Is the manufacturing industry turning?

Measuring control valves

Concrete solutions at SPS

Measuring control valves

In AUTOMATIE | PMA 7, the October issue of last year, there was an interesting column about this subject. The message was clear: "provide ports in the body of the control valve with which the pressure before and after the valve can be measured". This because the pressure difference before and after the valve is an indication of the material flow through the pipe. Vincent van der Wel.

Vincent van der Wel

Moreover when the temperature and the density are determined, all physical properties are known and, by means of this infor-mation, a perfect valve position control can be provided. And is such an integration not a good step towards Industry 4.0 or the Smart industry? Of course, the following conclusion is the necessity of an increase of the valve body.

This approach is completely correct. However, the question immediately arises “isn’t there a simpler method”? The aforementioned approach requires four measurements, twice the pressure, one time the temperature and at last the density. Additionally, it requires adjustments, an increase of and measurement openings in the valve body.

Weighing creates knowledge

Every molecule has its own mass. So when the mass of the flow through the pipe can be determined, it reduces four measurements to one. With mass measurement you get a result, insensitive to differences in temperature, density and even aeration. The usual method of measuring masses is the weighing technique. The definition of weighing is: "measuring mass by means of gravity". Of importance too is the weight sensors - the load cells – are installed outside the material flow. This is beneficial for both the hygiene and the lifespan of the measuring element, because it does not suffer wear and tear. In certain cases it may be important that the chosen measuring technique is suitable for solids, gases and liquids.

The starting point is that the vessel, out of which the mass flow has to be measured - and eventually regulated -, is weighed. The correct measuring method for this one determines, based on the ratio between the desired minimum and maximum material flow, and the weighing capacity of the vessel.

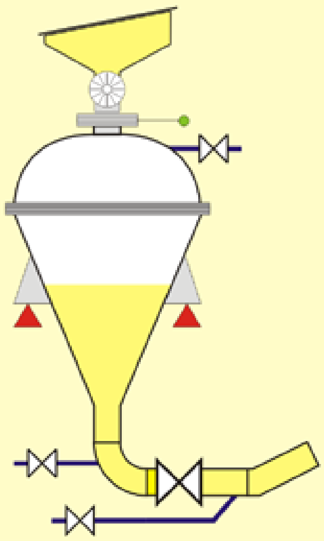
After all, a truck weighbridge is not suitable for weighing letters. In this case the accuracy of weighing systems - especially over parts of the weighing range - is an important factor. The technology we discus here has ample compensation for the dead weight, ie the mass of the weighing vessel.

Weighty equipment

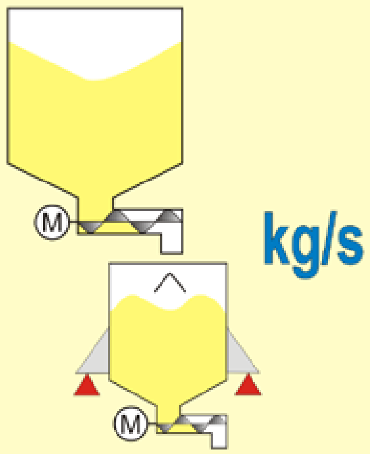
An example: imagine a vessel with its own - dead - weight of 2,000 kg. This vessel is carried by three legs, out of the vessel must be dosed, deducting from a weighing range of 600 kg. With the current industrial standard, such a vessel can be mounted on three load cells of 1,000 kg each, so a total of 3,000 kg carrying capacity. The accuracy over the weighing range of 600 kg then becomes 0.2 kg. This value you calculate as follows. Modern weight sensors – load cells - have a utilization of 30, or even 20 %. This means the full accuracy in percentages can be used over a weighing capacity of 20 or 30 % of the carrying capacity. The "industrial" accuracy of a modern weighing system is 3,000 divisions or 0.03%. That value may also be divided by the root out of the number of installed sensors. So in this specific case, 30% of 3,000 kg = 900 kg; 0.03% of this offers 0.27 kg, divided by √3: 0.155 kg. Rounded off to whole metric units this means a measuring/ weighing accuracy of 200 g.

#Read it

With measuring control valves a very reliable process control can be achieved. Here you can read how



△ Figure 1. A vessel for pneumatic transport with valve position regulation for the mass flow



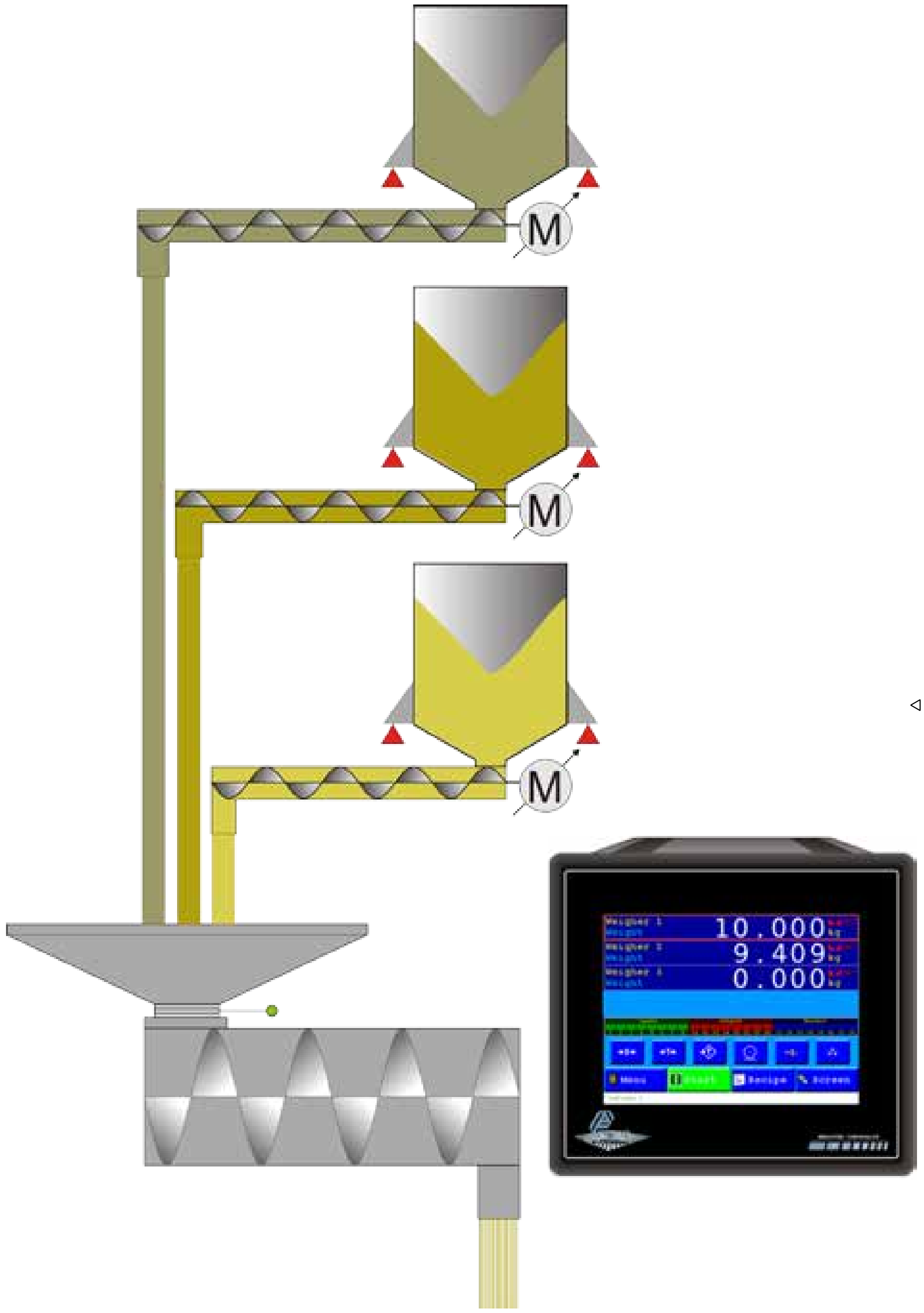
△ Figure 2. Controlling the mass flow by means of a speed-controlled screw conveyor

▽ Photo 1. A vessel for pneumatic transport

Next step, how does one translate the weight (m) into a mass flow (m/s)? For this purpose it is usual to check the deduction of the weight (Δm) and simultaneously determine the time this requires (Δt), see figures 1 and 2. Then a simple calculation (Δm : Δt) provides the mass flow. So in fact two measurements take place simultaneously - within one instrument. For example, where a control valve is used, a standard version - without an adapted valve housing - can be used. Photo 1 shows how a vessel for the regulated pneumatic transport of powders in real life looks like. In operation, these types of weighing instruments provide a wealth of information, the

- contents of the weigher
- weight reduction
- total dosed mass
- material flow

For the calculation and control of the mass flow, the weighing electronics possesses two important characteristics, the measuring speed, 1,600 measurements per second, and the internal resolution, 16,777,216 parts. Thanks to these properties, unpleasant side effects such as vibrations can be mathematically suppressed. Equally important, both small and rapid changes in weight are detected excellent. ▶



◁ Figure 3. The continuous preparation of mixtures out of three dosing devices with a continuous mixer.

For this task the instruments have several filters, so depending of the circumstances the right combination can be selected. In the aforementioned example - the dosing vessel for 600 kg - even material flows of 10 grams per second or 3.6 kg/h are measured and regulated with an accuracy ≤ 1%. The accuracy of the sensors is in fact mainly determined by the temperature and creep. Under normal operating conditions, the temperature is fairly constant, by such a small decrease in weight the creep hardly plays a role.

Options

As an extra there are the options to switch the dosage on and off and you have the choice to regulate the mass flow simultaneously. In the first case, the total

‘After all, a truck weighbridge is not suitable for weighing letters’

dosed mass is compared with a preset value and, as soon as reaching this value, the dosing is switched off. The material flow control is done by means of a continuous comparison of the actual and the preset mass flow, including, if necessary, adjusting the valve position or the speed of the dosing device. When the scale gets empty, it can be filled by weight automatically. During filling - in other words, when no reduction of weight can be observed - the valve position or the speed of the dosing device is adjusted in several empirically determined steps, according to the degree of filling. A more detailed example can be seen in figure 3.

In this application, a mixture is realized by means of three continuous dosing devices in combination with a continuous mixer. The result is a continuous stream of mixed product. Optionally, a master/slave control can be created. Doing so, the measured mass flow of the main component is used as a calculation factor for the determination of the mass flow of the other ingredients. This guarantees the ratio between the ingredients follows that of the main one.

Photo 2 shows another example. With this mobile installation, plastic road surfaces, the wear layers of bridges, are composed out of four components. This application shows how practical weighing technology is. With one type of measuring principle, mass/weighing, two liquids and two solids are in a continuous flow dosed, mixed and applied on the road surface.

Modern weighing electronics excels through the combination of a high measuring speed with a high resolution. Due to these characteristics, large differences in flow rates appear to be precisely controllable and adjustable. Small differences in mass flow are detected rapidly, so corrections can be made immediately. The conclusion therefore is this way reliable process control is achieved.

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▽ Photo 2. The continuous preparation of mixtures out of two liquids and two solids