


Real-time control drives efficiency into dry bulk handling operations

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Dry bulk cargos must be loaded and unloaded quickly, efficiently, cost effectively and safely if shipping operations are to be profitable.

The processes have long been mechanised, but by harnessing the power of computers to monitor the handling equipment, operational performance can be improved, scheduling for maintenance can be optimised and billing of customers can become automated. Tony Ingham of Sensor Technology Ltd, a global technology development company based in Banbury UK, explains the theory and gives examples.

Fifty years ago, ships were loaded and unloaded manually, so each port employed a small army of strong men who worked long and hard as soon as a ship came in. But nevertheless, the handling operations protracted and so the ships were in harbour for extended periods. It is also worth noting that back then, health and safety legislation was virtually unknown and it was practically impossible to accurately account for the whole cargo.

However, dockside operations have long since changed for the better and even in developing countries harbours now bristle with cranes, elevators and loaders.

There is a simple rule that drives the development of such technologies – a ship at sea is earning its owners' money; a ship in port is costing its owners money. Therefore, shipping companies drive harbour operators to constantly improve their services and will transfer their loyalty to new docks if necessary. Quite simply, rapid loading and unloading are critical to the success of a shipping company and so dockside technology continues to develop to provide ever more speed and efficiency.

So, from manual operations, cranes, elevators, augers and loaders were developed, each one suited to a handling a different product - grain, coal, gravel or chemicals. While these were motor driven, they were controlled by human operators – and no matter how skilled the operators became, they had no real way of telling if they were optimising processing and working efficiently. Then computers were brought in to automate the calculations and decision making and efficiency took a turn for the better; further, the computers could automatically collect operational data and convert it into commercial information for billing customers.

Today, another new generation of technologies is emerging and it is taking bulk cargo handling operations to new levels of efficiency, accuracy and flexibility. Put simply, robustly built sensors are being installed on dockside handling equipment; these constantly measure operational parameters of the machinery in 'real time' and feed live information back to a controlling computer, which can adjust operations on the fly so that efficiency is maintained. Further, all this data can be collated to provide billing information, and analysed to determine how much work the machinery has done so that pre-emptive maintenance can be scheduled for minimal disruption to normal operations.

Unloaders come in several different designs, each suited to different materials. The core technologies include bucket wheels, flighted vertical conveyors and elevators, augers, horizontal belt conveyors and pneumatic systems. The mechanical principles of each of these are self-explanatory, but it is essential that control and monitoring of this equipment are maintained always to both ensure trouble-free operation and to calculate the weight of cargo being unloaded.

The fundamental parameter to be measured is load (which can also be called weight or mass). The weighing scale was invented in ancient times, but is of no use in modern bulk handling operations; a load cell is required. This is an electronic sensor (in a robust housing if it is to be used in a harsh working environment) that constantly sends a signal to a remote computer proportional to the load being experienced at every moment in time.

As such it is simple to see that a load sensor is very useful on a crane; each load is weighed and the figures added up to give the total amount of cargo lifted.

However, a load cell is not appropriate on a conveyor, auger, or other equipment that works by constantly having a quantity of cargo 'in flight'. The amount in flight will be approximately constant, and the duration of the operation will determine the total amount of material handled. For this type of handling system, you measure the torque of the motor's drive shaft.

Torque is in effect a measure of the amount of power being transmitted in a rotational direction. A simple example that aids understanding is riding a bike: to accelerate or go uphill you need to pedal harder – or apply more torque via your leg muscles. The same principle applies with conveyors, augers, etc; the more heavily loaded they are the more power the drive motor needs to supply and therefore the total amount of power supplied over time is proportional to the total load handled.

It is increasingly common to fit torque and/or load sensors to handling equipment to obtain a real-time measurement of their performance. They constantly feed information to the control computer, which can then adjust machine settings to optimise operations. The computer also collects the data for commercial purposes and maintenance planning.

As noted earlier these sensors are mounted inside a strong housing so that they can withstand the rigours of dockside life. Significantly they must transmit their data back to the control computers; the normal way to do this would be with electrical wiring, but that could not be expected to last long in the demanding environment of a busy port. One solution would be to use armoured cable and to route via the most benign areas; however, a better solution is wireless transmission of the signals.

Now, with over 20 years of research and development into digital non-contact torque monitoring, Sensor Technology UK Ltd is at the forefront of an important enabling technology. Its TorqSense transducer is based on the patented technology of measuring the resonant frequency change of surface acoustic waves (SAWs) generated by rotating shafts. It's a proven technology that has solved torque measuring challenges in a host of industries.

TorqSense torque sensors use two tiny SAW detectors made of ceramic piezoelectric material containing frequency resonating combs. These are securely mounted onto the drive shaft at a 90-degree angle to one another. As the torque increases the rotating shaft twists very slightly along its length which causes one comb to expand and the other to contract in proportion to the torque being experienced.

An adjacent pickup device emits radio waves, using the unrestricted 2.4 GHz waveband, towards the SAWs. The combs reflect them back, but because one comb is expanded and the other is contracted they return at two different frequencies. The difference in frequency of the reflected waves is proportional to the torque at any moment in time. This arrangement means there is no need to supply power to the SAWs, so the sensor is non-contact and wireless.