APPLICATION REPORT

OXYGEN MEASUREMENT

Hospitals / Building Technology

"We have appreciated the speed of support from Flexim to provide urgently required real-time oxygen metering for better demand management of oxygen at Leicester University Hospitals during the COVID-19 pandemic."

Martin Owen,
Senior Specialist Engineer,
Leicester Royal Infirmary

Measuring Task

Oxygen consumption monitoring within the hospitals of UK's National Health Service to proactively manage the oxygen delivery system

When the Coronavirus reached Europe in early 2020, hospital estate managers of the the UK's National Health Service (NHS) quickly realized that their conventional way of measuring and securing oxygen supply was inadequate for the dramatically increased demand due to the pandemic. This has led to a genuine concern that existing oxygen systems are vulnerable to bottlenecks in supply pipework, or, worse still, overloading the Vacuum Insulated Evaporators (VIE) without advance warning; a situation with potential risk to life. Systems designed for what was considered 'normal' oxygen demand rates pre-pandemic have insufficient capability to provide real-time demand data with the continuously high volume flows now experienced. This can lead to system overload and freeze-up. This potentially results in evaporator inefficiency, and consequent oxygen delivery capacity limitations.

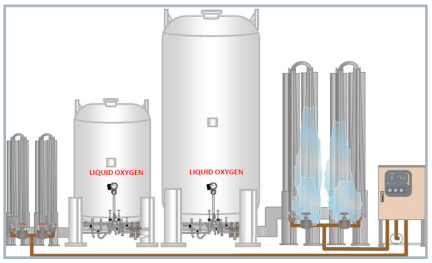
Most cryogenic oxygen systems comprise at least one VIE storing cryogenic liquid oxygen at –321 ˚F, plus possibly a secondary VIE or other reserve sources of liquid oxygen. These VIEs convert liquid oxygen into gas by absorption of atmospheric heat, the pressure of the system dropping from

~200 psi to the hospital system delivery pressure at typically 60 psi. Flow rates vary from 400 gallons per minute on the oldest systems, to as much as 1,600 gallons per minute on the newest dual VIE systems.

The management and refilling of these VIE systems is generally based upon the pressure of liquid oxygen within the VIE pressure vessel delivering indicative average consumption data. VIE manufacturer systems have been developed with the sole intent to provide sufficient advance warning of the need for refilling by tankers brought onto site before oxygen supplies are fully depleted. However, these systems were designed for pre-COVID-19 levels of oxygen use, delivering capacity data in terms of 'days of supply at typical demand', and were not designed around the soaring daily demand seen during increased ICU bedspace peaks during COVID-19. Systems designed for VIE pressure vessel replenishment generally only provide a measurement frequency of every hour, which is then only uploaded once a day to an online portal, and thus incapable of providing the data granularity required to understand which hospital wards and departments are creating most demand, or which are at greatest threat of supply deficiencies. The systems were simply not designed with the ability to manage the increased oxygen demand with any certainty; only to provide an advisory output for scheduling O2 deliveries for VIE replenishment.

Due to these concerns, and the limitations of the existing VIE systems to indicate real-time demand, NHS Trusts have identified the importance of installing their own dynamic oxygen flow demand measuring systems on their copper pipework. As a result of these issues, raised within the NHSE/I – 2020/001 alert relating to the Adequacy, Continuity and Quality of Oxygen as delivered through the Piped Medical Gas System, many Trusts have investigated how to achieve actual dynamic flow measurement at various delivery and takeoff points, rather
than a theoretical pipe flow/capacity methodology based purely on a pressure transmitter measuring the VIE pressure vessel. Realtime data could be used to ensure efficient bed management and patient care by clinical staff.

But how is it possible to install consumption meters on oxygen delivery systems without interruption of supply.



A typical Vacuum Insulated Evaporator (VIE) compound, consisting of two vacuum insulated cryogenic storage tanks and two vaporiser units. Supply monitoring only relies on pressure measurements on the liquid oxygen storage tanks.

The ideal solution: Continuous oxygen flow measurement from the outside of the pipe.

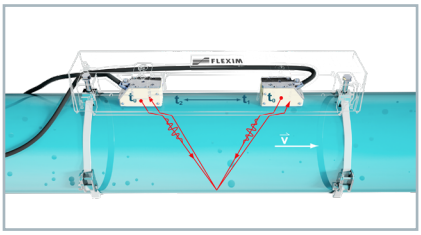
With his portable FLUXUS® G601 CA Energy, Flexim 's service engineer was able to convincingly demonstrate on site the suitability of the non-intrusive ultrasonic technology for the measuring task.

Solution

Non-intrusive oxygen flow measurement with Flexim 's FLUXUS® clamp-on ultrasonic flowmeters proves to be an ideal solution. Flexim 's FLUXUS® G721CA oxygen meter is easily retrofitted to existing oxygen delivery systems without any pipe re-work, invasive modifications, or critical system outages. Ultrasonic flow transducers are simply clamped onto existing copper pipework and introduce no new leak paths or pipe tapping points which could harbour health-threatening microorganisms.

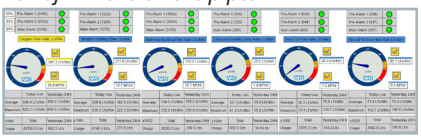
When applied to pipes within the hospital at a regulated typical 61 psi pressure, there is little need for any pressure or temperature compensation to the measurement to achieve acceptable levels of flow measurement uncertainty that are a significant improvement over the basic data from the VIE pressure-based alert system. In the rare cases where installation is required before the 60 bar regulators, i.e. on the ~200 psi pipework directly from the VIE pressure vessel, it would be recommended to compensate for pressure and temperature to achieve greater accuracy due to fluctuating operating conditions.

Advanced digital signal processing and measurement algorithms of Flexim 's FLUXUS® measuring transmitters ensure highly accurate and repeatable flow measurement data, instantly capturing changes in the flow regime. Data is either transmitted via simple 4-20 mA output, or via a communications bus, such as BACnet or Modbus, to the local building management system, where there is usually some form of interface presenting a real-time dashboard of oxygen use for the use of estates or clinical staff. Some hospitals even have remote tablet dashboard displays and emailed or texted alarms sent to relevant personnel, including the MGPS Authorised Person. The greatest advantage in the application of the FLUXUS® G721CA clamp-on flow meter, however, is the ability to install without any shutdown to the critical delivery of oxygen. All commissioning takes place on live, working oxygen delivery pipes, with zero interruption to daily hospital care activities.



Flexim 's flowmeters work with ultrasonic transducers which are mounted on the outside of the pipe. The acoustic signal propagated in the direction of the flow runs faster than the other signal propagated against it. The transit time difference is proportional flow velocity of the fluid. On basis of the given pipe geometry and physical parameters as temperature and pressure, the transmitter than calculates the volumetric and, if needed, standard or mass flow.

Measuring point with a stationary FLUXUS® G721CA transmitter and the ultrasonic transducers mounted in Variofix L rails on the pipe.



Real-time oxygen consumption data are fed into the BMS via BACnet or Modbus.

Measuring Points and Instrumentation

Pipelines	typically, copper, 0.6” – 4.25”, acc. to standard BS EN 1057: R250, Table X
Medium	oxygen (also medical air and gases)
Pressure	55 psig – 65 psig (145 to 200 psig before the VIE regulator – P&T inputs advisable)
Measuring Devices	Dozens of fixed installation FLUXUS® G721 clamp-on ultrasonic flowmeters (including some dual channel units measuring two separate adjacent pipes for greatest economy), companion pairs of clamp-on ultrasonic transducers Q Shear, P Lamb and P Shear wave according to pipe size, mounted in Variofix L fixture (0.6” – 1.4” require additional bolting assembly) portable flow meters FLUXUS® G601CA for site-wide flow checks

Advantages

- Reliable non-intrusive flow measurement without any negative impact on oxygen supply
- Connection to MGPS or BMS systems via BACnet, Modbus or simply 4-20mA output
- Live oxygen consumption data ensures dynamic O2 usage visibility and opens potential for optimizing piping systems and operations
- Portable flow meters FLUXUS® G601CA allow for check-metering of various oxygen, medical gases, liquids, and energy flow measurements across hospital sites

Customer

National Health Service, United Kingdom

National Health Service (NHS) is the umbrella term for the publicly-funded healthcare systems of the United Kingdom (UK). Since 1948 they have been funded out of general taxation. There are three systems which make up the „NHS“ (NHS in England, NHS Scotland and NHS Wales). Health and Social Care in Northern Ireland was created separately. (In Ireland the HSE are the Republic’s publicly financed healthcare providers).

The founding principles were that services should be comprehensive, universal and free at the point of delivery — a health service based on clinical need, not ability to pay. Each service provides a comprehensive range of health services, free at the point of use for people ordinarily resident in the United Kingdom apart from dental treatment and optical care.

Most of the health services are organised in a geographical localised NHS trust, established under the National Health Service and Community Care Act 1990. As of April 2020, there are altogether 217 trusts, and they employ around 800,000 of the NHS’s 1.2 million staff.

For more information, visit
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