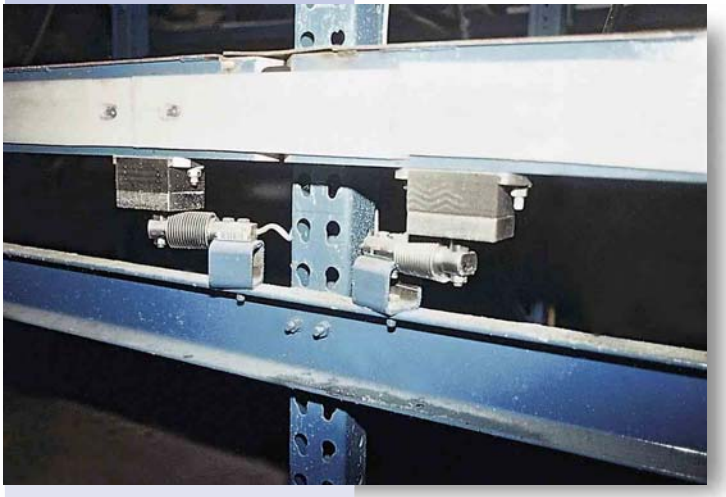
Bending Beam Load Cell is Ideal Weighing Component for Fertilizer Manufacturer

For many automated mixing applications, greater accuracy is achieved by measuring by weight than by volume. Load cells are often used due not only to their measuring accuracy, but also for their stability, ruggedness, ability to handle hostile environments, and compatibility with automated, computer-controlled production systems.

In the case of Plant Marvel Laboratories, one of the foremost manufacturers of water-soluble fertilizer, a bending beam load cell has proved to be an ideal weighing component.



Based in Chicago Heights, Illinois, Plant Marvel is the oldest and one of the largest manufacturers of water-soluble fertilizers. Established in 1922, the company played a pioneering role in the development of water-soluble fertilizer for crops as varied as those cultivated in greenhouses, grown for nurseries, vegetable production, and turf for golf courses and the like.

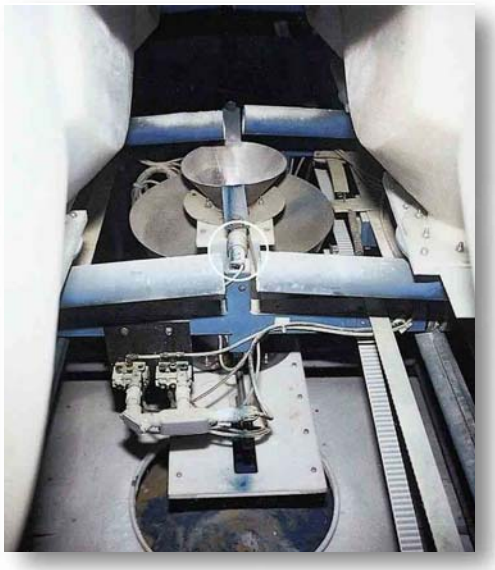
Plant Marvel's Nutriculture® fertilizers dissolve completely in water without leaving any residue, and are designed for use with the finest nozzle injectors and spray equipment. Nutriculture fertilizers are exceptionally high in total nutrient value, usually around 60% to 70% or more. Plant Marvel offers over 50 stock formulas, and frequently develops custom blends to fit a customer's specific need. Plant Marvel fertilizers are in use all over the world and on every major type of crop.

In May of 1999, Plant Marvel recognized that in order to grow the business and keep up with rising demand, especially for the constantly changing custom blends, it was imperative that they increase production capability. At the same time, they needed to continue to provide the accuracy required to ensure the high quality, purity & consistency that their formulas prescribed.

To underscore the importance of accuracy in Plant Marvel's manufacturing process, there are nearly 30 ingredients used in varying amounts that can make up a particular formula. If an error is made and the wrong ingredient is mistakenly added to the mix, the end product may not meet the label specifications for the product. Worse yet, it could cause a sticky sludge that could clog a customer's equipment. For these reasons, along with the need to increase production capacity, Darryl Slater, Plant Marvel's Vice President and Plant Manager, wanted to automate the entire operation, and he began mapping out the system and researching the various components he would need.

Slater's basic plan consisted of two rows of plastic tanks that would hold each of the various ingredients in bulk, and would meter them out through a screw feed into large weighing hoppers (called "totes") that were resting on scales between the two rows of tanks. When a tote reached its target weight, the screw feed would stop, and the tote would move on to the next station where it would pick up the next ingredient. The plastic tanks could be kept full either automatically or manually by an operator, who simply had to maintain a certain height in the tanks. Each tote would roll through the system, picking up its ingredients one by one before moving to the blending area where the mixture would be processed and put into bags.

After consulting with various vendors, it was determined that measuring ingredients by weight rather than by volume was indeed the best way to go. HBM was selected for their experience with conveyor systems, and because they offered load cells that seemed to be tailored to Plant Marvel's list of requirements. These characteristics included corrosion-resistant, stainless steel construction, hermetically sealed for harsh caustic washdown applications, accuracies into the double and triple digits, and the ability to be easily mounted into the new system.



Art Rebello, Business Development Manager, Weighing Technology for HBM, offered a number of suggestions that solved problems and opened doors for additional improvements. He also brought to the table considerable experience working with programmable logic controller (PLC) systems, which would be required for programming and automating the system. All details were discussed, including the size and weight of the mixing hoppers (totes), structure of the conveyor system, and the entire sequence of operation. They also covered all of the usual application engineering issues, including system and component life, reliability, accuracy, speed and flexibility.

Jointly, HBM and Plant Marvel wrote a thorough functional specification for a completely automated system. After final engineering was completed on the mechanical conveyor equipment, the batch system was sized accordingly. The proper load cells were selected for each major and minor additive based on their ability to handle the most commonly specified recipes.

To keep pace with the need for accuracy and durability, HBM recommended their Model Z6 bending beam load cells as the primary weighing components for Plant Marvel's production system. In addition to their exceptional accuracy (Accuracy Class according to OIML R 60), Z6 load cells are well suited to withstand the harsh fertilizer manufacturing environment. Their ZEL elastomer flex mounting accessory enables them to withstand a great deal of vibration, and both the load cells and their mounting aids are constructed entirely of rugged, washable stainless steel.

Plant Marvel now utilizes an Ethernet Controller-based batching system. The en-

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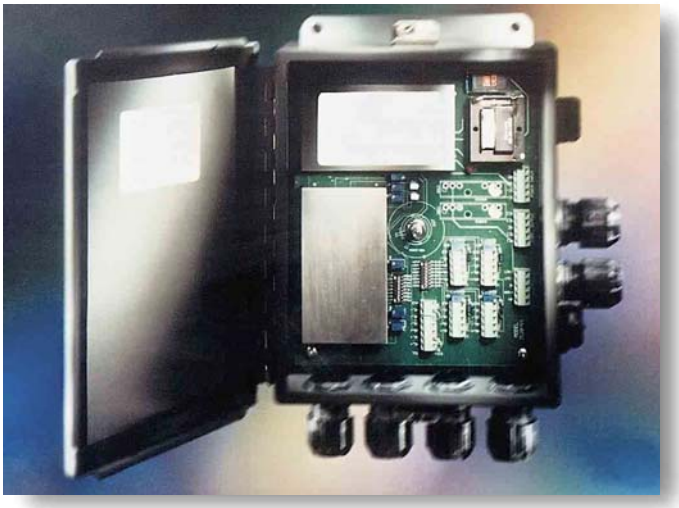
tire operation is automated. The production line requires precision in-motion weighing capability, and obviously, downtime must be kept at an absolute minimum. The system dispenses chemicals in seven different stages. Pre-specified chemicals are dispensed into large 4 x 4-foot tote hoppers in a continuous operation prior to final mixing and bagging that takes place in a separate area of the factory. The total weight of the totes (metal frame plus the plastic hopper) is 355 lb. (160 kg). The totes, along with the ingredients being added, are weighed at each station.



Each major additive filling and weighing station utilizes four Z6FD1 bending beam, hermetically- sealed load cells, with two mounted on each side. They all employ ZEL flex mounting to minimize vibration. Maximum capacities vary, ranging up to 1,100 lb. (500 kg) per load cell. Minor additive stations use lower capacity versions. The load cells utilize a 6-wire circuit (due to the environment and the distance to the transmitters) and are optimized for parallel connection with corner pre-adjustment.

Each station is equipped with a surface-mounted HBM Model 4800 load cell summing transmitter that sends the information collected by the load cell back to the computer. The transmitters, mounted in a NEMA 4 enclosure, have a 4-20 mAdc output. The transmitter has a built-in excitation supply capable of providing enough current to drive four 350-ohm load cells.

Chemicals are fed into the totes, which are inserted at the beginning of the production line. Totes ride on four wheels (two on each side) along rails that incorporate photo electronics and the load cells underneath each section. Each set of load cells has a floating, independent rail on top of it. The load cells (also referred to as "weigh cells") are mounted along a solid metal beam.

The totes stop at precise, pre-programmed intervals. Ingredients are "augered" (poured) into the tote in prescribed amounts. At each station, tote and additives are weighed together, and as the prescribed weight is reached, the filling stops and the tote is moved to the next station to receive the next additive. If a particular station does not call for an ingredient, the tote will bypass it and move on to the next one. As the ingredients are dispensed and simultaneously weighed, the load cells send the electronic signal back to the computer.

The production line includes six filling stations, plus a seventh where material is picked up from a smaller traveling trolley that has two scales (with funnels), one on top of the other. The top scale catches ingredients that weigh less than a pound, and the bottom scale catches the heavier ingredients that weigh up to 50 pounds. When both types of ingredients are required, all ingredients pass through the top scale and are funneled into the bottom scale. Two load cells each support both the top and bottom scale. The funnel has a slide gate at the bottom, so when it finishes picking up all of the various trace elements, it drops the material into the tote.

After all the chemicals in the recipe have been fed into the tote, it is transported by a forklift to a mixing area, where the material is mixed and subsequently bagged.

When the system was originally designed, it was intended to be semi-automatic with an operator plugging recipes for each tote into the system manually. With the amplifier boards from each set of HBM load cells putting out a 4-20 milliamp signal, it was clear that the software required to interpret that signal could be used to automate other areas of the process as well.

Slater looked at several automation programs that could link the system components together. A major consideration was the ability to expand the system in the future or make changes as the need arose. He chose Entivity's "Think and Do Studio" for programming because it was easy to learn and was supported by many of the electronics that they were using from Automation Direct, the vendor Plant Marvel selected to supply the PLC. Automation Direct also supplied many other components, including the touch-screen monitor, motor controls, sensors and even the VFDs to control the feed screws.

The software was set up to calculate the output from the Z6 amplifier boards, and to switch the screw feed motors to a lower dribble speed through the VFDs as the scales approached their target weights. After achieving their target weights and turning off the screw feeds, the software pauses just long enough to allow any free fall to settle before taking a second and final reading. The software then compares this final reading to the target weight, and any overage or underage is averaged along with the past three fills into the target weight for the next fill. Using the tote's work order number, all weights for each tote are retained by the system and can be retrieved and printed out for a permanent record.

A PC was set up and connected to the company's existing LAN with a touch screen monitor that uses a graphical overview of the system for HMI. As the system developed, it turned into a fully automated "Batch-a-tron," as Plant Marvel's office staff christened the system. Work orders for batches are entered using the company's existing software. Any special custom blends or customer requests or alterations are handled in the office at the time orders are received, and become a part of the work order stored in the system. Even the number of bags a customer requests can be plugged in so the tote receives just enough raw materials to complete the order. This capability can be especially helpful if the product is a non-stock item.

These work orders are printed out and handed to the production personnel for processing. Here a worker simply enters the work order number into the Batch-a-tron computer touch screen, clips the work order to a tote and enters the tote into the system. The system then uses the work order number that the worker entered to go over the LAN and reads the exact ingredients required for that particular tote. The operator verifies that the proper work order was retrieved, and from there the system moves the tote from station to station, collecting the right ingredients in the proper amounts until the filled tote rolls out the back of the machine and is moved to the mixing and bagging area. Multiple totes can be put back-to-back through the system, and each will receive its own ingredients according to its work order number.

Ultimately, Plant Marvel found that HBM's Z6 load cells helped realize far higher production line yield and more accurate in-motion weighing of ingredients. The Z6 load cells have allowed faster speeds and greater accuracy in capturing weights. This combination also results in minimal product waste. The HBM load cells were easy to install into the production line, and in the rare event of a failure, can be easily replaced with very little disruption to the process. Plus, their stainless steel, hermetically-sealed construction enables them to withstand practically any challenges the fertilizer manufacturing environment can dish out. As you may imagine, the Z6's ability to absorb a very high amount of vibration is another key advantage.

Entivity's software, coupled with the output from HBM's load cells, enabled Plant Marvel to build a system that has gone beyond their original hopes and has made it possible to create, in Darryl Slater's words, "our dream system". The system has been online and functioning virtually flawlessly for close to a year. They maintain a tight quality control that tests every batch, and there has been very little rejected product since the new system has been up and running.

By using load cells to perform the weighing, and completely automating the system through an Ethernet Controller, Plant Marvel has been able to almost triple its production rate and maintain tighter quality control compared to its previous system. **HBM Inc.,** 19 Bartlett St., Marlborough, MA 01752. (800-578-4260) hbm.com

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