

SWISS PRECISION 

World's most precise coating dies



TSE TROLLER
COATING SECRET



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Pioneering pre-metered coating solutions

More than 60 years of know-how in the development and production of pre-metered coating dies have made TSE Troller a world leading specialist in the applied coating technology sector. The company based in Murgenthal, Switzerland, has developed advanced coating solutions which have paved the way for the future.

TSE Troller brings you the benefit of unrivalled precision tailored to your specific needs. Our coating dies, designed exclusively for pre-metered applications, satisfy almost all coating needs. We specialize in high precision multilayer coating and complex coating dies.

At TSE Troller we maintain secrecy about our own achievements and those of our customers. Our best reference is silence.

**Therefore don't ask about.
But ask.**



TSE Troller – Exceptional precision and high quality

0.5µm

slot accuracy leads to less material consumption

30+

highly qualified employees at our location in Switzerland

60+

years of know-how in the pre-metered coating technology

660+

individual projects we have realized for our customers worldwide

We live the following values



precise

We design our coating dies for high-precision applications. However, we are not only precise in our design, but in all our activities. We are tireless and extremely persistent when it comes to quality.



serious

You can absolutely rely on us. We stand by our word – today and tomorrow. Together with our customers, we develop technological treasures. These are not only precise, but also highly reliable – dependable. We guard these treasures as our greatest secrets.



exclusive

We develop unique customer solutions. To do this, we take a serious interest in our customers' needs and processes. We develop customized applications that have a decisive impact on our customers' production: Their production costs are usually reduced more than expected.

Innovative evolution for a knowledgeable advantage

The basis of all TSE Troller dies is the pre-metered coating technology. The exact flow design in combination with the highest manufacturing precision leads to a homogeneous distribution of the fluid on the carrier material.



PAPER INDUSTRY



CONVERTING INDUSTRY



ELECTRONIC INDUSTRY





Paper industry

Curtain coating increases efficiency and lowers energy consumption. The contactless “curtain coating” reduces strip cracks and enables rapid product and coating width changes. The simultaneous application of several layers increases the productivity of the machine. Saving energy and resources by increasing the solid contents of the coating fluids, increasing the web speed and using a more precise coating application.



THERMAL PAPER



PAPER COATING



SPECIALTY PAPER



**CARBONLESS COPY
PAPER**



INKJET PAPER



**CARDBOARD
PRODUCTION**



**BARRIER LAYERS
PACKAGING**



IMPREGNATION

... and many more.



Converting industry

Apply up to X layers at the same time. The refinement of substrates and the addition of functional layers are the basic requirements in the converting segment. This is where all the advantages of TSE Troller coating dies come into play!



LABELS



ADHESIVE TAPES



MEMBRANES



COLOR / DECOR



FOOD INDUSTRY



SAND PAPER



OPTICAL FILMS / FOILS



PHARMA / MEDICINE

... and many more.



Electronic industry

Scalable from 1 mm up to more than 1500 mm. The process is ingeniously easy to adapt from laboratory to production scale. Very thin layers for OPV or OLED applications or very homogeneous layers for battery slurries are just some of the applications for which the pre-metered coating technology is ideally suited.



**LITHIUM-ION
BATTERIES**



**ORGANIC LIGHT-EMITTING
DIODES (OLED)**



FUELL CELLS



**ORGANIC PHOTO-
VOLTAICS (OPV)**



**BARRIER LAYER
ELECTRONICS**



**PRINTED
ELECTRONICS**



CONDENSERS



**FUNCTIONAL LAYERS
(NANO)**

... and many more.



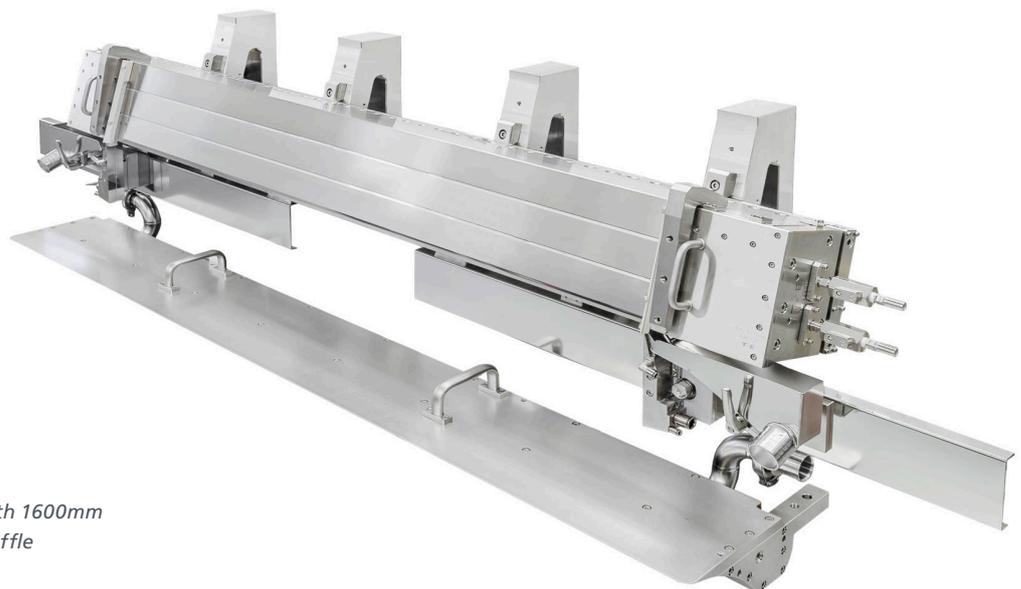
Dual layer curtain slide die with 260mm coating width on TableCoater for curtain coating



*Single layer curtain slide die with 4640mm coating width during curtain preparation
Picture courtesy Bellmer*



*Single layer slot die with 200mm coating width for battery application
Picture courtesy Mathis*



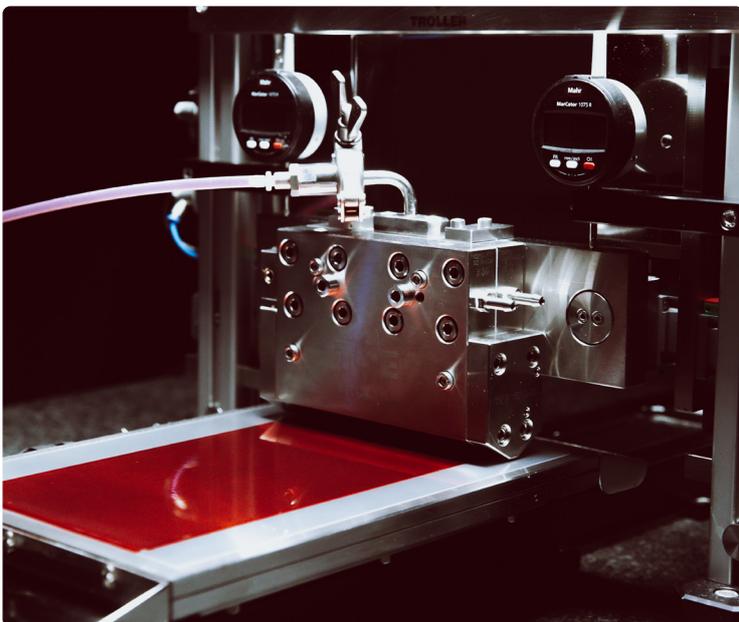
Dual layer curtain slide die with 1600mm coating width including air baffle

Process description of pre-metered coating

Pre-metered coating methods are a group of technologies which are used for the continuous application of functional fluids on substrate in web format. Unlike the “self-metering” methods, a uniformly operating pump delivers the necessary volume of fluid to maintain the desired wet film thickness on the substrate to be coated for a given working width and at the planned working speed.

This fluid quantity is held constant, e.g. by flow control. The coating liquid is then distributed over the desired working width by means of a coating die. For this purpose, a distribution system consisting of a distribution chamber and a subsequent metering slot is incorporated in the die. The design of this distribution system, in terms of flow technology and the uniformity of the metering slot

height, are the key contributory factors to uniform distribution of the fluid across the working width. The coating fluids may contain water or organic or inorganic solvents and for some applications may be used without a solvent (100% solids). As in the case of all other coating techniques, the properties of the fluids must be adjusted to the needs of the pre-metered techniques.



Self-metered vs. pre-metered coating systems

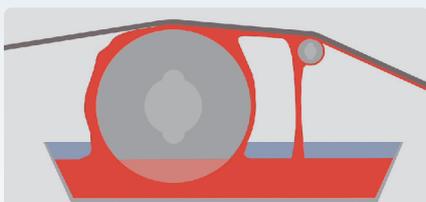
Self-metered coating systems have been standard in the industry since the industrialization of coating while pre-metered methods were introduced mid of last century by the photographic industry. Since then it has also become state-of-the-art technology in the specialty paper and adhesive industry.

The advantages of pre-metered coating systems such as very uniform cross profile, optimized and low liquid consumption, higher coating speed and the possibility to coat several layers simultaneously has further spread these methods into many new fields of the industry. While the liquid formulation and viscosities in self-metered systems do change from the beginning to the end of the batch, the formulations in the pre-metered systems remain the

same over the entire batch. This results into uniform coating thickness in longitudinal direction. The achievable cross profile tolerances are much narrower in case of the pre-metered systems as compared to self metered systems. Therefore, with pre-metered coating the liquid savings are significant. Due to short residence time in optimized dies it is possible to coat reactive fluid systems, which gives more freedom in designing functional layers.

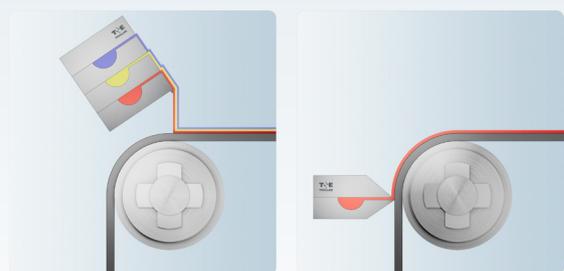
Self-metered coating system

- Simple methods
- Lay-down depends on liquid properties and web speed
- Formulation changes affect lay-down
- One layer applied at the time



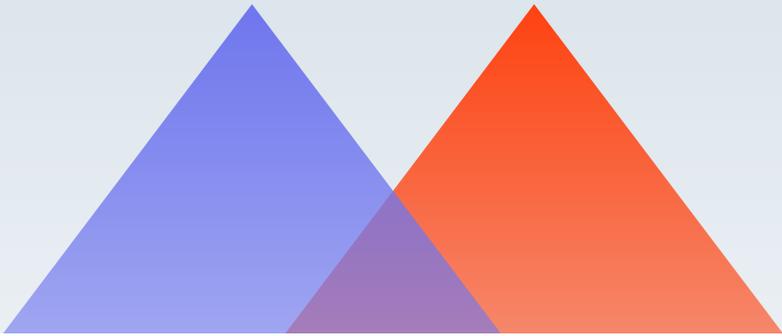
Pre-metered coating system

- More complex, requires a die distributor
- Lay-down is specific within operating range of process
- Formulation changes do not affect lay-down
- Multiple layers coated simultaneously
- Multi component liquids possible



High-end performance with experience

Our coating dies are designed for high-precision applications – both in slide and slot coating for bead mode or curtain coating. Thanks to specifically optimized geometry, our customers achieve consistent quality and lower material consumption.



Requirements

In the majority of the coating applications multiple products with different fluid properties at different speeds, coat weights and often also at various coating widths shall be coated within pre-determined specifications. The requirements further include a uniform fluid distribution both in cross-web and in machine direction, quick change over times and short cleaning and adjustment times. For an efficient production it is also important to reduce the downtime due to unexpected production stops, e.g. through web breaks. Raising performance requirements often demand better production methods to improve the product properties.

Our Approach

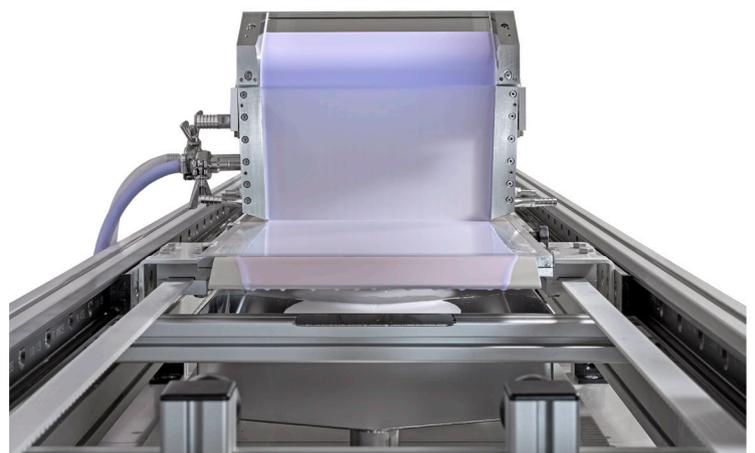
TSE coating dies are especially designed to fulfill two different requirements, which are acting in an opposite direction. The first is the uniformity of the coated film in cross-web direction. For the evenness in machine direction the uniformity of the web-run and of the metering pump are responsible – this cannot be influenced by the applicator head.

The uniformity of the film thickness in cross direction depends on:

- the design and the mechanical precision of the die
- how the die is used during operation
- the operating conditions and mechanical precision of the coating process
- the uniformity of post-coating operations such as drying and curing

Focusing on the location of the slot exit, the cross profile depends on three classes of parameters, namely operating conditions, fluid properties and geometrical parameters. Especially the measurement and definition of the rheological behavior is important. Very often real coating liquids show a shear-depending viscosity. Since the fluid experiences different shear rate levels during the coating process, the viscosity gradient must be known. For customers who do not have appropriate rheological measurement equipment, TSE can arrange access to laboratories who provide rheological measurement services.

The customer specific design of TSE dies covers a wide range of fluid properties and operating conditions. Therefore the distribution geometry in the “coat hanger” design is determined by optimizing more than 10 parameters in accordance to one design product. With the geometry selected the other applications in the product range will



be checked to determine the expected cross-web uniformity too. If some of the other products exceed the specifications the defined geometry will be tuned to improve the performance for these products, which usually is an iterative process. With this procedure the geometry fits to a fairly wide range of products and creates coated films with cross-web uniformities within tight limits.

The second requirement is to avoid internal contamination during a production campaign and to minimize the time needed for flushing and cleaning the die especially during change-over from one to another product. If a die has to be opened for cleaning this 1) causes non-productive time and 2) increases the risk for damaging the die which would influence the quality of the coated film.

Ideally the distribution geometry is designed in a way that the die does not contaminate in production and so does not need intense cleaning at the end of a run. According

to practical experience and theoretical considerations, the wall shear stress is a useful measure for the tendency of a die to contaminate.

The optimized distribution geometry of TSE production scale dies is designed such that no dead zones or spots with low wall-shear-stress are present. This minimizes contamination during coating and allows to flush the die with water or solvent only to clean the interior within a short period of time. This also leads to a short residence time for all fluid elements inside the die which is important especially when the coating liquids contain chemically reactive components. Furthermore TSE dies incorporate the possibility to alter the coating width. For development and pilot scale purposes, TSE offers versatile die heads that can be used with a wide variety of products. For example, the possibility to change the slot height with shim foils in R&D slot dies satisfies the need to easily adapt the die head to new products.

Your benefit

TSE coating dies combine superior quality of your coated products with minimized need for cleaning to help you economically manufacture products on a high level. This leads to a sustainable coating process with the following advantages for our customers:

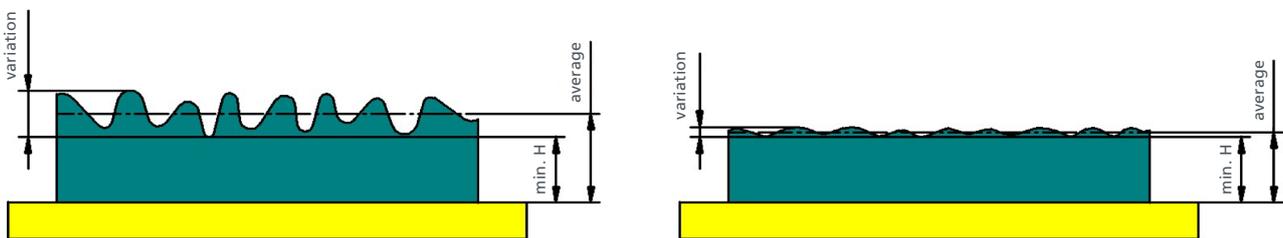
- High efficiency with coating liquids and machinery
- Less material consumption due to the high precision coating (cross web uniformity)
- “Self cleaning” effect inside the die – low frequency for breakdown
- Chemically reactive liquids can be coated
- Liquids which tend to sediment (containing particles) can be handled very well
- Simultaneous multilayer coating (fewer runs)
- Wide range of applications
- Stable process, no adjustments
- Low number of defects
- Extendible
- Adjustable coating width
- Low maintenance (no wear parts)
- Short return on investment (ROI) of equipment

Especially for the use of pre-metered dies in the different field of electronics, where the coating liquids are both rare and expensive, the TSE die design focuses on minimized volumes inside the coating die. For a coating width of 200mm for example a few millilitres are absolutely sufficient to fill the die.

Advantages of optimized dies

The reduced cross web deviation (variation) of a TSE Toller high precision coating die results in lower average thickness at a given minimum height (min. H) which saves money on every coating run.

Example for a functional layer (mass production)



Material savings with high precision dies:

$$\frac{1'080 \text{ kg/h}}{100\%} \times 1\% = 10.8 \text{ kg/h}$$

$$(1.2 \text{ m} \times 50 \text{ m/min} \times 300 \text{ g/m}^2 \times 60 \text{ min/h} \times 0.001 \text{ kg/g} = 1'080 \text{ kg/h})$$

Saving: 10.8 kg/h = 1'080.– €/h

- Coating width: **1'200mm**
- Coating speed: **50 m/min**
- Coat weight (wet): **300 g/m² for cathode slurry**
- Cost of cathode slurry: **approx. €100.– per kg**
- Hourly consumption of slurry: **1'080 kg/h**

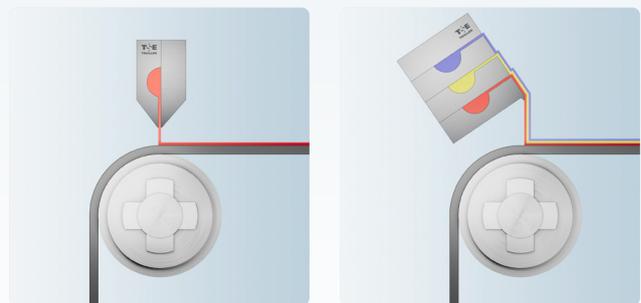
The figures are based on assumptions and may vary depending on coating conditions.

Curtain Coating

The curtain coating technology enables layers ranging from thin to thick to be applied. The application area ranges from moderate to very high coating speeds, well above 2'000m/min. Curtain coating methods enable one or more fluid layers to be applied in a single operation. The number may exceed ten to suit the particular application and depends on the shape of the coating die (slot die or slide type die). When the curtain coating method is used, the die lip is positioned at a great distance above the web to be coated, the fluid drops downwards in free fall as a closed liquid curtain and is deposited on the substrate.

In the case of the curtain coating method with a slot die, the exit slot is orientated downwards while in applications with a curtain slide die the fluid film leaves the exit slot(s) upwards and then flows down the inclined surface ("Slide") before leaving the die body at the lip and passing

into the curtain. Because of the great distance between the lip and web, the curtain coating method is largely unaffected by linear coating defects and produces a very uniform layer on uneven surfaces (contour coating). For this application method too, TSE develops and produces coating dies and also various accessory components which are used to optimize the application window.

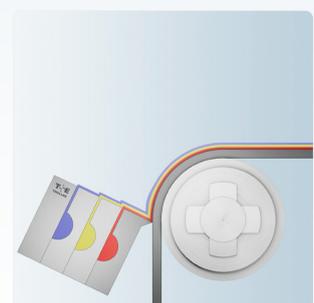


Slide-Bead Coating

The slide-bead coating technique enables layers of medium to large thickness to be applied. The application range extends from rather slow coating speeds up to maximum speeds of 300–400m/min. Slide-bead coating enables one or more fluid layers to be applied in a single pass to the substrate which is to be coated; the number of layers may exceed ten, depending on the particular application.

When the slide-bead coating method is used, the fluid film emerges from the exit slot of the die in an upward direction and then flows down the inclined surface ("Slide") before bridging the narrow bead gap between the die lip and the running web – in much the same way as when the slot-bead coating method is used.

To achieve the most uniform possible film thickness on the substrate to be coated in cross-machine direction, the parallelism of the bead gap must be set with great precision as must the slot height. An inherently stable and highly accurate positioning system is required. For this purpose, TSE develops and produces coating dies and also various accessory components which are used to optimize the application window.



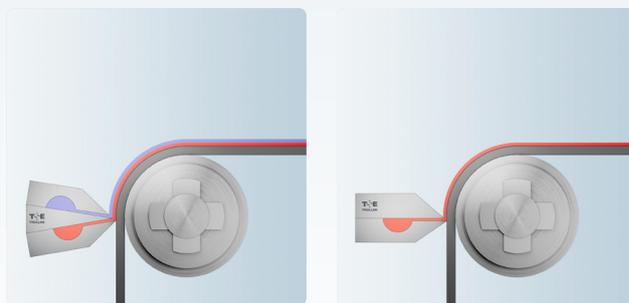
Slot-Bead Coating

Slot-bead coating permits the application of layers which may range from very thin to relatively thick, depending on the particular use. The application area extends from very slow coating speeds of a few cm/min up to speeds of 300–600m/min.

By means of slot-bead coating techniques, one or more fluid layers can be applied in a single pass onto the web which is to be coated; the number of layers is limited. In the slot-bead coating method, the fluid film leaves the exit slot of the coating die and directly bridges the very narrow bead gap between the die lip and the running web.

To achieve the most uniform possible film thickness on the substrate to be coated in cross-machine direction, the parallelism of the bead gap must be set with great precision

as must the slot height. For this purpose, an essentially stable and highly accurate positioning system is required. For this application method, TSE develops and produces dies and also various accessory components which are used to optimize the application window.

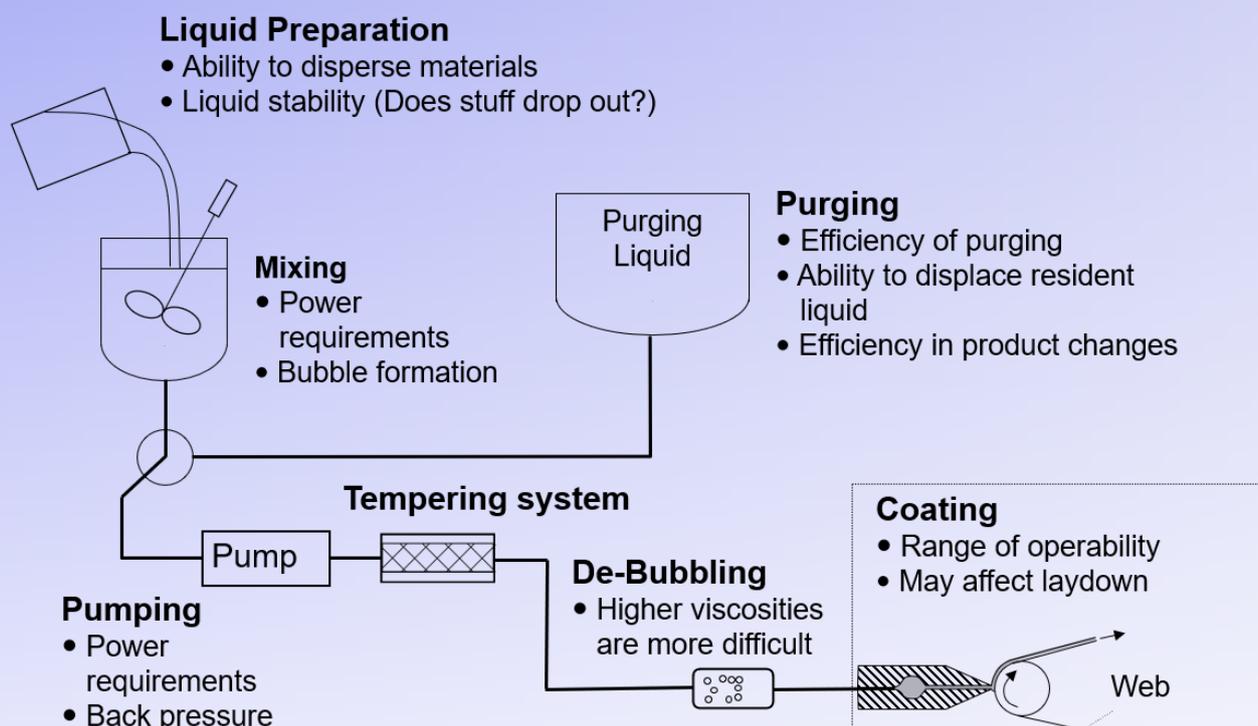


Liquid preparation

The liquid preparation takes a key role in pre-metered coating. Depending on the range of different liquids to be prepared and dosed, the selection of pump and degassing unit has to take into account the different behaviors of each liquid.

The capacity range of the pumps has to cover the entire flow rates, while the operating window of the dosing pumps should not be utilized to its minimum or maximum. Hence the pumps should operate in the middle of their working ranges. Very high as well as very low pump loads should be avoided and can lead to strips, pulsations or other unwanted effects in the coating. TSE can make some advises on the design of such liquid preparations or can help to find an ideal partner for such a system. To avoid die distortions during operation, the temperature of the die as well as the entering liquid must be equal in small toler-

ances. A water circuit using tempering holes in the die keeps the temperatures in the die at constant levels. The liquid preparation must also be equipped with a temperature control system which is coupled with the system of the die in order to guarantee that both temperatures are equal. For some applications, multi component liquids must be dosed. The pre-metered coating method allows the mixing in a static mixer located shortly before the entrance into the die. As one can see, the variety of requirements for liquid preparation and dosing in the coating industry with different substrates and liquids is extremely wide.



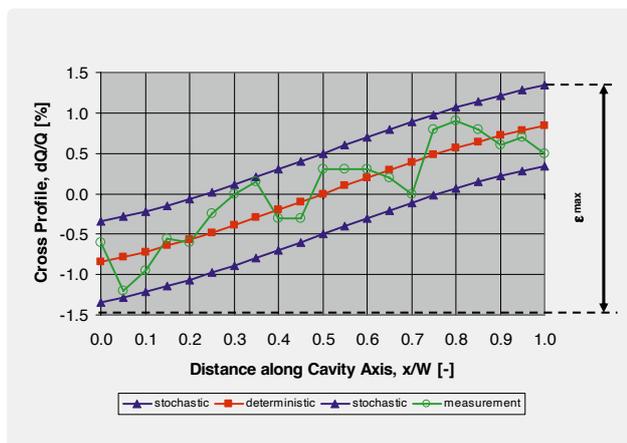
Core competence in pre-metered coating systems

The dies of TSE Troller are of highest quality. Every die plate is made with excellent quality and polished to perfection. When ordering at TSE, outstanding accuracy and quality can be taken for granted.

At TSE we use the most precise equipment for building, measuring, and testing our dies in order to be certain that we will produce equipment of the highest possible quality. This measuring device is accurate down to 0.1 microns. Beside precision and surface quality it is the design of the cavities that plays a crucial role in achieving a good function and performance of the die. TSE has wide know-how in modeling different liquids and is in contact with leading institutes and universities in material science world-wide. Target of modeling the dual cavity distribution system is a uniform cross profile of the coated film on the substrate as well as long intervals between die cleaning cycles to achieve high coating line efficiency – for a wide range of applications of course. In the diagram the uniformity of the film thickness is shown over the width of the die – measured from the feed port. For a centre fed die the resulting profile will

be symmetrical relative to the centre line of the die. The red curve shows the theoretically calculated flow profile for a specific application. The blue curves represent the level of mechanical precision and the green line stands for the actual measurement data of the finished die.

Depending on the requirements of the coating cross profile tolerances, TSE can manufacture dies in different precision levels defined in the following table. Of course the high precision manufacturing experience allows customers to have also coating dies repaired, overhauled or modified, regardless if they are manufactured by TSE or not.



Cross profile band, defined by slope and width



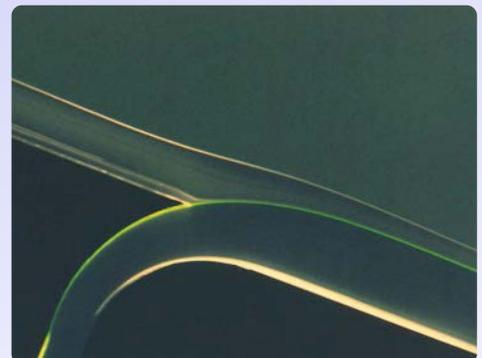
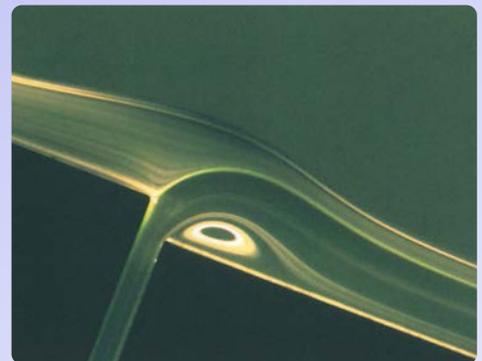
Measuring a dual cavity slide curtain die plate

Level of mechanical precision	Precision of nominal slot depth $\pm\mu\text{m}$	Precision of inner slot surface (System 1) $\pm\mu\text{m}$	Precision of outer slot surface (System 2) $\pm\mu\text{m}$
B	20	6.00	6.00
A	10	4.00	2.50
A with changeable lips	10	4.00	3.00
AA	5	2.00	1.00
AAA	5	1.00	0.50
AAAA	5	0.50	0.25

Know-how about fluid dynamics

Maintaining optimum laminar flow conditions is crucial especially for multilayer applications, but as well for applications with particle loaded liquids and / or with reactive components. Vortices as shown left at the exit of an upwards orientated slot of a multilayer slide die might create a recirculation inside the flow field and potentially mixing of both layers; or gathering and releasing particles which might lead to line defects.

By optimizing the geometry of each detail section in the different flow fields they become less susceptible for disturbances and thus to defects of the coating, which lead to reduced product quality.



Comparison of fluid behavior for different geometries. Photos courtesy by Dr. Peter M. Schweizer.

Our experience for your solution

The standards we set ourselves: We support you in every phase of your project, from the initial idea to commissioning. This is based on decades of experience which you can benefit from. We are your qualified partner for finding the ideal solution.



Slot Dies

Of all the pre-metered coating methods, slot coating can be the most demanding when it comes to die design and precision fabrication.

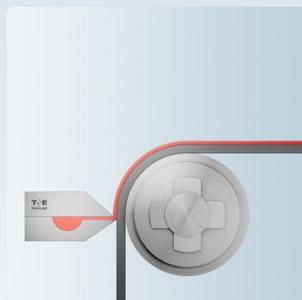
First, the internal manifold of the die must supply a uniformly distributed flow to the coating transfer gap region. However, complex liquid rheology and / or significant flow effects may require the use of an optimized manifold design with varying slot length and cavity cross-section (coat-hanger design). Even with optimized design, excellent coating weight uniformity requires exacting slot depth uniformity. Achieving desired slot coating transfer flow is also challenging. Process-capable lip designs carried out with superb straightness, uniform lip

lands and well-defined, uniform lip corners are all required to maximize coating windows and to enhance coating robustness within these windows. TSE is certainly up to this task and excels in unmatched fabrication precision, optimized design capability with advanced flow modelling, coating know-how, and decades of supplying precision dies to the world's most demanding companies. Supplying dies that conquer challenging, demanding coating applications is our niche!

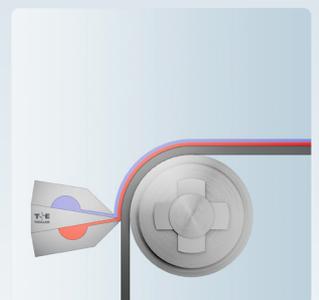
Range of application (order of magnitude only)

- Viscosity range: **[mPas]** **1-10'000**
- Surface tension: **[mN/m]** **-**
- Coating speed: **[m/s]** **0.01-10**
- Wet thickness H_{wet} : **[μ m]** **> 5**
- Dry thickness H_{dry} : **[μ m]** **< 1-1'000**
- Number of layers: **1- \leq 3**
- Minimum flow rate: **[cm²/s]** **-**

Single Layer Slot Die with Vacuum Box



Triple Layer Slot Die



Curtain Slot Dies

Slot curtain coating is an attractive coating method because several major process advantages are achieved. These advantages include a potential for high speed coating, a significant coating robustness with respect to web disturbances, and a substantial tolerance for imprecision in the clearance between die and substrate.

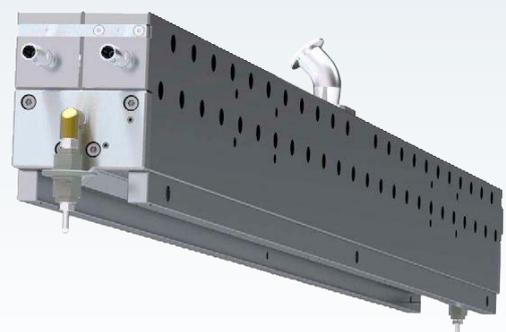
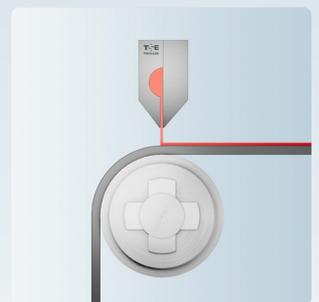
The design and fabrication of the curtain slot die must be executed with high precision if excellent coating quality is to be achieved. For example, the slot die lip region must have an excellent surface finish. It should also be designed such that it resists irregular wetting along the lip. Furthermore, these lip features must be uniform across the die width. Finally, as with all premetered coaters, the production of a uniformly distributed flow via the internal flow manifold requires both optimal manifold design and excellent slot depth uniformity. TSE has produced many suc-

cessful curtain dies in both slot and slide die formats. TSE has also developed the essential supporting technologies and practical designs associated with capable curtain edge guides, baffles to remove the air boundary layer on the incoming web, coating initiation / termination functions and devices that protect the liquid curtain from the detrimental effects of air currents. In view of this complete technology package, TSE is the leading supplier of dies for successful curtain coating.

Range of application (order of magnitude only)

- Viscosity range: **[mPas]** **10–5'000**
- Surface tension: **[mN/m]** **<40**
- Coating speed: **[m/s]** **1–30**
- Wet thickness H_{wet} : **[μ m]** **> 5**
- Dry thickness H_{dry} : **[μ m]** **< 1–300**
- Number of layers: **1–2**
- Minimum flow rate: **[cm²/s]** **> 1.0**

Single Layer Curtain Slot Die



Slide Dies

Slide coating has been the multilayer workhorse for the photographic industry for many years and its use has been extended to other applications where excellent quality multilayer coatings are required.

TSE has a long history of providing successful slide dies and slide coating stations to the world's most competitive coating companies. For truly excellent coating quality, slide dies require a level of excellence in design and fabrication precision rivaled only by slot dies. The slide die lip region is critical. The die lip must have a capable shape, a superb surface finish, well defined corners and these features all must be uniform across the coating width. Furthermore, the lip must be extremely straight. The geometry of the transition between the individual distribution

slot exits and the slide surface is also critical in that it must allow disturbance-free introduction of the layer into the multilayer package flowing down the slide. Finally, as with all pre-metered coaters, the production of a uniformly distributed flow via the internal flow manifold requires both optimal manifold design and excellent slot depth uniformity.

Range of application (order of magnitude only)

- Viscosity range:	[mPas]	1-1000
- Surface tension:	[mN/m]	-
- Coating speed:	[m/s]	0.5-5
- Wet thickness H_{wet} :	[μm]	> 50
- Dry thickness H_{dry} :	[μm]	< 1-300
- Number of layers:		1-> 10
- Minimum flow rate:	[cm^2/s]	-

Five Layer Slide Die with Vacuum Box



Curtain Slide Dies

Curtain coating in the slide format is being adopted increasingly by large segments of the coating industry because of its high productivity, multilayer capabilities and robustness with respect to web disturbances.

The curtain coating concept is simple enough to allow a liquid layer falling from a die edge to impinge on a moving web. However, the realization of excellent coating quality with this method demands optimal die design coupled with precision fabrication. These are TSE's strengths. As with all pre-metered coaters, the production of a uniformly distributed flow via the internal flow manifold requires both optimal manifold design and excellent slot depth uniformity. The curtain lip also must be designed to resist irregular wetting and the teapot effect. Furthermore, lip fabrication uniformity is essential for

excellent coating uniformity. TSE has produced successful slide curtain dies for many years and for a wide variety of customers. During this time, TSE has developed the essential supporting technologies and designs associated with capable curtain edge guides, baffles to remove the air boundary layer on the incoming web, coating initiation / termination functions and devices that protect the liquid curtain from the detrimental effects of air currents.

Range of application (order of magnitude only)

- Viscosity range: **[mPas]** **10-5'000**
- Surface tension: **[mN/m]** **<40**
- Coating speed: **[m/s]** **1-30**
- Wet thickness H_{wet} : **[μm]** **> 5**
- Dry thickness H_{dry} : **[μm]** **< 1-300**
- Number of layers: **1->10**
- Minimum flow rate: **[cm²/s]** **1.0**



TSE-TableCoater for batch-wise coating

For several years, new products and applications in the fields of electronics are being developed, which raise particular demands even on the application technology. The specialty here is to apply very thin layers in the dry thickness range of approximately 50 to 200 nanometres on various substrates.

Ideally this should be done with a suitable application method for an economical mass production. The development of conventional coatings in areas such as paper or adhesive so far allowed the application by hand in the laboratory, since the later transfer was tested in a production. Even the most economical use of the coating materials was not necessary because the liquids commonly existed in sufficient quantity. When designing new products in the field of flexible electronics (with the examples of organic photovoltaic (OPV) and organic LED's (OLED)), the appropriate components of the coating liquids are often only available in very limited amounts and correspondingly expensive. Thus, the filling volume of the entire system is very important to allow for economic development. Also, the application of a few micrometers thin, uniform layer with a simple manual procedure is not possible.

In order to ensure the scale-up from the laboratory in a subsequent "Roll-to-Roll" process the same application process should be used from the beginning, as it is most promising for a later production. The pumping system must be appropriate also to deliver the liquid in the required, very low quantity. This requires bridging the gap between the lab-scale of the development laboratory on one hand and industrialized, well proven coating processes on the other hand. On the occasion of the ICE-2011 in Munich, the new TSE-TableCoater was decorated with the C2-Innovation Award among around 40 competitors. The TSE-Table Coater including a single or a dual layer slot die is available for rent for first feasibility trials. Please contact us for a quotation.

TSE-TableCoater with single layer slot die



Often only a few samples of a new development step are sufficient in order to analyze the functionality, efficiency and other features. Nevertheless, the conditions of the experimental setup should be comparable with a later production runs, to minimize risks.

For this purpose TSE has developed a modular coating system which allows to coat onto individual "sheets" with a slot die in the lab-scale. The TSE-TableCoater can be characterized by the following key features:

- High precision slot coating method, scalable from lab to industrial production
- Variable size of the substrates to be coated made of glass, plastic, paper or metal foil
- High precision height adjustment
- Skip-Out function available
- Minimized dead volume in the slot die, thus cost effective development of new products
- Generic or custom-designed slot dies with customer specific coating width
- Modular design with multiple options
- Slot dies manufactured of various acid-resistant materials, with heating capability
- Large operating window – "from water to honey"
- For water- and solvent-based systems, also for solvent-free liquids
- Dry thickness of 20nm to 2000 micron
- Wet thickness below 5 micron possible
- Speeds between 0.1 and 10m/min
- Customized fluid delivery system
- Transferable to "Roll-to-Roll"-Process
- Operating software on a laptop or industrial mobile panel



Optional with dual layer slot die, vacuum clamping table, flow box, enclosure and base frame



Several options are also available:

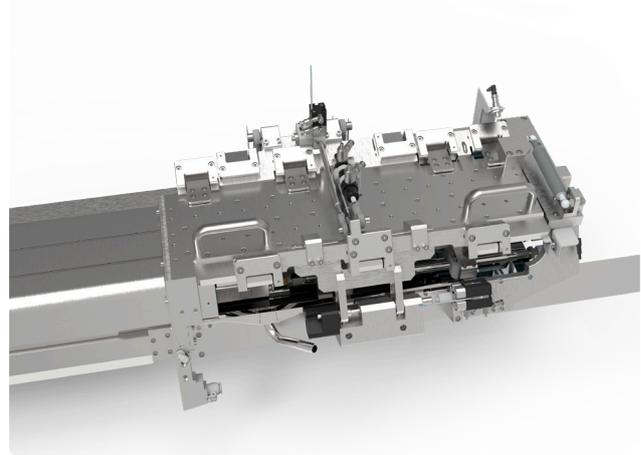
- Dual and triple layer slot dies
- Alternate die materials (PEEK, Titan, Hastelloy, Langalloy ...)
- Vacuum clamping table
- Heating or cooling provision for table
- Servo driven height adjustment
- Automated coating gap calibration
- Flow box / clean room
- Integration in Glove-Box
- Dryer
- ...

Accessories to increase in production

Motorized Variable Coating Width (MVCW)

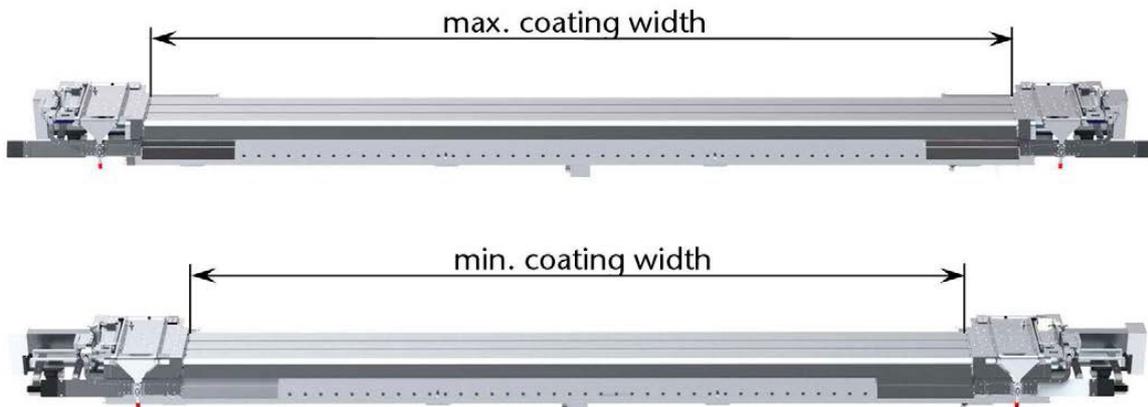
Driven by market demand for a wide product assortment as well as smaller production lots, companies are more and more forced to change the production width very frequently. Due to the long non-operational periods during width changes, the converter line efficiency becomes very low while on the other hand our customers have to increase their plant efficiency continuously in order to cope with the cost pressure.

To have an option available for our customers with curtain coating slide dies, TSE has developed the MVCW system, which can adjust the coating width motorized, continuously and fully automatic. The different coating widths can be set by the same system and the big number of parts being necessary for conventional width adjustments can be covered by the MVCW, thus making the spare part management easier and less costly. The changeover time could be reduced at one of our customer plant from 4



MVCW on a dual layer curtain coating die

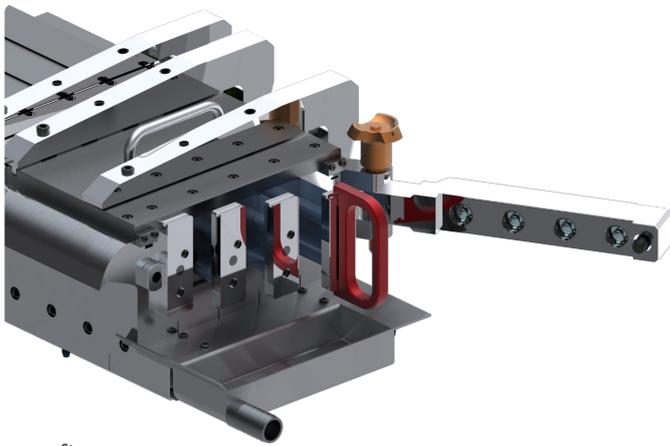
hours to only 12 minutes with the MVCW system. Furthermore, the risk of damaging parts due to improper handling was eliminated. An integrated flushing system is cleaning the cavity deckles during the process of changing the width. The movements of the MVCW are pneumatic and motorized while sensors are controlling the movements. The development team of TSE Troller AG has designed and industrialized this system in close collaboration with its customers.



Variable Coating Width (VCW)

The majority of modern coating lines must cope with various product settings in terms of coat weights, speeds, different formulations and last but not least variable working widths. In order to supply an option available to our customers with curtain coating slide dies, TSE has de-

veloped the VCW system, which can adjust the coating width manually in discrete steps. This system is ideal for applications with sporadic alternation of the working width or with coating dies running at a few different widths only. The variable coating widths can be set by changing some parts restricting the coating flow inside the cavities and outside, on the slide surface. To change the coating width, the die does not have to be disassembled, which saves time and decreases the risk for damaging the die internally. The changeover time from one to another coating width can be estimated to be approximately 1-2 hours with the VCW system including flushing of the die and external cleaning. For quicker changeover TSE offers the fully automated and continuous MVCW-System. This particular width adjustment system has been proven in industry for decades and provides the possibility for a future upgrade with additional widths as well.



VCW on a 4-layer curtain coating die



Sample of a VCW with a width adjustment range of 700mm

Air baffles

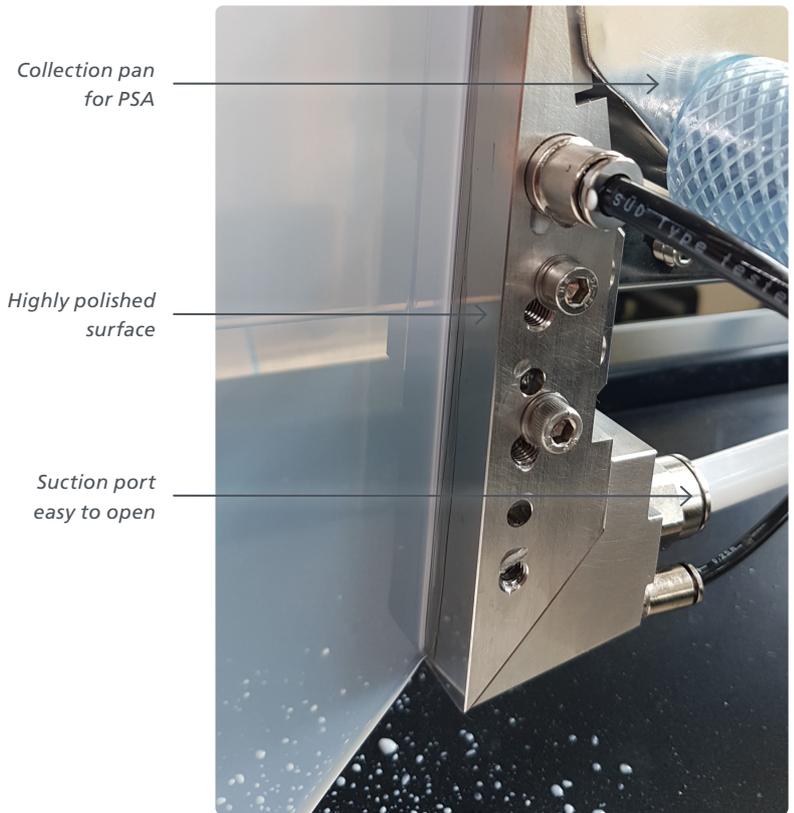
High precision, stainless steel suction-type air baffle unit for a web width same as the die. The air baffle is equipped with a vacuum connection on each side.



Curtain Edge Guides

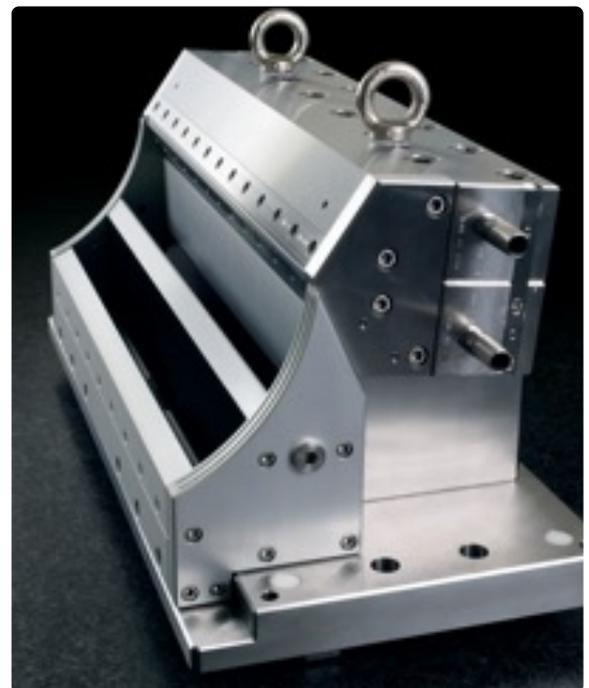
TSE offers different types of Curtain Edge Guides, depending on the application. For example specific for PSA applications as shown in the picture, featuring the following components:

- Guiding water adjustable with extraction at bottom
- Edge guides adjustable in width
- Easy cleaning, less contamination due to polished surfaces



Vacuum box

The vacuum box has a dual chamber box design and is constructed from stainless steel. The box's adjustable front plate allows the user to set the gap against the incoming web. The special side plates seal perfectly against the roller, and the inclined floor of the downstream chamber facilitate liquid drainage during the cleaning process. For high viscosity fluids the box will have a flushing bar to help with draining the chamber. Vacuum ports, a port for a pressure gauge and a port for flushing liquid are all included in the box.



Slot Die with dual chamber vacuum box

Cleaning Station for Slot Dies

Our cleaning station for slot dies is designed to deliver outstanding results while simplifying your maintenance processes. Engineered with efficiency and sustainability in mind, it offers a range of compelling benefits for your operation:

- Designed for battery, fuel cell as well for medical applications
- Residue-free, efficient cleaning no coating fluid inside the die
- Extended lifetime of your slot dies
- Less maintenance, more productivity
- Less risk for damaging the die
- Eco-friendly and user-friendly design
- Closed system to minimize exposure of the operator to hazardous substances

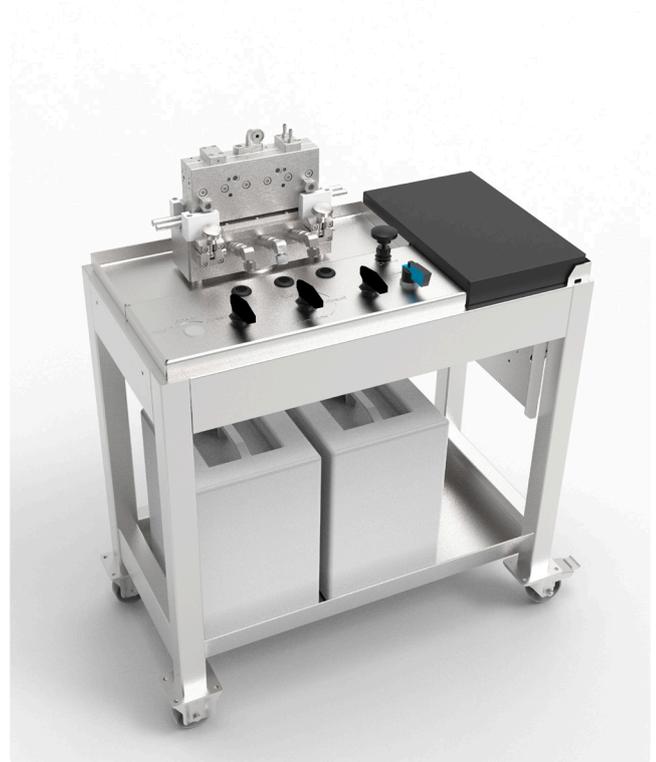
Optimizing the cleaning procedure is an important step towards more **cost-efficient operations in daily business.**

Range of application (order of magnitude only)

- Die type: **slot die**
- Number of layer: **1 (2-layer – on request)**
- Pump for the cleaning fluid
1 or 2 pulsating pumps for 1 or 2 different solvents
- Barrell for fresh cleaning fluid and waste fluid
each 1 piece for single layer dies

TSE recommends using the cleaning station with a special high-performing cleaning agent from a partner with the following advantages:

- free from halogenated and aromatic solvents
- free from CMR-substances
- very mild labelling
- no corrosive effect on metal surfaces
- no dangerous goods
- very high bath loading capacity = long service life
- very high dissolving power



Services

While outstanding precision is important, it would only be half of the story without good services. TSE offers a comprehensive range of services to accompany your project from its start to the very end.

Consulting

New to the field of pre-metered coating or with decades of experience, our application engineers support you with any questions you might have. Drawing from over 60 years of experience, we help you move forward in your project.

Coating tests

You bring the idea and raw material, we bring the technology. Verify the feasibility of your idea with trials at our or your own facility.

Refurbishment

Your die has a damage? No worries, the specialists at our facility will bring it back to original perfection. We even repair dies from other manufacturers.

Engineering

Discuss your specific requirement with our engineers and will design a solution tailored to your process.

Rental dies

Rental dies with up to 1.7m coating width are at your disposal to further develop and test new coating ideas.

Propelling technology together



PRECISION

Excellent slot accuracy leads to less material consumption



SCALABLE

Process parameters transferable from R&D over pilot to production



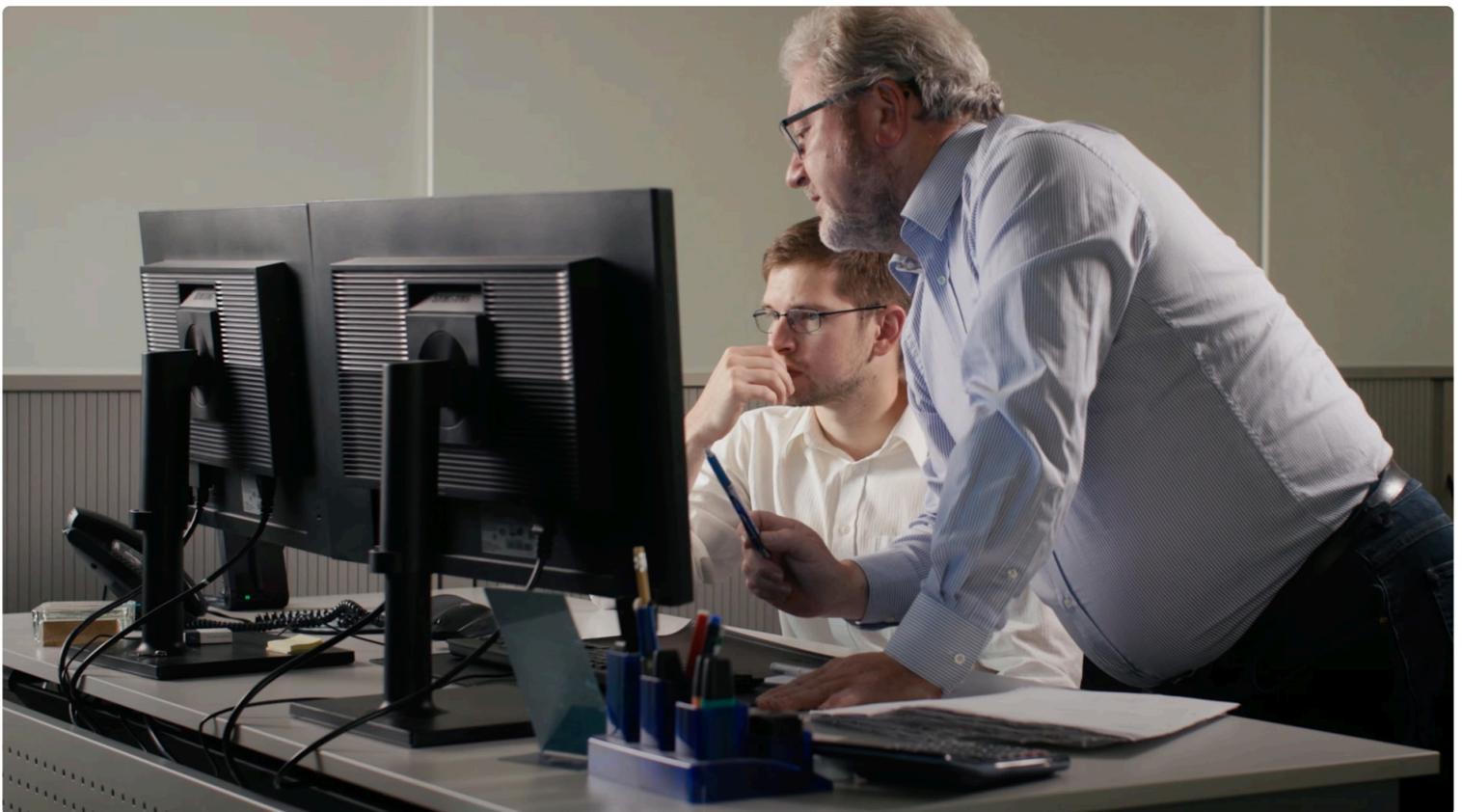
MULTILAYER

Simultaneous production of different layers enables a wide range of products



SUSTAINABILITY

Lower raw material consumption due to high coating uniformity



CONTACT

We look forward to your inquiry



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