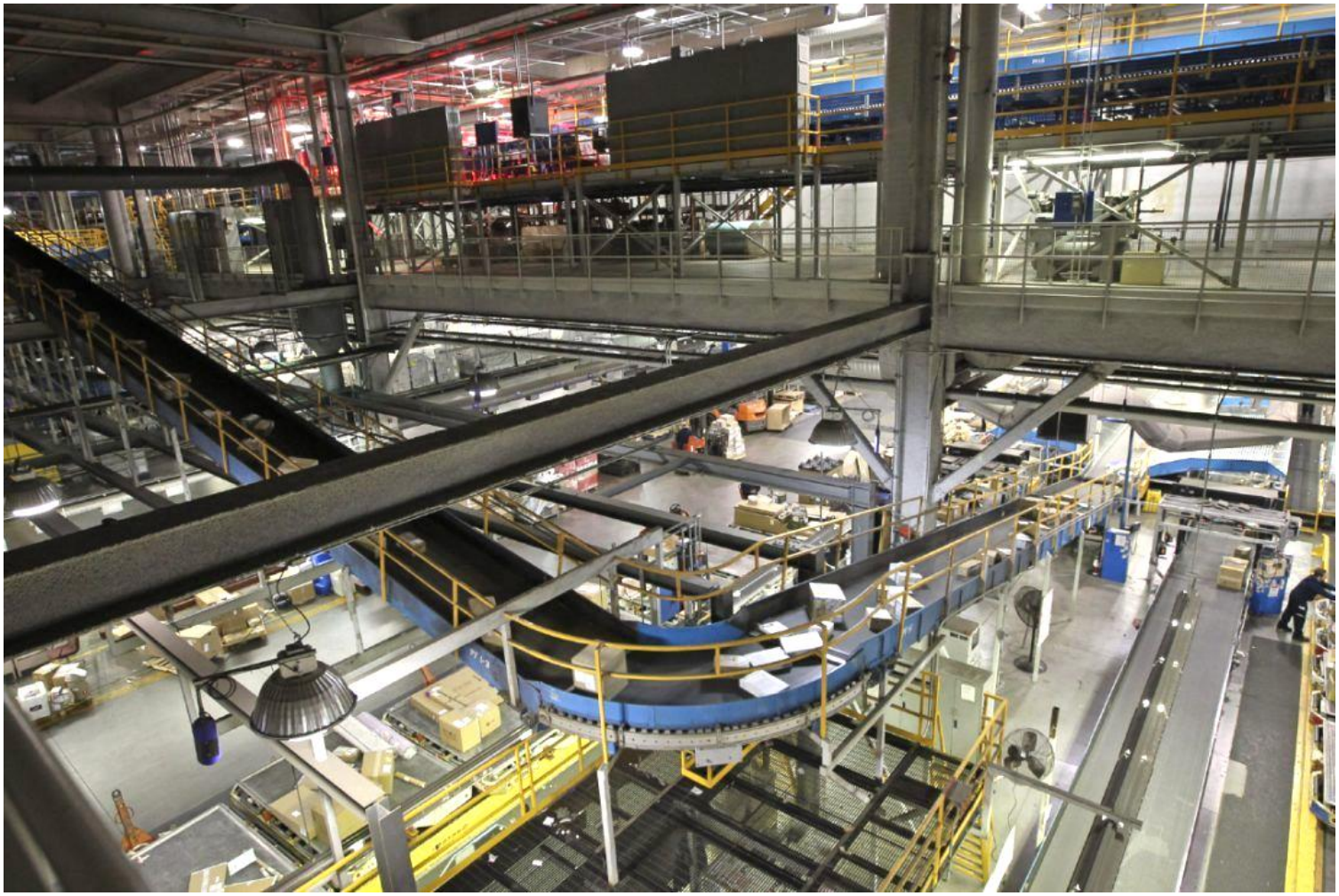
/Advanced Weigh Cell Technology

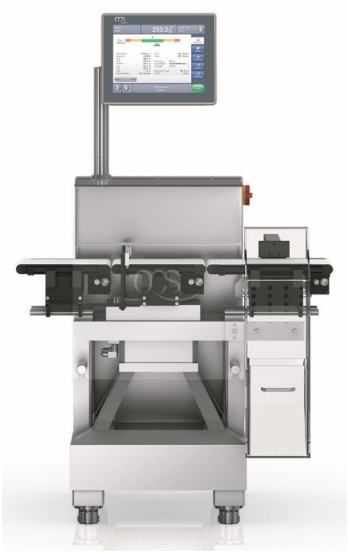
How EMFR and AVC Improves Weighing Results



White Paper

WIPOTEC OCS

WEIGHING AND INSPECTION SOLUTIONS



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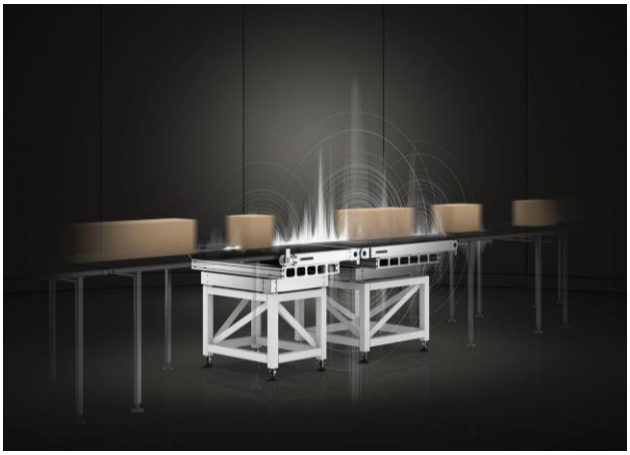


Introduction

For parcel processing, as well as food and healthcare packaging, recent technology advancements have made in-motion weighing operations more precise and profitable.

Catchweighers, which in North America are more commonly known as in-motion scales, are an essential aspect of material handling and parcel processing and distribution. In a fast-paced distribution environment, catchweighers must operate both swiftly and with exacting accuracy; in terms of precision, the weigh cell becomes the central mission-critical element.

Checkweighers used in food and healthcare packaging operations prevent the under filling and overfilling of product, resulting in brand protection and cost reduction due to less product giveaway. Reducing product giveaway is simplified by utilizing the checkweigher's filler feedback capability. The cost reductions achieved with a checkweigher implementation usually result in machine return on investment (ROI) times of well under a year.

Like many crucial machinery items, technology has evolved in recent years. The latest and greatest catchweighers and checkweighers incorporate weigh cells featuring Electro-Magnetic Force Restoration, or EMFR. Let us explore what this entails, and how it compares to conventional weighing methods.

What is EMFR Technology and How Does it Work?

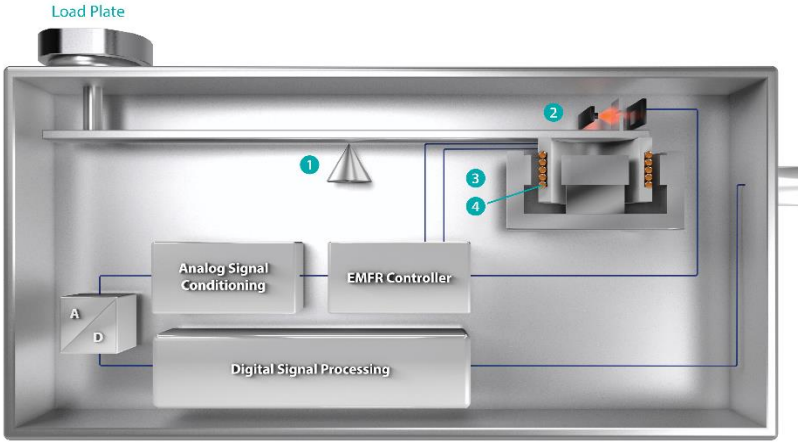
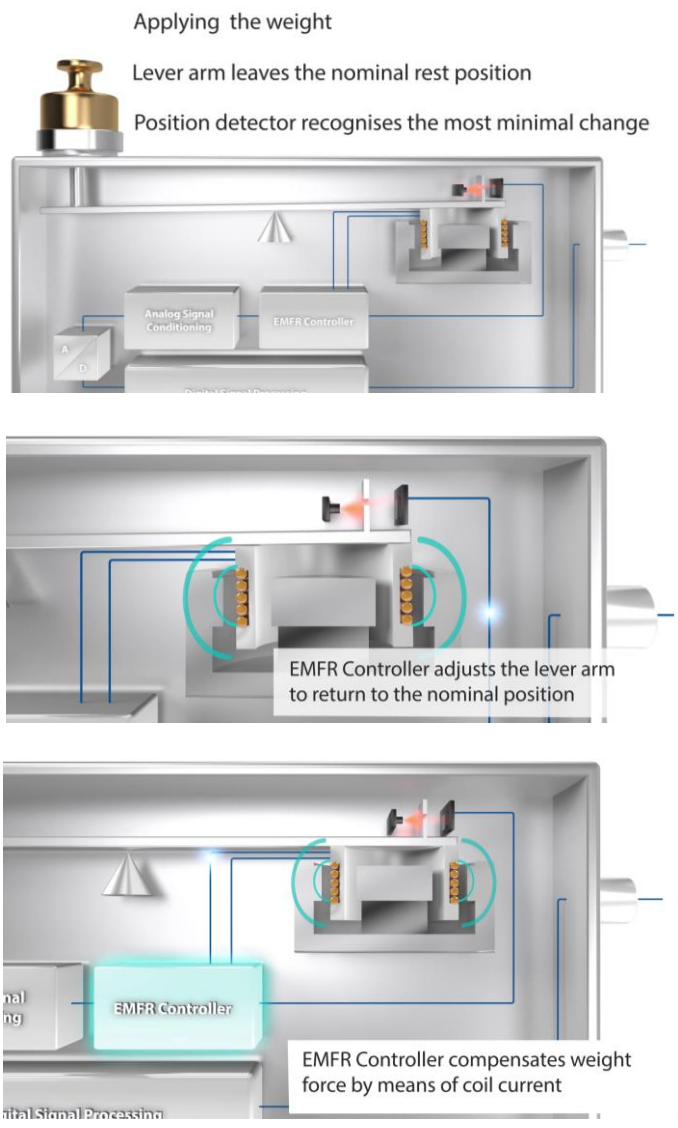


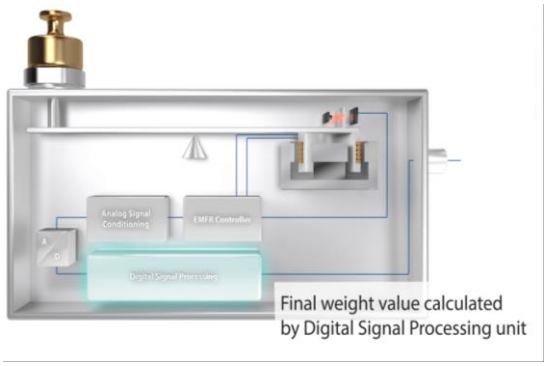
Figure 1 - Block diagram of an EMFR weigh cell



EMFR systems can be compared to a simple beam balance – though the intricacies are anything but. Incoming weight on the load plate causes the lever arm (1) in Figure 1 to leave its nominal resting position. The position detector (2) recognizes this slight position change and forces the coil (4) on the other side of the lever arm to move out of the magnet's field (3).

When this occurs, a photoelectrical beam recognizes any minute deviations in lever arm position and immediately sends its findings through a measurement resistor, transforming this data into a digital signal via an analog-to-digital (A/D) converter. The resulting digital weight value is determined by an advanced digital signal processor at exceptionally fast speeds with an internal sampling rate of 1mS, or 1,000 weight values per second. The weigh cell's digital signal processor output is sent to the interface connection of the catchweigher, checkweigher, or other third party OEM device or machine.

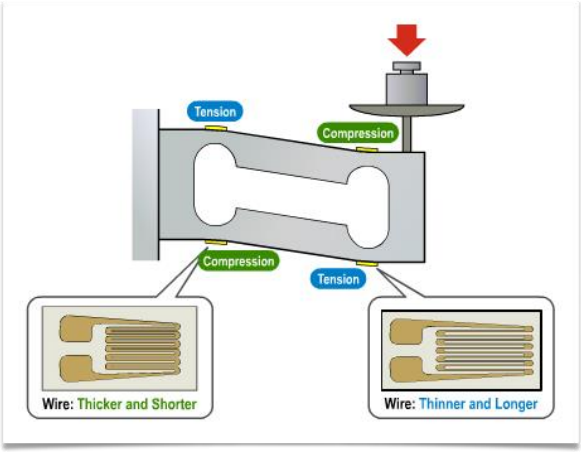
With their lightning-quick sampling rates, EMFR-based weigh cells enable extremely accurate weighing results that provide space and cost savings when integrated into existing systems. They possess high throughput rates – some EMFR-equipped triple scales can weigh up to 19,000 parcels per hour – while high-speed checkweighers can capture product weights at rates up 600 pieces per minute. Other smaller and mid-range scales and checkweighers offer fantastic price-to-performance ratios, and all EMFR scales deliver increased plant efficiency thanks to precise and reliable weighing results. It's no wonder EMFR-based solutions are used by wide variety of packaging and supply chain industry leaders, as well as leading food processors and manufacturers of critical healthcare products.



The Benefits of EMFR Technology with Application Examples

Dead Load Compensation and Resolution

Compared to conventional strain gauge scales, EMFR scales offer a number of benefits. When compensating for a dead load, traditional strain gauge-based checkweighers require a stiffer load cell to process the weight. With strain gauge checkweighers, the resolution of the weighing range declines. Since many load cells like the one illustrated in Figure 2 rely on a relatively large amount of metal bending, they all exhibit a spring-like operational behavior called ringing. These type of cells cannot tolerate fast weight changes because this ringing action needs to be compensated within the load cell. Dead load weight also needs to be compensated, and it is more cumbersome to accomplish in strain gauge-based load cells. Since EMFR weigh cells do not rely on large degrees of metal deflection, ringing is not a major concern. EMFR scales can also balance dead load with far less cumbersome software commands, keeping the weighing range available and the resolution intact.



Source: AutomationForum.co

Figure 2 – Bending Beam Load Cell with Strain Gauges

Settling Time

When measuring dynamic performance, EMFR checkweighers have a short settling time and active attenuation by the electronic controller, while preventing sensitivity and resolution from changing — eliminating the need for constant calibration checks. As seen in Figure 3, strain gauge scales and checkweighers generally possess less effective dampening oscillatory systems and a higher resonance frequency while settling, while the stiff load cell reduces sensitivity and resolution, requiring consistent calibration and maintenance. In short, EMFR scales are faster, more efficient, more precise, and require less maintenance than conventional weight cells. Since the EMFR accurately acquire the product information faster that a load cell, this enables more weight samples per unit of time. This is one of the major reasons EMFR based scales and checkweighers provide more precise product weigh information at much faster throughput speeds.

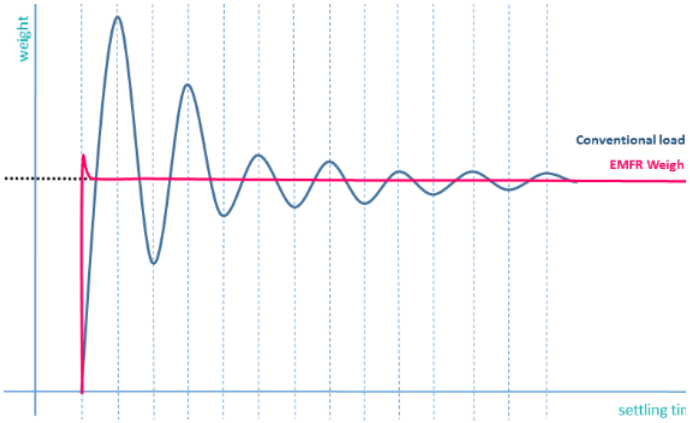


Figure 3 – EMFR Weigh Cell vs Load Cell Settling Time

EMFR Weigh Cell Application – Logistics

Catchweighers are called industrial scales in North America. The EMFR based scales are used in many different warehouse and logistics applications to catch the parcel weight in real time as the package moves over the weigh bed of the scale. The unique arrangement of the scale's incoming photo-eye and the weigh cell implementation using a mechanical weigh bridge enables Wipotec scales capture parcel weights with precision and at faster transport speeds than strain gauge based catchweighers. The weigh bridge used in EMFR based scales allow the parcel weight to be captured accurately regardless of the parcel's location on the weigh bed. Figure 4 illustrates a triple scale design where the three-weigh beds combine to capture more package size variations with the smallest parcel gap possible.

Figure 4 – WIPOTEC-OCS Triple Scale – Model HC-FL-T

Figure 5 - EMFR Checkweighers – Models HC-M and HC-A

EMFR Weigh Cell Application Example – Food Packaging

The EMFR weigh cell in the checkweigher types illustrated in Figure 5 is frequently found in the center of the machine and just under the center weight bed conveyor. Checkweighers used in Food Packaging applications take advantage of the high sample rates of EMFR weigh cells in order to deliver accurate package weights at throughput speeds as high 600 packages per minute. This enables the checkweigher to make quick reject decisions it a particular package is overweight or underweight. Frequently checkweighers in food packaging applications are placed after the package filler. This allows the user to take advantage of the checkweigher's filler feedback capability. If the checkweigher sees a series or package over- or underweight measurements, the filler feedback loop enables automatic adjustments to the filler machine in order to bring the package fill weight back into the acceptable tolerance range. This capability prevents expensive product giveaway errors in the case of package overweight conditions, or dissatisfied customers and/or product recalls in the case of product underweight situations.

Figure 6 - EMFR Checkweighers – Models HC-A-Pharma and HC-A-IS

EMFR Weigh Cell Application Example – Pharmaceutical and Healthcare Packaging

Some of the EMFR weigh cell-based checkweighers used in pharmaceutical, healthcare, cosmetics, and medical device packaging are very similar to the ones used in food packaging applications. For example the model HC-A-Pharma shown in Figure 6 is very similar to the HC-A checkweigher but with the ability to easily integrate into pharmaceutical package serialization applications. The model HC-A-IS checkweigher uses an indexing wheel rather that a belt conveyor to bring the products to the checkweigher. As such, the indexing wheel design is well suited to round, cylindrical product packages like the aerosol cans used in inhalers, and vials used to package vaccines. The EMFR weigh cell in this checkweigher design is located in the 12-o'clock position underneath the indexing star wheel. Depending on the star wheel design up to four EMFR weigh cells may be incorporated into the machine design. This design feature allows up to four product weights to be checked simultaneously.

Figure 7 – Five-lane Checkweigher with Metal Detection

EMFR Weigh Cell Application Example – Multitrack Checkweigher

Multiple EMFR weigh cells are also incorporated into belted checkweigher designs such as the one illustrated in Figure 7. The compact size that is possible with an EMFR weigh cell design makes it the ideal technology choice for this type of checkweigher design. The custom checkweigher shown on the left was designed for a cheese packaging application. Notice that there are five belts i.e lanes. Each lane has an EMFR weigh cell under the individual weigh bed conveyors, and they operate somewhat independent of each other. However, as per the customer's request, if one package is over or underweight, than all five packages in that batch are rejected. Notice that there is a metal detector incorporated into this multitrack checkweigher design. In food packaging applications it is very common to see a checkweigher integrated with a metal detector. The metal detector interface is controlled using the machines common HMI. This HMI control both the checkweigher and metal detector functions thereby making it easier for the machine operator. Like the checkweighing function if any one package is found to have metal present, then all five packages in that batch are rejected.

What is AVC and How Does it Work?

Introduction

Active Vibration Compensation or AVC is based on the WIPOTEC fast sampling (FS) EMFR technology, and is an electronic method of removing the key portion of the ambient noise spectrum from a product weight signal using internal software tools. These noise sources are commonly found in factory and warehouse environments and includes such things as conveyor sorters and fork lift trucks.

Why is AVC important? In just about every distribution warehouse and parcel sorting center all available space is used. This means that there are multi-level sorting conveyors placed on mezzanines, and often times the dynamic industrial scale or catchweigher is mounted off the ground in one of these vertical mezzanine levels. Rather than build super rigid mounting platforms for the dynamic scale to reduce vibrations, the AVC equipped industrial scale can be mounted using less expensive options because the weigh cell will compensate for the vibrations electronically.

Similar mounting advantages come into play with checkweighers equipped with EMFR weigh cells with built-in AVC used in food and pharmaceutical production. Combining EMFR Weigh Cell technology with AVC sensors enables accurate product weight measurements.

Figure 8 – EMFR Weigh Cell with AVC
(Model EC-FS-AVC)

How AVC Works

Here is how AVC works. As illustrated in Figure 9, two weigh cells are mounted inside one EMFR housing, one weigh cell measures vibrations including the load to be weighed (1), while the other measures vibrations only (2). Vibration-based interfering variables are calculated by comparing the two measurement curves in the signal processing section of the EMFR weigh cell (3), where the major vibration components of the load signal are removed. Due to the FS technology, we are able to deduct the disturbing signal from the load weight signal and come up with a “compensated weight value”. The resultant measurement signal is very close to a load signal that would be achieved without any influence through vibration (4). This final weight measurement signal shows a major reduction, if not complete removal of the negative effects caused by interfering vibrations present in the in-motion scale (catchweigher) or the checkweigher installation environment. Unlike filtering technology common in strain gauge based weigh cells, the AVC approach used in Wipotec's EMFR weigh cells is unaffected when the disturbing signal (i.e vibration component) occurs within the same frequency range as the information signal or load weight signal. AVC is a patented technology only available in Wipotec EMFR weigh cells.

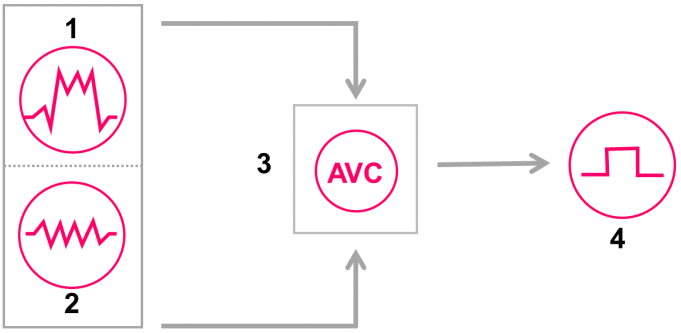
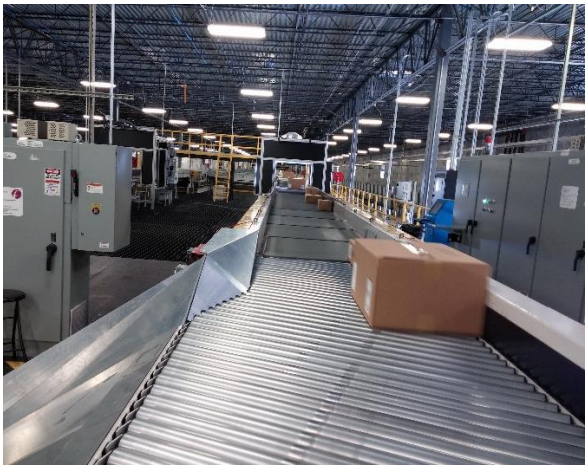


Figure 9 – Automatic Vibration Compensation (AVC) Schematic

1. Measured signal of the captured weight with vibration signal superimposed
2. Vibration signal (i.e. interference)
3. Signal processing section of the EMFR weigh cell
4. Resultant clean weight capture signal with vibration component removed

The Benefits of AVC Technology

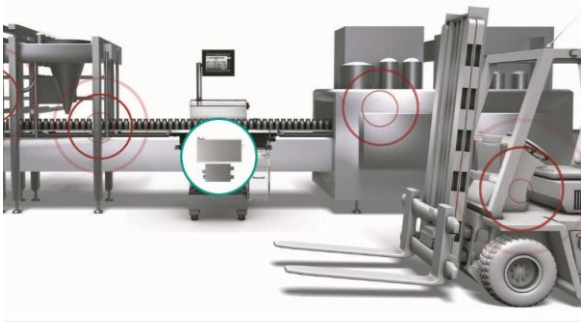


Logistics – Scales Mounted on Mezzanine Decks

AVC improves the weighing accuracy and repeatability of in-motion scales or catchweighers that are under the influence of floor vibrations under the critical limit of 15Hz. These types of floor vibrations are typical on mezzanine decks with a coverage span over 23' x 23' (7m x 7m). Since most of the parcel sorting actions in a modern distribution center happen up in the mezzanine decks, that is where the in-motion scales are mounted. As a precision scale manufacturer, Wipotec would love to have all of our catchweighers mounted firmly on a concrete floor, but we know that is not practical due to the need to utilize the floor of the sorting center for internal freight traffic. So what do you do?

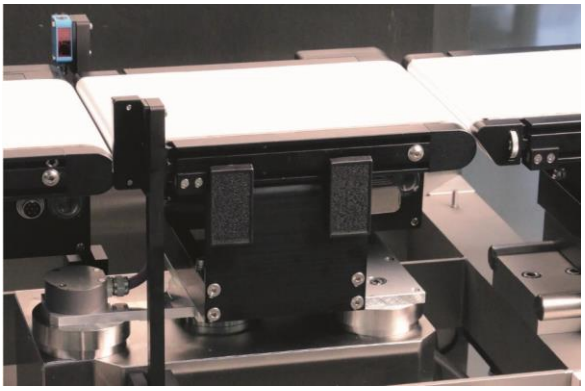
The first step might be to utilize a diagnostic tool we call the D-Box. Placing the D-Box at the designated location for the scale installation and connecting it to a laptop will allow you to use the D-Box software to calculate the achievable scale accuracy based on your individual application data such as speed, parcel size, etc. The D-Box will also provide information on the impact of AVC to the weighing result.

All steel platforms will resonate at certain frequencies depending on how the mezzanine is set up. Ideally, the mezzanine deck is less than 16’ (5m) high, and the mechanical set-up results in a resonant frequency above 10Hz. The filters inside the EMFR weigh cell in combination with the AVC technology will take care of removing the vibration components from the incoming load weigh signals. Compensating for vibrations within the catchweigher’s weigh cell allows for a simpler and less costly steel platform construction.



Food Packaging – High Speed Checkweighers

In food processing and packaging plants the equipment to cook, form and package the food products are large and quite heavy. As such, these machines are floor mounted, and so are the checkweighers. Vibrations are still present and can be very troublesome, particularly at the higher production speeds common in today’s food packaging lines. The product to be weighed and checked must transition over the weigh bed conveyor as smoothly as possible. Checkweighers from WIPOTEC-OCS offer many different in-bound and weigh bed conveyor designs that ensures this smooth product movement. The EMFR weigh cell itself; with its AVC option, can also help with making sure that environmental vibrations do not cause incorrect product weight measurement event at production rates of 600 products per minute.



Pharmaceutical – Serialization and Completeness Checks

In pharmaceutical packaging applications, it is necessary for manufacturers to put tracking codes on each individual package. The code content and code type is governed by several international regulations. The TQS-HC-A machine interfaces with upper level host software to acquire the tracking codes and print them on the individual cartons. The serialization codes are used to track and trace the packaged product throughout the supply chain in order to prevent counterfeiting. The code data makes it possible to find specific product(s) and recall them if necessary. Oftentimes a final completeness check by weight is done after the serialization code is applied. The EMFR weigh cell used in the TQS-HC-A machine offers an available AVC option. This option proves most useful for machine installations in high-vibration environments.

Summary and Conclusions

Electro-Magnetic Force Restoration or EMFR is a technology that has been proven in some of the toughest in-motion weighing applications around the globe.

EMFR eliminates the reliance on bending metal as a primary means of gathering weight data. The optical and electronic methodology approach use in EMFR weigh cells results in faster settling times and allows for the capture of more weigh samples as the product moves over the weigh cell. More product samples allows the checkweigher, catchweigher, or industrial scale to deliver more accurate and repeatable weighing results at faster production line speeds than what can be obtained with a strain-gauge based checkweigher or scale.

Active Vibration Compensation or AVC is incorporated into some EMFR weigh cells to electronically reduce or eliminate the affect low-frequency vibrations may have on the weighing results obtained by in-motion scales (i.e. catchweighers) and checkweighers. These environmental vibrations are common in production facilities and warehouse distribution and parcel sorting centers. The source of the vibrations are typically conveyors, mechanical sorters, forklift trucks, and other machinery. A typical AVC implementation involves two weigh cells located inside the EMFR housing, where one of the cells senses abient vibrations of a certain frequency range. Singnal conditioning is employed to reduce or eliminate these vibration signals from the weighing signal resulting in accurate product weights in envionments where that may not have been possible with conventional strain gauge or load cell technology.

Wipotec has been developing precision weighing and product inspection solutions for over thirty years. We are committed to our customers, and their need for accurate, repeatable, and reliable machines and technology. We will continue researching new ways to solve customer application requirements, while exceeding their expectations for quality weighing, inspection, and data gathering hardware and software products.

About WIPOTEC

WIPOTEC was founded over thirty years ago in the town of Kaiserslautern in Southwest Germany. We are an ISO 9001 certified company with over 100 subsidiaries and partners operating around the world. Our largest subsidiary is in the USA and was founded more than twenty years ago as OCS Checkweighers. It is now known as WIPOTEC-OCS and based in metro Atlanta. WIPOTEC-OCS has engineers, service technicians and project managers located across North America, and a major USA spare parts depot to ensure the best possible service and support for our American customers.

We are a weighing and inspection technology company built on ideas and innovation. Our first big idea was the EMFR weigh cell. The company founder and CEO is Mr. Theo Düppre and while working at the Technical University of Kaiserslautern (TUK), Mr. Düppre invented the Electro Magnetic Force Restoration weigh cell. Mr. Düppre is very active in managing the day-to-day activities of the company.

Other innovations such as the Active Vibration Compensation technology we discussed in this paper were developed in response to solving a customer's unique product weighing or inspection problem. Many times over the past thirty years our engineers have worked in partnership with our customers to develop a machine solution that exactly matches the customer's specific application requirements.

We make over 85% of the content used to construct WIPOTEC machines in our Kaiserslautern factory. This level of vertical integration enables us to support our machines for a much longer time period compared to our competitors. Our in-house approach to producing our own machine sub-components enables us to be very flexible when it comes to producing custom solutions.

From the smallest weigh cell used in one of our healthcare checkweighers, to the largest weigh bridge used in our widest in-motion scale or catchweigher all WIPOTEC products are built to stand up to the harshest application environments. We have checkweigher and catchweigher installations around the world that have been running in factories and parcel sorting centers for decades. We are very proud of this fact.

Additional product lines include are our X-Ray and Vision inspection machines that are ideal for ensuring the safety of our food supply by detecting foreign bodies and performing other package and product inspection tasks. Our line of TQS pharmaceutical serialization and aggregation machines are helping to ensure a safe and secure supply of medications. These machines help drug companies to effectively track and trace all medications from their point of origin to their point of distribution to the patients in order to prevent drug counterfeiting.

Figure 10 - WIPOTEC Factory in Kaiserslautern, Germany

Figure 11 – WIPOTEC-OCS Facility, Lawrenceville, Georgia USA

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