

REVIEWING PAPER-WEB SPRAYING FOR THE FUTURE

- INCORPORATING LOW-PRESSURE SIZING & COATING TECHNOLOGY

What happened to spraying technology in commercial paper coating and sizing applications since our first article (Paperi ja Puu Vol 83/no. 7/ 2001) was published? A resurgence of interest today, combined with new capabilities and new applications fuels a revival but requires industry support.

Figure 1



Paper spraying was a hot topic at the start of the millennium. Trade journals and conferences were very optimistic and excitedly touted bright future prospects. It was a new breakthrough. The front running concept being promoted at that time was high pressure spraying. But there have been few reports during the past few years concerning successful paper spraying applications. The big European commercial trial initiated in 2003 drifted away over a prolonged start-up and a lack of results that supported initial publicity. Few major paper companies continue to carry an expressed interest in high- pressure applications. There are few new journal articles.

With this in mind, it was very encouraging to read the Paperi ja Puu 7/2004 research article by Anne Kuusisto-Rajala et al. from the University of Jyväskylä. Their spray-sizing concept for controlling two-sidedness in SC paper is a very appropriate application. Their research confirmed that low-pressure spraying can position high consistency sprayed material onto the paper surface or saturate the sheet, as required. A second set of trials in 2004 replicated the SC results with high-pressure spraying on a test machine but this experience is not transferable to coating or necessarily to other sizing applications. More recently, other companies have come forward to re-explore spraying applications recognizing that low-pressure spraying is a viable option.

DRYAD Technology Inc. (DTI) has pioneered the patented low-pressure spraying technology development for both coating and sizing applications. The group is committed to low-pressure systems and has demonstrated that today this is the pervasive technology. More recently, new trials have been undertaken on pilot machines that confirm the technology. This article provides an introductory renaissance for low-pressure spraying. For additional background information, our article published in Paperi ja Puu 7/2001 compares high pressure and low pressure spraying.

The low pressure benefits were clear to the initial DRYAD team, based upon their research. The requisite building blocks were re-defined in a second international spray coating and sizing patent WO 94/11116 in 1992. It covered all aspects from special low-pressure spray nozzles to a smoothening device like an air brush or lightly-loaded doctor blade as needed to secure the required surface quality. Further interim patenting and proprietary technology development by DTI have secured both sizing and coating applications, including spray boxes and nozzles. All of these developments have been based upon cost effective systems capable of being retro-fitted upon most paper machines. Figure 1 shows a low-pressure pilot spray unit in operation.

Low pressure development process

It is instructive to consider the various technical aspects, some inter-related, that create successful paper-web spray coating and sizing on a commercial basis. These are the basic principles from a DTI perspective. Research and industrial experience, starting from the beginning, have indicated the following DTI solutions to the major problems encountered:

- Selecting / designing proper low-pressure spray nozzles
- Eliminating nozzle plugging
- Maintaining the spray-cone shape with variable flow rates
- Containing the aerosols
- Attaining the highest quality -- rotogravure surface quality

Selecting / designing proper low-pressure nozzles – a design problem

The first nozzle selection for testing was, of course, the high pressure nozzle, as it sprays anything using brute force. In an early test in the 1970's, high-pressure nozzles were tried in Finland. The results were encouraging but there was no nozzle tip material that would resist the abrasion and aerosols were a major problem. These trials, as many subsequent high-pressure spray trials, ended in failure.

This left the low-pressure nozzles as the viable alternative but the equipment suppliers had nothing really practicable at high levels of operating efficiency. In the late 1980's, the initial DRYAD group began researching and testing various nozzles, including ultrasonic and air nozzles. Many had tried air nozzles, but failed as the nozzles plugged with starches and coatings. Today, there are a couple of specialized and energy efficient low-pressure nozzle designs available, supplied by DTI and an associate.

Eliminating nozzle plugging – part of the design solution

The principal solution to the low-pressure nozzle plugging, was to substitute “gas” for “air” as the driving medium in the patents. The initial patent invoked secondary alternatives to include hydraulic and ultrasound nozzles, and electrostatic-assistance, but these were not the primary delivery systems. In addition there were other issues related to nozzle plugging for sizing and coating:

Sizing - In sizing, steam is the preferred selection to moisturize or to replace the air as it is inexpensive and readily available in all mills. The low pressure trials proved this to be a practical solution using up to 15% starch solutions, while the industry at large operates at much lower solids levels, 8%-10% in size presses, and around 2% in direct spraying.

Coating -The coating nozzles required different treatment. Some coating solution components react with heat and start to solidify on surface contact, including the nozzle interiors. However, wet coating color can always be washed away before it has dried. The solution was totally new nozzles (patented).

Maintaining the spray cone shape – another design solution for variable flow rates

Flow rates determine the amount of sizing / coating laid down. But for the high pressure nozzle, a minor change in flow rate will change the spray pattern and controlling the system of high pressure nozzles individually is challenging, ranging from difficult to impractical.

The proprietary low-pressure nozzles behave differently as demonstrated and reported by DTI at an Atlanta TAPPI Exhibition in early 2002. These special nozzles can spray any amount of desired liquids from zero to their design maximum while maintaining the spray pattern. This provides the ability to spray variable coating/sizing amounts as required on a paper-web surface and, concurrently, operate with complete profile control. This “spray & profile” capability meets the most stringent requirements of the paper-makers. In principle, it is a unique complete “sheet moisturizing” system, to be supplied by the premier profiling and DTI nozzle associate.

Containing the aerosols

The aerosol phenomena persists in any open air spraying, water removal from the wire, in film splitting on presses, with sizing or coating stations, with sheet moisturizers, and in normal rain and fog. The aerosol phenomena was first studied back in the late 1800’s by Nobel Price winner Lord Raleigh. Aerosols form when conditions are right, and these aerosols are always electrically charged when water is present, as the water molecule is bipolar. There is no escape; it requires building a gas tight enclosure and disposing of the aerosols by condensing or washing them back into a liquid. The “gas tight” designation means that the unwanted aerosols cannot escape from the spraying area.

Attaining the highest quality -- a surface suitable for rotogravure printing

The proprietary low-pressure nozzle system provides another advantage over the high-pressure counterpart. With spraying, there is a fast outward moving wave pattern on the web that forces the surface water and liquid to move in the first phase of the surface smoothing process, which in many cases might be sufficient. However, this is not necessarily always the case, and more force might be required. The patented smoothing process, an air blade, lightly loaded doctor blade or similar solution using LAS type rollers, will provide quality over self-metering applications in all instances. This effect was tested by DTI with a major paper maker’s laboratory coater. Their analysis indicated that there was no difference between their standard rotogravure coated paper and low-pressure spray-coated-smoothed paper under a range of operating conditions.

The future – combining low-pressure and high-pressure spraying

The DRYAD low pressure system development by DTI has been a step-by-step process. It has isolated the historic issues and moved from problems to solutions. DTI has welcomed high pressure trials as these have vindicated the low-pressure alternative technology. Concurrently, there is respect for high-

pressure research and the associated Intellectual Property. Undoubtedly there are areas of useful overlap and future collaborative potential. Unfortunately, this is not the direction in which the industry appears to be heading. Seemingly, the high-pressure developers remain slow to expand their vision for extending or combining the spraying technologies.

If the high-pressure spraying system on the market today lacks industry support with no new high-pressure applications, the paper industry needs to revisit the spraying concept. Concurrently, there is an unfulfilled solid market demand for spraying applications and various major companies are looking for efficient spraying solutions.

Industry experts that believe in spraying suggest that the paper industry should support a continuation of spray technology development and implementation. The high-pressure system supplier, in its patenting, established an Intellectual Property position based upon flawed assumptions indicating that low- pressure spraying was not commercially viable. Now DTI has proven this position to be inaccurate through successful low-pressure trials, as shown in one example in Figure 1.

DTI is proposing to support the paper industry and provide a cooperation umbrella for all parties. One suggestion to break the current de-evolution for spraying is that the paper industry, through an common group (an industry R&D group or a group of committed paper producers), join forces and properly organize the implementation of spraying technology. Working with researchers and suppliers, the intent would be to create the best technology. The industry needs this type of independent support.

For more low-pressure spraying information, with patenting details and to indicate support, contact www.dryadtechnology.com.