



**DETERMINATION OF THE PERFORMANCE
OF A MICROGENIX AIR PURIFICATION
SYSTEM WITH AIRBORNE MODEL FOR
*MYCOBACTERIUM TUBERCULOSIS***

**A report produced for
Microgenix Technologies Limited**

W.D. Griffiths

April 2003



**DETERMINATION OF THE PERFORMANCE
OF A MICROGENIX AIR PURIFICATION
SYSTEM WITH AIRBORNE MODEL FOR
*MYCOBACTERIUM TUBERCULOSIS***

**A report produced for
Microgenix Technologies Limited**

W.D. Griffiths

April 2003

Title	DETERMINATION OF THE PERFORMANCE OF A MICROGENIX AIR PURIFICATION SYSTEM WITH AIRBORNE MODEL FOR <i>MYCOBACTERIUM TUBERCULOSIS</i>
Customer	Microgenix Technologies Limited
Customer reference	Project No. RM04 (MODIFIED)
Confidentiality, copyright and reproduction	Commercial in Confidence © <i>Airborne Matters</i> . The contents of this report may not be abstracted, published or used for advertising without permission.
File reference	
Report number	MICROGENIX_REP04
Report status	Final Version

Airborne Matters

	Name	Signature	Date
Author	W.D. Griffiths		29 Apr 2003

Executive Summary

The performance of a Microgenix Air Purification System, was determined under the manufacturer's standard operating conditions against aerosols of *Mycobacterium vaccae* (ATCC 15483) a mycobacterial model selected as a surrogate for *Mycobacterium tuberculosis*. The Microgenix Air Purification System was challenged with the *M. vaccae* at 500 m³ hr⁻¹ in a controlled system with six UV lamps activated. The results of the tests are summarised below for each run as percentage (%) efficiency of the system:

Test Conditions	% Efficiency of the System
6 UV Lamps Activated (1)	>99.995
6 UV Lamps Activated (2)	>99.997
6 UV Lamps Activated (3)	>99.998

The mean % efficiency of the Microgenix Air Purification System is **>99.997 ± 0.0015** (standard deviation).

The duct-mounted Microgenix Air Purification System operating at settings recommended by the manufacturer in a controlled system (6 UV lamps activated at 500 m³hr⁻¹) has an **efficiency in excess of 99.997 % (± 0.0015)** against airborne *M. vaccae*.

Contents

1	INTRODUCTION	3
1.1	The Study	3
1.2	Microgenix Air Purification System	3
2	AIM AND OBJECTIVE	4
3	PROGRAMME OF WORK	5
3.1	Test Rig for Challenging Microgenix Air Purification system with Airborne <i>M. vaccae</i>	5
3.2	Measurement of Flow Rate	5
3.3	Microbiological Air Sampling	6
3.4	Test Microorganism and assay	6
3.5	Test Methodology	7
3.6	Calculation of PERFORMANCE Efficiency	7
4	RESULTS	9
5	DISCUSSIONS	10
6	REFERENCES	11
	TABLES	12
	Table 1: Percentage Efficiency of the Microgenix Air Purification System When Carried Out in Triplicate with 6 lamps activated (standard operating conditions)	12
	FIGURES	13
	Fig. 1: Rig for Testing Microgenix Air Purification System	13

1 Introduction

1.1 THE STUDY

Airborne Matters was asked by Microgenix Technologies Limited to outline a programme for testing the performance of a Microgenix Air Purification System (in-duct system) with a surrogate for *Mycobacterium tuberculosis* aerosol, under standard operating conditions. The programme of performance testing was outlined by Airborne Matters and carried out under controlled laboratory conditions by the Centre for Biology and Research (CAMR) at Porton Down. The Microgenix Air Purification System was tested by challenging it with a high aerosol concentration of a mycobacterial model (*Mycobacterium vaccae*).

M. vaccae is a rapid growing non-pathogenic mycobacteria. It forms short rods of 1 - 4 µm and forms distinctive orange colonies on Tryptone Soya Broth Agar (TSBA) plates. It was sprayed from spent nutrient broth at a concentration of 1.68×10^8 cfu/ml.

1.2 MICROGENIX AIR PURIFICATION SYSTEM

The Microgenix Air Purification System achieves anti viral and/or anti bacterial action through a combination of filtration of bioaerosol through a fibrous filter pre-coated in biocide Biogreen 3000 solution followed by exposure to UVc radiation from an array of lamps (in this case 6 lamps). The manufacturers recommend this system be operated at $500 \text{ m}^3 \text{ hr}^{-1}$.

2 Aim and Objective

The aim of this work is to determine the performance of a Microgenix Air Purification System (in-duct system) with a mycobacterial model for *M. tuberculosis* aerosol, under the normal operating conditions recommended by the manufacturer.

This study has one principal objective:

To demonstrate the duct mounting Microgenix Air Purification System effectively destroys the airborne surrogate mycobacterium used to model *M. tuberculosis*.

3 Programme of Work

Because of safety issues, the performance of the Microgenix Air Purification System was tested with a mycobacterial model acting as a bioaerosol surrogate for *M. tuberculosis*. The selected mycobacterial model used was *M. vaccae* (ATCC 15483) obtained from the National Collection of Industrial and Marine Bacteria, Torry Station, Aberdeen. A test aerosol was produced from a suspension of *M. vaccae* in spent Tryptone Soya Broth sprayed from a Collison nebuliser (Collison, 1935 and May 1973).

3.1 TEST RIG FOR CHALLENGING MICROGENIX AIR PURIFICATION SYSTEM WITH AIRBORNE *M. VACCAE*

The Microgenix Air Purification System was bolted onto the CAMR test rig, shown diagrammatically in Figure 1. Filtered air (using a coarse filter) was drawn through the rig by a fan unit. The volumetric air flow rate was then adjusted to $500 \text{ m}^3 \text{ hr}^{-1}$, measured by the anemometer (see Section 3.2). The air was initially drawn into a spray chamber housing a 3-jet Collison spray. The 3-jet Collison spray contained a suspension (10-20 ml) of the test mycobacterium *M. vaccae*. The *M. vaccae* was aerosolised by applying compressed air to the Collison nebuliser at 180 KPa for 5 minutes. The breakthrough and challenge were sampled simultaneously using cyclone samplers, during the 5 minutes, via test ports provided both upstream and downstream of the system being tested. The aerosolised microbes were passed into a mixing chamber and then into a duct which housed the Microgenix Air Purification System. At the downstream end of the housing, another length of duct was connected which is linked to the fan units via a back-up HEPA filter assembly which was designed to prevent the escape of any remaining airborne microorganisms into the environment.

3.2 MEASUREMENT OF FLOW RATE

The flow rate of air through the system can be varied. The flow rate was set to $500 \text{ m}^3 \text{ hr}^{-1}$ as recommended by Microgenix technologies

Limited and measured with an anemometer at the inlet to the spray chamber. The anemometer was an Airflow AV2 anemometer (Serial No. 79286, Cal. Date 29.04.02, Airflow Development Ltd, High Wycombe, UK). The airflow was checked at the centre of the inlet and the volumetric airflow was determined from the cross sectional area.

3.3 MICROBIOLOGICAL AIR SAMPLING

Cyclone samplers were used to sample the air via the test ports in the ducting described above (Upton *et al.*, 1994, Griffiths and Boysan, 1996, Griffiths *et al.*, 1997, Griffiths, 1998, and Griffiths and Stewart, 1999). The clean glass cyclone samplers were linked to a vacuum pump so that circa. 700 litres of air per minute (lpm) could be sampled both upstream and downstream of the Microgenix Air Purification System. The collecting fluid (Phosphate buffer plus manucol and antifoam) (PBMA) was injected into the inlet of the cyclone at a rate of about 1-2 ml per minute.

The airborne particles containing the microorganisms were deposited by centrifugal forces on the cyclone wall and washed off by the swirling collection fluid. The fluid was withdrawn from the base of the cyclone by a syringe at the end of the sampling period. The volume of fluid collected was measured. This test method was carried out in triplicate with six UV lamps activated.

3.4 TEST MICROORGANISM AND ASSAY

Mycobacterium vaccae (ATCC 15483)

An ampoule of *Mycobacterium vaccae* (ATCC 15483) was obtained from the National Collection of Industrial and Marine Bacteria, Torry Station, Aberdeen. The freeze dried culture was resuspended in nutrient broth, spread onto TSBA plates and incubated for 24 hours at $37 \pm 2^\circ\text{C}$. A liquid culture of the *M. vaccae* was prepared by inoculating two 250 ml flasks containing 50 ml each of Tryptone Soya Broth. A full (generous) 10 μl loop of *M. vaccae* was taken from a stock plate previously stored at $4^\circ\text{C} \pm 2^\circ\text{C}$ and added to each of the flasks. The culture suspension was mixed thoroughly by shaking and placed in a

37°C ± 2°C shaking water bath for 24 hours. The suspension was stored at 4°C ± 2°C until used.

The suspension was assayed by plating out 0.1 ml of a ten fold serial dilution in duplicate onto Tryptone Soya Broth Agar (TSBA) plates and incubating the plates at 37°C ± 2°C for 24 hours. The colonies were counted after incubation to determine the concentration of the Mycobacterium (colony forming units (cfu) per millilitre of suspension. The resultant suspension was 1.68×10^8 cfu/ml. This suspension was used neat for the spray suspension.

3.5 TEST METHODOLOGY

The Microgenix Air Purification System, fitted with 6 UV lamps, was bolted onto the CAMR test rig as described in Section 3.1. The volumetric air flow rate was then adjusted to $500 \text{ m}^3 \text{ hr}^{-1}$, measured by the anemometer. The Collison nebuliser containing the *M. vaccae* (10-20 ml) was placed in the spray chamber and the cyclone samplers were connected to the upstream (challenge) and downstream (test) sampling ports. The Collison nebuliser, operated at 180kPa, and the upstream and downstream cyclone samplers were activated for 5 minutes. The collection fluids from the cyclone samplers were collected, the volumes were measured, and the samples assayed following the procedure similar to that described for the spray suspension in Section 3.4. The concentration of *M. vaccae* aerosol was calculated from samples collected upstream and downstream of the Microgenix Air Purification System. This test procedure was carried out 3 times.

Fresh sterile cyclone samplers and tubing were not used between the three test runs using the same test conditions. The Microgenix Air Purification System was not decontaminated between test runs. The UV lamps (when operated) were allowed to get to maximum power for at least 15 minutes before the start of the run, as advised by Microgenix Technologies Limited.

3.6 CALCULATION OF PERFORMANCE EFFICIENCY

The percentage efficiency of the Microgenix Air Purification System was calculated using the following formula where A is the

concentration of colony forming units (cfu m^{-3}) challenging the unit and B is the concentration of colony forming units (cfu m^{-3}) exiting the unit.

$$\text{Efficiency}(\%) = \left(\frac{A - B}{A} \right) \times 100$$

4 Results

The details of the results of the 3 tests are shown in Table 1 in the Tables section at the end of the report.

5 Discussions

The duct-mounted Microgenix Air Purification System operating in a controlled system with 6 UV lamps at $500 \text{ m}^3\text{hr}^{-1}$ has an efficiency in excess of **99.997 %** (± 0.0015) against airborne *M. vaccae*. The result of these tests has confirmed the effectiveness of the Microgenix Air Purification System against aerosols of *M. vaccae* when used under the conditions recommended by the manufacturer.

6 References

Collison, W.E. (1935) "Inhalation Therapy Technique". Heinemann, London.

Griffiths, W.D. and Boysan, F. (1996) "Computational Fluid Dynamics (CFD) and Empirical Modelling of the Performance of a Number of Cyclone Samplers". J. Aerosol Sci. 1996;27(2): 281-304.

Griffiths, W.D. Sampling Guidelines for the Assessment of Bioaerosols Chapt. 5 of "Aerosol Sampling Guidelines". Edit. A.L. Nichols. Published by The Royal Society of Chemistry, Cambridge, UK., 1998.

Griffiths, W.D. and Stewart, I.W. "Performance of Bioaerosol Samplers Used by the UK Biotechnology Industry". J. Aerosol Sci. 1999;30(8):1029-1041.

Griffiths, W.D., Stewart, I.W., Futter, S.J., Mark, D. and Upton, S.L. "The Development of Sampling Methods for the Assessment of Indoor Bioaerosols". J. Aerosol Sci. 1997;28(3):437-457.

May, K.R. (1973) "The Collison Nebulizer: Description, Performance and Application". J. Aerosol Sci. 4, 235-243.

Upton, S.L., Mark, D, Hall, D. and Griffiths, W.D. (1994) "A Wind Tunnel Evaluation of the Sampling Efficiencies of Some Bioaerosol Samplers". J. Aerosol Sci. 1994;25(8): 1493-1501.

Tables

Test Conditions	Total Challenge to system(cfu/m ³)	Collected downstream of system (cfu/m ³)	% Efficiency of the System
(1) 6 UV activated	1.40 x 10 ⁵	<5.9	>99.995
(2) 6 UV activated	2.11 x 10 ⁵	<5.9	>99.997
(3) 6 UV activated	4.76 x 10 ⁵	<5.9	>99.998

TABLE 1: PERCENTAGE EFFICIENCY OF THE MICROGENIX AIR PURIFICATION SYSTEM WHEN CARRIED OUT IN TRIPLICATE WITH 6 LAMPS ACTIVATED (STANDARD OPERATING CONDITIONS)

Figures

FIG. 1: RIG FOR TESTING MICROGENIX AIR PURIFICATION SYSTEM

