AVC – ACTIVE VIBRATION COMPENSATION
HIGH-PRECISION WEIGHING RESULTS IN SORTING CENTRES THROUGH AVC
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The CEP services (courier, express and parcel) mainly transport packages weighing up to 60 kg, as well as letters, documents, parcels and small individually packaged goods. Restrictions on weight and dimension lead to the need for standardisation of processes, as well as, the automated handling and sorting of packages. The rise in e-commerce (Internet trade) also contributes to the strong growth in CEP services.

For CEP and intralogistics companies, this means corresponding expansion of capacities. These increases require higher parcel handling speeds, which in turn leads to shorter sort times. To reduce sort times, the level of automation must be increased. It also translates into higher speed for sorting systems and scales.

This automation also includes the dynamic weighing technology, which forms the crucial basis for accurately billing transport services provided in the CEP sector.
THE PROBLEM

The use of dynamic weighing technology in sorting centres frequently poses a special challenge, as vibrations play a major role. Vibrations are present in all parcel freight centres, as the sorting technology has been changed over from semi-automatic to fully-automatic systems. The components of weighing technology, frequently used in weighing systems such as DWS systems (dimensioning, weighing, scanning), consist of a combination of the weighing belt for transporting the parcels and the actual weigh cell. These weighing systems are often located close to sorters, which due to their moving parts, transfer vibrations to the platforms or to the transport systems themselves. Sorters and the transport systems generate high amplitude oscillations. These low-frequency oscillations with a high signal level can impede or influence dynamic weight measurements. A further complication is that the majority of sorting operations take place on steel platforms at a higher level, since the floor space is used for internal freight traffic, which relies on clear routes.
THE SOLUTION: 
AVC – VIBRATION COMPENSATION FOR PLATFORMS

AVC solves vibration issues. This exclusive vibration compensation technology from WIPOTEC-OCS uses intelligent algorithms to ensure the most precise weighing results, achieving the required weighing accuracy even in environments where vibrations prevail. AVC filters out ambient disturbances from measuring results without any loss in speed.

To save space and expenses, sorting centres frequently employ support towers to maximise use of the converted area. These towers oscillate during operation. Measurement results and practical experience of weighing technology in sorting centres show the advantage of decoupled support towers. However, the effort involved in installing weighing systems in such a way that vibrations do not affect them is considerable. This stems from the specific challenges when planning distribution centres arising from additional vertical beams of decoupled support towers. Scales are mounted on mezzanine floors – often constructed as steel towers. These girders require additional, valuable space and impair safety-relevant concepts such as escape routes and driveways. Since interfering vibrations significantly influence dynamic weighing systems, there are two ways of minimizing their influences: The first approach minimises the vibrations of the supporting structure and the second method limits the remaining influence of residual vibrations. The first comprises the mechanical layout, the second the use of the AVC vibration compensation technology of WIPOTEC-OCS.
Designs of steel platforms have a significant impact on the intensity of the vibrations that affect these platforms. Vibrations caused by external systems (e.g., a sorting system) are transmitted and damped in different ways depending on the structure’s design. It is advisable to mount the scales directly on the concrete floor; although it is not always possible to do so in all cases.

If a separate support platform is used, it should have a maximum height of five metres and be anchored to the concrete floor. The structure of a steel stage tends to oscillate with a higher amplitude than the resonance-triggering structure. Since the resonant frequency leads to excessive oscillations, the mezzanine structure should be set in a way that the resonant frequency is above 10 Hz. A low-pass filter within the weigh cell software filters out vibrations with frequencies above 10 Hz.
Possible alternatives to the decoupled platform could be mounting the weighing technology on main or cross beams with an additional vertical support. In any case, the weighing systems should be equipped with an active vibration compensation system. The WIPOTEC-OCS system is called AVC (Active Vibration Compensation). It effectively reduces the influence of spurious oscillations from the environment on the measuring result of catchweighers.

/ OBJECTIVE:
LOWER AMPLITUDES AND HIGHER RESONANT FREQUENCIES

The resonant frequencies of steel platforms, on which weighing systems are installed, should be above 10 Hz.

Important design criteria:

- Installing support beams with a high modulus of elasticity and a high surface moment of inertia
- Platform length up to ten meters
- Rigid, bend-resistant connections between beams (welded connections)
- Cross connection between beams
- Truss reinforcement of main girders

Simulation of the measuring accuracy of scales based on real acceleration values of vibrating platforms. Display of the simulated weighing signals in the time and frequency range.

The results show that without vibration compensation, it is not possible to calibrate with an accuracy of 50 g.
AVC – ACTIVE VIBRATION COMPENSATION

The AVC solution filters environment-induced interferences out of the measurement results without any loss of speed and enables the weighing technology to be used even in sorting systems or freight centres where continuous scales have to be set up on vibrating floors. The AVC technology is particularly effective for vibrations caused by sorters or transport systems below 10 Hz. It reduces vibrations to one tenth of their value, equivalent to an attenuation of the effects on the measurement result by 20 dB.

How AVC works
AVC filters out ambient disturbances from measuring results without any loss in speed. It furthermore enables the use of weighing technology in sorting systems or freight centres, in which continuous scales need to be installed on vibrating floors. Two weigh cells are mounted inside one housing, one of which measures vibrations only, while the other measures vibrations including the load to be weighed.

Interfering influencing variables are calculated by comparing the two measurement curves. The obtained measurement result is very close to a result that would be achieved without any influence through vibration.
Results to be achieved with AVC

The WIPOTEC-OCS AVC eliminates, or at least greatly reduces, the negative effects of floor vibrations on weighing results. More specifically, the active vibration compensation system ensures that correct weight measurements can be carried out even at high transport speeds; as well as when the packages remain on the weighing belt for a short time. AVC can be provided as an option to be used in scale systems within sorting and distribution centers that need to either omit a support tower, or are influenced by large environmental vibrations.

A comparison of curves with and without AVC shows that with AVC activated the fluctuations due to vibrations are very much smaller and therefore the scales can measure very much more accurately.

/ THE ADVANTAGES OF AVC

All systems equipped with AVC from WIPOTEC-OCS have weigh cells based on electro-magnetic force restoration, which deliver very precise weight values considerably faster.

AVC:
- More efficient than planning and construction of decoupled platforms
- Reduces vibrations to one tenth of their value, equivalent to an attenuation of the effects on the measurement result by 20 dB
- Particularly effective for vibrations caused by sorters or transport systems (< 10 Hz)
- Allows calibration of continuous scales for calibration values that would not be possible without AVC
Significant reduction of the disturbances below 8 Hz

Digital filtering range

Massive disturbances within the critical range

Comparison of results with and without AVC:
AVC massively reduces the effects of oscillations especially in the range below 8 Hz, which could influence the weighing results.

AVC cannot subsequently boost the efficiency of an unsuitable steel structure in all cases, since the use of AVC requires compliance with acceleration limits imposed by the mechanical design. These acceleration limits depend on the conveying speed, the calibration value and the frequencies and amplitudes of the disturbance variables. The influence of the disturbance source (products, sorters, motors with high imbalance) also has to be taken into account.

ECONOMIC ADVANTAGES OF AVC USE

The use of calibrated weighing systems is required by law. In combination with AVC, it leads to substantially more accurate weighing results and therefore helps prevent incorrect billing of transport fees. Many companies in the CEP sector increase their profit margins by using automated weighing technology that is equipped with active vibration compensation systems.

AVC provides the potential to increase profits through gram-precise weighing results from the group of goods in transit. This is because AVC enables a more precise determination of weight that prevents parcels from falling into a lower pricing category. The price difference between the categories results in additional revenue by using a more precise scale. In addition, billing can start earlier if the calibration value is lower. For MID and NTEP applications, 5e* and 10e* respectively, is the lowest weight value that can be calculated. This means that with a calibration value of 50 grams parcels are billable starting at 250 grams. Respectively, a 20 grams calibration value makes parcels billable starting at 100 grams.

This is generally known as revenue recovery, i.e. the ability to make additional demands for logistics services actually provided. In the parcel sector, this additional income can amount to several thousand euros per day.

*The "e-value" is the value of the verification scale division. It represents the stated accuracy or tolerance of a scale e.g. e-value = 0.1 gram.
All systems equipped with active vibration compensation technology have weigh cells based on electro-magnetic force restoration (EMFR). The crucial advantage of a WIPOTEC weigh cell with electro-magnetic force restoration (EMFR) is its extremely short settling time. Compared to the weighing principle with strain gauges, this type of weigh cell provides very precise weights significantly faster, which allows it to be used at high transport speeds. This type of weigh cell also has no wear parts and so operates absolutely maintenance- and wear-free.

The EMFR-based solutions from WIPOTEC-OCS therefore offer decisive benefits, especially in the CEP sector. Here in particular, the weighing technology installed must be so robust, reliable and fast that on the one hand it can keep up with the high system speeds, and on the other it has sufficient stability to enable it to cope in the shipping and logistics environment.

References include well-known players, such as DHL, FedEx, USPS and UPS; here there are installations of impressive size, including in international freight centres. Added to these are a large number of installations for international integrators who have also secured this technology for themselves.
In the CEP sector, the product range of WIPOTEC GmbH consists of high-speed scales and extremely compact DWS systems. All machine solutions are developed and manufactured at the company’s headquarters in Kaiserslautern. The product range offers genuine solutions for almost any customer application. WIPOTEC Weighing Technology precision weigh cells are used exclusively in all catchweighers from WIPOTEC-OCS. They are used in many areas of activity for completeness and quality control, actual contents and weight per unit checking.

Double scale

Double scales solve the problem of chaotic product sequences with significantly different package lengths, which cause considerable difficulties for standard continuous scales. With regular scales, the consequences are larger product distances and thus a reduction in throughput.

The HC-FL continuous scale is the WIPOTEC-OCS solution to solve just this issue. This double scale is a combination of two single scales in line. Both scales can operate independently of each other or in combination. If a package is larger than each of the individual scales, the two scales automatically work together as one bigger scale, i.e. forming a virtual third scale.
The HC-FL continuous scale is the ideal solution, wherever high belt speeds and top throughputs are required for products weighing up to 60 kg – which is especially relevant for CEP environments. The design principle offers 60% more throughput at the same speed compared to a single scale. Another advantage of the use of two individual scales is that it enables the shortest possible product distances.

**DWS Compact**

DWS Compact are dimensioning, weighing, and scanning systems from WIPOTEC with shortest implementation times. DWS solutions on the CEP market also use AVC.

With integrated volume measurement, auto-identification, and weighing modules, these systems collect the package parameters required for complete invoicing of all transport services (revenue recovery). The data collected also forms the basis for calculating capacity utilisation, or capacity planning. The modular design allows the seamless integration of auto-ident systems and volume measurement technology from leading manufacturers. All individual components are accessible without barriers and are not restricted in terms of maintenance. The delimitation of all system components enables a structured maintenance concept. The intelligent system design allows exchange of the belt body without dismantling system components, resulting in higher availability. 360° data acquisition guarantees reliable planning and control of transport and product flow. DWS Compact systems can optionally be equipped with an active vibration compensation system (AVC).

The DWS Irreg from WIPOTEC-OCS also provides a solution for parcels that previously required special treatment. Irregs, because of their size, shape or weight, cannot be sorted with the normal parcels. Both irregs and small parcels are responsible for the impressive increase in freight volume experienced in the e-commerce sector. Here WIPOTEC-OCS offers both semi- and fully-automated system versions.
CONCLUSION

The use of vibration compensation technologies is one of two basic approaches to avoid the effects of vibrations on the result of weighing processes. The starting point for effectively preventing the distorting effects of vibrations is to appropriately design the steel platforms on which the weighing systems are to be used from the outset. However, it is not always possible to boost the efficiency structurally or to mechanically decouple the platform sections in which weighing systems are to be built. The reasons preventing this may be the additional expense necessary but may also be the restrictions on the additional supports required for this.

If it is impossible to dispense with platforms, then their mechanical layout must be designed in such a way that their resonant frequency, i.e. the frequency at which higher amplitudes occur than at adjacent frequencies, is preferably above 10 Hertz. This objective can be achieved as described here in this document with a special selection and arrangement of beams and by limiting the platform length.

The WIPOTEC-OCS Active Vibration Compensation (AVC) system can effectively limit the remaining effect of the residual vibrations to the extent that the results obtained are practically those that would be achieved without any vibration influence. AVC makes it possible to achieve the calibration values specified for scales even outside decoupled platforms and is a very successful solution to preventing vibration problems in sorting and distribution centres. AVC is an exclusive solution from WIPOTEC-OCS.

SOURCES

1 Bachelor’s thesis in the Department of Mechanical Engineering, studying mechanical engineering “Development of methods for ensuring the correctness of the measured values of scales as a subsystem of conveying and handling technology” submitted by Sebastian Mahnke, matriculation no. 7073053.