Premetered size presses different methods for optimization of product-, operation- and economical performance

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1 Abstract

UMV was founded in 1876 and became sister company with former BTG Coating Systems in 2002. The two companies were combined and got the name UMV Coating Systems in 2007. UMV Coating Systems is a supplier of coating machines since 1973 and the initial product was the Billblade coater, one of the most sold coaters in the world.

TWIN [™] Sizer, HSM

UMV Coating Systems started the development of roll coating technology in the middle 1980íes, in order to make it possible to coat and surface size weak base sheets with high recycled fiber content and or low basis weights and the first TWIN[™] Sizer, HSM was installed in 1991 at Papateries Bourray France to coat and surface size, low basisweights recycled printing paper.

TWINTMSizer, HSM technology has in the meantime been sold to 75 references for different applications, surface sizing, pigmenting, and coating on various base sheets from Bible paper to board. Installed ON- and OFF line.

The basic technology behind the TWINTMSizer, HSM is the premetering principle. It is based on the wire winding of the metering roll thus creating a volumetric metering with long service life due to the big diameter and mass of material. The cost level for the refurbishment of the wire wound roll is the cost of the wire itself which is about 1/5 compared to the corresponding costs for the conventional rod premetering principle. The large HSM premetering roll is found to be forgiving to small particles in the base paper or in the media. This has resulted in that most TWIN TMSizer, HSM units are installed for treatment of base sheets with up to 100 % recycled fibers. The most important application being surface sizing of Liner & Fluting based on recycled fibers, where the volumetric premetering allows for uniform application of wet amounts up to 20 gsm per side, which is of interest when penetration is wanted.

The strength improvements that are achieved by starch surface sizing with TWIN Sizer, HSM can be demonstrated by an example for 180 gsm testliner.

A base sheet RCT value of 1,3 kN, would be improved by 25 % by 6 gsm total application and 35 % by 8 gsm total application. A base sheet Burst Index value of 1,5 kPa/gsm, would be improved by 25 % by 6 gsm total application and 30 % by 8 gsm total application.

The TWIN[™] Sizer, HSM is based on the volumetric premetering technique, which has a working range from 8 - 20 gsm wet application, depending on choice of wire diameter. The dry pickup is controlled by the solids of the media for a chosen wire diameter.

TWINTMSizer, Gravure

In order to get a working range that also takes care of low wet amounts, 4-8 gsm, like the Gate Roll principle as well as 8-20 gsm, then UMV Coating Systems developed the TWINTM Sizer, Gravure, where a gravure roll is the base for the premetering.

This technology gives a two dimensional coatweight control where the dry coatweight/pickup is controlled by a combination of the gravure roll speed and chosen solids level. The TWIN Sizer, Gravure can due to the possibility to apply low wet amounts run at high speed +1500 m/min minimizing fogging that otherwise is a problem by roll coating. The gravure pattern gives a uniform application due to the fine distribution of the engravings in the gravure roll. There are 80 cells/cm. An interesting example is at Korsnäs Frövi mill where they apply reverse side treatment with the actual TWIN Sizer, Gravure applying 3 gsm coating at high solids with excellent distribution. Pilot trials show that printing paper can be treated with 5 gsm wet amount (0,5 gsm dry at 10 % solids, 0,75 gsm dry at 15 % solids mening 4,5 gsm water to be evaporated) of starch solutions with completely stripe free distribution.

2 TWINTM Sizer, HSM technology

The TWINTMSIZER, HSM as such is a premetered size press and can be supplied in either upwards or down wards web run. The functionality of the TWINTMSIZER, HSM can be divided into three different functions: application, premetering and transfer.



Figure 1. *TWIN*TM*SIZER, HSM with upwards or downwards webrun*

2.1.1 Application

The web run has impact on the application of starch/media. If the web run is upwards then the application is done into a pond that is formed between the transfer roll itself and the HSM metering roll. If the web run is downwards, then the application is done via a spray application.

2.1.2 Premetering

The premetering is done with a wire wound roll, the HSM roll, and it is in principle volumetric, dependent on the wire diameter, but it is also partly hydrodynamic, because of the big diameter of the HSM roll (see **Figure 1 and Figure 2**). The level of hydrodynamic impact depends on the viscosity of the media and the speed of the web.

Pressure surface over-skewed roll



Figure 2. HSM premetering and skewing principle

The hydrodynamic component of the premetering lubricates the metering zone and reduces wear of the rubber transfer roll surface.

The volumetric part of the premetering is most dominating for low viscous solutions utilized by surface sizing. The pickup and distribution is very stable in this case.

To ensure the good distribution CD/MD except for the volumetric premetering there is a skewing mechanism, see Figure 2, installed on the premetering roll. It's function is to give the same linear pressure all across the machine between the metering roll and the transfer. The reason for having this variable crowning is to make it possible to run with different linear pressures between the HSM and transfer roll. The linear pressure is normally run between 5-10 kN/m, dependent on application, surface sizing, pigmenting or coating.

2.1.3 Transfer

The transfer roll hardness by TWINTMSIZER, HSM technology, can be chosen in a wide range from 20-90 P&J by the HSM premetering technique. The choice is dependent on the need for pene-tration of media and the need for a good film forming. Soft transfer rolls give good covering characteristics and hard transfer rolls give penetration.

3 Surface sizing of Liner & Fluting with TWIN [™] SIZER, HSM

About fifteen years ago the paper industry started to utilize metered size presses (MSP) for surface sizing of fluting and liner. The MSP:s gives approx. 25% higher production capacity and approx. 35% less drying cost compared to the pond size press for a given number of drying cylinders. It gives also same strength development for the important parameters such as Burst, RCT, and CCT.

Based on 12 years experience from excellent performance by surface treatment of base sheets containing recycled fibers it was quite natural to enter the Liner & Fluting market with the TWIN™SIZER, HSM technology. The metering element, the HSM roll, has a big diameter compared to the metering rod of other conventional MSP:s and therefore more forgiving for recycled fibers. This result in minimal risk for streaks caused by fibers stuck in the nip between the metering element and the transfer roll.

The first TWINTMSIZER, HSM for surface sizing of Liner & Fluting was installed in Asia and has now been running since 2001. Due to the excellent performance fourteen more TWINTMSIZER,

HSM units have been sold for this application. The widths of the units are 4,5-7 m and they are running at speeds 600-1200 m/min.

3.1 Specific issues by corrugated Liner & Fluting

The quality/strength improvement of corrugated medium is dependent on the amount of starch that is applied. The higher amounts of starch the higher the strength improvements. The solids of the starch solution and TWINTMSIZER, HSM conditions determine the starch amount applied. The below table shows the wide range that can be controlled by the conditions/settings for the premetering.

 Table 1. Starch pickup versus solids

Solids %	Dry pickup gsm Total both sides	Wet Pickup Total both sides.
12%	2,5 - 7 gsm	20 - 55 gsm
16%	3 - 8gsm	18 - 50 gsm
20%	4 - 9 gsm total	20 - 45gsm

The surface sizing of Liner & Fluting requires a relatively big wet amount in order to apply a high starch amount for strength improvement and penetration. A high solids increases the viscosity and this result in low penetration. In order to improve the penetration it is essential to increase the temperature in order to get lower viscosity for better penetration.

In many installations customers want to be able to run with premetered mode for low basis weights and with pond size press mode for high basis weights. The upper border line for premetering is in the range of 180 gsm.

The wet pickup by premetering is determined by the choice of wire diameter and linear load between the HSM premtering roll and the transfer roll.

The pickup level from 20 gsm total to 40 gsm total, both sides, can be applied through premetering. To go from 40 gsm total to 53 gsm total both sides needs mini-pond or pond mode.

A TWIN[™] Sizer, HSM in downwards webrun can be run in all three modes; premetered -, minipond- and pondmode.



Figure 3. surface sizing of Liner and Fluting with TWIN ™ SIZER, HSM

Above figure show a typical lay-out for the TWINTMSizer, HSM for surface sizing of Liner & Fluting.

3.1.1 Particles from Base Sheet and Starch Quality passes the Premetering area

The big diameter of the premetering roll gives a low specific linear pressure between the HSM metering surface and the transfer roll. This in its turn means that loose particles that often occur in base sheets of recycled fibers, can pass the metering surface without causing streaks.

It is appealing from cost perspective to utilize the lowest grade of native starch, for instance Tapioca starch. The lowest grade is not cleaned to the same extent as more expensive grades and it has particles that to a high degree originate from the shell of the Tapioca. These particles can swell and cause problems in the circulation systems. Low-grade starch needs better screening in the circulation system.

3.1.2 Transfer - Impact on Penetration

By surface sizing of Liner & Fluting there is basically a need for penetration to achieve optimum product characteristics. Low viscosity, high linear pressure and hard rubber surface gives comparably deeper penetration. The linear pressure used, is up to 40 kN/m and the rubber hardness is, as a rule, 30 P&J by surface sizing of Liner & Fluting.

3.1.3 Starch Conversion – Impact on Starch Stability

The starch quality and the relation between solids, temperature and viscosity are important for the development of the strength improvement and the operation of the sizing unit. As seen in the **table 1**, it is possible to get the same pickup at different solids. The choice is based on quality and energy considerations. In other words lower solids, means lower viscosity and deeper penetration but the drying energy demand will increase.

Pre-converted starches (normally oxidized) have a stable relation between temperature, solids and viscosity. The drawback is the higher costs. The other solution is to convert native starch at the mill, which means lower costs and is therefore the rule for corrugated Liner & Fluting.

The converting of the native starch is basically done with two different prevailing techniques; APS and enzyme conversion. The APS is less stable, meaning that the viscosity increases rapidly by loss of temperature in the starch. The enzyme conversion gives comparatively a more stable relation between viscosity and temperature.

3.2 Expected strength improvements by surface sizing of Liner & Fluting

The quality/strength improvements expected by surface sizing of Liner & Fluting was studied in pilot scale. See below graphs.

The surface sizing starch utilized at the trials was a pre-converted oxidized maize starch.

3.2.1 RCT, Ring Crush Test, improvement by surface sizing

The RCT, Ring Crush Test value increases with starch amount. as can be seen in figure 4.



Figure 4. RCT Ring Crush Test

3.2.2 Burst Index, improvement by surface sizing

The Burst index increases by increased starch amount as can be seen in figure 5.



Figure 5. Burst Index

4 TWIN Sizer, Gravure, Technology

4.1 TWIN-Sizer Gravure Technology in general

The TWIN Sizer, Gravure as such is a premetered size press and is supplied for either upwards or down wards web run. The TWINTMSizer, Gravure is introduced because it has a wider range of application compared to conventional premetered size presses. It can except for the normal premetered application range also apply low wet amounts like the Gate Roll but with better coatweight/pickup control, profiles and microscale distribution.



Figure 6. TWINTMSizer, Gravure with downwards resp.upwards webrun.

The functionality of the TWIN Sizer, Gravure can be divided into three different functions: application, premetering and transfer.

4.1.1 Application

The web run has impact on the application of starch/media. If the web run is downwards the application is done into a pond that is formed between the gravure roll itself and the metering blade beam. If the web run is downwards, then the application is done via INVO[®] Jet pplication. See figure 6 above.

4.1.2 Premetering

The premetering is done by metering the media into the gravure roll cells with the help of a steel blade with a soft polymeric tip. The gravure roll is presented in the below figure 6,





The Gravure premetering is a based on the volumetric principle. The premetered volume is controlled by choice of cell size and the speed of the gravure roll in relation to the transfer roll/machine speed. (In special cases it can be of interest to utilize a hydrodynamic component, like for instance by coating with clay color at high solids in order to avoid bleeding.)

The below graphs show, the coatweight control by surface sizing. In this case the cell volume is 20 cm3/m2.

I can be concluded that it is easy to control the amount of starch by control of the gravure roll ratio to transfer roll speed. The Graphs are based on the choice of cell volume 20 cm3/m2. Bigger cellvolume give a higher range of CWT/pickup.

The Wet applied weight in the graph below shows that we have similar behavior applied wet amount versus Gravure roll speed for all solids levels; 10, 15, 20 and 25 %.



The below graph shows the relation between dry CWT/pickup of starch versus the gravure roll speed.



(The deviation from a straight line can be explained by difficulties to measure low pickup levels.)

4.1.3 Transfer by TWIN Sizer, Gravure

The transfer roll hardness by TWIN Sizer, Gravure technology, can be chosen in a wide range from 20-90 P&J by the Gravure premetering technique. The choice is dependent on the need for penetration of media and the need for a good film forming. Soft transfer rolls give good covering characteristics and hard transfer rolls give penetration.

The indirect premeting done in the TWIN[™] Sizer, Gravure,see explanation in adjacent figure 8, is beneficial, since it protects the rubber surface from wearing. The good properties of the surface is kept longer than by direct premetering like Rod or HSM. In our mill experiences we have seen 7 times prolonged time between regrinding of the rubber transfer rollsurface. The good condition of the surface also ensures a good distribution/patternfree treatment. This is of high importance especially by low wet amounts, in the range 5-9 gsm. (If the rubber surface has markings, then this will immediately be seen in the treated paper or board.)





Since the film consists of the small pixels (app. 80 cell/cm) developed by the gravure roll we get a uniform distribution by the premetering. This means that the redistribution in the transfer point is less critical. Therefore it is possible to reduce the wet amount and still get a good distribution. In the below graphs, we can see two interesting examples. It concerns surface sizing of wood containing paper with 0,5 gsm at 10 % and 0,8 gsm at 15 % solids.In both cases this means a water amount of 4,5 gsm. We can see a uniform coverage by this small amount of starch. The energy demand is also low.







Figure 9. Surface sizing of woodcontaining sheet with 0,8 gsm at 15 % Solids Iodine

5 TWINTM Sizer, Gravure for reverse side treatment of cardboard.

The coverage characteristics by roll coating can be applied single sided by the TWIN[™]Sizer, Gravure coater. Below is one example at Korsnäs Frövi Board Mill.

5.1.1 TWIN[™] Sizer, Gravure, Korsnäs, Frövi mill

A TWINTM Sizer, Gravure (MONO) coater was installed, October 2006, on the board machine in the Korsnäs, Frövi mill with the target to improve the surface sizing of the reverse side on coated liquid packaging board and general packaging board produced with unbleached back. Furthermore the new coater made it possible to produce a new developed general packaging board grade with a low grammage film coating on a bleached bottom side.

The reverse side coater was chosen in competition with conventional MSP's. The decision factors were the high controllability and flexibility, necessary to meet the multipurpose needs by the project.

The experience shows that the reverse side treatment in Korsnäs Frövi mill is characterized by good coverage and uniform distribution.

Good printability results are achieved also at low coat weights. The targets set up for the new developed product and existing products are achieved.

The coater meets high operational demands with good controllability and availability.

The uniform distrtibution and coverage makes it possible to apply small amount getting excellent printing results.



Figure 11. TWINTMSizer, Gravurecoater (MONO)installed at Korsnäs Frövi Board mill

5.1.2 Machine design in Korsnäs Frövi

Below pictures show a foto of the TWIN TMSizer, Gravure installed in Kornsnäs Frövi and corresponding Process explanation.



Figure 12. Foto TWINTMSizer, Gravurecoater(MONO) installed at Korsnäs Frövi Board mill



5.1.3 Quality by surface sizing and pigmenting at Korsnäs Frövi mill

The below picture shows the starch distribution on the reverse side of the board. The applied pickup is 0,35 gsm of starch applied at 4 % solids.



Figure 14. Starchdistribution (Iodine)by 0,35 gsm applied at 4 % solids with TWIN™Sizer, Gravure at Korsnäs Frövi Board mill

5.1.4 Pigmenting on the reverse side of the board

The TWINTMSizer, Gravure is also utilized for pigmenting on the reverse side of the board.

As can be seen a very small amount 3 gsm dry improves the Printability, Print Mottle. The naked eye can clearly see an improved WTL (White Top Mottle) on the unprinted sheet.



Figure 15. Printing on Uncoated reverse side

Figure 16. Printing on 3gsm pigmeting applied with TWIN Sizer,Gravure (MONO on reverse side

The Improved Print mottle can be seen in the above printing images. The improvement is also explained in the below graph comparing different methods and pickup levels. By Carton Board it is essential to keep the basis weight low to geet bulk and stiffness. 3 gsm application with TWIN[™]Sizer, Gravure offered a good solution under these conditions.



5.1.5 Coat weight control in Korsnäs Frövi mill



The controllability of the coatweight is demonstrated in the below graph.

6 Conclusion

The premetered size press is a good option for surface sizing of Liner and Fluting in modern production lines. It has less drying needs compared to the conventional pond size press and can be run at substantial higher production speeds

The penetration of starch depends on the viscosity of the starch and the transfer roll hardness. The viscosity of the starch is dependent on the temperature and it is therefore important to have good control of the starch temperature, from cooking to the point of application.

The Liner & Fluting mills often combine the possibility to run pond and premetered size press, in which case high basis weights are run in pond mode and low basis weights are run in premetered mode.

The Gravure premetering technique has a big application range, from coating to small amounts like the Gate Roll but with better coat weight control, profiles and distribution/pattern.

Gravure premetering technique is successfully operated in board mill environment. It meets the demands on; flexible applications, good printing characteristics (also at low pickups), uniform distribution and excellent control the wet and dry coatweight.