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Why Choose High Flow Microbial Air Samplers?

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Introduction

Most microbial air samplers sample at 100 litres per minute, taking 10 minutes to sample $1m^3$ of air. Ten minutes can be a long time waiting on site for something to complete; made even worse if multiple samples are needed with different media and in several zones within an area. This time represents a cost to your business, added downtime to production or disruption to your customers.

The use of high flow rate samplers may appear obvious in this case - shorter time to take samples. But, is this correct in real life situations and will a high flow rate sampler really be the best option?

This paper presents a simple aid to calculating if there is such an advantage and presents two examples giving time saving calculations to demonstrate the benefits.

What are the time consuming factors when sampling?

The sampling time for a volume of air is not necessarily the key time consuming component of sampling activity. Many factors need to be considered including, but not limited to:

- Time to physically set-up the sampler
- Time to sterile wipe the sampling head and insert a media plate
- Time to operate the sampler controls to start sampling
- Time to unpack the equipment and pack away
- Size of the area to be tested and the number of sampling zones within that area
- The number of samples to be taken at each zone
- The number of media types being used at each zone

To gain a picture of aerosol contamination in a space, samples need to be taken at multiple locations to determine where the contamination is. Multiple samples at each of these points should be taken to produce a statistical mean of contamination levels - often requiring the use of two or more different media types to ascertain what type of organisms are present - bacteria or mould, etc.

Now, some mathematics

To help understand what benefit high flow samplers give, we developed a mathematical model to take key considerations into account, resulting in a total sampling time estimate.

$$T = n_z \left[n_p \, n_m \left(\frac{\frac{V_s}{U_f} + t_c + t_p}{n_s} + t_d \right) + t_s \right]$$

equation 1.

T	Estimate of time to perform sampling
Vs	Volume of air to be sampled per media plate, e.g. 1000 litres
U_f	Sampler flow rate in litres per minute, eg. 100 or 180
n_z	Number of zones to sample
n_m	Types of media types to used
n_p	Number of samples to be taken for each media type in each zone
n_s	Number of microbial air samplers being used
t_c	Time taken to change media plate
t_p	Time to programme/configure sampler to sample air
t_d	Sampling start delay - i.e time to enable operator to leave area
t_s	Time to set-up a sampler in the required zone

All times are measured in minutes.

Limitations of the equation are:

- The same number of samples are taken at each zone within the space
- The same media types are used at each of those zones
- Will only work if: $n_s \leqslant n_p \times n_m$

Equation 1 is then used to calculate times T_1 and T_2 for both standard flow (U_f=100 lpm) and high flow (U_f=180 lpm) respectively, for the required sampling requirements.

The time saving found as:

$$T_s = T_1 - T_2$$ equation 2.

Alternatively, Equation 1 for both U_f cases can be substituted into equation 2 resulting in a time saving calculation that requires fewer variables to consider the saving:

$$T_s = \frac{n_m n_z n_p V_s (U_h - U_s)}{n_s U_h U_s}$$ equation 3.

U_h High flow rate (e.g. 180 lpm)

U_s Standard flow rate (e.g. 100 lpm)

To compare Cantium Scientific Limited MicroBio MB2 standard and high flow models, the time saving equation can be simplified further to:

$$T_s = \frac{n_m n_p n_z V_s}{225 n_s}$$ equation 4.

A simple cost saving estimate can be made by summing the hourly cost of lost production ($C_{p\ =\ \$/hour}$) and the hourly rate of labour ($C_{L\ =\ \$/hour}$) involved in sampling, then multiplying by the saved time ($T_{s\ minutes}$):

$$S = \frac{C_p + C_L}{60} \times T_s$$ equation 5.

For all makes and models of microbial air samplers, combining equations 3 and 5 gives a cost saving equation of:

$$S = \frac{n_m n_z n_p V_s (U_h - U_s)(C_p + C_L)}{60 n_s U_h U_s}$$ equation 6.

Example 1: Low volume single zone sampling

In this example, we consider the use of standard and high flow samplers. The requirement is to use a single media type and take three 200 litre samples. Firstly, we are assuming 1 minute to clean the head and insert a petri dish, 15 seconds to programme the sampler to take a sample, not use delayed start and take 3 minutes to physically set up a sampler, i.e. unpack and place on a tripod.

Using equation 1 for a 100 lpm (litre per minute) sampler, the total sampling time becomes:

$$T_1 = 1 \times \left[3 \times 1 \left(\frac{\frac{200}{100} + 1 + 0.25}{1} + 0 \right) + 3 \right] = 11.75 minutes$$

Repeating the calculation for a 180 lpm sampler gives:

$$T_2 = 1 \times \left[3 \times 1 \left(\frac{\frac{200}{180} + 1 + 0.25}{1} + 0 \right) + 3 \right] = 9.08 minutes$$

$$Saving = T_1 - T_2 = 2.67 minutes$$

In this example, a high flow sampler does not yield a great saving and their use would need careful consideration.

If production in a zone has to stop for a short period of time, the cost of lost production due to regular sampling would need to be considered and a high flow sampler may be a better option. If sampling can be undertaken while work continues, and sampling is only done occasionally, a standard 100 lpm flow rate sampler may be the economic option.

Example 2: Multiple zone sampling application

Here's an example where a clean room requires sampling in 8 zones. Each zone will use two different media types with three samples on each of 1000 litres.

We are assuming 1 minute to clean the head and insert a petri dish, 15 seconds to programme the sampler to take a sample, 1 minute of delay for the operator to move away from the sampler and 3 minutes to physically set up each sampler, i.e. unpack and place on a tripod.

If two standard 100 lpm samplers are used, one for each media type, how long will sampling take?

By using equation 1 for the 100 lpm samplers, the time taken becomes:

$$T_1 = 8 \times \left[3 \times 2 \left(\frac{\frac{1000}{100} + 1 + 0.25}{2} + 1 \right) + 3 \right] = 334 minutes$$

Now, if we use a 180 lpm samplers, the time to perform all samples is reduced to:

$$T_2 = 8 \times \left[3 \times 2 \left(\frac{\frac{1000}{180} + 1 + 0.25}{2} + 1 \right) + 3 \right] = 227.3 minutes$$

$$Saving = T_1 - T_2 = 106.67 minutes$$

Saving over 1½ hours labour cost and reducing production interruption time to carry out sampling will offer an enormous cost saving. In a very short time, the added cost of a high flow sampler will be recovered.

Equation 5 can now be used to determine that exact saving and payback time.

Considerations when buying a high flow sampler?

If the decision has been made to purchase a high flow sampler, the following questions should be answered:

What's the flow rate?

Most high flow devices will be in the range of 180 - 200 lpm. Very high flow rate samplers exist, but they are often large and require large vacuum pumps making them expensive and time consuming to set-up, negating any benefit of the faster flow rate. Be careful calculating savings with some samplers that describe high rates, such as 360 lpm. This may be achieved using two sampling heads running at 180 lpm each, so treat as two samplers for calculation purposes.

How big is it?

If the machine is big and heavy, it'll take longer to move around and set-up. Ideally the machine should be easily handled in one hand and mountable on a tripod for the easiest use and quickest set-up time on site.

Is it easy to set-up and change sampling media?

What can slow operators down is the time taken to set-up the sampler, insert a petri dish or contact plate and then navigate through sometimes complex options to get it to take a sample.

Look for a machine with a sampling head that's simple to clean between samples, is easy to insert and remove media plates from and has simple controls to start sampling with the fewest actions. Being easy to set-up on a tripod or site on a surface should also be considered.

How long does the battery last and is it easy to swap out in the field?

Many samplers on the market have built in battery packs that cannot be easily removed and swapped with a fully charged pack. With high flow machines enabling more samples to be taken in a day, the battery will more than likely run out before the day is over so consider looking for a machine where the battery can easily be swapped out and not having to take the sampler out of services while it is charged. Can a set of alkaline AA cells be used? Some also offer external DC power supplies so they can be mains powered and run without the worry of the battery fully discharging.

If a battery discharges during a sample, that sample will need to be retaken with a fresh plate, re-cleaning the sampling head and delaying other sampling work. This adds further cost and time.

How much does it cost?

The long term and operating costs should be considered. Do they use generic media in the form of contact plates or petri dishes that are readily available at low cost, or use proprietary media that may be more expensive with limited availability? Are spare parts available at low cost? If the built in rechargeable battery fails, and they will, can it be replaced at a sensible price?

Conclusion

Not every use case can justify the additional purchase cost of a high flow sampler. However, if you can answer yes to any of the following questions, then high flow models should be considered:

☑Regular daily sampling with multiple plates

☑Sampling multiple zones within an area

☑Always sampling large volumes of air (>500m^3) per sample

☑Sampling with multiple media types

If performing many multiple samples, particularly when sampling requires the use of different media types, consideration should also be given to using a sampler for each of the media types or a multi-headed sampler.

To conclude, before choosing to buy a standard flow or high flow microbial sampler, perform a simple calculation using equations described in this paper to see how much time and money can be saved.