LATEST DEVELOPMENTS IN CURTAIN COATING

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Extended Abstract:

Curtain Coating is an attractive method to apply single or multi-layer structures of functional layers to running substrates. In the past 15 to 20 years, it has become more and more attractive in the field of Pressure Sensitive Adhesive (PSA-) labels, specialty paper and cardboard and latest developments address the special needs for these industries. The presentation shall give an insight into applications with complex liquids, running at wider widths and higher speeds compared to traditional curtain coated products.

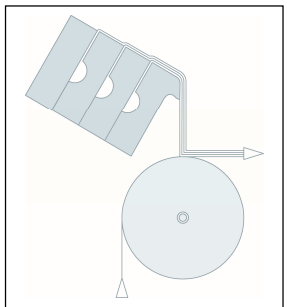

Fig. 1: Multilayer slide curtain die

***Keywords**: premetered coating, curtain coating, development*

1. Introduction

Running a multilayer slide curtain application in the photographic industry was mostly optimized to a fixed condition, which was maintained for long time, sometimes several weeks. The high demands of these optical products did not allow any compromises and the equipment was dedicated to single products. Similar fluid properties and operation conditions have led to a similar and well-proven design of curtain coating equipment over decades.

2. Motivation for new developments

In the photographic industry, production campaigns often lasted two or three weeks and the conditions were not changed. In the current applications, the requirement to be more flexible is much more important. Multiple liquids need to use the same coating die under variable conditions and sometimes, single coating runs only last a few hours and the conditions sometimes need to be adjusted after a short time; therefore, flexibility as well as short cleaning processes are very important.

The main challenges in the rather new application fields such as PSA labels as well as in specialty papers and cardboard are the following:

- Short production runs, frequent changes
- Large variability in terms of fluid properties and operating conditions
- Viscosity level and solids concentration higher
- Rheological behavior of coating fluids more complex
- Requirement for larger coating width at high speeds
- Short maintenance time in production (cleaning, width adjustment, product change…)
- Lower cost for spare parts

The shown developments below describe solutions to successfully run new applications or – in some cases – show possibilities to improve existing units.

3. Developments on curtain dies

A multilayer slide curtain die for example could be used to switch between different layers within rather short changeover time. In some cases it is allowed or beneficial to use dedicated slots for individual colors. Slots not in use can be taped on the top of the slide surface and the fluid runs over such slots on the slide surface without disturbance.

For mass production with continuous operation (24/7) it is important to keep the most delicate parts of a curtain die in stock, especially when no other coating method is used in the line for the particular layers. Larger widths over 3m and higher pressure on investment cost can be addressed with exchangeable lip inserts in the front plate (see Fig. 2) in order to reduce cost for spare parts. The basis investment for such a front plate then is higher of course, but the cost for the spare parts decrease significantly.

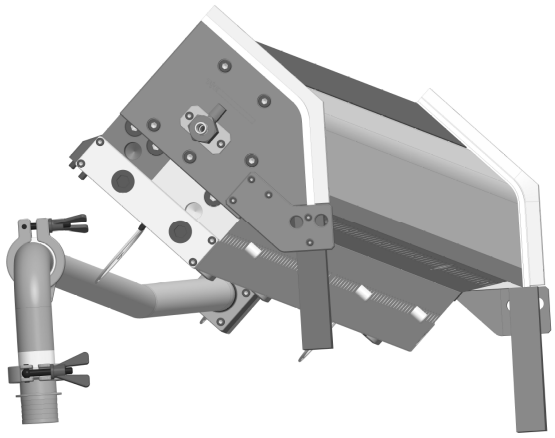

Fig. 2: 4.6m wide single-layer slide curtain die with lip insert

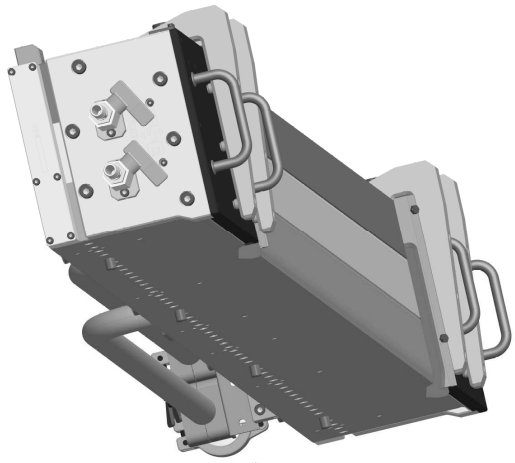

Fig 3: Multi-layer slide curtain die with 75° slide angle with variable width adjustment

Running fluids as for PSA labels with higher low-shear viscosities and strongly shear thinning behavior can be optimized by steeper slide angles up to 75° (see Fig. 3), which mainly helps to improve the situation on the edges of the coated film, especially at the very high specific flow rates of the PSA label business. Since the rheologies of such fluids typically show rather high viscosities at low shear rates and a significant shear-thinning behavior the effect of a steep slide angle is even more pronounced compared to other applications.

The film thickness on the slide surface will be reduced due to stronger acceleration of the film and the shear-thinning behavior of the fluids, and reduces the effect inside the boundary layer near to the slide edge guide, which is the wall on the slide surface guiding the fluid film. The higher flow velocity and lower

film thickness in the edge region, improves potential irregularities in the film thickness, which leads to a more stable curtain in the edge region. An example of such a die is shown in Fig. 4 below. Nevertheless the reduction of the boundary layer effect can also be achieved by other measures for example on existing slide curtain dies.

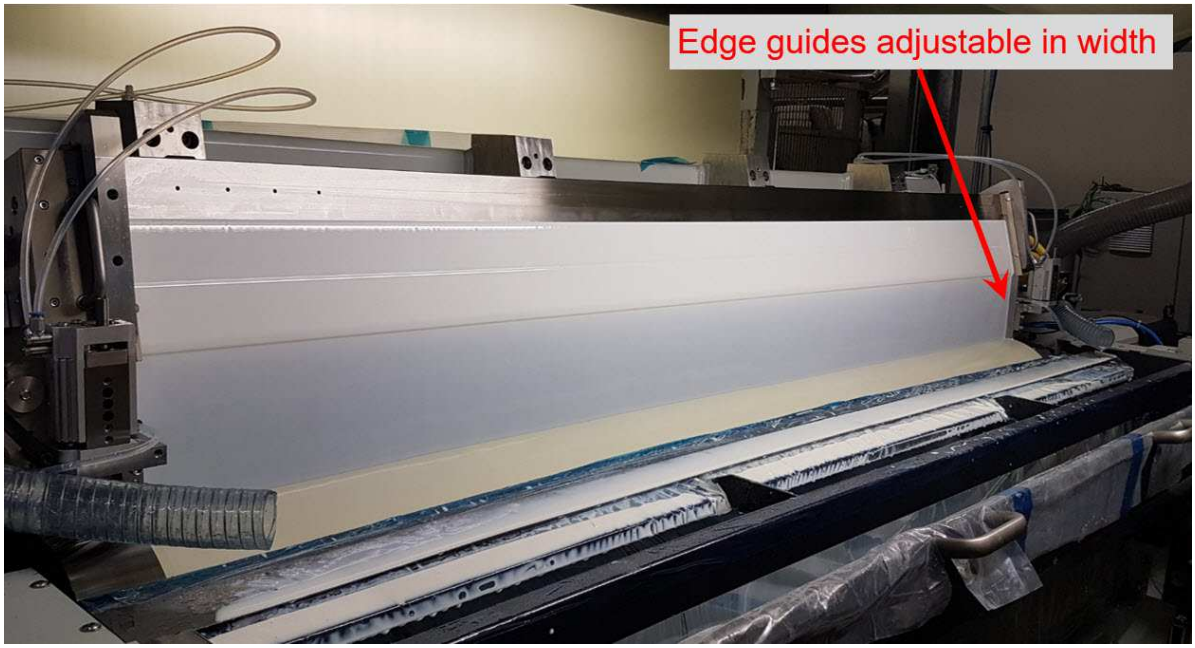

Fig 4: Multi-layer slide curtain die with 75° slide angle with variable width adjustment in operation

In conjunction with the steeper slide angle for PSA applications an optimized design of Curtain Edge Guides shall be used, combining straight edges with minimized edge effects and improved cleaning of the internal suction chamber.

By a combination of dual layer coating with the overboard mode products can be coated in conjunction with non-properly defined paper edges typical on an inline coater in the cardboard industry. The first layer needs to create a sufficiently stable curtain; the second layer is reduced to the paper width. By adjusting the viscosity and surface tension of both liquids for good runability, potential separation, shrinking or bleeding in the second layer can be avoided [(1)]. Therefore, the first layer is collected in the drip pan and can be recirculated without mixing with the second layer.

4. Conclusions and summary

All shown possibilities in conjunction with pigment loaded fluids and high solids concentration help to suit the current requirements and to prepare the industry for future developments. Nevertheless, it remains necessary to optimize the equipment to each industry in collaboration with an experienced partner.

- The single- and multilayer- curtain coating methods are well known and understood and combine all advantages of premetered coating methods with an optimized production setup.
- High speeds at large production width combined with excellent CD and MD uniformity fulfill the demands both in technological as economic aspects.
- Curtain coating is an attractive method also for (newer) applications such as PSA- labels, cardboard, barrier coatings and others.
- With the shown developments, the curtain coating method can be optimized for the new applications and the industries are prepared for the future.
- These methods require thorough planning and preparation for a successful implementation – each application is unique!

5. References

[1] Ralf Gericke (PTS), Maick Nielsen (TSE) (2016). High-grade finishing of packaging papers thank to innovative coating technology. Paper&Biorefinery 2016, Graz.