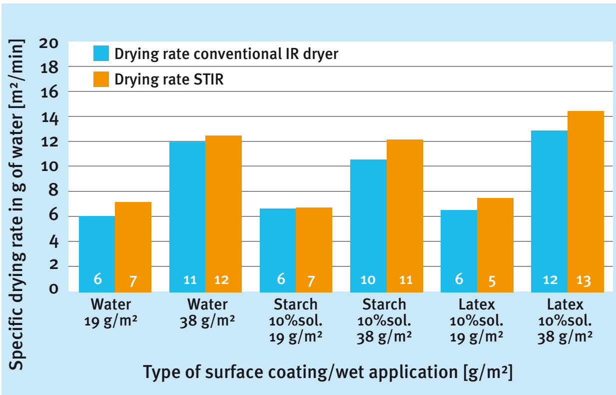

Figure 3: Specific drying rates of various types of surface coating at 90% dry content

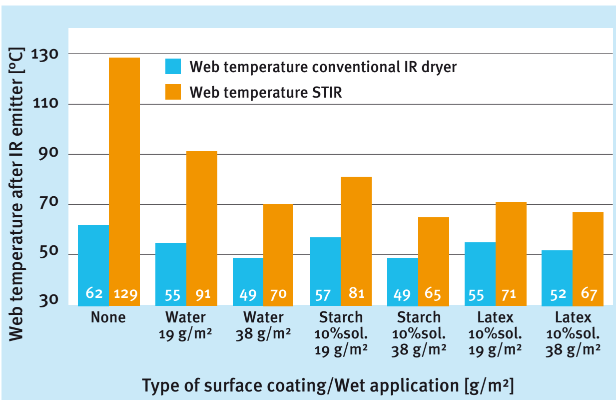

Figure 4: Web surface temperature of various surface coatings at 90% dry content

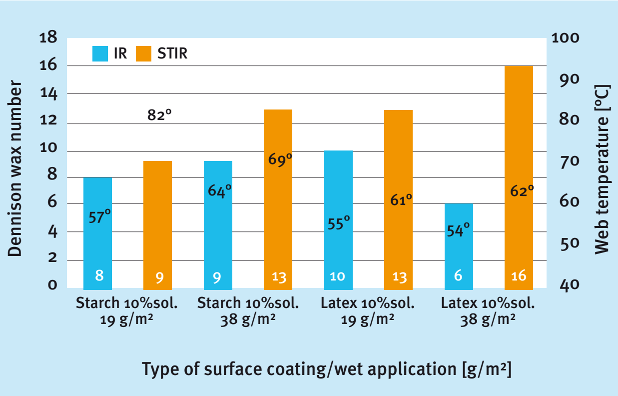

Figure 5: Surface strength of various surface coatings at 45% dry content

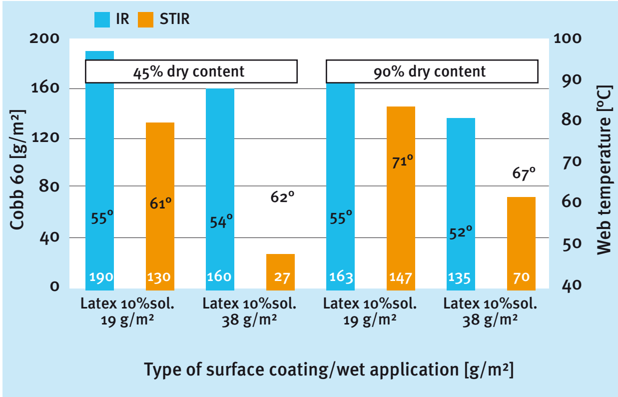

Figure 6: Water absorption of various surface coatings

specific drying rates in this case because their medium-wave IR radiation acts more intensely on the surface (Figure 3). As before, web surface temperatures achieved by the STIR emitter are approx. 20 to 25°C higher than those of the conventional emitter.

Surface strength is hardly influenced by web temperature at 90% dry content; strength levels are similar for both emitter types. Water absorption is noticeably influenced by emitter types, however (Figure 6): The density of latex films increases whilst water absorption decreases when using the STIR emitter.

Conclusions

IR drying of inline or offline coatings ahead of the subsequent drying cylinder offers several advantages.

The wavelength of emitters influences the specific drying rate, web surface temperature and, in the end, film formation and surface properties of coated paper. The dry content of paper web, type of coating medium and application weight are parameters which have an effect as well. Figure 9 summarises the results of the trials.

STIR emitters are advantageous if

- a high surface temperature of the web is desired. It leads to better film formation or cross-linking,
- water is to be evaporated from the surface, and
- coatings are to be dried which have been applied on dry paper (approx. 90% solids content).

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Type/concentration/application weight	Dry content of web before coating (%)	Specific drying rate difference IR-STIR emitter vs. conventional IR_emitter (g Water/m²/min)	Specifc drying rate difference IR-STIR emitter vs. conventional IR_emitter (%)	Average temperature increase conventional emitter vs. STIR (factor)	Change in water absorption Cobb 60 as compared to conventional emitter (g/m²)	Change in Dennison wax strength number as compared to conventional emitter (number)
None	45	-2.2	-43	1.83	n.b.	1
Water 19 g/m²	45	0.7	15	1.26	n.b.	-1
Water 38 g/m²	45	6.5	98	1.40	n.b.	0
Stärke 10%sol. 19 g/m²	45	-2.0	-46	1.75	n.b.	2
Stärke 10%sol. 38 g/m²	45	-1.5	-16	1.17	n.b.	4
Latex 10%sol. 19 g/m²	45	-3.3	-38	1.19	-60	3
Latex 10%sol. 38 g/m²	45	-2.4	-18	1.17	-134	10
None	90	0.0	-2	2.60	n.b.	0
Water 19 g/m²	90	0.8	14	1.94	n.b.	-1
Water 38 g/m²	90	0.7	6	1.68	n.b.	-1
Stärke 10%sol. 19 g/m²	90	0.3	5	1.55	n.b.	0
Stärke 10%sol. 38 g/m²	90	15.5	15	1.42	n.b.	1
Latex 10%sol. 19 g/m²	90	0.9	14	1.28	-17	0
Latex 10%sol. 38 g/m²	90	1.5	12	1.29	-65	0

Figure 7: Summary of results