

Hospital Gas Monitoring in Operating Theaters



Gas Monitoring at a Hospital

Occupational exposure to inhalation of anaesthetic gases should be minimised as it may lead to adverse health effects for the personnel exposed. Many countries pay special attention to workers safety in operating theatres which is leading to increased awareness of recommended exposure levels and measuring methods.

This article will describe real time monitoring using Photoacoustic Spectroscopy (PAS) as an affordable and time saving principle of continuously monitoring of hospital gas with minimum maintenance and high measurement quality.

Exposure to Hospital Gases

It is well known that people working in hospital operating theatres are often exposed to anaesthetic gases. The system used to supply a mixture of anaesthetic gases to the patient consists of two parts, the anaesthetic machine and the anaesthetic breathing circuit and the amount of leaking hospital gases contaminating the room can be traced back to a number of sources (2):

A. Anaesthetist's work habits

- Failure to properly connect and utilise the available scavenging equipment.
- Poor choice of or imperfect fitting of the facemask.
- Leaving gas flows on with the breathing system disconnected from the patient.

B. Anaesthetic equipment

1. High pressure system (components between the flow meters and the high-pressure N₂O source and the flow meters)
2. Low pressure system (components between the flow meters and the patient in the anaesthesia machine and in the ventilator)

- Loose, defective or absent gaskets and seals.
- Worn-out or defective bags and breathing hoses.
- Loosely assembled or deformed slip joints and the threaded connections.
- Loose flow meter tubes.
- Inadequately designed or poorly maintained scavenging system.
- Spillage when vaporisers are filled.

Why Hospital Gas Monitoring?

Studies have shown that there are numerous health effects associated with the exposure of waste anaesthetic agents. These include increased risk of spontaneous abortion to females exposed to anaesthetic gases in hospitals with incidence 1.5 - 2 times greater than in unexposed females. Further more the surveys have shown a possible relationship between occupational health exposure of hospital operating theatre personnel to anaesthetic gases and the onset of toxic symptoms or mutagenic risks.

A: Acute effects

- Loss of concentration
- Fatigue
- Depression
- Headache

B: Reproductive effects & chronic effects

- Loss of fertility
- Spontaneous abortion
- Miscarriage
- Birth defects
- Malignant diseases
- Altered DNA synthesis in the bone marrow*
- Mild megaloblastic changes*

* These changes are only temporary and are reversed within 9 days.

For this reason many countries have imposed recommendations for the limits to exposure to Nitrous oxide and other anaesthetic gases for already existing and for newly constructed or renovated operating theatres

Air Sampling of Hospital Gases in Operating Theatres

Air sampling in the operating theatre can be accomplished by instantaneously sampling with a syringe. This method will only accurately represent the personnel exposure when the air conditioning system provides ideal mixing and when the leak of the anaesthetic agent is constant. Because rates of leakage vary from moment to moment during clinical anaesthesia, the interpretation of such samples must be made with caution.

An alternative to the instantaneous sampling is to sample over a period of time sufficient to average out the short-term variations. This "time weighted" sampling method is normally made by using personnel sampling pumps, with either temporary storage in gas tight bags or charcoal tubes; however this is ineffective to N₂O. Such samples are then carried to the laboratory where the samples are treated in a Mass Spectrometer.

The disadvantage of this method is that it is time consuming and the delay between sampling and analysis result will prevent the personnel from reacting to any rapid changes in the gas concentration.

For this reason, continuously monitoring of hospital gas is preferable, as this will provide the immediate concentration level at a specific point. This is illustrated in Figure 1 which is based on measurement results with continuously monitoring of hospital gas from an operating theatre.

