Coating of polyester film with thin wax layers

Bruno Dätwyler

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Polytype Converting AG

CH-1701 Fribourg, Switzerland

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Summary

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- Introduction to Thermal Transfer Technology
- Ribbon Structure of the company **ARMOR**
- Range of Application
- Development of the Wax Coating Method
- Quality Requirements to **Polytype**
- Acknowledgement

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Abstract

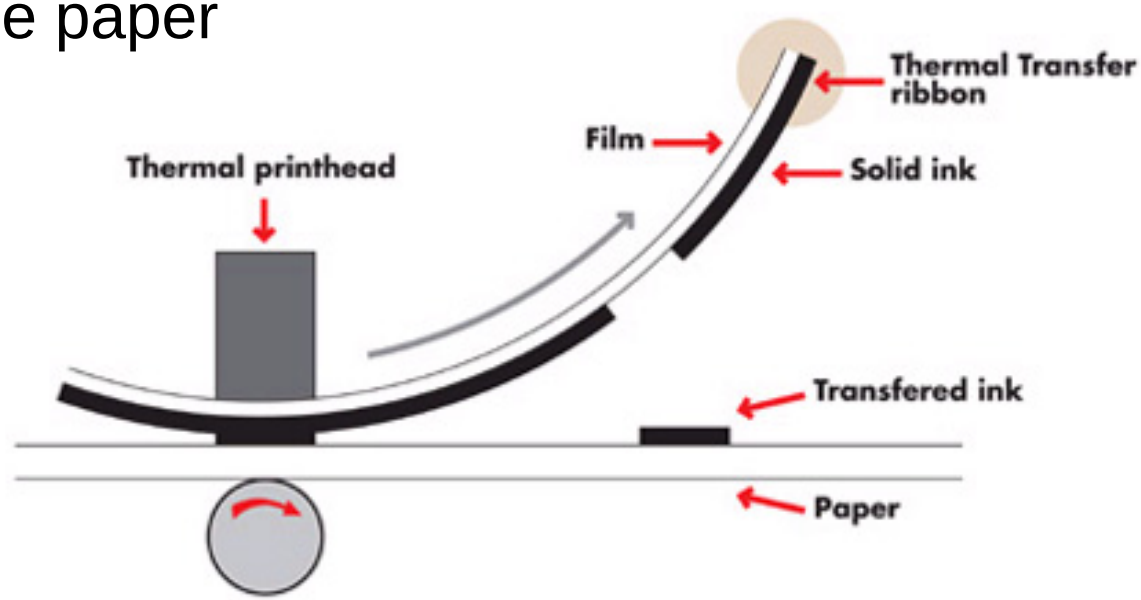
- Special applications require coating of thin layers of molten wax onto thin polyester films. The coating is approximately 1.5 micron thick on a substrate of 4.5 micron thickness. The standards for coating quality and uniformity are high. In the **Polytype** Pilot Plant we analysed several coating methods. Criteria related to quality as well as productivity, in particular the line speed, have been used for selecting the optimum coating method.

Introduction to TT Technology

- History:
  - Thermal transfer is a 20 year old technology
  - Thermal transfer was created by a Japanese company, originally for printing the Kanji characters
  - At the same time automatic identification with Barcode technology started up
  - Both direct thermal and thermal transfer technologies were perfectly adapted for printing Barcodes and text
  - The new technology was introduced in Europe by **ARMOR**

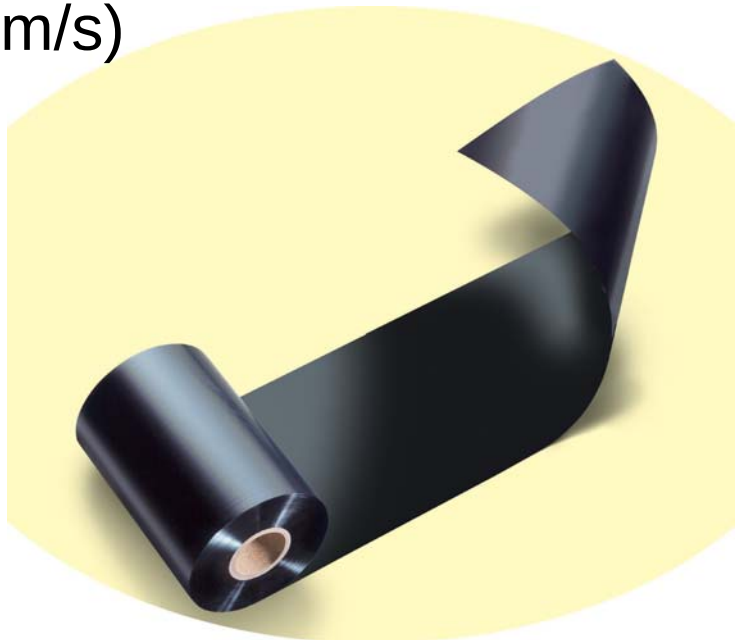
Introduction to TT Technology

- Working Principal:
  - To deposit by means of a heat source thermo fusible ink on a substrate
  - The ink, coated on a polyester film, is solid at ambient temperature. Under the heated print head the ink becomes fluid and is transferred from the film to the paper



Introduction to TT Technology

- Benefits:
  - Suitable for industrial environments
  - Low cost on demand printing
  - Ability to print on paper, film and textiles
  - Capability to print at high resolution
  - High speed printing (> 1000mm/s)
  - Large choice of ribbons



Ribbon Structure

- Structure:

  - The thermal transfer ribbon is a PET film upon which a thermofusible ink is deposited on one side and a protective layer called back coating on the other side.

Ribbon Structure

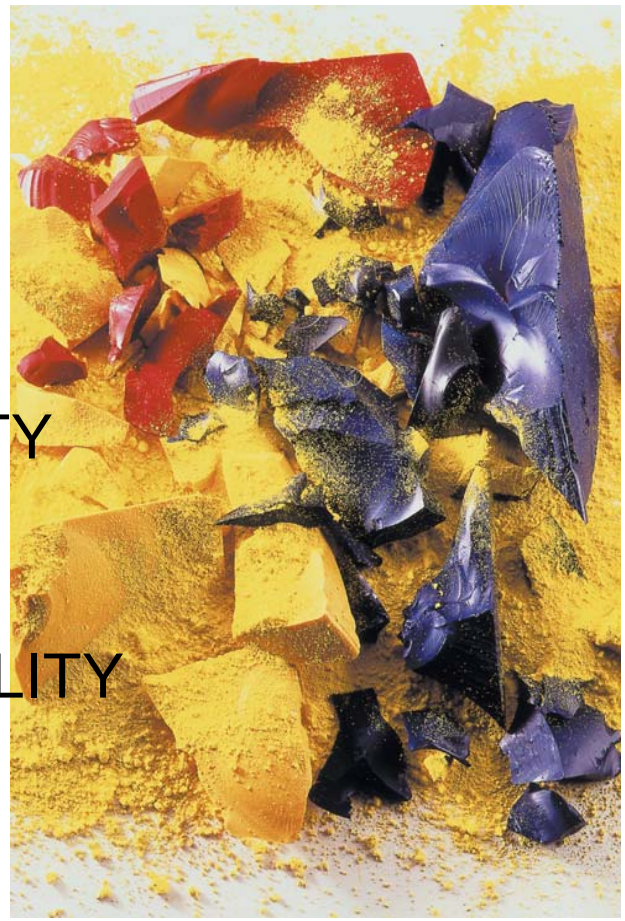
- The Back coating:
  - Non-abrasive (very low coefficient of friction)
    - Protects the print head
  - Helps to reduce static charging
  - Outstanding silicone based product
    - Perfect to avoid build up of dirt
  - Very high heat resistance
    - Prevents the film from burning
  - Thermal conductor
    - Favors an excellent ink transfer

Ribbon Structure

- The Carrier:
  - Characteristics
    - PET film
    - Thickness 3.2 – 5.0 µm
  - Mechanical features
    - High resistance to tearing
  - Thermal behavior
    - Good thermal conductivity
    - Very good heat resistance (melting point of film = 250°C)

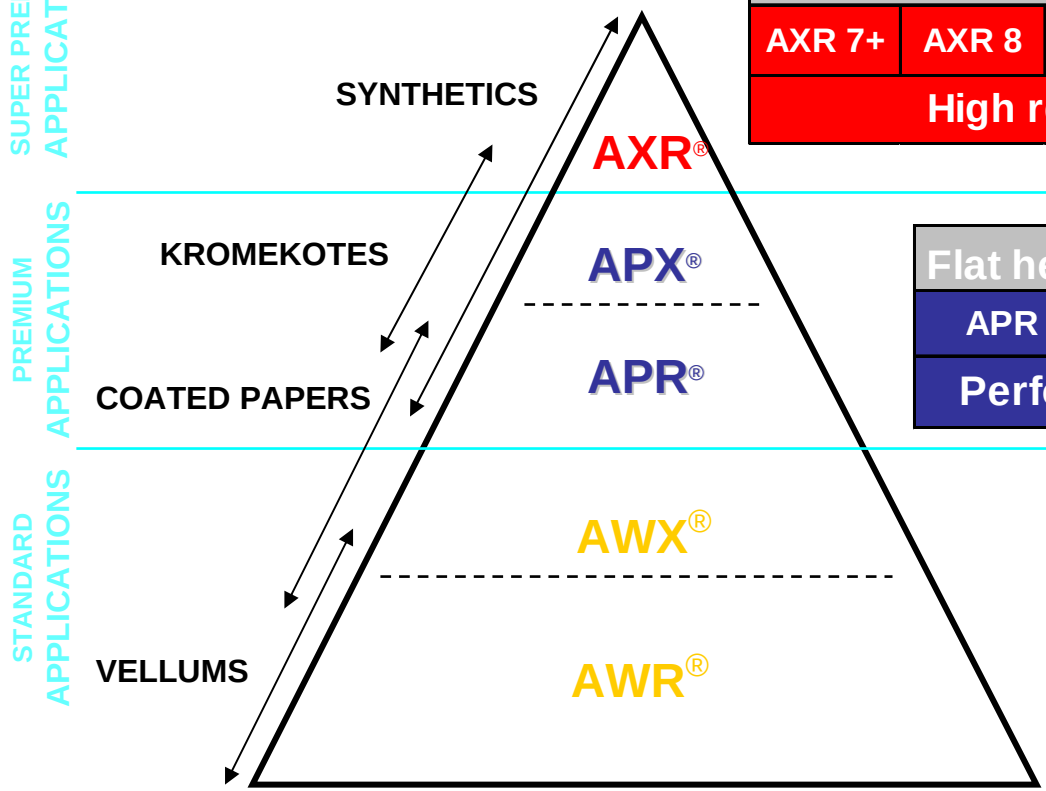
Ribbon Structure

- The Ink layer(s) in three qualities:
  - WAX ⇨ STANDARD QUALITY
    - Economy and quality
  - WAX-RESIN ⇨ PREMIUM QUALITY
    - Performance and multi-purpose
  - RESIN ⇨ SUPER PREMIUM QUALITY
    - High resistance and durability



Ribbon Structure

- The three Product families:



Flat head			Corner edge-Near edge		
AXR 7+	AXR 8	AXR 9	AXR 600	AXR 800	AXR 900
High resistance and durability					

Flat head	Corner edge-Near edge		
APR 6	APR 600	APR 700	APX 650
Performance and Multi-purpose			

Flat head		
AWR 210	AWR 470	AWX 500+
Economy and Quality		

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Range of Application

Range of Application

- Thermal transfer technology is used in the following areas:
  - Barcodes / Labeling / Automatic Identification
  - Flexible packaging (over printing)
  - Ticketing (railway and airline tickets, boarding pass)
  - Plastic cards (badges, driving license)
  - Plain paper fax
  - Signage / Banners

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Range of Application

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Range of Application

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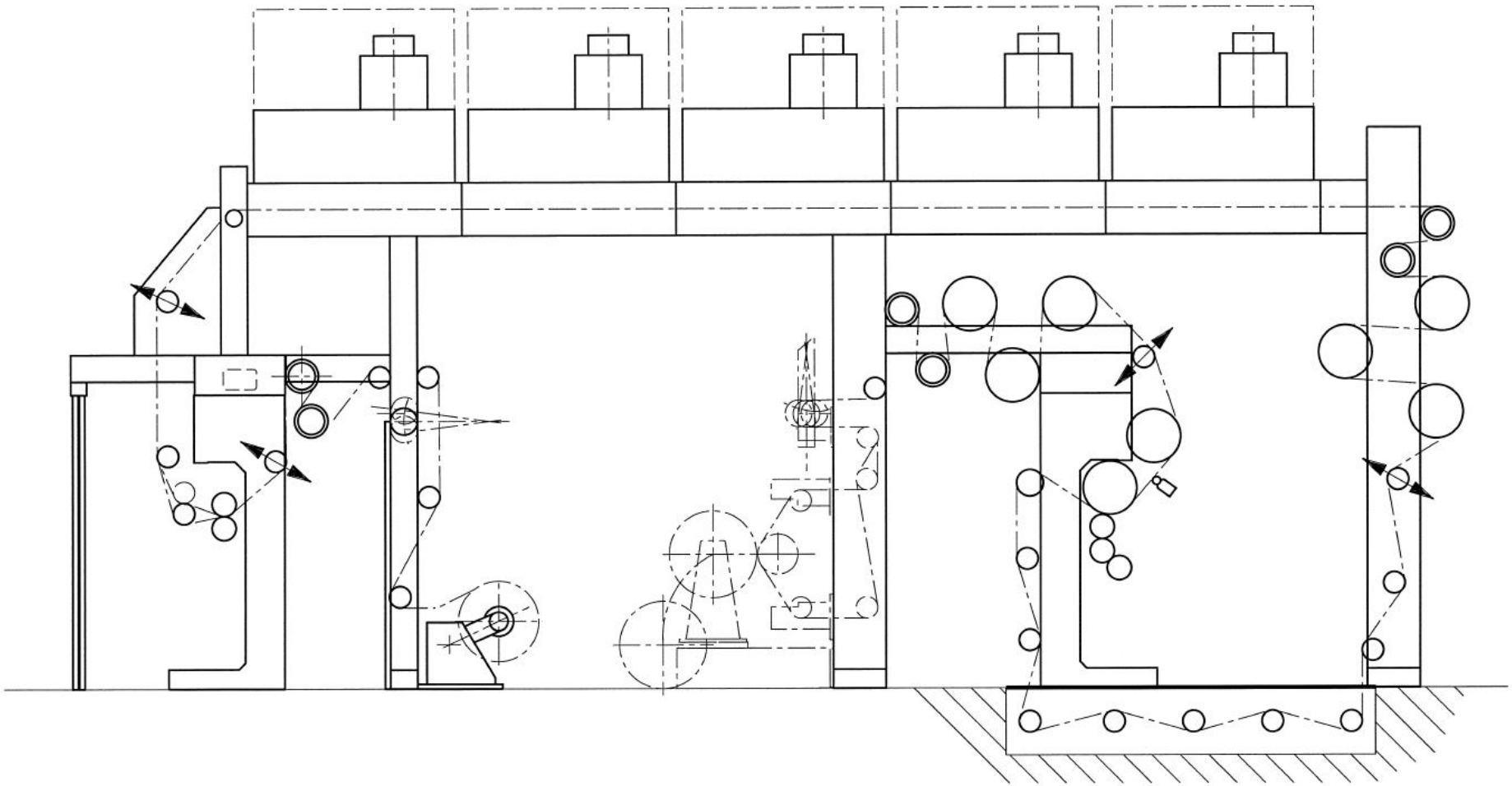
Range of Application

Development of the Wax Coating

- Since more than eight years the company Polytype works together with the company ARMOR. During this period of time Polytype executed serveral developments and created various product ideas. Thereby we could prove our competence and experience in coating very thin substrates at high production speeds. This was surely the main reason why ARMOR decided to purchase a coating line for thermo transfer film from us in the year 2001. The commissioning of this coating line was executed in the year 2002. This coating line has the following layout:

Development of the Wax Coating

Polytype Coating Line 2002



Development of the Wax Coating

- The layout above shows a coating line with two coating heads. First the back coating is applied. After the drying process in a guide roll dryer the second coating head applies a wax based ink layer. After the solidification of the wax via chill rolls the ribbon is rewound.
  From a customer point of view the leap forward in technology was the quite higher productivity of the new coating line. With a production speed of 250 m/min and a design speed of 300 m/min this coating line was running double the speed of the existing coating lines the customer had in his machine park.
  The applied coating processes were based on the experience of the customer and were integrated into the Polytype machine design. The wax coating is applied as follows:

Development of the Wax Coating

Wax coating

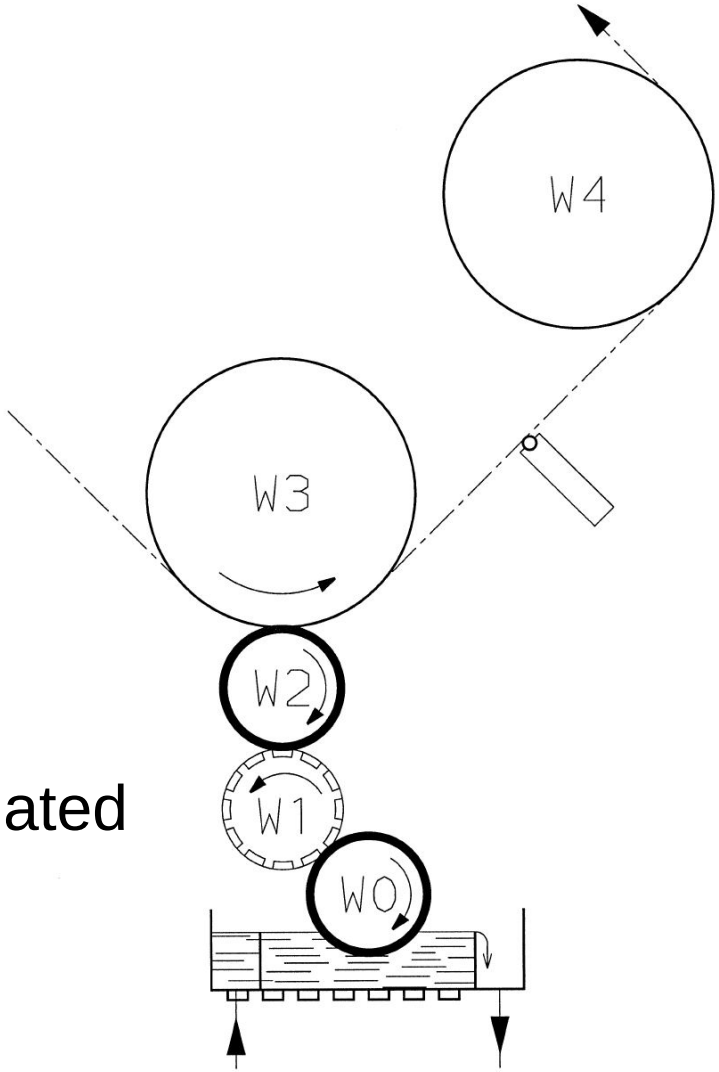
W0: Metering roll rubber coated

W1: Gravure roll

W2: Transfer roll rubber coated

W3: Backup roll steel chromium plated

W4: Chill roll



Development of the Wax Coating

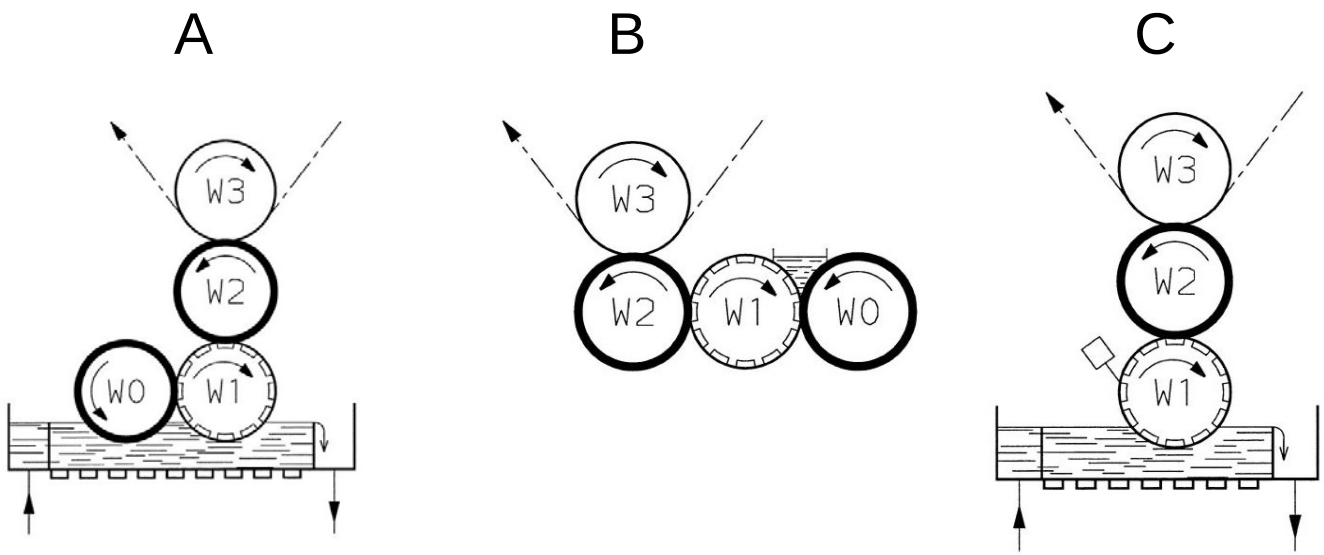
- It is well known that wax has a very narrow melting range and a relative low viscosity in molten condition. At a process temperature of 110 to 130°C and a viscosity of 100 up to approx. 300 mPas wax is easy to pump. In the heated dip pan the wax level is controlled via an over flow system.
  A rubber coated metering roll W0 feeds the wax to a gravure roll W1 and from there via a format transfer roll W2 onto the web. The coat weight is controlled through the velocity of the rolls and the footprint between W0 and W1. Of course all the rolls W0 to W3, also those with rubber coating, are heated with thermo oil. The described coating head applies typical coat weights from 1 up to 5 g/m². There is an option provided to process the coated layer with a smoothing bar before entering the cooling station.

Development of the Wax Coating

- Shortly after the successful commissioning of the before presented coating line the company ARMOR took up the development again to further improve their wax coating processes. The formulations of the three product families of ARMOR have several standards which results in different specifications for the wax coating head. In the technology centre of Polytype the customer examined the following coating systems:

Development of the Wax Coating

Wax coating at the technology centre



W0: Metering roll rubber coated
W1: Gravure roll
W2: Transfer roll rubber coated
W3: Back up roll steel chromium plated

Development of the Wax Coating

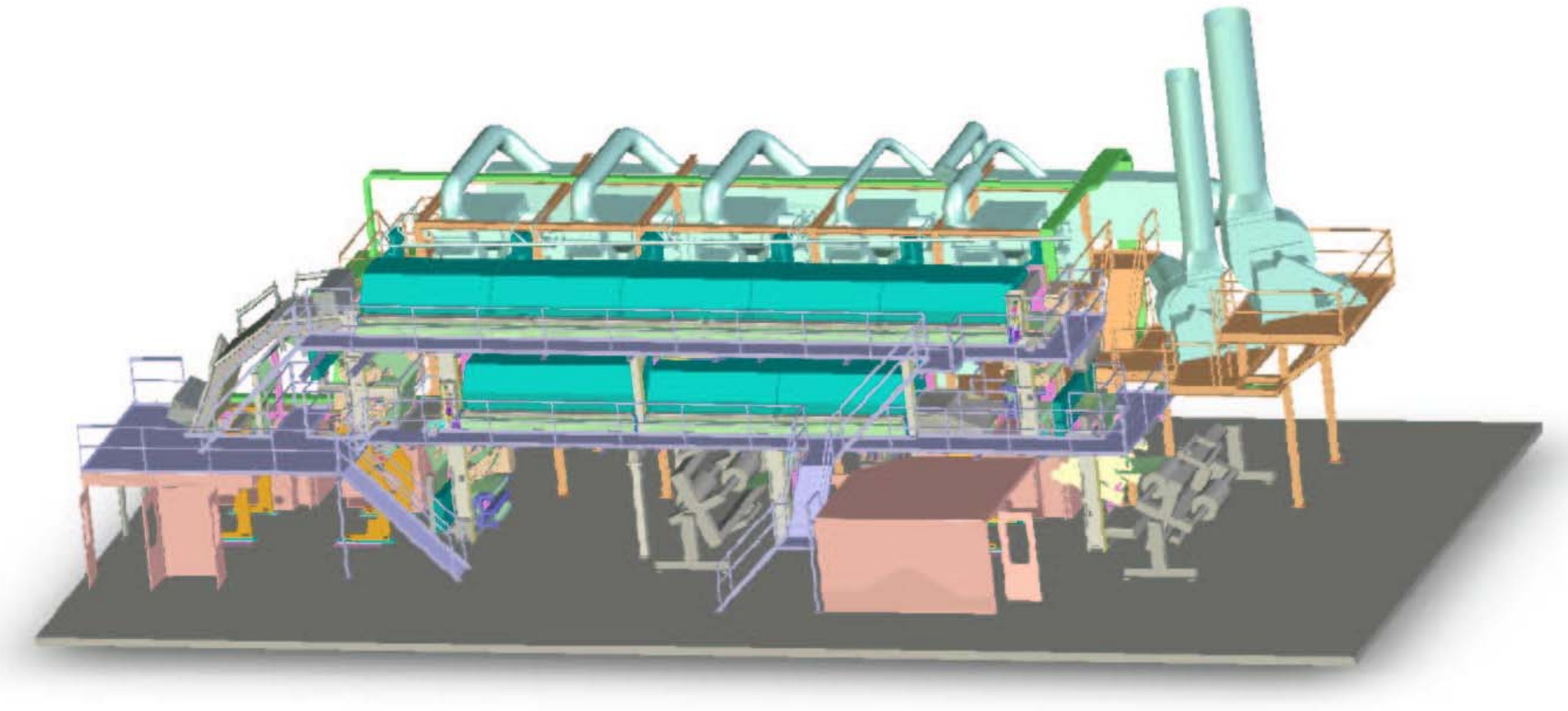
- As expected each of the different coating systems showed specific advantages and disadvantages. If we take the classic coating system A) as a reference, then system B) has the advantage of a smaller dead volume since there is no circulation pumping required. For small production lots this can be an advantage. Further for pigmented formulations there is no risk of sedimentation of heavy particles in the area of low flow rates. The systems A) and B) are dosing the coating between two equally rotating rolls. The fluid properties (viscosity, surface tension) and process parameters (roll speed, foot print) create hydraulic lines, called Ribbing lines. These physical effects are well known in theory and practical use and are likely to appear for these two systems despite using a gravure roll. System C) is able to reduce this effect considerable since with the heated and oscillating gravure doctor blade the main source of ribbing lines is eliminated.

Development of the Wax Coating

- The global market for thermo transfer ribbon products is still strongly increasing. Therefore ARMOR needed to increase their production capacity again to cover the increasing demand from the global market. As soon as the new technology leap was digested by the production department a new target was set to increase the productivity again. The next goal was to reach a production speed of 450 m/min for the next wax coating line.

Development of the Wax Coating

High Speed Polytype Coating Line 2006



Development of the Wax Coating

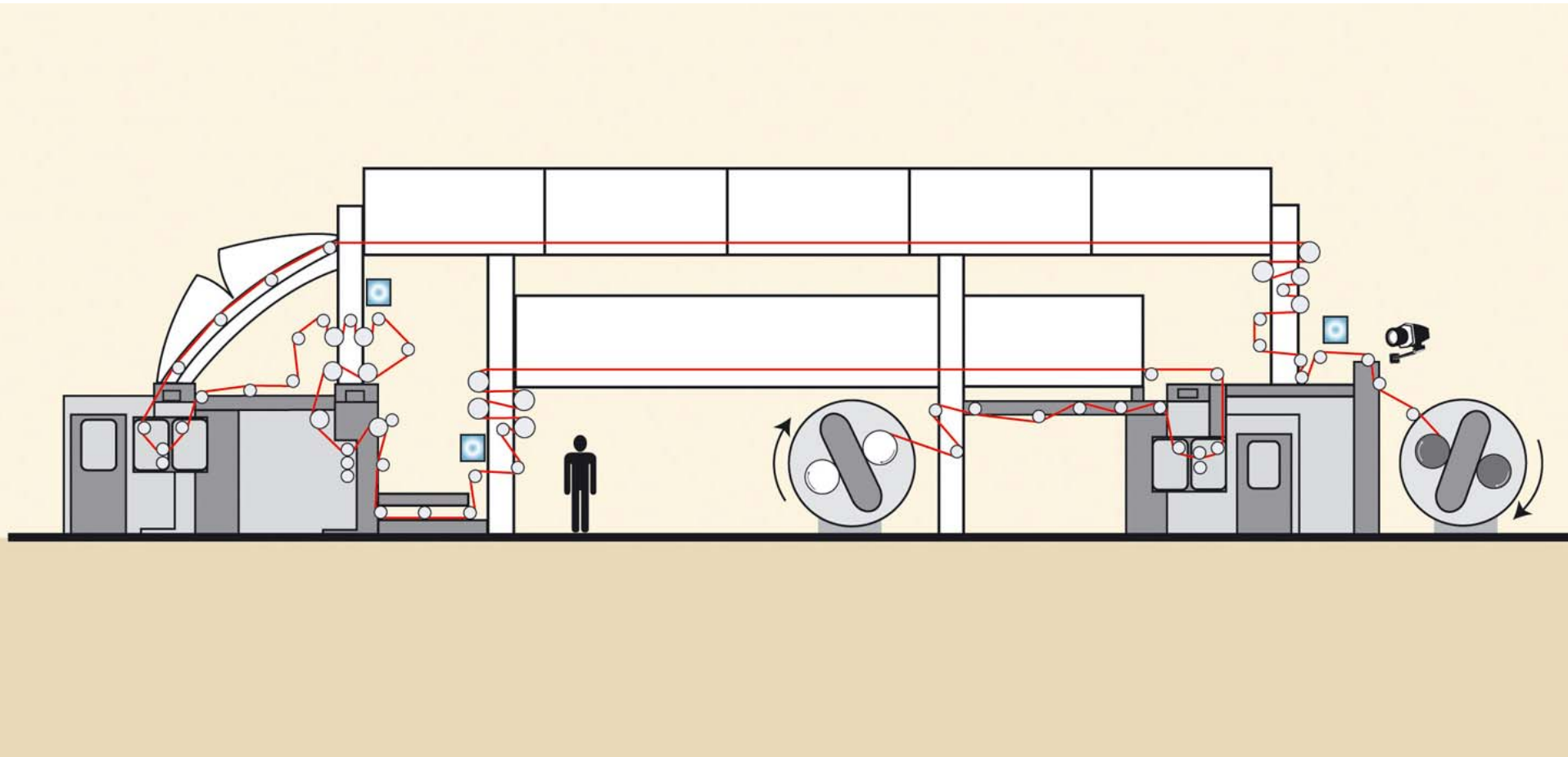
Polytype Coating Station and Unwinder

Development of the Wax Coating

Polytype Guide Roll Dryer with PET film

Development of the Wax Coating

High Speed Coating Line 2006



Development of the Wax Coating

- In the year 2005 Polytype received again the purchase order for this next investment. In spring 2006 ARMOR did start the production with the new and faster coating line.
  This time the coating line is equipped with three coating heads, one back coating head and two coating heads on the transfer side. One of them for the wax coating process.
  Due to a longer web path and a faster production speed ARMOR decided to install winders with flying splice. Production speeds of this magnitude with such thin substrates are an enormous challenge for the coating line and require a very precise web handling system since the required web tensions are very low. Of special interest are again the different coating systems installed:

Development of the Wax Coating

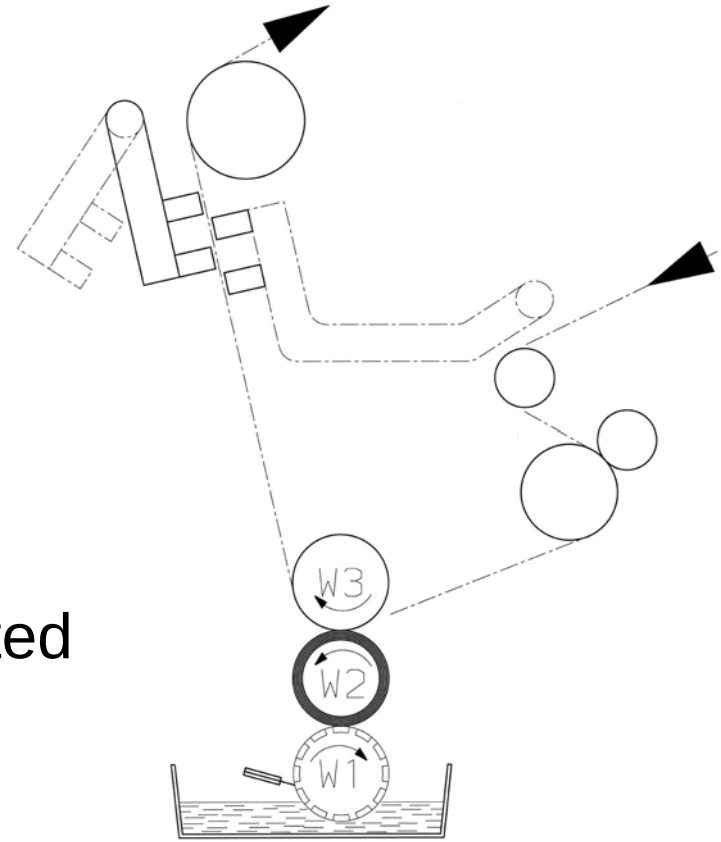
Wax coating

Offset gravure

W1: Gravure roll

W2: Transfer roll rubber coated

W3: Backup roll steel chromium plated



Development of the Wax Coating

- The customer decided to install the joint developed and optimized wax coating head into his new machine which was thoroughly tested in the technology centre of Polytype. This offset gravure coating head allows to coat thin and even wax lavers of 1 up to 3 g/m².
- To solidify the molten wax there are different chill systems available after the wax coating station.

Development of the Wax Coating

Polytype Wax Coating Station

Development of the Wax Coating

Polytype Wax Coating Station

Quality Requirements

- Performance profile of **Polytype** coating line:
  - Extreme low wax coat weight 0.5 – 3.0 µm
  - High precision cross and MD profile +/- 5%
  - Perfect optical coating quality
  - Web handling of very thin films 3.2 - 5.0 µm
  - Extreme constant web tensions
  - High coating speeds up to 500 m/min

Acknowledgement

- As a machine manufacturer with the focus on speciality machines one often is in a dilemma. Our customers request creativity and innovative solutions for their specific tasks. The development is normally based on a mutual confidentiality agreement. That means, we produce nice pieces of equipment but we are not allowed to tell anybody about it. Sometimes we are even not allowed to mention that we are having talks to a customer.

Acknowledgement

- Also for that reason we appreciate very much the open minded behaviour of the **company ARMOR**. First they made it possible to publish significant and detailed facts related to the presented project. In addition to that, they made generous available figures for process parameters and background information. This broad-mindedness is not self-evident in the industry and unfortunately rare. A special thank deserves to the management team of ARMOR for the fruitful co-operation. They have contributed a very significant share to this presentation.

MAKING THERMAL TRANSFER EASIER