

Bosch Rexroth Corp.

Distribution **in** BRIef 05

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**Partnering Keeps Plastic Film on a Roll**

Making trash bags shouldn't produce trash. That's the viewpoint of Ricky Keller, sales director at Davis Standard, which makes surface winders for blown and cast films. Davis-Standard is a global leader in the design, development and manufacturing of extrusion systems, feedscrews, barrels and process controls for the flexible web converting, plastics processing and rubber industries. Founded in 1848 as a cotton gin machinery manufacturer, the company entered into extruder manufacturing in 1948 and by 1955 was designing and manufacturing extruders for the wire and cable, plastic and rubber industries. Today, their wide-ranging product lineup includes systems for producing superior film quality at the highest production rates with high output dies, MAC extruders and high-velocity air rings. Single or multi-layer blown film systems include high technology single and multi-layer dies and high-speed winders.

Davis Standard recently redesigned the pressure control on their high-end winders to provide real-time adjustment of the lay-on pressure and to allow larger rolls—up to 60 inches—to be produced. The result is more consistent winding of the plastic film onto the roll, with less waste and rejected material.

In a typical production, multiple extruders feed an annular die that blows a bubble into the air, as high as three stories. The film is then wound into rolls as large as 60 inches in diameter—or about 150,000 linear feet of film weighing approximately 10,000 pounds. The roll is then moved to the bagging machine, which measures, cuts, bonds, and otherwise processes the film into trash bags or products made of film. Feeding the bagging machine directly

is inefficient, since the bag-making equipment operates much faster than the extruding process. A single bag-making machine can easily consume the output of two extruders.



*Davis Standard maintains a complete production system for in-house development and customer demonstrations, including blown film (right) and film winding (left).*

Rolling the film at high speeds onto a 6 inch cardboard core is a complex and precise task if the goal is to eliminate waste. The film passes over a large rubber-coated steel cylinder and onto the rolls. The winding force is always on the surface of the rolls, but it is dynamic and always changing as the size of the roll increases. To complicate the operation, the cardboard core is not perfectly round and the eccentricity creates “wobble” in the rotation of the rolls. This eccentricity and wobble result in pressure variations that cause inconsistent wrapping of the film. Materials and film thickness are also variable, and affect the required pressure.

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One wants to maintain a highly consistent lay-on pressure of the film onto the roll. The consequences of poor winding are seen in the process of unwinding. In many competitive systems, the film at the center gets packed so tight that it actually overheats and fuses—costing several hundred feet of unusable film.

The first key to high-quality is to maintain consistent tension on the roll even as its diameter and weight change. The second key is to continually monitor and adjust the pressure to eliminate the detrimental effects of eccentric wobble. The eccentricity will have a frequency of load variation that changes with roll diameter. If the eccentricity is not accounted for during winding, the degree of eccentricity will increase, resulting in increased wobble.

Davis Standard already had a winding system that offered good pressure control. But to accommodate a move to roll diameters of 50 and 60 inches, they wanted to create a pressure control system that could resolve control to lower levels than was possible with existing system. Better pressure control not only would allow bigger rolls, but also it would allow materials such as photo-quality film, which is especially sensitive to pressure, to be processed at high speeds. “We wanted to take a big step in achieving finer pressure control, which not only means a better quality film, but also means customers can process the whole roll with not waste or scrap,” said Davis Standard’s Keller. The Somerset, NJ, company embarked on a program to develop a new pressure control system.

Davis Standard turned to Airline Hydraulics, a value-added distributor of fluid power solutions, and to Bosch Rexroth ([www.boschrexroth-us.com](http://www.boschrexroth-us.com)), whose products Airline carried. “We wanted to add

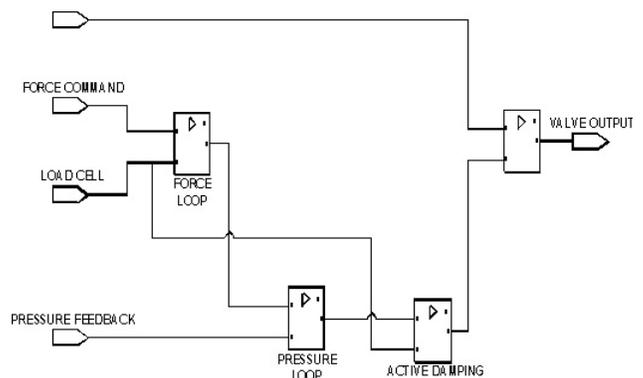
closed-loop digital control to the pressure system. Going digital offers many advantages over analog in terms of complexity of the closed loop control and repeatability of

the process, but it also requires more complex processing capabilities. The first controller we tried simply didn’t have the processing power to keep up with our demands for real-time monitoring and adjustment,”



*The VT-HACD digital hydraulic axis controller offers sophisticated control in a compact format.*

explained Keller. “That’s when Airline suggested we try the VT-HACD controller from Bosch Rexroth.”



*The ability to cascade control loops gives the VT-HACD its formidable processing power in maintaining high-quality rolls.*

In operation, a hydraulic control circuit with feedback for both hydraulic force and roll-mounted load cell consistently maintains lay-on pressure. Two hydraulic cylinders, one at either end of the roll and

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both controlled by a single valve, will provide small, rapid adjustments to maintain consistent force and pressure. The cylinders also must move the roll outward, away from the drum to maintain the proper load between roll and drum.

The force applied is measured in pounds per linear inch (pli). Typically, a very low force—as a low as 0.1 pli—is required to maintain the proper tension. “You can actually stop the roll with moderate pressure from your hand,” said Keller.

Fine control of pressure requires the VT-HACD controller to sample the forces 4000 times a second and make any adjustments. The controller compares actual conditions to set point, with the difference being used in the closed-loop controller to adjust the force. The system becomes more complex since it is comparing both the hydraulic force applied to the drum, and the mechanical load measured by the load cell on the drum.

James Moorhead, vice president of sales and marketing at Airline Hydraulics, observed that the VT-HACD controller has one unique feature not found in other controllers. “It can cascade multiple control loops, where the output of one closed loop feeds the input to another closed loop. The ability to cascade control loops gives the VT-HACD controller the incredible flexibility that is required in this application in order to maintain a constant force on the drum while compensating for the wobble caused by the eccentric roll.” The first controller Davis Standard engineers evaluated simply didn’t have the computational power needed for this demanding application. This drawback increased the drum load during processing sufficiently that the engineers looked for a better answer, which they found in the VT-HACD.

Neal Gigliotti, a senior application engineer at Bosch Rexroth concurred. “Cascading the control loops gives us the ability to implement a control scheme that measures roll wobble in real time, and dampens out force changes before they affect the readings from the load cell on the drum. Using our Active Damping technology on the output of the control loops has the further effect of allowing higher electronic gain without sacrificing system stability. The net effect is the capability to make very fast and precise on-the-fly adjustments of force. These adjustments occur so fast they seem to be predictive rather than reactive.”

The VT-HACD gives the performance required to maintain high-quality production. Even better, it’s fast and easy to commission and setup. Bosch Rexroth’s Gigliotti explained, “The VT-HACD is user configurable through a intuitive Windows-based graphical interface that uses pull-down menus, check boxes, and value fields. There is no programming language to master. A system designer can configure the controller in only a few hours.” Indeed, the first Davis Standard system was up and running in less than a day.

Keller said the whole development cycle was less than three months. “The program was a story of true collaborative partnership between Davis Standard, Airline, and Bosch Rexroth. The application knowledge Airline and Bosch Rexroth brought to the program was exceptional. They listened, they understood our goals, and they were able to propose a solution that made sense technically and economically.”