Keeping anaesthetic pollution to minimum in theatre environment

Author: Gianluca Bini

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Atmospheric pollution in anaesthetic practice is of paramount importance and cannot be stressed enough.

Figure 1. Male (blue) and female (green) 30mm connectors of a collecting system.

Anaesthetic gases and vapours are a potential pollutant in veterinary practices, with a prolonged lifetime of up to 120 years in the atmosphere. They impact not only on ozone depletion and, consequently, on global warming, but also on the health of operating theatre staff. In 2014, 2 of the 30 human adverse events reported involving veterinary surgeons and veterinary nurses in the UK were due to inhaled anaesthetic exposure.

This article aims not to debate the effects of inhalational agents, but describe how to avoid pollution in practice.

It is important to remember UK employers are legally required, under the Control of Substances Hazardous to Health (COSHH) regulations, to control medical pollution and avoid passing the workplace exposure limits to inhalational agents set by the Health and Safety Executive.

Scavenging system
The COSHH code of practice recommends putting in place the most effective and reliable control options, to keep substances hazardous to health in the working environment to the smallest possible amount. This can be achieved with the installation of a scavenging system.

Moreover, the RCVS Practice Standards Scheme sets the presence of a scavenging system and regular pollution control as a core requirement for veterinary practices.\(^5\)

A scavenging system collects waste gases from the breathing system and releases them outside the building at a safe distance. Two types of scavenging systems essentially exist – passive and active. Both are composed of a collecting, transfer, receiving and disposal system.

The waste gases from the exhaust port of the anaesthetic machine, ventilator or adjustable pressure-limiting valve of a breathing system move through the collecting system, which is usually composed of 30mm male and female conical connectors (Figure 1). In addition, certain collecting systems include a pressure relief valve. This valve is usually set to open if the pressure is equal to, or greater than, 10cmH\(_2\)O.

The connector’s diameter is deliberately different to the conventional 15mm or 22mm tubing used for breathing systems (Figure 2) to avoid wrongful connection.
Figure 3. An open receiver cylinder with filtered openings.
Figure 4. The filtered opening of a receiver. Dust can be noted on the filters.
Figure 5. An open receiver showing a non-fluctuating (a) and fluctuating (b) purple disc.

Figure 6. The switch of an active scavenging system.
Figure 7. Ventile.
Figure 8. Charcoal adsorber.

In human medicine, the use of a collecting system with the same diameter of a breathing circuit has been reported to potentially cause serious accidents. Ultimately it is important the collecting system does not result in any resistance to expiration, especially in veterinary medicine where we often deal with very small animals.

A tube from the collecting system to the receiving system makes up the transfer system. Both connectors of this tube have a 30mm diameter for the same aforementioned reason. Moreover, this tube should be as short as possible to prevent any risk of kinking. The pressure increase in the system caused by a kink in the tube can lead to barotrauma and potentially fatal consequences,
particularly in small patients.

The receiving system is basically a safety device, protecting the patient from excessive negative or positive pressure. Two types of receiving systems exist – an open system is used if an active scavenging system is in place, while the receiving system is a closed type if a passive scavenging system is used.

The most important part of the receiving system is the reservoir. In the open system, this is a cylinder of rigid material (Figure 3), with one or more openings acting as pressure breaker between the patient breathing system and the final stage of the scavenging system.

Some models have a filter over the openings to stop debris entering. Dust can accumulate on these filters (Figure 4), so they should be cleaned monthly. Some reservoirs have a coloured disc that fluctuates or lifts when the scavenging system is active (Figure 5). In the closed system, this part is usually a reservoir bag and two valves, one for negative and the other for positive pressure relief.

Complications may occur if a receiving device is not in use due to several factors, including negative pressure from either the fan of the active scavenging system or the wind on the exterior tubing of the passive system, or positive pressure if the tubing is kinked.

**Disposal**

![Image](image_url)

**Figure 9.** A leak test on a rebreathing system. Close the adjustable pressure-limiting valve (1) and press the oxygen flush button while occluding the opening of the breathing system with your thumb (1), until the reservoir bag is completely inflated and distended (3), and wait 30 seconds. If the bag is inflated and distended as before, the circuit does not have a leak. Once finished, open the valve (4).

The disposal system can be active or passive. In both cases, the end part of the disposal system is positioned outside the building, in a rarely attended location.

An active disposal system requires a fan or exhaust unit creating negative pressure and a vacuum regulating valve controls pressure fluctuations in the system. The BS EN ISO 7396-2:2007
standard defines a range of 50L/min to 80L/min for high flow and 25L/min to 50mL/min for low flow active scavenging systems. The switch (Figure 6) is usually placed inside the practice, in an easy to reach position, although an active disposal system may be working at all times.

A passive disposal system is made of a wide-bore tube passing through a wall or the roof. This can either terminate outside or in a ventile (Figure 7). A ventile uses wind to move the exhaust gases from the system. A short, wide tube is preferred to minimise resistance.

It is important to choose the best position for the external opening of the tube. A non-windy position should be chosen; if not, suction can be created inside the tube. The opening should be covered with a filter to prevent insects, small animals or debris entering.

Passive scavenging systems are less expensive to set up and maintain and commonly used in small premises, while active scavenging systems may be more convenient in large practices.

**Adsorber**

Another option commonly employed in veterinary practices to control operating theatre pollution is using an adsorber (Figure 8).

These are canisters containing about 1kg of activated charcoal, but their weight increases as they adsorb vapour. Such adsorbers cannot deal with nitrous oxide. Their capacity can vary between brands and individual canisters. They are disposed of by incineration and should be stored safely to prevent leaks. They should be weighed regularly and disposed of when the canister reaches the weight indicated on the label.

**Other pollution factors**

![Figure 10](image)

Figure 10. The Association of Veterinary Anaesthetists’ safety checklist.
Other factors impacting on pollution in clinical areas are filling vaporisers, patients recovering from anesthesia, mask or box inductions and capnography outlets (when a line to reintroduce the gases and vapours into the system is not in use).

For the correct management of these, vaporisers with a key-fill system and adequate ventilation are important. Between 15 and 25 air changes per hour are suggested, which can be addressed using a correctly maintained air conditioning system, keeping in mind recirculating or partially recirculating air conditioning systems may affect their extracting efficacy.

Checking the anaesthetic machine and breathing system, including a leak test (Figure 9), should be performed at least every day. Anaesthetic safety checklists, such as those produced by the Association of Veterinary Anaesthetists (Figure 10), are freely available. Even if a scavenging system is in place, anaesthetic gases can leak into the room.

Ultimately, it is important to remember the use of rebreathing systems, such as the circle system combined with low-flow anaesthesia, will reduce waste gas production – thereby reducing the economic and environmental cost of anaesthesia.

References

8. Association of Veterinary Anaesthetists safety checklist: www.ava.eu.com/resources/checklists