Go fanless and be culture friendly

The advantages of fanless direct heat incubators are being recognised by a growing body of researchers

Contamination is the enemy of cell culturists and has sparked many innovations in the design of CO_2 incubators, but the key to standard chamber conditions could be to turn off the fan. In the past, the manufacturers of CO_2 incubators have employed many different techniques for maintaining the uniformity and homogeneity of the chamber conditions. Designs have included water jacket and air jacket systems and, more recently, direct heat.

One of the main threats to the viability of a culture is that of contamination either from organisms already within the chamber, or as a result of ingress through the inner or outer doors when opened. The direct heat system operates by thermodynamic convection through the chamber walls. This ensures that CO_2 and humidity levels remain even and thoroughly mixed – and temperature to within ±0.1°C without the use of a fan. Consequently, when the door is opened there is minimal movement of the atmosphere inside. Outside air is not immediately drawn inwards so there is reduced displacement between air and atmosphere. CO_2 injection stops as soon as the door opens.

CO_2 loss significantly cut

It is not only temperature that is influenced by door-opening events: loss of CO_2 and relative humidity is another consequence, and the resulting environmental disturbance can acutely affect the viability or physical condition of cells within the chamber. Just as the stable nature of the direct heat convection system impedes the displacement of warm air when the incubator is accessed, so the CO_2 level is similarly protected, although CO_2 supply is stopped by opening the door for safety reasons.

After the door is opened, fast recovery of temperature, humidity and CO_2 levels is essential to preserve continuity of environmental conditions. The design of the heating system combined with the geometry of the chamber allows intelligent control sensors linked to microprocessing software to smoothly restore set-points to previous levels without overshoot. Because it is achieved without the use of a fan but by convection currents, the process is fluent, natural and less liable to disrupt the growth cycle.

No HEPA filter!

With the door closed, very weak positive pressure ensures no ingress for contamination. The ideal conditions for working with CO_2 incubators are in a clean room, but the majority of laboratories do not have everyday access to such a facility. Unless the door of the incubator is never opened, therefore, the risk of bacterial and fungal spores entering the chamber from the surrounding atmosphere must logically occur during door-opening events, with or without a HEPA filter. The necessity of opening the door renders redundant the fitting of such a costly accessory – one that requires regular replacement if it is not of itself to become a potential contamination source. A HEPA filter is made ineffective during door opening and the threat of re-contamination of the chamber is far greater from an imperfectly cleaned fan assembly and its cowling.

Speedy cleaning

One of the most appealing consequences of dispensing with a fan assembly is that there are no moving parts or ductwork to be removed then autoclaved to ensure thorough cleaning. Complex shapes associated with fan assemblies are potential harbourers of contamination, but the direct heat design allows a featureless interior that provides no anchorage for organisms. Shelves can be independently autoclaved at 121°C/1.5 bar and the empty chamber can be quickly and simply swabbed clean or put through a high-temperature decontamination cycle.

A HEPA filter is made ineffective during door opening

Dispensing with the cowling and false back-plate means that the space these would normally occupy is available to maximise the internal capacity of the cabinet, allowing the reduction of outside dimensions.

A model sufficiently small in size to be sited inside a flow cabinet or other environmental chamber can be achieved with undue disruption of the airflow pattern. Another result is that the unit is not as tall as is customary, so when sited on top of the bench the controls and settings are at a height easily reached and viewable by users of all heights. Further space is liberated by dispensing with the HEPA filter, which can encroach substantially into the usable space on the top shelf of the incubator. Without it the entire shelf area is made available for samples.

Zero vibration

Vibration caused by a working fan may adversely affect conditions inside the chamber, especially at very low volumes. This potential threat to optimum cell growth is completely eliminated because the direct heat system does not require a fan to maintain good cell culture conditions. Finally, a less obvious advantage of the direct heat system is that there is no noise being generated by a fan motor. When multiple units are running simultaneously in one laboratory, the combined noise can significantly affect the working environment so any reduction is welcome.

Cost and time advantage

The advantages of fanless direct heat incubators are being recognised by a growing body of researchers now using them routinely. HEPA filters, particularly in larger capacity CO_2 incubators, can be expensive consumable overheads.

There is an additional cost in the cumulative time spent in replacement and the extra time necessary to remove, autoclave and re-fit fan assemblies. There is no substitute for scrupulous hygiene and the simplicity of straightforward chamber cleaning is an added incentive to leave behind fan-driven, filter protected chambers in pursuit of the ultimate objective: optimum culture conditions.

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