Starch Spraying : A New Technology for Improved Paper & Board Properties

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ABSTRACT

The Application of starch for improvement of various properties of paper and board is well known and new technologies for application are rapidly evolving. This paper covers developments in technique and engineering associated with the spraying of starch. Starch spraying is compared with other methods of applying starch, and its special benefits discussed, with actual case studies.

INTRODUCTION

Surface sizing of paper with starch is well established and has many advantages, including dry-strength, internal-bonding, stiffness and surface-property improvement. Mostly, starch is applied by the size press (basically simple, reliable and uncomplex piece of equipment). However size press has some disadvantages viz. the drying section required after the size press, and high capital cost.

It is the goal of many researchers to match effectiveness of starch applied at the size press by technique that avoids its disadvantages. The advent of starch spraying will not universally replace the size press, and will be used on machines built without a size press and will be used in addition to the size press on some grades and machines.

Starch spraying is advantageous over conventional wet end pre-gelatinised starches. It has the advantage over cationic wet-end starches of applications specifically to the paper surface with considerably greater cost-effectiveness. High percentages of starch can be applied by spraying without losing its high retention characteristics.

PRODUCTS FOR SPRAYING

The spray starch must be designed to perform various functions

1. It must perform well in the spraying equipment. It must resist settling out and have uniform rheology for spraying.

2. It must have a small partical size so that the number of fibre/starch/fibre link is maximized.

3. It must have a large enough particle size to enable it to be retained by a filtration mechanism.

4. Its granules must swell, burst and, if possible, migrate a little, during the passage of the paper web through the drying section.

Some of these requirements are in conflict, so in practice, a compromise is reached to give optimum properties, also taking commercial factors into consideration.

For efficient starch gelatinisation, the starch granules must reach its gelationisation temperature whilst it is still surrounded by several times its own weight of water.

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Ideally, the starch granule should be heated to its gelatinisation temperature of about 70°C as quickly as possible in the drying section, whilst the moisture content of the paper is still high. It is sometimes necessary to adjust the early cylinder temperatures to have a faster initial rise in temperature. If the desired temperature/moisture profile of the sheet in the drying section is not obtainable, then it will probably be necessary to use a specially-modified starch with a low gelatinisation temperature and a low energy of gelatinisation.

Closely linked with the gelatinisation temperature and energy of the starch is its bound water content. If the starch is unlikely to reach its gelatinisation temperature until well down the drying section, the deficiency of water available in the sheet for complete gelatinisation of the starch granules can be somewhat offset by using a starch which has water already bound up in its granules. A process (covered by CPC patents) provides a controlled partial swelling of the starch to give a granules with a high bound water content and a lower energy of gelatinisation. This larger, softer, partially-swollen starch granule is also more suitable for those very low substance and open sheets where retention can be a problem.

BENEFITS OF STARCH SPRAYING

1. Raw Material Savings: Initial euphoria over the concept of starch spraying led us to consider its application to improve paper properties, particularly on machines without an existing size press and in applications where starch had never before been used. Recent economic changes have altered the emphasis, and starch spraying is now also looked at as a means of reducing the cost of paper made on machines with, as well as without, a size press.

First, there is the possiblility of reduction by replacing cellulosic fibre by starch to a maximum increase of 10%. Upon adding 5 per cent by spraying, the strength of the paper increased, so allowing a maintenance of the status quo by increasing the filler by, typically, 5 per cent.

Energy Savings: If the size press could be eliminated, apart from any increase in machine speed a considerable amount of energy could be saved due to reduction in steam consumption in additional dryer section of the size press. Considerable saving in electrical power due to less refining required.

2. Technical Improvements: A selection of typical results achieved recently is presented below.

a) Burst Factor : It is general rule that the better the paper properties to start, the lower is the percentage improvement with starch spraying. Burst strength is typical in this respect as Table demonstrates.

TABLE IMPROVEMENTS OBTAINED IN BURST STRENGTH

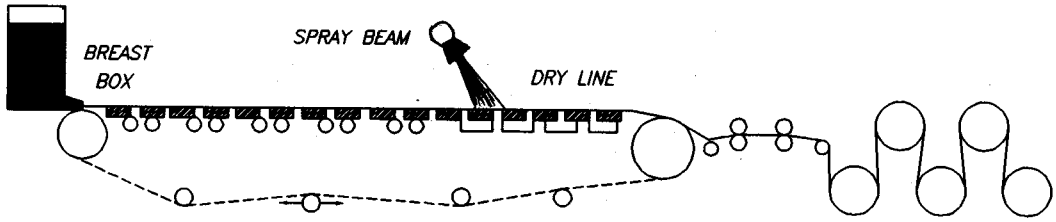
b) Plybond Strength : The overall plybond strength of a multiple board is only as high as the weakest plybond. Identification of the position of failure is important. For example, a three ply board with an overall plybond strength of 68 kPa between the liner and middles and a plybond strength of 70 kPa between the middles and the back. An improvement of the liner- middle plybond to 100 kPa would only result in an overall increase to 70 kPa as the failure would move to the next weakest plybond. For some boards, it may only be necessary to spray in one position; in others, more than one. Table shows

Type of Paper	Raw Material	Burst Factor		Increase %
		Fore	After	
Kraft Paper	70% OCC	18	24	33
(100g/m^2)	30% Indian Waste			
Kraft Paper	50% OCC	19	23	21
(170 g/m^2)	50% Indian Waste			
Kraft Paper	100% Indian Waste	12	15	25
(90 g/m^2)				

Application

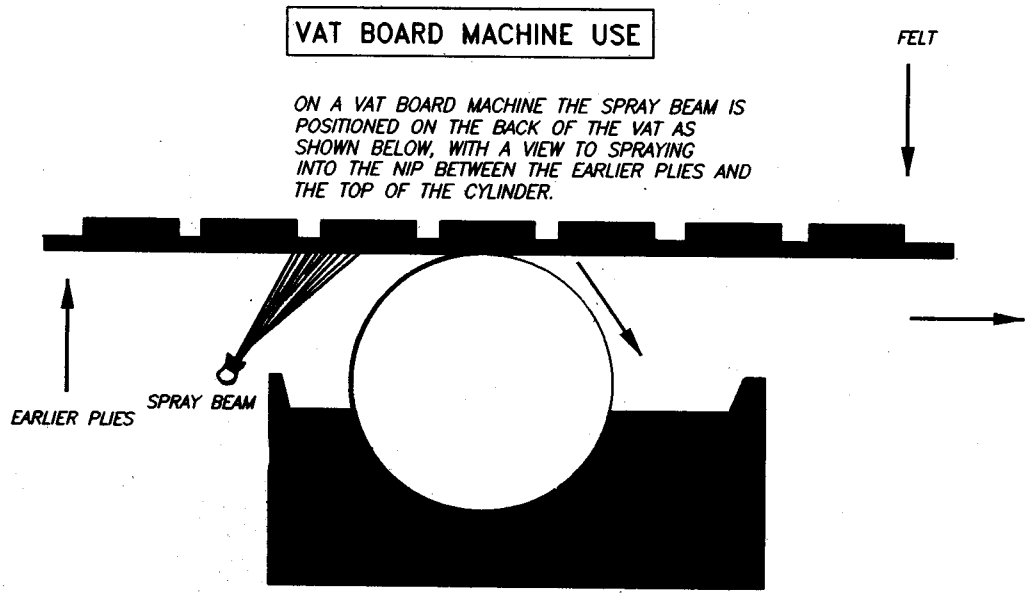
CONVENTIONAL FOURDRINIER MACHINE USE.

ON CONVENTIONAL FOURDRINIER MACHINES THE BEAM IS MOUNTED OVER THE WIRE SOMEWHERE BETWEEN THE HEADBOX AND THE DRY LINE.



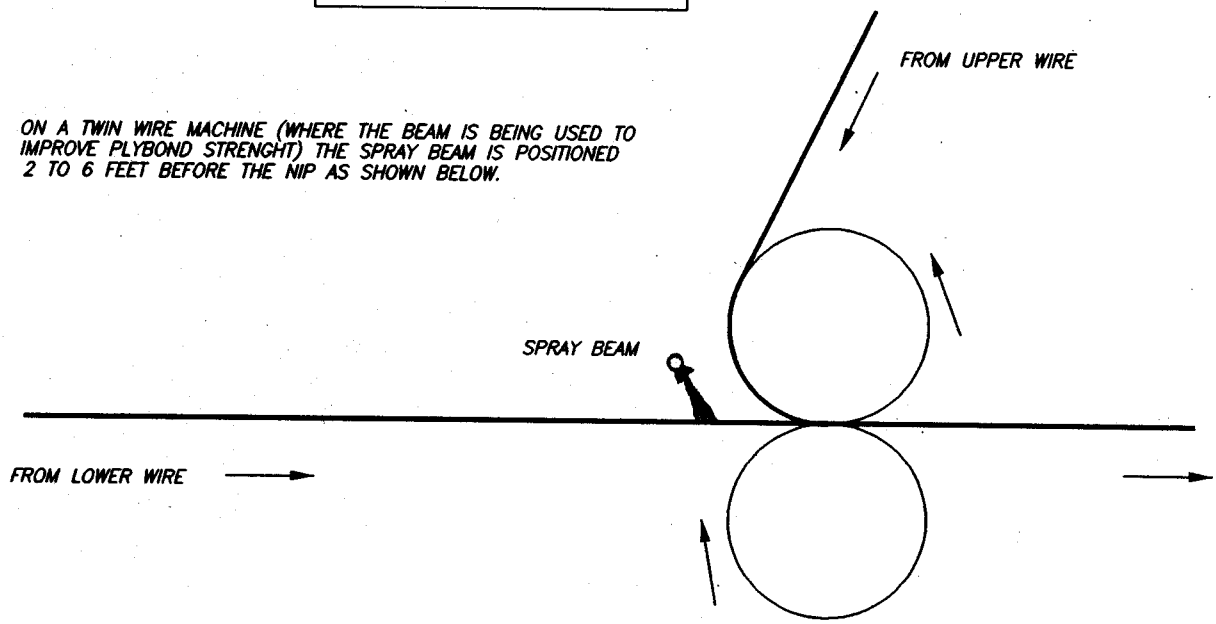
VAT BOARD MACHINE USE

ON A VAT BOARD MACHINE THE SPRAY BEAM IS POSITIONED ON THE BACK OF THE VAT AS SHOWN BELOW, WITH A VIEW TO SPRAYING INTO THE NIP BETWEEN THE EARLIER PLIES AND THE TOP OF THE CYLINDER.



TWIN WIRE MACHINE USE

ON A TWIN WIRE MACHINE (WHERE THE BEAM IS BEING USED TO IMPROVE PLYBOND STRENGHT) THE SPRAY BEAM IS POSITIONED 2 TO 6 FEET BEFORE THE NIP AS SHOWN BELOW.



some typical improvements obtained. Our case study 1 in the following paper highlights the various improvements obtained.

c) Pick Resistance : Strach spraying is most effective in improving the surface strength of the top side of the sheet. This is not necessary a disadvantage as it is often the top side that is in need of improvement. Improvements in the wire side are also possible. Table and show some typical results.

d) Stiffness : Case studies which will follow show the improvements in stiffness properties such as rigidity and concern (CMT) achieved by spraying starch, and again show how improvements achieved depend on the furnish quality.

e) Surface Finish: Smoothness and Porosity In several cases we have been able to improve MG finish, even a wire-side glaze if the correct spray position is selected.

CONCLUSION

Starch spraying has definitely moved out of the development phase and has become a recognised tool of the paper maker. We can now see quite clearly the usefulness of this technique and how it fits in with other methods of starch application. This is the reason that the technique has been very well appreciated by paper maker and there are a number of units in operation in short span of time.

It is possible to make some reasonable predictions of the sort of level of improvements in properties that can be obtained by starch spraying on machines without a size press. In addition, it is also feasible to supplement the size press to obtain further improvements of properties, significant raw material savings through fibre replacement, and the possibility of savings in drying energy.

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REFERENCE

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