biosystems Application Note	**Dilution Monitoring**	Date	August 9, 2001
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Introduction

Some gas detection applications require the detection of combustible gases and vapors in environments that contain little or no oxygen.

Catalytic "hot bead" combustible gas sensors, such as the type used in the Cannonball[3], require at least 10% by volume oxygen to produce an accurate full scale LEL reading. The reason for this is that catalytic hot-bead LEL sensors physically burn the combustible gas that is present in the environment in order to produce a reading. Oxygen is a necessary component in this process. Since inert environments are devoid of oxygen by definition, it is necessary to add oxygen to the sample stream to allow the combustible gas sensor to operate.

Figure 1 shows a sketch of a confined space and the display of a typical gas detector. The actual condition of the confined space is 2% oxygen and 50% LEL combustible gas. The gas detector will show an O_2 reading of 2% whereas the LEL sensor reading will be unpredictable due to the low oxygen condition. Most gas detectors will display a rapid up-scale reading followed by a declining reading to settle at a very low or even a zero reading for LEL. In the case of most Biosystems gas detectors a message "O_2 too low for LEL to operate" will actually be displayed when the oxygen level is detected to be below 10%.

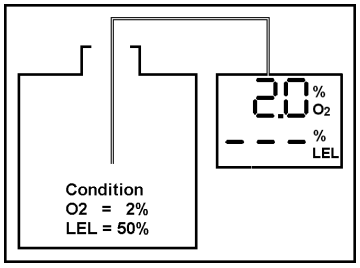

Figure 1

Dilution Orifices

Traditionally a dilution orifice has been used to add oxygen to the sample stream. Figure 2 shows a sketch of a confined space with the same condition as in figure 1. In this example, however, an orifice has been inserted into the sample line. The orifice is designed to dilute the sample in a ratio of 50% with fresh air. In other words half of the sample that the gas detector sees comes from the confined space and half is fresh air.

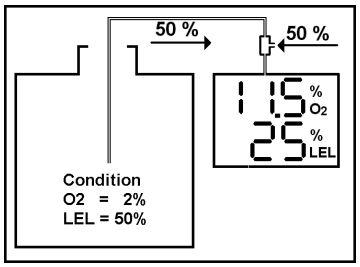

Figure 2

The gas detector in this example will display 11.5% O_2 and 25% LEL. The LEL calculation is simple and straightforward. Since half of the combined sample is fresh air the display will be half of the actual concentration in the confined space. The O_2 reading of 11.5% derives from the fact that half of the sample contains 20.9% oxygen and half contains 2% oxygen. The formula is as follows:

$$(20.9\% / 2) + (2\% / 2) = 11.45\%$$

This setup requires that the user must recalculate the actual concentration from the readings displayed by the gas detector, for any change of conditions.

Further, the accuracy of the dilution orifice is suspect at best. The 50% dilution ratio must be calibrated mechanically. Any dirt that may enter the orifice will affect the ratio. The ratio is also affected by changes in tube length, changes in the restriction of the in-line filters as they get dirty or saturated with moisture and vessel pressure during testing.

Dilution Pump

The Cannonball[3] uses a more accurate and innovative way to mix a known ratio of fresh air to the sample without the drawbacks of a dilution orifice. The Cannonball[3] is available in a two-pump configuration where one pump is used to draw the sample from the confined space and the other is used to draw fresh air in to the gas detector.

Figure 3 shows a sketch of a confined space with the same condition as in figure 1 and 2. In this example a Cannonball3 with two pumps is used.

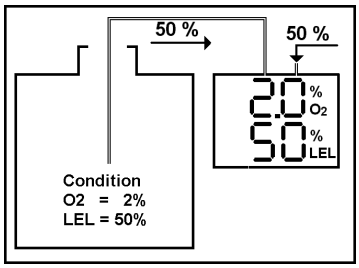

Figure 3

Each pump line is equipped with a flow transducer that accurately reports the flow through each pump to the Cannonball[3] microprocessor. The Cannonball[3] can then calculate the final readings and display the actual conditions in the confined without the need for user calculations, and independent of external factors.

Summation

Using two pumps with independent flow control makes the Cannonball[3] a superior solution to dilution orifices. All calculations are done by the microprocessor. The system works independently of tube length, filter conditions (as long as an adequate sample can be drawn through them) and vessel pressure. Additionally the Cannonball[3] automatically changes the alarm set points when it is switched from normal detection mode to dilution mode. A switch that is done in seconds using the Cannonball[3] keypad.