CONSOLIDATED UP-PACKING UNIVERSAL DENSITY BALE PRESS

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Abstract

Consolidated Cotton Gin Company has developed a new bale press capable of exceeding capacities of 60 bales per hour. It is a typical up-packing door-less press where most of the structure is located below the gin floor. Only the area where the bale is ejected is above the floor. This press is available in both universal and high-density models.

Introduction

Consolidated Cotton Gin Company is a full line cotton gin manufacturer who has been manufacturing down-packing bale presses since 1991. The hydraulic cylinder is mounted on the top sill, above the boxes, and actuates downward to press the bale against the bottom sill. The press boxes are raised to expose the bale. Due to the time required to lift the box and complete the compression, the down-packing press is limited to approximately 45 bales per hour. The need for a bale press that exceeds 60 bales per hour evolved over the years out of increasing gin plant capacities. Consolidated has relied on other manufacturers in the past to provide presses in high capacity plants due to the 45 bale per hour limitation of the down-packing press. At Consolidated, a campaign was mounted to obtain a share of the high capacity press market by designing and manufacturing a durable bale press to meet and exceed capacities of 60 bales per hour. Other requirements were for the system to operate with minimal horsepower and maximum efficiency using more current hydraulic technology than has ever been used in cotton ginning. Simplicity in plumbing and troubleshooting was another imposed requirement of the press.

Discussion

Background

In developing this press, other presses were studied to locate possible weaknesses or areas of stress concentration. This information was used in developing the structural characteristics of the press. Logistical, procedural and process control variables were also studied to learn where time could be saved in the process thereby increasing speed and capacity.

Operational

Operationally, the press is similar to any on the market. The top follow block is lowered to the "extrude" position just below the top of the box sleeve. The bottom follow block moves upward pressing the bale against the top platten. When the system pressure reaches 2500 psi, the bottom cylinder begins to override the top cylinders. The top and bottom cylinders move in unison extruding the bale from the box until the top follow block is seated against the top sill. The bottom cylinder finishes the compression by continuing to move upward until it reaches the proper "tying" position. The bale is then tied and ejected from the press onto the bale handling system. The bottom cylinder returns to the "home" position and the top cylinders return to the "extrude" position in anticipation of the next bale. Meanwhile, the press box on the tramper side of the press is being filled. When the box is filled to capacity, it rotates to the "press side" and the process is repeated.

Durability

It was found that most presses are weak in the corners of the boxes on the side where they connect to the center strain rod. Many presses studied had developed stress fractures in these areas. This problem was addressed by using heavier material and lapping the reinforcing ribs such that the welded seam was located as far from the stress concentration as possible. Another problem the study revealed was worn box latch assemblies, which allowed a high degree of slack in the alignment of the boxes. This problem was addressed by designing the box latch with a large area for absorbing shock. The result was an extremely sturdy assembly allowing the forces to be distributed over a large area thus reducing wear and extending usable life.

Elsewhere, this press is of a typical up-packing, door-less design (see Figure 1). Most of the structure is located below the gin floor and only the area where the bale is ejected is located above the floor. The bottom sill, which sits on the pit floor, is joined to the top sill, which is located above the gin floor, by two 7" high tensile strain rods. Two 7" (10" for high-density model) hydraulic cylinders are mounted to the top sill and drive the top follow block. The main cylinder, mounted on the bottom sill, has an 18" (20" for high-density model) bore and a 12" rod diameter. The boxes are mounted to, and rotate freely about, the center strain rod. The end columns, designed to withstand side loading, are extremely sturdy and are attached to the strain rods but allow the strain rods to slip through as they stretch.

Capacity

In any press, the structure must be capable of withstanding the operating speed, but the operating speed is a function of the hydraulic system. As mentioned earlier, it was required for this press to operate at over 60 bales per hour with minimal horsepower and maximum efficiency. One way this was accomplished was by engineering a hydraulic cylinder as opposed to a ram to provide the force for pressing bales (see Figure 2). Cylinders have two connections, one on the rod end and one on the blind end. Oil can be pumped into the rod-end of the cylinder driving it down hydraulically. Hydraulic controls allow for a smooth deceleration with very little "bang" or hydraulic shock. This method saves time over a ram, which must rely on gravity to return it to the "home" position. Cylinders have the additional advantage of a mode of operation known as regeneration or "regen". In regen, oil is pumped to both the blind and rod end of the cylinder. Both ends of the cylinder are subjected to the same pressure but, since the area of the blind end is greater than that of the rod end, the force is greater on the blind end causing the cylinder to extend. No oil is allowed to return to tank therefore; the oil from the rod end must join the oil from the pump and be routed to the blind end. The speed of the cylinder can increase up to 60% with no additional pumping capacity or horsepower (see Figure 3). This is a tremendous capacity advantage over hydraulic rams.

The investigation of presses also revealed that the most common problem with high capacity presses is in feeding the boxes. It is difficult to feed large charges into a relatively small press box. To overcome this problem, a roller-type lint charger was designed to feed the lint pusher at a high rate of speed thereby increasing the weight and density of each charge. The lint charger is driven by a hydraulic motor, which is powered by the pusher/tramper pumping unit. The lint pusher is hydraulically driven and is controlled by a double-acting proportional control valve. The proportional control valve provides the capability to control the acceleration and deceleration of the cylinder while extending or retracting. This control capability enables faster operation thus greater capacity. The lint pusher, in turn, feeds lint cotton into the box enclosure where a hydraulically driven tramper actuates downward to charge the press box.

Efficiency

To provide efficiency, variable displacement swash plate piston pumps were chosen as the hydraulic power source. In this pump, the pistons are contained in a barrel, which is rotated by the input shaft. A trunnion-mounted swash plate is operated by the displacement plunger, which modulates the angle of the plate. Each piston terminates in a shoe, which rides the surface of the swash plate as the barrel rotates imparting a

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reciprocating motion to the pistons. The angle of the swash plate determines the stroke of the pistons and therefore, the displacement of the pump (see Figure 4).

Variable displacement pumping has many advantages over the traditional staged pumping systems. First, during idle operation, constant volume pumps must dump oil to the tank, as this is the only method of unloading pressure. This requires a great deal of horsepower even when the press is not in use, i.e. between bales. Many control systems will shut the pump down between bales in order to conserve energy. This constant starting and stopping reduces the life of motors and switchgear. To unload a variable displacement pump, the swash plate is moved to a vertical position causing the stroke of the pistons to become zero therefore, the displacement becomes zero. The pump rotates totally idle, which requires very little horsepower. When an idle mode of operation is possible, it is no longer economical to start and stop the motors saving the unnecessary wear on motors and starting equipment.

Secondly, in constant volume pumping systems, it is common practice to select a motor for the average horsepower requirement of the system saving motor size and cost. As pumps are unloaded, the horsepower required by the system modulates above and below the design horsepower of the motor (see Figure 5). Motor life is reduced every time the horsepower peaks above design. Motors are designed such that peak efficiency coincides with design horsepower so, when the system spikes below design, efficiency is lost. As can be seen, there are disadvantages to operating either above or below the design horsepower of the motor. In contrast, variable displacement pumps can be controlled to operate at design horsepower thus, peak efficiency, throughout most of the cylinder stroke again, saving motor wear. Locating it below the oil level in the tank further extends pump life. The pump remains flooded preventing it from running dry during startup.

Simplicity

Several steps have been taken to make this press easy to install and troubleshoot. The end columns are machined to length ensuring accuracy and eliminating shims and spacers during installation. Surfaces of top and bottom sills are machined flat and parallel to ensure strain rods install plumb and square. Structural supports are designed to install cleanly and easily. Overall, the design allows flexibility in assembly, which results in a much simpler and more accurate installation.

To further simplify installation and troubleshooting, a hydraulic manifold was designed to house all hydraulic valves and elements. Every hydraulic function takes place within the manifold and all piping originates or terminates at the manifold. All pressures, solenoids, valves, and logic elements can be viewed from a central location.

Conclusion

Four Consolidated Up-Packing presses have been installed to date. The first was a high-density model installed for Auscott Limited in Trangie, Australia and has been in operation since March of 1999 (see Figure 6). Auscott installed a second high-density press in their Midkin plant the same year. Olton Coop Gin in Olton, Texas installed a universal-density model, which has been in operation for the last two seasons. United Farmers Coop Gin in Plainview, Texas also installed a universal-density model and has operated it through this past season. Overall, more than 16,000,000 bales have been packaged with this press. The Consolidated Up-Packing Press has proven to be a durable 60 bale per hour press that operates smoothly and efficiently. It is easy to install and troubleshoot, and is capable of keeping pace with even the highest capacity gin plants.

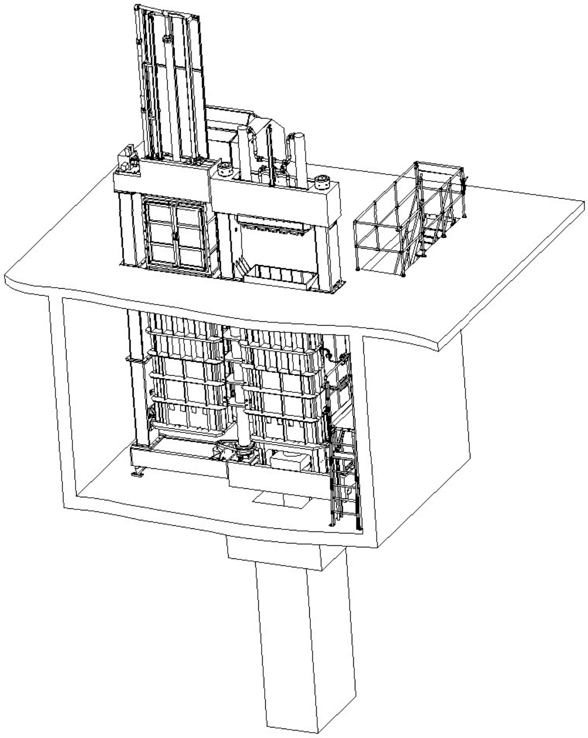

Figure 1. Consolidated Up-Packing Press.

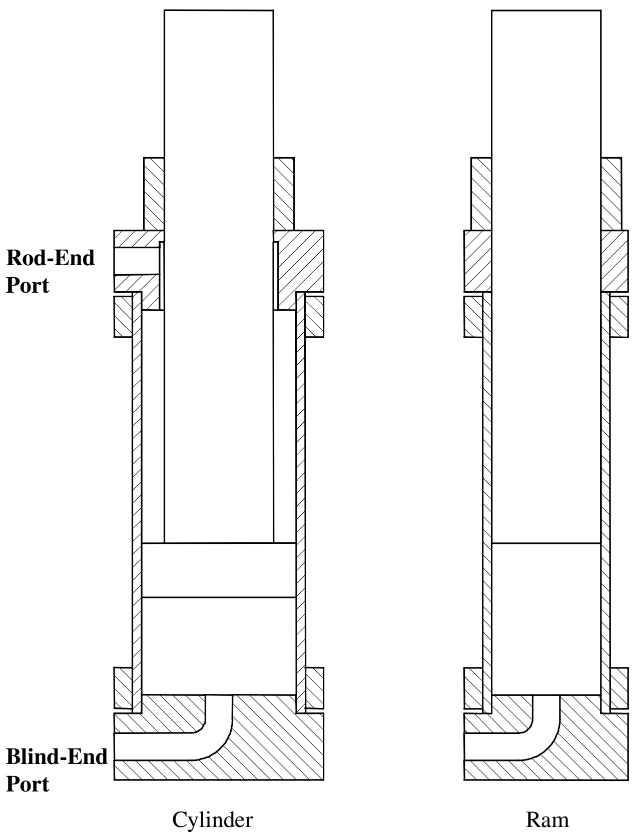

Figure 2. Cylinder vs. Ram.

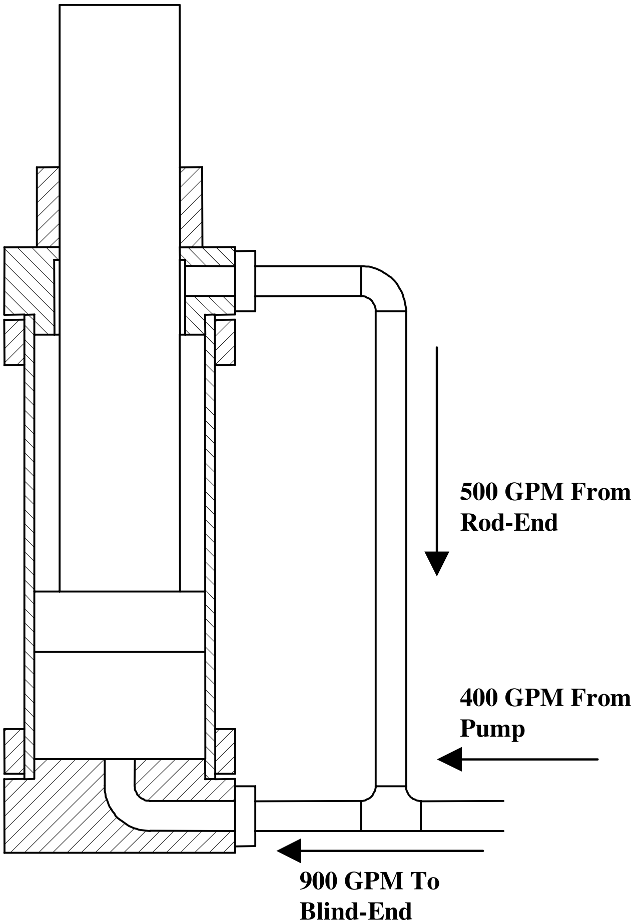

Figure 3. Regenerative Mode.

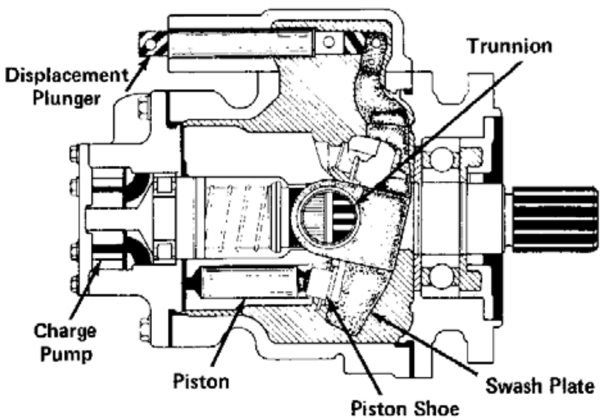

Figure 4. Variable Displacement, Swash Plate Piston Pump (From National Fluid Power Association).

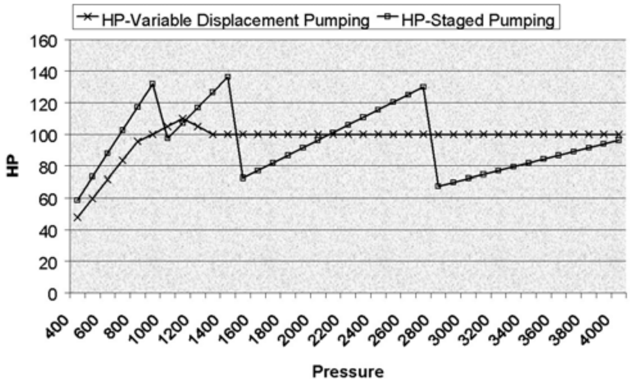

Figure 5. HP vs. Pressure at 100 HP Motor Design.

Figure 6. HD Press - Auscott Limited - Trangie, Australia.

Figure 7. HD Press - Auscott Limited - Trangie, Australia.