Production Issues at Local Paper Mill Required Multiple Resolutions from The Hope Group

When a local paper mill began experiencing continuing production issues in its paper rolling and positioning system it turned to The Hope Group for a series of design changes to solve multiple production issues. The first of several issues concerned an inspection device used to scan paper as it was being produced. The device was mounted on a 20 foot beam, which had to be moved in and out 20 inches vertically over the sheet-paper with one electro-mechanical actuator mounted at each end of a beam. According to Ron Ruel, Hydraulic Sales Engineer for The Hope Group, "The original approach used two electro-mechanical ball screw actuators that were synchronized by monitoring a rotary encoder on each of the mechanical actuators with a closed loop position control by an external PLC."

Ron described the problem the mill was having as slippage with the electro-mechanical actuator stepper drive motors, which caused misalignment and binding of the actuators. This condition led to eventual failure of the internal ball screws on the actuator. Further problems from the misalignment resulted in metal grit falling onto or near the paper as it was being produced. In response to this challenge, Ron introduced a solution using two Parker 2ANX-Series pneumatic cylinders that were equipped with internal Balluff Z-style internal linear displacement transducers (LDT). Each pneumatic cylinder was controlled by a pneumatic Enfield Technologies S2 proportional-servo directional valve.

Enfield S2 Proportional Valve Helps Achieve Precise Position Control
In redesigning the inspection device system at the paper mill, The Hope Group introduced the use of pneumatic Enfield Technologies S2 proportional-servo directional valves to control the synchronization of the cylinders.

Ron said, "The position of the cylinders were synchronized by closing the loop with the onboard electronics on the Enfield S2 valve. An external PLC supplied the command signals and monitored the maximum-allowed position error of the cylinders. If a position error exceeded a maximum allowable value, the PLC had the ability to lock/stop the pneumatic cylinders in place by turning off both 2-way NC blocking valves plumbed to each port of the 2ANX cylinders."

Inspection Camera Positioning

Similarly to the beam-mounted inspection device (above), an inspection camera/lights device needed to have position control on a similar type of paper machine. Since the mill had so much success and was impressed with the Parker / Enfield solution (described above), they decided to use the same approach for this application. In the end it was decided that rather than using a ball screw mechanical actuator, the mill would incorporate a Parker 2ANX cylinder (w/ Balluff LDT) along with

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the Enfield S2 pneumatic servo valve to accomplish the precise position control.

Roll Nip Pressure Control

A third production issue at the paper mill involved the winding of paper onto a cardboard core to form a roll of paper for retail sale. During production, the roll of paper increases in diameter as it is wound onto the core. The pinch force needs to be reduced as the roll grows in diameter. That is, as the roll gets larger in diameter and the pinching force needs to decrease smoothly and controllably. The original, old-fashioned technique used a cam that was connected to a lever arm, connected to a pressure regulator that would change the pressure based on the geometry of the cam profile.

Ron said, "This was a cut-and-dry set up and the roll pinch force was basically controlled by the cam profile as the paper roll grew in diameter. The problem was that this was basically mechanical logic and the pinch pressure was only adjustable by changing the mechanical profile of the cam. In other words, the pinch force at a given diameter was dictated by the machined profile of the cam." A design was developed to address the issue. The solution was to add a Balluff LDT to the control arm that moved outward as the paper roll grew in diameter. Now, knowing the roll diameter (signal from LDT), the pressure to the pinch roll pneumatic actuator could be varied/controlled by the Enfield technologies TR pressure regulator via a 4-20 mA signal from a PLC that controlled the machine. The end result was that the desired pinch force at a given roll diameter could be infinitely controlled and the process could be changed and individualized for each individual paper roll product. The customer was no longer "tied" to the output force that was dictated by the mechanical cam profile and the mechanical pressure regulator.

Synchronized Roll Positioning and Pressure Control

A fourth and final challenge on the paper mill production line involved a sensitive control requirement, according to Ron. "Basically, the requirement was to synchronize two pneumatic cylinders into a position and then change from 'position control' of the cylinders to 'force control' once the rolls nip." Restated: The two cylinders need position-synchronization to move a steel polished roll to a "pre-nip" position on a paper machine. The cylinders, one at each end of the roll, then move from a "pre-nip" position before physically contacting a secondary roll with paper on it that needs to be calendared. The goal is to press/pinch the paper between the two spinning rolls and control the forces acting on the rolls.

Ron described that the solution was to add two externally mounted Balluff position feedback devices (LDT) to the machine's existing pneumatic position actuators. Ron said, "Each pneumatic actuator was controlled by closing the position loop with the Enfield Technologies S2 Proportional Servo directional valve with a command signal coming from the machine's PLC. The input pressure source which feeds each of the S2 valves was controlled by an Enfield Technologies TR pressure regulator; one for each S2 valve." An external PLC on the machine would control the input position signals to the S2 valves for position. Once the rolls were nipped together, the PLC controlled the PLI by varying the command signal to the TR valve.

Enfield TR Pressure Control Valve Gradually Varies Pinch Force on Paper Roll

A solution using an Enfield TR valve was designed to vary/control the pressure of the pinch force on the paper roll as it grew in diameter. As the as the roll's diameter increased, the pinching force needed to decrease gradually. The pinch force in the old method was dictated by the machined profile of the cam.

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