Achievements In Spray Skin Technology

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ABSTRACT

Spray skin elastomer technology has been utilized in industrial scenarios for the application of a soft feel, leather-like "skin" material, mainly used in the automotive industry. Elastomers applied with the spray technology allow the manufacturer to apply the skin in various thicknesses, locations, and colors as desired by the skin producer. Typical automotive applications are consoles, dashboards or instrument panels, and interior door panels.

This paper will discuss the new innovations that Cannon has developed in order to facilitate the application of the spray skins. Although spray skin technology is not specifically a new technology on its own, Cannon has developed several unique and cost effective alternatives to how the sprayable skin is applied to its respective tool. These innovations help to provide the manufacturer with maximum versatility, including the ability to control the addition of multiple stream additives on demand as needed. This additional stream can be a color additive, or any suitable chemical that the process should require. Also discussed will be the unique Cannon spray skin mixhead, which is relatively light weight, versatile, small in size, and production tested.

APPLICATIONS

The application of spray skin polyurethanes is a unique way for suppliers to provide coverings that are durable, cost effective, leather like, and can be formed to fit just about any type of mold. The demand for expensive automotive interiors without the desire to pay for such and the trend to eliminate PVC containing items from the automotive interiors has heightened the demand for this application. Production spray skins are currently utilized in car models produced by Daimler Chrysler, BMW, Volkswagen, GM and others, with future applications expected to continue to increase substantially.

Spray polyurethane (actually elastomers) are applied to produce several different automotive products. The main applications are dashboards (instrument panels), consoles, and internal car door panels. Automotive suppliers are now using spray skins to replace vinyl in many automobiles, and the advantages of spray skin over conventional vinyl produced parts include the following:

- Appearance - spray skins can duplicate virtually any surface to which it is applied. In this way, the skin can successfully take on the look of leather including the detailed grain appearance.

- Wear Resistance - spray skin polyurethane has very good durability and can withstand severe punishment. The durability of spray skin PU is very high, including the ability to handle extremely cold temperatures without cracking or breaking down.

- Excellent Detail Retention - Spray skin will retain any feature that the mold possesses. These can include grain (to represent leather), stitching, or any other design that the mold may entail.

- Fogging issue - Vinyl products tend to release chemicals that cause a "fog" to appear on the inside of vehicle windows. PU skins do not emit these chemicals which eliminates this fogging issue.

- Bonding to other PU - For applications where a back foaming is necessary, the PU skin can be directly back foamed in a single additional step. The polyurethane foam bonds extremely well with the PU skin.

- The fact that the skin and the backing are made of the same material greatly facilitates their recycle.

TYPICAL SPRAY SKIN PRODUCTION SETUP

A typical scenario for spray skin production involves the following components:

Dosing Machine - typically this machine includes the basic components of day tanks, metering pumps, filters, in-line high pressure heaters, flow meters, and heat exchanger.

Typical chemical systems in spray skin require elevated temperatures for processing. The higher temperatures (140-155 deg. F) assist in mixing and aid in the fast curing process, as desired spray skin demold times are generally in the 45-60 second range.

Robot - The nature of this process requires the necessity of a spray robot for the purpose of applying the PU. This is needed for both safety reasons as well as for the purposes of achieving duplicity in the production environment.

Exhaust Booth - The atomizing of the polyurethane requires the use of an exhaust booth to control the overspray of the parts.

Wand and Tip - The typical spray setup involves a spray tip for applying the PU skin, mounted on a wand or tube which contains an internal static mixer. Various types of spray tips can be utilized on the Cannon spray system including cone, fan, etc.

Solvent System - Due to the necessity for a wand and spray tip, a solvent flush system is required to purge the wand and spray tip of residual chemical components that remain after the spray is complete.

Tooling/Molds - Typical spray skin molds are of nickel shell design for scratch resistance and superior heat dissipation purposes. Surfaces of nickel shell molds have a very high resistance to production environment wear and tear and have the capacity to reproduce fine details. For spray PU only half of the total mold is required since there is no need for mold clamping or compression of the PU if no back foaming is to be performed.

Mixhead - The Cannon spray skin mixhead is a hydraulically operated self-cleaning direct impingement style mixhead. Attached to the head is a wand, a spray tip for the application of the skin, and a flushing block for the solvent cleaning of the wand and tips. The wand is required to permit the lay down of the PU on the tool where necessary, including the ability to spray into deep undercuts especially on instrument panel applications.

Turnkey Systems - Production of spray skin parts involves the employment of one or several different delivery line systems. Common systems are:

- Cannon designed Rotoflex or Pit Stop Power and Free Conveying Systems
- Turntable Design
- Carousel
- Stationary Fixtures

Figure 1: *Rotoflex Line*

Figure 2: *Pit Stop*

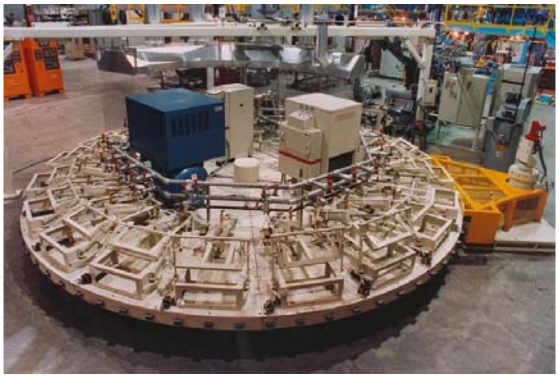

Figure 3: *Turntable*

Figure 4: *Carousel*

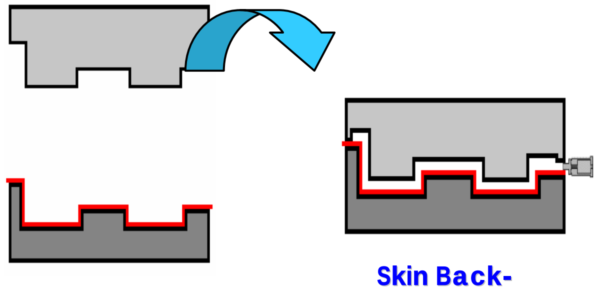

Figure 5: *Spray Skin Back Foaming*

Typical demold times are within 60 seconds, which permits relatively high production rates. In the event that the skin is to be directly back foamed, the mold can be either transferred to a foaming station or in some applications if the mold is designed as such, the tool handles spray and back foaming jointly.

For productions scenarios, first the heated mold (temp= 155-160 deg. F.) has an in-mold coating applied which will yield the colored skin. Then the PU skin is sprayed onto the tool by the spray robot, again with the chemicals being heated to 140-155 deg F for assistance in mixing and decreasing demold times. After approximately 50-60 seconds the skin, if not being directly back foamed, is demolded by the operator. Typical skin thicknesses are in the range of 1 mm +/- 0.2 mm.

Following the spraying of the tool, the mixhead proceeds to the flushing station where a cleaning of the mixhead is accomplished utilizing the solvent circuit. Typical solvents are di-basic ester (DBE) or M-Pyrol (methyl Pyrrolidone) based.

CANNON'S NEW APPROACH

In 2001, Cannon began to enter the spray skin market by manufacturing its first machine dedicated solely for PU spray skin applications. Through testing and continued improvements, Cannon was able to create a unique method for mixing and applying the spray skin.

The Cannon solution to improving applicability started with its mixhead. Cannon decided to rely on a production tested mixhead rather than to invent a new model. By pursuing the solution through this method, Cannon was able to utilize a mixhead that they knew was dependable and operated through conventional methods utilizing standard Cannon fittings and orifices. The head is small by design measuring only 5" long, lightweight (weighing less than 2 3/4 pounds), and functions via a simple single hydraulically operated piston. Chemicals recycle through the mixhead piston, so that shot accuracy is improved and the chance for lead or post lag is eliminated. The chemical mixing is initially achieved by direct impingement method in the mixhead which begins mixing the foam as soon as the mixhead opens. This head is also capable of mixing at pressures ranging from 1800 to 3000 psi, at flow rates ranging from 10 to 130 g/s total flow for the main chemical streams.

The Cannon process also utilizes another unique feature. The dispensing wand or tube on the Cannon mixhead is completely hollow. This has extreme advantages over utilizing a typical production wand with an internal static mixer that include the following:

*** Low cost** - the hollow tube cost is minimal as compared to a tube containing a static mixer.

*** Easily Replaceable** - the wand tubing used is standard tubing available commercially and can be purchased through most industrial suppliers. A manufacturer can have a large stock of wands on hand for very low cost.

*** Maintenance Free** - Since the tube cost is very low, it can either be cleaned via standard solvent soaking methods or simply discarded and replaced with another wand. If wand cleaning is desired, no static mixer exists to hinder cleaning efforts. Wand change on the mixhead takes literally seconds.

Figure 6: *Cannon Spray Mixhead*

Figure 7: *Complete Spray Mixhead Assembly*

* **Cut to Size** - Because the wand is hollow, it can be cut to virtually any length required to suit the manufacturer's needs, and this length can be varied as necessary to adapt to different tools as required.

* **Adaptable** - Due to the flexibility in the design, the wand can be adapted to fit various styles of spray tips.

Through this unique application, Cannon has been able to successfully process various chemical systems with differing applications. Because the mixhead used is a slightly modified standard Cannon mixhead, mixing pressures can be tailored to individual applications, as pressures during successful trials have varied from 1800 to 3000 psi. The spray system is also quite flexible. During trials, chemical flow rates, and consequently mixing pressures, have been varied by as much as 20% with no adverse consequence to the mixing quality. This can be a tremendous advantage should it be necessary to fluctuate flow rates when producing parts. The following table illustrates some typical process parameters that were involved in recent trials that took place at Cannon USA's R&D facility in Cranberry Township, PA. This data reflects the processing of two different chemical supplier systems.

The Cannon dosing machine includes the ability to process both aliphatic and aromatic systems, the availability of magnetic couplings on the chemical pumps, and closed loop controls for more accurate spray control. Through the use of the closed loop system and coordination with the robot, the PU spray flow rate can be increased or decreased as needed during the spraying of the part, leading to a savings as a result of better controlled chemical usage.

ADDITION OF ADDITIVES NOW A POSSIBILITY

The production of PU spray skins is only one part of the technology scenario. Another challenge was to allow for the flexibility of spraying various colored skins for any application that may arise. While the addition of color in typical foaming applications is nothing new, it was somewhat of a new frontier in the spray skin world. The challenge presented several hurdles, including:

- Production of a skin that could be pigmented only when needed (on the fly change)
- Production of a skin that could maintain superior mix quality regardless of whether or not pigment was being used
- Production of a skin that would successfully reflect the instantaneous and smooth transition of pigment demand
- Metering a pigment consistently at very low flow rates (2 to 4 g/s)

Cannon introduces the ability of users to inject multiple stream additives on demand at the mixhead. This can be a great advantage, as manufacturers can now add virtually any additional additive they need at any time during the spraying process. This additive can be any suitable pigment or reactive agent. Due to the innovative design of the additional stream

Table 1: Recent Lab Trial Results Depicting Typical Process Parameters

Iso Flow	Poly Flow	Temp @ Mixhead	Iso Pressure	Poly Pressure
8 g/s	14 g/s	145-150	2900 psi	2900 psi
8 g/s	14 g/s	145-150	2400 psi	2100 psi
7 g/s	16 g/s	140-145	1960 psi	2300 psi

injection system, the response time of the added component is basically instantaneous. This can allow users of the system to color individual layers of spray skin as needed by their process and it permits the manufacturer to place the pigmented skin where it is needed, when it is needed. A typical application would involve spraying the first layer of the part with color, then continuing with production utilizing non-pigmented polyurethane, all done on the fly without any hesitation in the spray process.

In addition, because the Cannon system is flexible, it would be possible to implement several different colors or additives, all which can be provided on demand during the spray as needed.

Through continued testing, a delivery system was designed that could meter the desired low flow rates and maintain this flow despite the mixhead being some distance away from the dosing pumps. Additionally, the system was designed to allow constant recycling of material to the mixhead area, which permitted the multiple components to be heated to a temperature similar to the polyol and isocyanate temperatures. This would be required to avoid a cold "shock" to the component mix since typical polyol and isocyanate temperatures at or near the mixhead are between 140 and 155 degrees F.

Another issue to contend with in this development was the ability to closely control the timing of the injection of the third component, and to have this take place virtually instantaneously to permit the operator to apply the pigment or other component exactly where desired. Again, through development and testing Cannon was able to produce a delivery system that was capable of achieving this, all the while maintaining an excellent mix.

This entailed reducing the flow rate of one of the main components (polyol or isocyanate) when the additional component was required, and increasing the component flow rate back to normal flow rates when the additional component requirement was finished.

This table reflects the reduction of the polyol from 12.0 g/s to 9.6 g/s to compensate for the addition of the 2.4 g/s of the third components. For this testing the third component was a polyol based pigment.

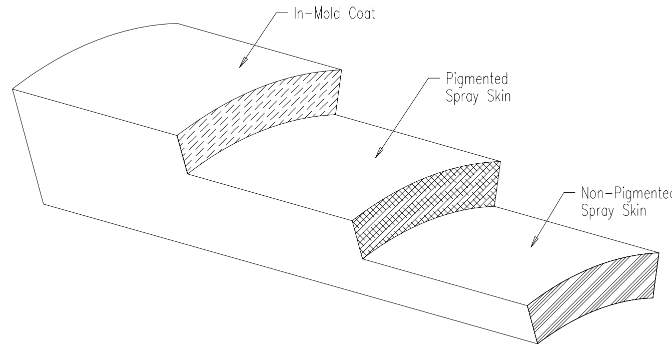

Figure 8: *A Typical Skin Produced with This Delivery System*

With the system as designed by Cannon, it would be possible to deliver multiple pigments or other components to the mix at various times. This would permit a manufacturer of colored skins, for example, to be extremely flexible in PU skin production by producing one particular skin color on one mold and spraying a totally different colored skin on the very next mold.

CONCLUSION

Cannon's innovative designs can provide manufacturers with a tremendous flexible advantage. The Cannon design provides the following advantages over a typical spray skin system:

- The ability to introduce various extra components, on demand, to assist in skin production.
- Elimination of the relatively expensive and difficult to clean wand/static mixer.
- Lower overall production costs by reducing down time and by "eliminating" the time allotted for cleaning the mixers and wands.

By incorporating these new developments on an original mixhead, Cannon provides the customer with new technology based on a proven and reliable design.

Table 2: *Test Results Utilizing a Third Component*

Iso Flow (g/s)	Poly Flow	Third Component (g/s)	Iso Pressure (psi)	Poly Pressure (psi)	Third Component Pressure (psi)
8.0	12.0/9.6	2.4	1600	1500	1600

BIOGRAPHIES

Mark Laughery – was born in Pittsburgh, Pennsylvania and has a Bachelor of Science degree in Chemistry with a minor degree in Business Management from the University of Dayton. He has been with Cannon USA since 1993 and has held duties of Cannon Technical Service Representative in Detroit, MI and Cranberry Twp., as well as his current position R&D Lab Manager at the Canon USA facility in Cranberry Twp., PA.

John Muto - born in Pittsburgh, Pennsylvania, in 1961, has an educational background in Mechanical Engineering from Penn State University. He joined Cannon USA in 1985 and has worked as Technical Service Manager, Project Manager, Rigid Foam Systems Sales Manager and currently is Automotive Product Manager.