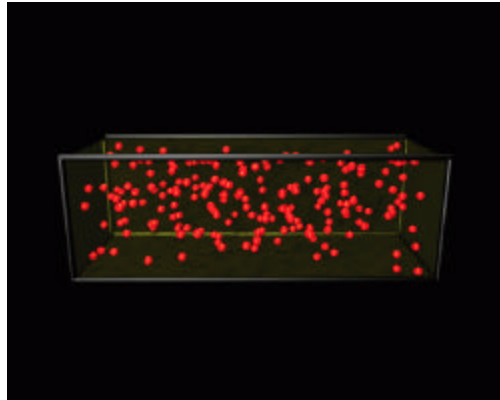


Measurements in Biogas

Biogas consists principally of methane and carbon dioxide. Generally these two components are measured with infrared sensors for a number of reasons.

1. Carbon dioxide is particularly difficult to measure by other means, as is the case with methane.
2. Infrared sensors do not suffer from cross-sensitivity effects.
3. They can work for long periods constantly without calibration.

Unfortunately, for some reason, the differing molecular weights of the two gases, or some other effect, amplify the fact that these are real gases, not the school-book ideal gases. The sum of the concentrations or partial pressures does not equal exactly 100%.



The Partial Pressure is defined as the pressure of a single gas in the mixture as if that gas alone occupied the container. In other words, Dalton maintained that since there was such a huge amount of space between the gas molecules in the mixture that the gas molecules could not have any influence on the motion of other gas molecules, hence the pressure of a gas sample would be the same whether it was the only gas in the container or if it were mixed with other gases. This assumption that molecules act independently of one another works perfectly well, providing there is a lot of space between gas molecules in the mixture and the temperature is not too low. Lowering the temperature and/or increasing the pressure will upset the assumption. Basically, this assumption is a postulate of the Kinetic Molecular Theory of Gases. If the assumption breaks down then the gas does not behave as predicted by all the Ideal Gas Laws, the gas deviates from behaviour as an Ideal Gas.

The gases are also both non-polar, as is shown below:

If we look at the methane molecule: The tetrahedral geometry contributes to the effect. This is a symmetrical molecule with electronegativities of the carbon and hydrogen almost the same, carbon being just slightly higher. When viewed, the electrostatic potential clearly shows that the carbon is just very slightly negative, whereas the hydrogen atoms are very slightly positive. The overall effect is an almost completely homogenous electrostatic potential surface which is thus neutral or non-polar.

And the carbon dioxide molecule: The linear geometry with two identical oxygen atoms attached to a central carbon atom gives rise to a special effect. The molecule is symmetrical. Partial charges arise from the difference in the electronegativities. The electrostatic potential is partially positive for carbon and partially negative for both oxygen atoms. However, the symmetrical nature of the bonds has the overall effect of cancelling the dipole, therefore the molecule is non-polar.

Suffice to say, that the effect is noticeable and will produce a measurable error, particularly at about equal concentrations. Here, an error of around 4% is to be seen, despite all attempts to remove all other measuring errors from the system. We now have included a calculation for this effect in all systems fitted with both methane and carbon dioxide sensors, whether stationary or portable. The calculation is analogous to the cross-sensitivity calculation, although the cause of the problem is definitely not due to one sensor reacting to the other gas. It is almost as if the methane molecules manage to slip between the carbon dioxide molecules and hence squeeze a few extra in!