The system, developed some four years ago, was intended primarily for the fuel industry.

Level and density measurement of fuels

With fuel becoming increasingly expensive, it made sense to devise a system that could accurately measure fuel in service station storage tanks.

**Bubble tube technology**

We started our development using bubble tube technology. This decision was taken for three reasons:

- We wanted to use a system that would be inherently safe, i.e. there would be no electrical components in the hazardous area.
- We wanted to measure the weight of the fuel. As fuel heats up and cools down, it expands and contracts, resulting in different fuel levels, even when the tanks are sealed off. However the weight of the fuel remains constant, regardless of the temperature.
- We wanted to have as few moving parts as possible.

Bubble tube technology has never been used successfully for level measurement in applications where the specific gravity of the measured medium is not constant. Fuel was an even bigger challenge, because the density changes with temperature. In essence, the technology revolves around measuring the force that it takes to move a bubble through the height of a storage tank.

**Density measurement**

To resolve the density problem we devised a probe with two measurement elements. The first measurement point is at the bottom of the tank (P1), and the second is at a precise height above the lower measurement point (P2) (Fig. 1).

By integrating the differential pressure over these two measurement points we are able to calculate the fuel density very accurately. This measurement provides a bonus, in that it is possible to determine whether the fuel density differs from the norm and to give alarm outputs for water contamination, or for other types of chemical contamination.

To the best of our knowledge this is the only fuel gauging product in the world capable of warning that fuel may be out of specification.

**Level measurement**

The microprocessor multiplies the fuel SG measurement with P1 to determine the weight of fuel in the tank. These values are applied to a strapping table and the results converted to volumetric displacement. Because the system requires no temperature compensation it is extremely accurate. Recent overseas trials have shown accuracies of better than 0.1%.

**Environmental factors**

Because this technology measures the weight of the fuel in a tank, it is the ideal product for tank leakage detection. Any change in weight during times when the tank is sealed can be attributed to loss of product by unauthorised means. Conversely, normal level
measurement techniques have to offset the effects of temperature, before assuming that losses are unauthorised.

**Industrial applications**

Industrial applications are a major focus of new developments in this technology.

**Standard configuration**

This system is configured for measuring fuel or any other liquid in a non-pressurised storage tank. We are investigating the possibility of using this technique to determine the value of materials stored in solution, e.g. platinum concentrate. (Fig.3).

**Thickener density profile**

Tapings are taken from a number of points at various heights in the thickener (Fig.2). The differential pressure over each set of measurement points (P1-P2); (P2-P3); (P3-P4); (P4-P5) is used to determine the differential pressure gradient through the height of the thickener. Flotation cells provide a measurement of the interface level (the point where the froth meets the concentrate) as well as the density of the material in the cell.

The bottom of the probe is used as a reference point, and is a known distance below the weir plate. The froth on the top of the concentrate will offer no resistance to the bubbles being forced through the process medium. By measuring the density of the process medium and calculating the actual height of the concentrate, we are able to give an output that is proportional to the distance of the concentrate from the weir plate. It is also possible that the density measurement can be used for flocculent addition, although this has not been proven at this stage.

**Benefits**

There are no electrical components in the measurement area.

The system offers none of the challenges of a conventional pressure measurement system, where a build-up of material over the pressure sensors creates inaccuracies.

There are no problems with vibration, etc.

Electronic components are located in a clean environment, especially in applications that make use of Magnetite and Fesi.

**The system is very accurate**

In applications that have moving parts it is possible to introduce the bubble from the side of the vessel, rather than installing a probe into the process.

In vented tanks, blocked vents can be detected because there is an apparent rise in density when gases cannot escape from the tanks.

When measuring volatile substances, changes in level due to temperature change are factored out, as the weight of the substance will remain constant.

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