Polyurethane Roll Covers, Revolutionized

Introduction

Due to new technologies, polyurethane (PU) roll covers no longer require molds, as they can be cast directly on the roll core surface using a robotic deposition system and a CNC precision-coordinated spindle. Although this process was originally introduced in the 1980s, advances in chemistry, robotics, and computer technology in the past several years have led to significant maturity of the process, resulting in growth of this technique. Once inaccurately referred to as “cold casting” due to the elimination of hot potted molds and post curing ovens, the process has now become the hottest approach to roll production as it sweeps across a variety of time- and cost-conscious industries that are interested in “greener” production processes.

For many years, the only polyurethane roller covering technique available was open mold casting. This popular covering method required the use of different molds for each shape and size roller, as well as large throughput dispensing machines and massive ovens for post-curing. The costs associated with the use of specific molds and ovens for each roller posed challenges for manufacturers as costs and time to develop and produce product was extensive.

Another technique, known as the rotary casting process (RCP), was introduced in the 1980s and effectively eliminated the need for molds and ovens. This process consisted of dispensing a very fast reacting polyurethane chemical mixture directly

on a rotating roll core. Not only were molds and ovens no longer required, but smaller batch, higher throughput machines could be incorporated into the process. The process was quick, consumed less energy, and was well-suited for experimentation with new formulations for varied application as the cycle from conception through use was markedly shorter and less costly than mold casting.

Advantages of Rotational Cast Systems Over Mold Casting

The Rotary Casting Process is based upon the application of highly reactive multiple-part urethanes directly onto a rotating core to create a solid roll cover in minutes. Since it eliminates the need for conventional poured molds and a secondary curing process, rotary cast rolls can be delivered in days, as opposed to weeks or months. Further time and cost savings can be realized as rotary casting lends itself to coating the roll without first having to remove the bearings from the roll journals.

The RCP is far more flexible than standard mold-based technology. Using this technique, the processor can direct cast different types of materials onto any rotational-symmetric body, maintaining tight hardness tolerances while optionally varying the hardness of specific layers.

The process can also be applied in a single layer of a coating that protects the journals and end plates. Additionally, a number of chemical systems can be delivered to include polyether and polyester urethanes, and polycarbonates.

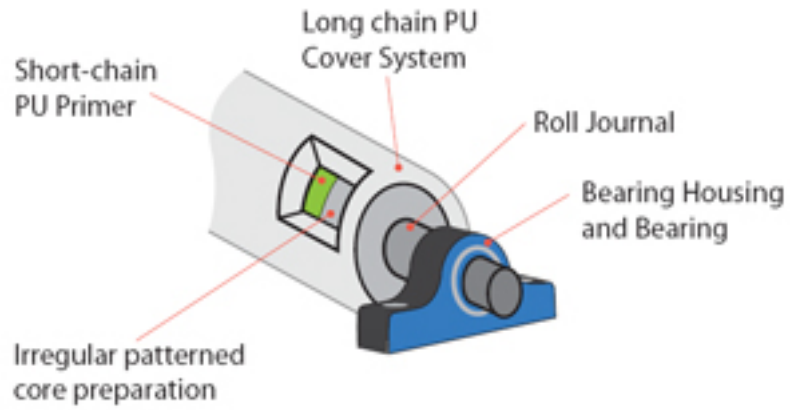
Given the scope of the rotary caster’s facility, roll sizes can be produced anywhere from 76 to 2,040 mm (3-80") diameter and up to 12,000mm (472") in length making it well-suited for a variety of industries.

There are numerous benefits offered by today’s Rotary Casting process.

Shorter Production Times: Time-consuming production steps are eliminated using Rotary Casting. There is no mold handling, no pre-heating, no pre-baking of adhesives, and no post-curing (of polyether and polyester based systems). This benefits both the processor, who saves time; and the user, who has fewer spare rolls to store.

No Post-Curing: The standard system and polyether-based base layer system are processed at ambient temperature. The majority of these can be produced with minimum energy consumption as the chemical reactions generate high heat during the molecular cross-linking, thus eliminating the need for artificial heat generation using ovens.

Energy Conservation: No pre- or post-curing autoclaves are needed, significantly reducing the energy needed following casting.



The Polyurethane Rotary Casting Process:

Rotary casting requires the use of a machine to rotate the roll cores while a low pressure dispensing machine measures and mixes highly reactive urethane components at precise ratios before dispensing the mixture onto a rotating roll core.

Basic Roller Anatomy:

The process starts by priming the surface of the roll base material to ensure permanent adhesion. This involves several consecutive steps to create a non-uniform surface that will enable the primer to adhere to the substrate. This typically involves turning to remove previous material and provide a concentric core surface.

Next, a two-part polyurethane primer is prepared. The primer is a short-chain polyurethane, which adheres better to the scratch patterns on the steel core produced from the abrading operations and creates a good base for the longer-chain polyurethane cover to grab onto. The primer must be applied quickly across the metal core and allowed to cure for between three to six hours prior to final casting.

At this point, the multi-part polyurethane system is pumped from storage tanks into the mixing head. A series of chemicals — the pre-polymer and the chain extender — react to form the elastomer. A polyurethane elastomer results from the reaction and cross-linking of compounds. Many different types of polyurethane elastomers can be formulated by changing the sequence of these components. All the chemicals that make up the polyurethane are precisely pumped in exact percentages through the lines that feed the dispensing head’s nozzle. The mixing head must be able to move laterally in order to dispense the polyurethane along the entire length of the rotating roll. Usually, the mixing head is attached to a robot or transverse, multi-axis shuttle carriage that is adjacent to the spindle holding the roll core.

After the first pass, the mixing head retracts and returns to the starting point if additional layers are needed. In this case, the first layer has started to cure, but remains active enough to bond with the next layer to become a mechanically sound homogeneous covering.

For optimal performance and efficiency, the equipment can be automated using software controls in a fully integrated system. In either case, the operator must be able to control the rotating speed of the roll as well as the speed of the lateral movement and feed rate of the chemicals.

After the roll is cured, typically within 24 hours, it is finished in a precision turning operation. First, a rough pass is made to even the surface and bring the roll into a balanced shape. Next, a series of more precise passes are made to refine the surface characteristics and bring the roll into the specified diameter or apply a specific finish such as ground, micro- finished or crepe.

FKM USA's Proprietary RCP Introduced in North America

In 2008, FKM introduced its proprietary rotary casting process for the production of polyurethane roll products into the North American market. FKM USA manufactures roll cores (steel and lightweight fiberglass) with polyurethane coatings using its state-of-the-art, CNC rotary casting system. FKM is also well known for its production of non-woven covered rolls.

FKM not only designed and built its own rotary casting machine, but custom-designed the accompanying controls software as well. This forward-thinking approach offers a number of advantages over conventional mold casting processes.

FKM's proprietary process also relies on the high reactivity and cross-linking capabilities of the polyester and polyether polyols. These chemicals mix together just prior to application on the roll surface. The high reactivity of the chemicals cures as the coating is being built up along the roll surface. Using a multiple-axis robot, the chemical mixture is applied by moving laterally along the roll form.

The actual coating is applied to the surface, which has been abraded, degreased and provided with a polymer primer. This approach enables a covering up to 20 mm thick to be applied in one single step. For optimal performance and efficiency, FKM has also developed proprietary software to enable full control of the processing parameters while dispensing the polyurethane in a natural or pigmented color.

The cover begins to solidify within seconds, but remains workable for a few minutes, allowing application of multiple coats before curing hardens the cover into a solid elastomer. A chemical reaction between the polyols is where the cross-linking of the polymer occurs as the roll cures. During this reaction, the roll can reach temperatures of >200˚F. The result is a homogenous cover, which is rapidly produced and possesses superior mechanical properties over many other mold casting techniques.

As mentioned previously, the rotary casting process produces roll covers that offer high abrasion resistance and load-bearing capabilities. This methodology offers a number of economic advantages for both processors and end users. These are due to its excellent mechanical properties, which help to extend roll service life. Today, using FKM's process, rolls can be cast in as little as 30-minutes and be fully cured and ready for finishing within 24-hours.

To learn more, see the full text of the white paper from FKM here [1].

Links:
[1] http://www.impomag.com/sites/impomag.com/files/legacyimages/1007/16/FKM_white_paper.pdf