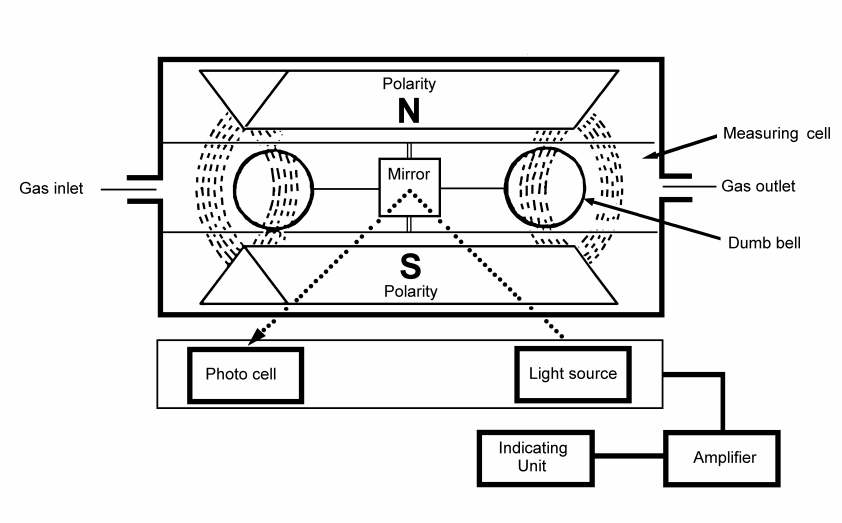
Paramagnetic Cells

Oxygen is a paramagnetic gas and is attracted into a strong magnetic field.
Because this measurement is a purely physical effect, nothing is consumed and in principle the cell has an unlimited life. However, contamination of the cell by dust, dirt, corrosives or solvents can lead to deterioration. Measurement range is typically 0.05% to 100% O_2.

Theory

The paramagnetic sensor utilises the paramagnetic susceptibility of oxygen, a physical property which distinguishes oxygen from most other gases.

The sensor incorporates two nitrogen-filled glass spheres mounted on a rotating suspension. This assembly is suspended in a strong magnetic field. The oxygen in the surrounding gas is attracted to the magnetic field, resulting in a force on the glass spheres. The strength of the torque acting on the suspension is proportional to the oxygen content of the surrounding gases.



Principle of Operation

Refer to Figure 1 above. The measuring system is “null-balanced”. First the “zero” position of the suspension assembly, as measured in nitrogen, is sensed by a photo-sensor that receives light reflected from a mirror attached to the suspension assembly. The output from the photo-sensor is fed back to a coil around the suspension assembly. This feedback achieves two objectives.

First, when oxygen is introduced to the cell, the torque acting upon the suspension assembly is balanced by a restoring torque due to the feedback current in the coil. The feedback current is directly proportional to the volume magnetic susceptibility of the sample gas and hence, after calibration, to the partial pressure of oxygen in the sample. Therefore the current gives an accurate measurement of the concentration of oxygen in the gas mixture.

Second, the electromagnetic feedback “stiffens” the suspension, damping it heavily and increasing its natural frequency, making the suspension resilient to shock.

Calibration

As the instrument uses an absolute measurement principle, once built and factory calibrated, it does not require any further factory calibration.

Factory calibration consists of calibration of the electronics to accept the input signal from the detection cell and checking that the instrument then reads correctly on air, 20.9%. The instrument is then further checked for correct reading on 100% oxygen content.

Applications

The paramagnetic analysers may be used for measurement of oxygen at any level between 0-100% in gases or gas mixtures.

The Systech 700 series provide, user selectable ranges of: 0-2%, 0-10%, 0-30%, 0-100%, 98-100% and 20-22%.
With oxygen purity measurements in the 98-100% range an absolute downstream pressure regulator must be used.

Interfering Effects

Some other gases are also paramagnetic and their presence in the gas stream can cause a false reading. The effect is relatively small in most cases. The table below shows the paramagnetic effect of background gases, at 20°C, in 100% concentration:

Interfering Gas (100% Interferent)	Interference Effect (% O_2)
N_2O	-0.20
CO_2	-0.26
H_2O	-0.03
Halothane	-1.93
Isoflurane	-1.97
Enflurane	-1.97
Desflurane	-2.10
Sevoflurane	-2.90
Chloroform	-1.37
Helium	0.29
NO	42.56
NO_2	5.00

The applications for the Series 700 are with industrial gas producers, industrial gas users and for safety monitoring.

Gas Producers
- for ensuring product quality; monitoring for oxygen purity or by measuring for an oxygen impurity.

Gas Users
- for ensuring product quality
- to ensure reliability of inert gas blankets
- to monitor for oxygen in contaminated gas streams.

Safety Monitoring
- to ensure sufficient oxygen is present in a working atmosphere where the atmosphere can become oxygen deficient.

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