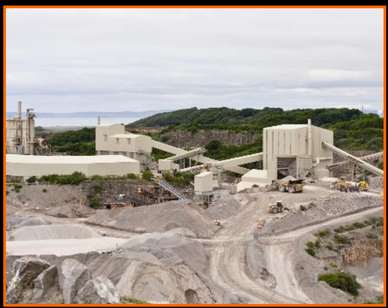
HYCONTROL
LEVEL MEASUREMENT SOLUTIONS






White Paper: Reliable Level Measurement Improves Screen-House Productivity

Reliable Level Measurement Improves Screen-House Productivity

Reliable level control is essential in the harsh environment of the quarry screen-house, where freshly-mined and crushed stone is sorted by size. However there are many challenges that this vital monitoring equipment will have to withstand, both in terms of the environment of the screen-house and the characteristics of the product being monitored. In this white paper level measurement experts ***Hycontrol*** *examine the issues surrounding level monitoring in screen-houses and outline the optimum measurement solutions for this challenging environment.*

Introduction

Screen-houses are a standard fixture in the quarry industry. Designs and sizes of screen-houses will vary from site to site, but they all fulfil the same basic function. Usually, belt conveyors are used to drop in processed, crushed stone from the quarry site at the top of the screen-house. The rock is then passed over a series of different-sized vibrating grilles which initially allows the smallest pieces of dust and stone to fall through into a bin below.

As the remaining unsorted rocks descend a ‘staircase’ of slightly angled, vibrating screens, progressively larger pieces of rock up to a size of 60mm are allowed to pass through into the appropriate bins. After screening, the sorted stone can be released from one of the discharge points at the bottom or the side of the bin for use in a wide range of potential applications including aggregate, the production of concrete, roadstone and general construction.

The challenges of screen-house level monitoring

Screen-houses are large, difficult, noisy environments full of potential hazards for workers, including high levels of dust, limited visibility and large oscillating plant. As such, appropriate goggles, filter masks and ear defenders must be worn at all times by staff working in the buildings. Clearly this abrasive environment will have a detrimental effect on any equipment that is used, including the vital level measurement instrumentation used to monitor the sorted stone in the bins. Reliable level control is essential not only for inventory purposes when the stone is removed, but more importantly for preventing overfilling of the bins. Product overflow will inevitably lead to equipment damage, plant down-time and a costly clean-up, not to mention the potential for Health & Safety issues. The worst-case scenario is if excess product lifts the screens off their vibrating mountings. Bearing in mind that they can be mounted up to 30 metres above ground level, this is nothing short of a catastrophic event. It will likely cause extensive damage to the screen-house, creating a hazardous working environment and leading to significant down-time whilst the very difficult and potentially dangerous task of repairing the screens is carried out. The cost of such an event is horrendous with lost production and repair charges.

The nature of the screen-house environment also restricts the level measurement options available.

Strain-gauge load-cell and force-based systems, which work by fitting special strain sensors to key parts of the load-bearing structure of a vessel, are highly sensitive devices unable to cope with the constant vibration of the screen-house structure.

Contact-based level measurement technologies such as TDR (Time Domain Reflectometry, sometimes erroneously called 'radar on a rope') and out-dated plumb-bob meters are both unsuitable for the screen house environment. Whilst both technologies have many other successful applications in the quarry environment, in the screen-house they are far too likely to be damaged by the falling stone and so would be limited to use on the dust bins only.

Therefore we are left with a choice of two technologies that are suitable for screen-house level measurement, namely **ultrasonics** and **radar.**

Ultrasonics

Ultrasonic technology provides a highly cost-effective, easy-to-install, non-contact solution for a wide range of solids level measurement applications. The transducer, mounted at the top of the vessel, emits sound waves that are reflected back from the surface of the material. The instrument measures the time-of-flight of these waves in order to calculate distance, from which is discerned the level of product in the vessel.

Frequencies as low as 5 kHz are used on long range solids materials and higher frequencies at 40 kHz or above are used on shorter ranges. The latest low frequency ultrasonics can be used for ranges of up to 60 metres, although a number of environmental and operational factors within the silo can reduce this range. Traditional ultrasonic devices struggled with the effects of false echoes and temperature changes. However, the latest corrective software can compensate for a number of adverse operational factors relating to weak and false echoes caused by dust, internal silo structures (for example ladders or cross braces) and temperature changes affecting time-of-flight.

It should be noted that when using ultrasonics, consideration has to be given to the so-called **dead band**, a range directly below the transducer face where measurement is not possible. This area can vary from 300mm to 1500mm depending on the frequency being transmitted. However this usually only presents a problem for applications with shorter measurement ranges, rarely affecting screen-house applications.

Radar

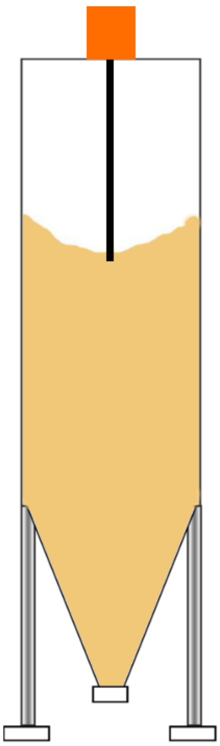
FMCW (Frequency Modulated Continuous Wave) Radar level measurement systems use high frequency microwave signals (24-26 GHz) that are unaffected by dust, pressure, temperature, viscosity, vacuum or foam. The measured level is proportional to the difference in frequency between the transmitted microwaves and those reflected back from the product surface.

This technology is suitable for measurement ranges up to 80 metres and provides high levels of accuracy for certain applications. However the effectiveness of radar technology is dependent on the dielectric constant of the material in the vessel. Radar usually works better on products with a dielectric constant of greater than 2.0 and in the instance of rock in a screen-house this is not generally an issue. Radar equipment is more expensive than ultrasonics which may be a deciding factor for certain applications.

Effects of Filling and Emptying

It is important to understand the way in which vessels are filled and emptied when installing level measurement systems in order to optimise performance. This is especially important given the unusual shape and properties of a screen-house. In a normal silo with a width of less than 3 metres, with centrally-located single fill and draw-off points, the way in which material behaves is usually repeatable. A single level sensor, located away from the fill point, will usually provide reliable and consistent results *(See figure **1**).* Please note that, depending on the size of the vessel and properties of the material, it may be necessary to locate the sensor an equal distance between the centre and outer edge of the vessel.

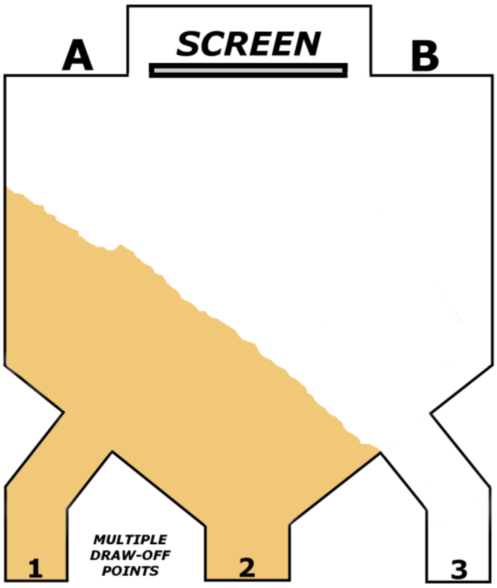
Figure 1



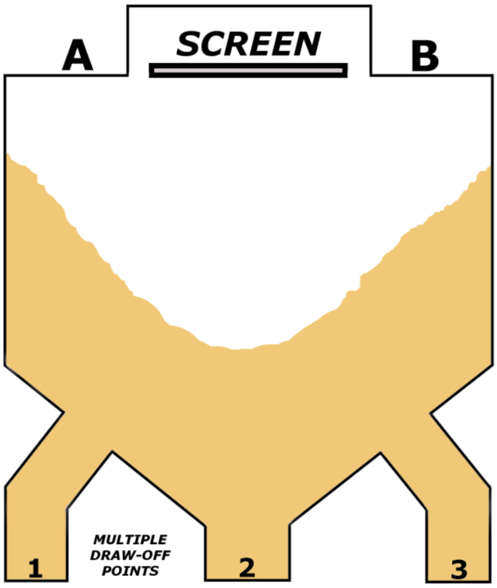
Complications can occur with vessels that have multiple fill and draw-off points, as in the case of quarry screen-houses *(See figure **2** below).* Typically bins have three discharge points and this will result in unpredictable product level behaviour. This means that a single sensor located on one side or the other of the vessel will not provide an accurate gauge of the contents – for example product may come to rest largely on one side of the bin, and a sensor located on the opposite side may erroneously show the tank to be empty or near-empty. Using the vessel shown in **example 1**, this would be the case for a sensor located at **point (B)**. With the 'staircase' of screens that runs down the centre of the building it is not possible to centrally-locate a sensor in a screen-house - the falling product would soon erode it away. Whilst covers could be fitted it would be totally impractical to gain access in order to service and conduct maintenance on the sensor.

<u>Figure 2</u>

Example 1:



Example 2:



The most effective solution is to mount two level sensors meters, each an equal distance from each side – in the *examples* above this would be at **points (A)** and **(B)**. The readings from each sensor are then used to discern the average product height in the vessel. This is done simply by feeding the information from the two probes to a site PLC or locally-mounted display panel where the readings from **(A)** and **(B)** are added together then divided by two, giving an average contents level for the vessel. This also provides the user with separate levels for both sides of the screen, making it easier to decide which point to draw the product from – for instance, in **example 2** *above* the product should be taken from **draw-off points (1)** and **(3)** to lower the product height at the sides of the bin.

<u>Maintenance</u>

As we have seen, level equipment in a screen-house is exposed to potentially damaging abrasive material, dust and vibration throughout its working life. Not surprisingly the cleaning and maintenance of level equipment in this unpleasant environment is often neglected.

This is a fundamental error and one that will ultimately accelerate the failure of the equipment. For process-critical equipment, maintenance is essential to ensure ongoing functionality and should be regularly scheduled. This should include not only cleaning and visually checking that the equipment has not become damaged, but also a thorough check of the functionality and calibration of the sensors. This will ensure optimum output levels and eliminate the risk of signal drift. The best solution is for this to be carried out by experienced specialist engineers as part of a regularly scheduled maintenance programme.

Conclusion

The need for reliable level control in screen-houses is clear and well-understood by quarry staff. However achieving that reliability in a harsh environment continues to be a challenge. It is now accepted that the use of a single sensor will not provide sufficient accuracy, but two sensors will give optimum performance. The chosen instrumentation must provide the precision and reliability required to monitor through a dusty atmosphere, whilst having the robustness and durability to cope with damaging environmental conditions. Ultrasonics and radar both meet these different challenges and, when correctly installed, provide reliable level measuring solutions for the screen house. In parallel, regular maintenance is essential for maintaining and prolonging the working life of this equipment. By ensuring all these factors are considered, better screen house performance and a lower overall cost of ownership can be achieved.

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