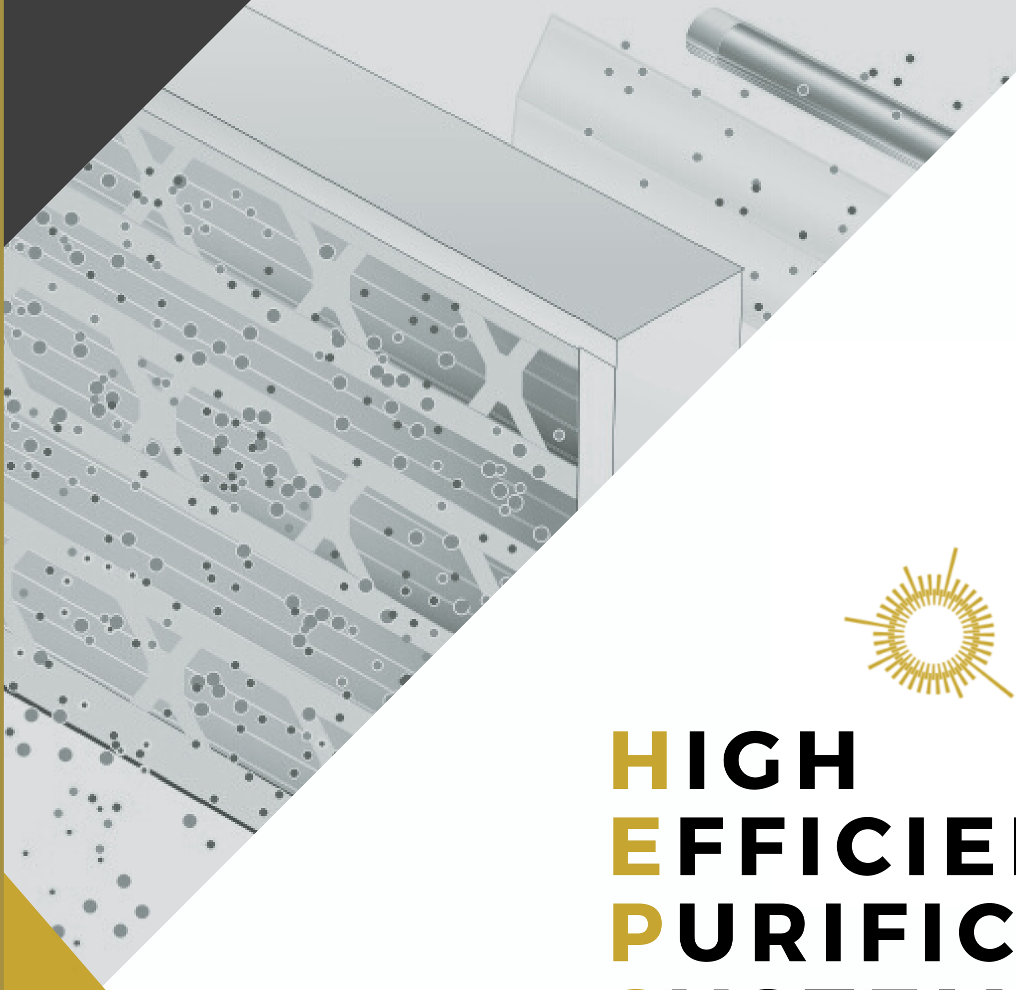

REMOVES:

- Airborne viruses & bacteria.
- Chemical pollutants (VOCs) & carcinogens.
- Particulate pollutants down to 0.3micron.

Effective for Coronavirus

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Version 1/06.2020

CONTENTS

THREE POWERFUL TECHNOLOGIES IN ONE SYSTEM

Ingenious fact:

NASA has used the HEPS purifier in the International Space Station because of its effectiveness in reducing serious indoor air contamination and the airborne spread of disease!

The HEPS creates a cleaner and healthier environment and improves indoor air quality and hygiene in line with the Chartered Institute of Building Services Engineers (CIBSE) TM40 recommendations.

The HEPS combines three powerful technologies in one system to decrease all three types of serious indoor air contamination:

1. **The electrostatic Grade F7 to EN779 (MERV-13) Filter**
   Removes allergens and particulates down to 0.3 micron.

   Symptoms of allergy, asthma, emphysema, hay fever and chronic bronchitis are alleviated by removing the primary causes, including pollen and fungal spores.

2. **Photo-Catalytic Oxidation**
   Destroys volatile organic compounds (VOCs) and eliminates odours. VOCs are carbon-based chemicals, which evaporate at room temperature. They include carbon monoxide, nitrous oxide, fumes and

odours emitted from paint solvents, car exhausts, and pesticides, cleaning fluids, chemicals and alcohol.

VOCs can be highly toxic and exposure can cause acute and chronic ill health.

Photo-catalytic oxidation (PCO) is achieved when ultraviolet (UV) light rays are combined with a Titanium dioxide (TiO_2) coated filter.

Photo-catalytic oxidation converts VOCs into benign constituents such as carbon dioxide and water without wearing out or losing its effectiveness.

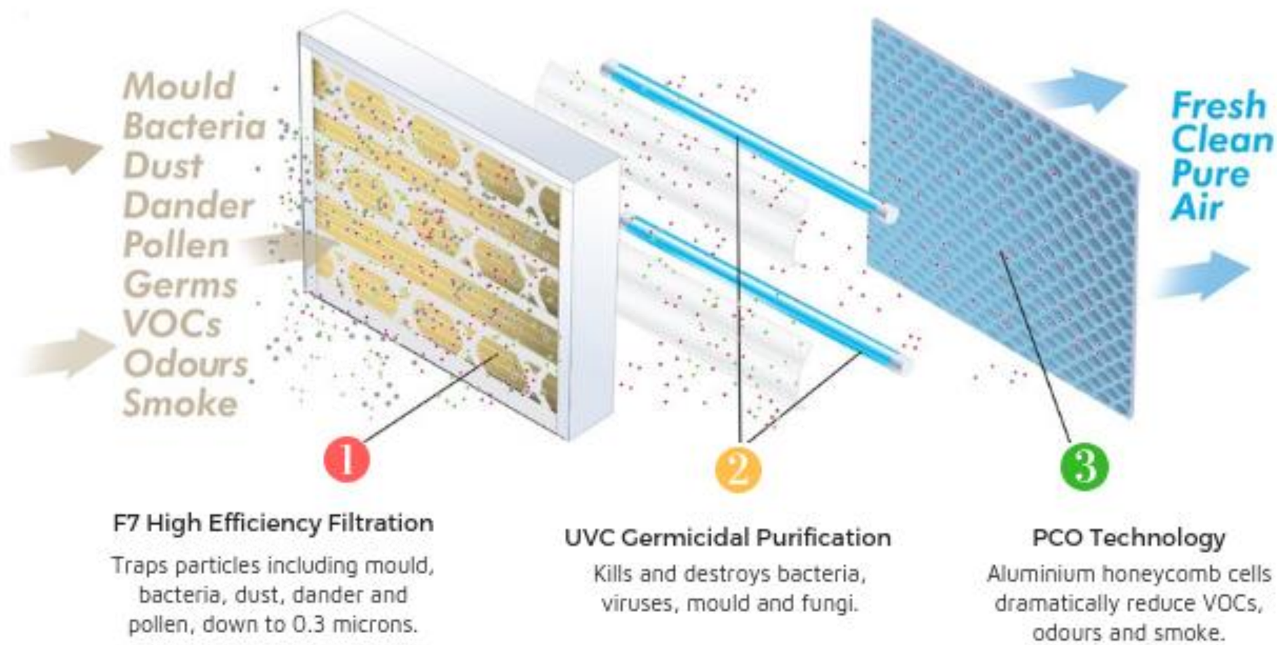
This has huge advantages over chemical absorbents, which can rapidly absorb large quantities of toxic fumes, but quickly become saturated and slowly release pollutants back into the air stream.

3. **Germicidal Ultraviolet Light**

Ultraviolet light 10,000 times the intensity of sunlight neutralises viruses and bacteria too small to be filtered out by a filter.

These include disease-causing micro-organisms such as the bacteria and viruses such as COVID-19 (Coronavirus), influenza, common colds, Tuberculosis, Legionella, E. coli, Pseudomonas, MSSA and C. difficile etc.

SPECIFICATIONS



Model	HEPS with flange
Dimensions	654mm x 451mm x 254mm
Weight	11.34 kg
Shipping box	3.40 kg
Power	220v/50Hz/54 watts/1.1 amps
Fuse	AGC 2 amps
Service panel	12 vac.
UV lamps	(2) ESP LT 016
Titanium catalyst	12,220 cells/425.77m^2 of surface area
Filter ESP FI016	406 mm x 635 mm x 102 mm MER-13 electrostatic needled fibre media
Service interval	Replace filter every 6 months (minimum) and replace UV lamp every 12 months

OVERVIEW

- ✓ Creates a healthier environment and cleaner air.
- ✓ Protects against the airborne spread of diseases.
- ✓ Reduces sick days and the need for medication.
- ✓ Produces fast and effective results. Air quality tests showed VOC reduction of 80% in two hours and bacterial reduction reduced below the level of detection in under three hours.
- ✓ Increases energy efficiency of heating, ventilation and air conditioning (HVAC) systems by reducing the build-up of mould and dirt on evaporator cooling coils and heat exchanger surfaces.
- ✓ Reduces duct cleaning requirements by eliminating the build up of mould and dirt on duct linings.
- ✓ Reduces costs by combining three technologies into one product. Using higher efficiency filters such as a HEPA filter can actually result in lower particle reduction due to the restriction in air flow, triple the electrical consumption of the blower and increase filter replacement costs by 500%.
- ✓ Cheap to run as it costs only a few pence to operate 24 hours a day.
- ✓ Always operates at maximum efficiency as built-in electronic service lights indicate when to change filters and ultraviolet lamp thirty days in advance.
- ✓ Low replacement cost as the ultraviolet lamp (approx. once a year) and the filter (approx. once every six months) can be changed in less than five minutes, without the need for tools. The titanium oxide mesh is self-cleaning and does not need to be replaced unless physically damaged.

GENERAL INFORMATION

Particulates

The HEPS uses the “needled fibre electrostatic filtration media” developed by 3M Corporation. The advantage is high efficiency particle reduction down to 0.3 microns while maintaining high dirt loadings and low static backpressure.

The American Society of Heating, Refrigeration, and Air conditioning Engineers (ASHRAE) sets the standards and test protocol for the entire USA. Many other countries also use their standards. ASHRAE rates the HEPS filter to ASHRAE Standard 52.2.

The MERV-13 rating is a comparison formula that consists of averaging together a number of different micron sizes to establish this rating.

It is important to be aware of spurious claims about using an even higher efficiency filter, such as a HEPA filter. HEPA filters will actually result in lower particle reduction due to the massive restriction in airflow, and will triple the electrical consumption of the blower and increase filter placement cost by 500%.

It is more important to have all the indoor air pass through the filter three to four times per hour. For example, while a MERV-11 filter is 91% efficient at 5.0 microns, it is 24% efficient at 0.3 microns. However, if the particle count is reduced by 24% three to four times per hour, a lower total particle count in the range of 86% to 92% overall room reduction will be achieved.

Toxic Chemical Fumes, Volatile Organic Hydrocarbons, Odours and Carbon Monoxide

Electronic air cleaners and air filters only remove particles and have no means to remove gas phase toxic chemical fumes. Having pioneered this technology over a decade ago, photo-catalytic technology was a supreme improvement in the field of indoor air quality. There is simply no other way to efficiently reduce the broad spectrum of VOCs created by man-made construction materials, household cleaners, auto emissions and out door air pollution.

The Southwest Research Institute (www.swri.com) located in San Antonia, Texas, conducted tests on the destruction of typical VOCs by the HEPS Air Purification System at a cost of $18,000 dollars.

Further tests were requested by the government of Hong Kong and conducted at The Hong Kong Polytechnic University, Department of Applied Biology and Chemical Technology. The result was a reduction in VOCs of 90% after 2.5 hours of operation.

Alpha Scientist in Reproductive Medicine tested the HEPS and portable HEPS for the reduction of VOCs in IVF laboratories, where even low levels of VOCs in the parts per billion can be extremely detrimental to the development of embryos.

The test data confirmed that the filter lowered the VOC levels by up to 82% down to an average level of (8ppb). The conclusion was that by installing the HEPS there was no longer a need for a burn-in period of 30-40 days before the lab could be used.

Micro-Organisms, Bacteria, Viruses and Mould Spores

Germicidal ultraviolet light with a wave length of 254 nanometres has been used for over 60 years for the control and eradication of both viral and bacterial contamination in hospitals, water purification plants, pharmaceutical companies, ultra-pure water systems for semiconductor manufacturing and air purification to name a few.

By using germicidal ultraviolet light to excite the titanium catalyst for chemical and odour reduction, the two processes act together to become an even more powerful means of deactivating micro-organisms. This is due to the fact that the titanium catalyst is a power oxidizer.

Where mould spores are not easily destroyed with ultraviolet light due to the long exposure time needed, most disease-causing bacteria and viruses are deactivated with levels of ultraviolet light of 8,000 microwatts per centimetre squared per second or less.

Removal of mould spores, which are 4-6 microns in size, is accomplished by the use of mechanical filters.

The more passes through the ultraviolet field and the greater the intensity of the ultraviolet lights, the greater the reduction of germs in the air.

Laboratories will not perform efficacy tests on dangerous germs due to their infectious nature. They test equipment using surrogate germs that are not infectious but are destroyed with the same level of ultraviolet radiation.

The test data performed by the Hong Kong Government confirms that this combination technology will reduce bacteria in the air from 111 colony-forming units (CFU) per square metre to 7CFU per square metre in two hours. After two hours, the level of bacteria was reduced to below the level of detection.

Tests were run on non-harmful background heterotrophic bacteria found commonly in the air of all indoor environments, as they require much more ultraviolet exposure for deactivation than typical disease-causing micro-organism.

With the arrival of MRSA and TB and new types of viruses (e.g. Covid-19) showing up every year, the need for true air purification is overwhelming.

PHOTO-CATALYTIC OXIDATION (PCO)

Information courtesy of Dr Bill Jacoby, the Department of Architectural Engineering, Pennsylvania State University

Titanium Dioxide (TiO^2) is a semiconductor photo-catalyst with band gap energy of 3.2e.v. When this material is irradiated with photons of less than 385nm, the band gap energy is exceeded and an electron is promoted from the valence band to the conduction band.

The resultant electron-hole pair has a lifetime in the space-charge region that enables its participation in chemical reactions. The most widely postulated reactions are shown here:

$OH^- + h^+$ __________>.OH *and* $O^2 + e^-$ __________>O^{2-}

Hydroxyl radicals and super oxide ions are highly reactive species that will oxidize volatile organic compounds (VOCs) adsorbed on the catalyst surface. They will also kill and decompose adsorbed bio aerosols.

The process is referred to as heterogeneous photo-catalysis or, more specifically, photo-catalytic oxidation (PCO). Several attributes of PCO make it a strong candidate for indoor air quality (IAQ) applications.

Pollutants, particularly VOCs, are preferentially adsorbed on the surface and oxidised to (primarily) carbon dioxide (CO2). Thus, rather than simply changing the phase and concentrating the contaminant, the absolute toxicity of the treated air stream is reduced, allowing the photo-catalytic reactor to operate as a self-cleaning filter relative to organic material on the catalyst surface.

Photo-catalytic reactors may be integrated into new and existing heating, ventilation and air conditioning (HVAC) systems due to their modular design, room temperature operation and negligible pressure drop. PCO reactors also feature low power consumption, potentially long service life, and low maintenance requirements.

These attributes contribute to the potential of PCO technology to be an effective process for removing and destroying low level pollutants in indoor air, including bacteria, viruses and fungi.

Technical issues that must be confronted before PCO reactors can be used in this application include the formation of products of incomplete oxidation, reaction rate inhibition due to humidity, mass transport issues associated with high-flow rate systems, catalyst de-activation and inorganic contamination (dust and soil).

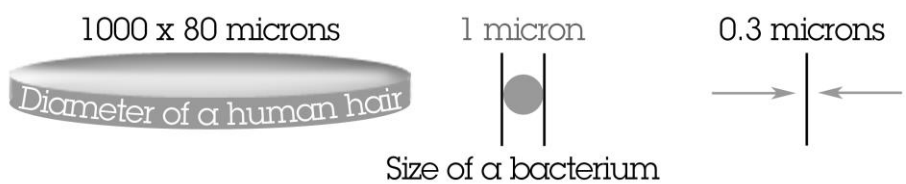
References

1. Block, SS; Goswani, DY (1995) “Chemically enhanced sunlight for killing bacteria.” Solar Engineering – ASME 1995 1: 431-437.
2. Goswani, DY; Trivedi, DM; Block, SS (1995) “Photo-catalytic disinfection of indoor air.” Solar Engineering – ASME 1995 1 421-427.
3. Ireland, JCKP; Rice, EW; Clark, R4M (1993) “Inactivation of Escheria coli by titanium dioxide photo-catalytic oxidation.” Applied and Environmental Microbiology 59(5): 1668-1670.
4. Jacoby, WA; Blake, DM; Fennell JA; Boulter, JE; Vargo, LM (1996) “Heterogeneous photo-catalysis for control of volatile organic compounds in indoor air” Journal of Air & Waste Management 46: 891-898.
5. Matsunga, T (1985) “Sterilisation with particulate photo semiconductor” Journal of Antibacterial Antifungal Agents 13: 211-220.
6. Nagame, S; Oku, T; Kambara, M; Konishi, K (1989) “Antibacterial effect of the powdered semi-conductor TiO2 on the viability of oral micro-organism”. Journal of Dental Research 68: 1696-1697.
7. Saito, T; Iwase, T; Horie, J; Morioka, T (1992) “Mode of photo-catalytic bactericidal action of powered semiconductor TiO^2 on Streptococci mutants” Journal of Photochemical Photobiology 14:369-379.

COMPLETE PURIFICATION UP TO 3000 SQ. FT

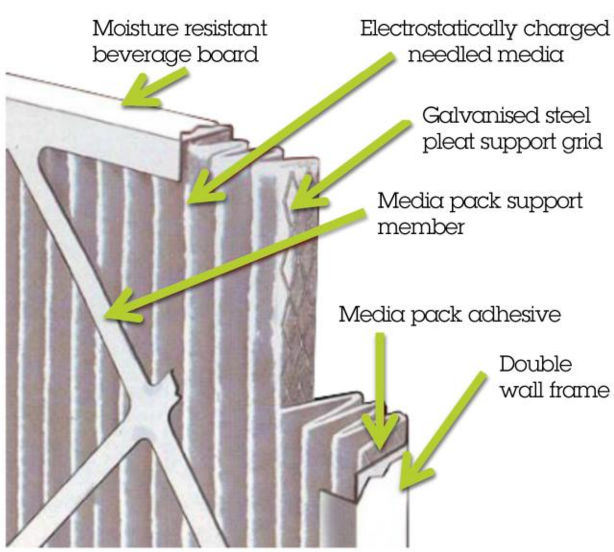
The electrostatically enhanced, needled media filter removes up to 96.3% of microscopic particles and airborne allergens as small as 0.3 microns in size. It is capable of filtering out bacteria, fungal spores, dust mites, pollen, insect dust, animal dander and tobacco smoke.

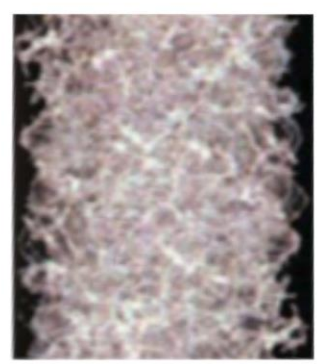
These microscopic particles are known to be one of the primary causes of asthma, emphysema, hay fever, chronic bronchitis and allergies. The elderly and children are especially vulnerable. (The average human hair is 80 microns in size and a bacterium is 1 micron in size).



The HEPS air purification system costs only a few pence per day to operate full time, 24 hours per day. This is a fraction of the cost of taking medication, which only masks health problems.

Media area = 23.5 Sq. Ft. Filter size: L25" x W20" x D4"





Needling entangles the fibres throughout the entire depth of the media, producing high mechanical efficiency

RESEARCH STUDIES

VOC LEVELS IN A NEW IVF LABORATORY

With both central and in-laboratory photo-catalytic air purification units *Lawrence, C et al (August 2007) Alpha (Scientists in Reproductive Medicine) No. 36.*

Introduction

Over the past decade, practitioners of Assisted Reproduction Technology ("ART") have become increasingly aware that the quality of the air in their laboratories and clinical procedure rooms can have enormous adverse effects upon embryo quality, and hence clinical outcomes of ART treatment.

Historical fears of toxic fumes from motor vehicles and industrial sources, and anecdotal reports among ART scientists of diminished success rates associated with building renovations, have now been confirmed and expanded into a solid evidence base. The earliest peer-reviewed publication on such issues was by Cohen et al. (1997) and led to the development of various products designed specifically to reduce the impact of toxic vapours inside incubators.

Attention has focussed upon volatile organic compounds (VOCs), many types of which can be detected by simple absorption and gas chromatographic or flame ionization detection and analysis. Aerosolized pesticides, small inorganic gaseous molecules such as nitrous oxide (N_20) and sulphur dioxide ($S0_2$), as well as heavy metals such as lead, are common air pollutants that can settle onto work surfaces or the surfaces of tissue culture plastic ware and also dissolve in aqueous solutions such as embryo culture medium.

Motor vehicle exhaust is a common contaminant of "fresh" air intakes for building air conditioning systems in urban areas (see Cohen et al., 1997: p.1744, re Dr B Dale's IVF laboratory in Naples), containing high levels of

VOCs (e.g. Varshney & Padhy, 1998) as well as lead (although greatly reduced in recent years).

Industrial emissions are also common contaminants of “fresh” air intakes for building air conditioning systems in urban areas, containing very many different VOCs, nitrous oxide, sulphur dioxide and other acidic gases, carbon monoxide, hydrogen sulphide and heavy metals. Road surfaces, i.e. tarmac and tarmac sealant (coal tar derivatives) contain acrolein, which is highly toxic to mouse embryos in vitro (Hall et al., 1998).

Construction materials represent a major source of VOCs in IVF labs. Particle board and other wood-based panels such as medium density fibreboard (“MDF” or “craft wood”) release formaldehyde (Brown, 1999). PVC flooring materials (Lundgren et al., 1999; De Bortoli et al., 1999) and carpet (De Bortoli et al., 1999) release VOCs, as does dry wall (plasterboard) and its filler. Paints (Sparks et al., 1999, Srivastava et al., 2000; De Bortoli et al., 1999) and adhesives (especially vinyl floor tile adhesive: Cohen et al., 1997) release numerous VOCs, including aldehydes. Many cleaning products are also sources of VOCS, e.g. vinyl floor liquid wax which can contain lead (Cohen et al., 1997), ammonia-based products such as glass cleaners, and aerosol propellants such as butane or iso-butane.

Pesticides include many poisons and even known teratogens, as well as aerosol propellants if delivered via that route. Plastic components of medical equipment can out-gas residual monomers, plasticizers, antioxidants and mould-releasing agents, and electronic components can emit various VOCs when warm.

In addition to common laboratory chemicals such as ethanol, methanol, iso-propyl alcohol, xylene and related substitute solvents, toluene, benzene, ethners, aldehydes and ketones, fixatives and sterilizers are obviously toxic, especially glutaraldehyde (e.g. Cidex). Ethylene oxide (“EtO”) can also be an issue if ART products such as catheters that were sterilized using EtO were not properly ventilated for at least 4 weeks and submitted to mouse embryo bioassay testing before supply to customers.

Chlorhexidine (e.g. Hibitane) is known to be toxic to human sperm. Anaesthetic gases can dissolve in aqueous culture media and impair embryo metabolism. Also, many products emit VOCs when heated, hence autoclaved materials (e.g. drapes, instrument packs) can release VOCs when packs are opened for use. Cosmetics, especially perfumes, colognes, and aftershaves, are highly toxic to embryos in vitro, primarily due to evaporation of their solvent bases (Johnson et al., 1993), and hence many IVF labs - even whole clinics - are now “perfume free” zones.

Finally, cigarette smoke contains several hundred volatile compounds including recognized carcinogens and mutagens (Stillman et al., 1986), and high levels can contaminate “fresh” air intakes if improperly located.

Objectives

1. To assess the levels of construction - and product-related VOC off-gassing in a newly constructed IVF laboratory with three in duct HEPS Purifiers installed in series in the HVAC system.
2. To assess the performance of floor-standing Portable HEPS in reducing ambient VOC levels in an IVF laboratory.

Materials and Methods

The Air handling system for the Pacific Centre for Reproductive Medicine (“PCRM”) was designed as a re-circulating, over-pressure clean-room system to supply HEPA- filtered air to the Embryology Laboratory and Procedure Room with a maximum of 15% fresh air per passage. In addition, three HEPS photo-catalytic units were installed in the return air flow where the velocity was lower. These photo-catalytic units were chosen because of their much lower operating cost compared to large charcoal/permanganate filters.

According to the manufacturer each unit removes approximately 15% of the circulating VOCs per passage; hence three units in series will eliminate almost 40% of the VOCs per passage. In addition, floor-standing in-laboratory units were installed in both the Embryology Laboratory and in the Andrology Lab (not supplied by the clean room HVAC system). These portable units were chosen due to their lower purchase and operating costs compared to passive filtration systems.

Prior to their introduction into the laboratories, the portable HEPS units were run outside the laboratories for three days to eliminate residual particle and odours from the units and filters.

Immediately after completing construction of the laboratories (i.e. no "burn-in" period), the VOC levels were measured at various locations within the laboratories, as well as at external reference areas, both before (week of 18 September 2006) and after (week of 25 September 2006) the introduction of the in-laboratories units.

VOC levels were measured using a RAE Systems model ppb RAE analyzer (RAE Systems, San Jose, CA, USA) which was provided on loan from Zander Medical Supplies. The ppb RAE unit was calibrated before each use as per the manufacturer's recommendations using a calibration gas of 10 ppb isobutylene.

Fourteen locations established as VOC measurement points and measurements were taken at those points at the same time each day:

- One outdoor reference location for external air: A.
- Three Andrology Lab locations (no HVAC system): B-D
- Five Embryology Lab locations: E-I as well as one location inside the laboratory cabinetry: N
- Four indoor locations in the PCRM facility that were not in the labs J-M

VOC measurements were taken at the identified locations for five consecutive days prior to introducing the portable units, and for four consecutive days after the units were activated and allowed to run for 24 hours in the Andrology and Embryology Labs.

Clinical efficiency of the new laboratory was evacuated over the first 30 treatment cycles, which commenced in October 2006. Laboratory systems were optimized as per Mortimer & Mortimer (2005) , and included an IVF Chamber workstation (HD Scientific, Wetherill Park, NSW, Australia), the Cook Sydney IVF sequential media system and Cook K-MINC-1000 bench top incubators) Cook Canada, Stouffville, ON, Canada) supplied with pre-mixed gas (6.0% CO_2 / 5.0% O_2/ balance nitrogen).

Results

Figures 1 and 2 show the measured VOC levels before and after the introduction of the portable units into the PCRM laboratories respectively.

Figure 1 VOC Levels Pre-Purifier

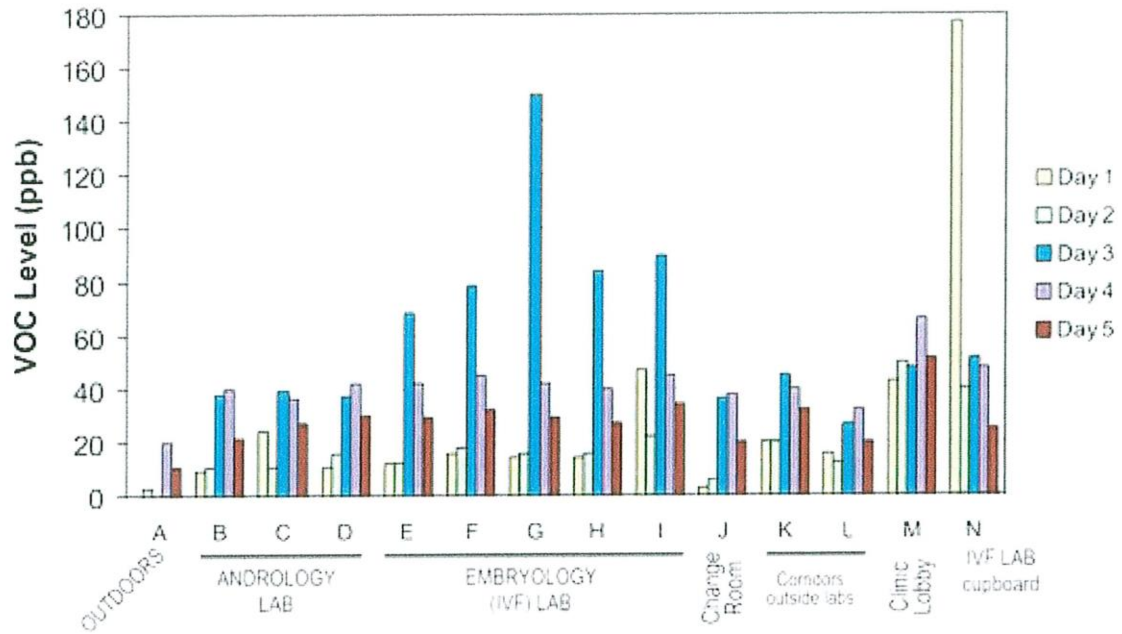
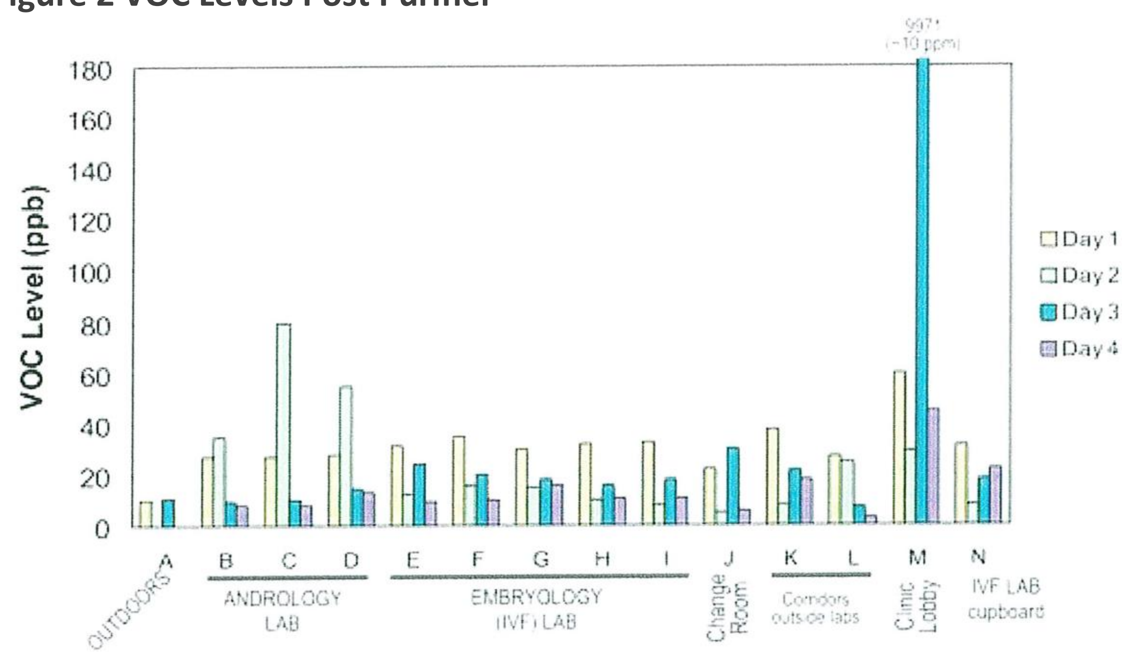


Figure 2 VOC Levels Post Purifier



The VOC levels in the laboratories were already low (typically 20 to 80 ppb, i.e. <1ppm VOCs) before the introduction of the floor-standing units, demonstrating the effectiveness of the three in-duct units installed in the HVAC system supplying the clean room zone, combined with apparently good quality local ambient air. The air coming directly out a portable unit was measured at 14 ppb VOCs.

Introducing the portable units reduced the fluctuations in VOC levels measured in the Embryology Lab (locations E-I in the Figures 1 and 2).

Although the mean values were not statistically different for each location before and after the introduction of the portable units (students t-test), the standard deviation values were much smaller for readings made after the introduction of local air polishing (see Table 1).

Table 1: *VOC measurements in the Embryology Lab before and after introduction of the portable units. Values are in parts-per-billion ("ppb") ad mean $\pm$ SD.*

Note that the size of the SD values indicates substantial, non-Normal variation in the distribution of the individual readings.

Location	Before	After
E	33 $\pm$ 23	19 $\pm$ 10
F	38 $\pm$ 25	20 $\pm$ 11
G	50 $\pm$ 57	20 $\pm$ 7
H	36 $\pm$ 29	17 $\pm$ 10
I	48 $\pm$ 26	18 $\pm$ 11

On Day 3 post- portable unit there were very high VOC levels in the corridor immediately outside the laboratory suites main doors (location M) due to a wooden door being varnished there: 9971 ppb, i.e. almost 10ppm.

However, in spite of this, there was no elevation of VOCs at any of the laboratory measurement locations, confirming that the over-pressure in the Embryology Lab was effective in preventing contaminated from entering the clean room area.

Clinical Efficacy

The results for the first 30 treatment cycles performed in the PCRM laboratory are shown in Table 2. Clinical pregnancy and implantation rate results are based on 7-week ultrasounds.

Table 2: *Summary results for the first 30 IVF/ICSI treatment cycles performed in the PCRM laboratory.*

Indicator	Results
Age of female partner	26 – 40 (mean = 34)
Number of embryo s transferred	29
Average number of embryos transferred	2.0
Positive ß-hCG	18/30 = 60% per cycle
Clinical pregnancy	14/30 = 47% per cycle
Implantation rate	38% (22 sacs from 58 embryos)

Discussion

The present results illustrate not only that attention must be focused on reducing VOCs in the air supply to an IVF Lab, but that employing additional, in-room air purification will help eliminate locally-generated VOCs within the laboratory (Cohen et al., 1997; Hall et al., 1998; Boone et al., 1999; Elder & Dale 200).

Moreover, paying particular attention to the choice of construction materials can also reduce VOC emissions, not only during the initial period post-construction/installation but also during the prolonged period of secondary emissions that can continue for months there-after (Wolkoff,1999). Consequently, we believe that when designing a modern ART laboratory, the following issues should be taken into consideration:

Woodwork Construction materials such as particleboard and MDF ("craft wood"), and also furniture will release VOCs, especially formaldehyde, at considerable levels for months (Brown.1999).

VOC emissions are higher for particleboard than MDF, and even higher for laminate office furniture, although MDF remains a low-level source of hexanal for several months post-construction. For these reasons, all woodwork in the PCRM laboratory was sealed on all surfaces to prevent out-gassing.

Floors While emissions of many VOCs from some PVF flooring are undetectable by 26 weeks after manufacture, some flooring materials show only minimal decreases in their emission rates beyond 6 months (Lundgren et al., 1999).

Floor tile adhesive is one of the most aggressive VOCs tested so far on embryos, arresting >90% of mouse embryos at the 2-cell stage- even though it was only used in an area adjacent to the ART laboratory (Cohen et al., 1997).

Consequently, a high-grade solid vinyl sheet with bonded urethane surface and welded joints was used in the PCRM laboratories.

Paints The powerful odour of many paints, from slow evaporation of the organic solvents that comprise their liquid phase, is well – known, hence latex paints are increasingly used when painting medical and laboratory areas because they have lower odours than traditional oil-based paints.

Even some “low-VOC” latex paints can have significant VOC emissions, which can be measured for over 200 days (Sparks et al., 1999) and the performance of some low-VOC latex paints is not as good as conventional latex paints (Chang et al., 1999). All paints used at PCRM were Dulux lifemaster products, which have zero VOCs when white, although small amounts of VOCs are introduced when tinted.

While professional codes of practice or accreditation guidelines for ART laboratories do not yet include specific air quality standards for VOCs, there are specifications for particulates and micro-organism contamination of clean room air in the EU Tissue Directive 2006/86/EC (European Union, 2006) – although there are concerns about the risk of decreased ART success rates with excessive air flows (Mortimer, 2006).

Nonetheless, ensuring that poor quality air (which must clearly include low VOC levels) does not have a detrimental impact upon outcomes should be a general consideration of professional responsibility.

Numerous guidelines and standards promulgated by regulatory authorities and professional bodies clearly place an obligation upon professionals working in ART Centres to ensure that everything that comes into contact with gametes and embryos is not toxic and will not cause any deleterious effects upon outcomes.

Even if air quality is not yet mentioned specifically, failure to recognize - and eliminate - such an adverse factor could be seen as a breach of professional responsibility, and perhaps preclude the unencumbered accreditation or licensing of an ART Centre.

Conclusions

The results of our study confirm the efficacy of including photo-catalytic VOC removal units in the HVAC system supplying the Embryology Laboratory. Moreover, the results also illustrate the value of having additional in-laboratory photo-catalytic "air polishing" units to help eliminate locally generated VOCs.

Finally, the results of the first 30 treatment cycles demonstrated that a "burn-in" period for a new Embryology Laboratory is not needed when it has been carefully planned and constructed.

References

Boone WR, Johnson JE, Locke A-J, Crane MM, IV, Price TM (1999) "Control of air quality in an assisted reproductive technology laboratory" Fertility and Sterility 71:150-154.

Brown SK (1999) "Chamber assessment of formaldehyde and VOC emissions from wood-based panels" Indoor Air 9: 209-215.

Chang JC, Fortmann R, Roache N, Lao HC (1999) "Evaluation of low-VOC latex paints" Indoor Air 9: 253-258.

Cohen J, Gilligan A, Esposito W, Schimmel T, Dale B (1997) "Ambient air and its potential effects on conception in vitro" Human Reproduction 12: 1742-1749.

De Bortoli M, Kephalopoulos S, Kirchner S, Schauenburg H, Vissers H (1999) “State-of-the-art in the measurement of volatile organic compounds emitted from building products: results of European interlaboratory comparison.” Indoor Air 9: 103-116.

Elder K, Dale B, (2000) “In Vitro Fertilization” 2nd edition, Cambridge University Press, Cambridge (UK), 310pp.

European Union (2006) “Commission Directive 2006/86/EC implementing Directive 2004/23/EC of the European Parliament and of the Council as regards traceability requirements, notification of serious adverse reactions and events and certain technical requirements for the coding, processing, preservation, storage and distribution of human tissues and cells” Official Journal of the European Union L294/32, 24.10.2006.

Gianaroli L, Plachot M, van Kooij R, Al-Hassani S, Dawson K, DeVos A, Magli MC, Mandelbaum J, Selva J, van Inzen W (2000) “ESHRE Guidelines for Good Practice in IVF Laboratories” Human Reproduction 15: 2241-2246.

Hall J, Gilligan A, Schimmel T, Cecchi M, Cohen J (1998) “The origin, effects and control of air pollution in laboratories used for human embryo culture” Human Reproduction 13 (Suppl.4): 146-155.

Johnson JE, Boone WR, Bernard RS (1993) “The effects of volatile compounds (VC) on the outcome of in vitro mouse embryo culture” Fertility and Sterility Suppl.1: S98-S99, Abstract P-038.

Lundgren B, Jonsson B, Ek-Olausson B (1999) “Materials emission of chemicals - PVC flooring materials” Indoor Air 9: 202-208.

Mayer JF, Nehchiri F, Weedon VM, Jones EL, Kalin HL, Oehninger SC, Toner JP, Gibbons WE, Muasher SJ (1999) “Prospective randomized crossover analysis of the impact of an IVF incubator air filtration system (Coda, GenX) on clinical pregnancy rates” Fertility and Sterility Suppl.1: S42-S43.

Mortimer D. (2005) “A critical assessment of the impact of the European Union Tissues and Cells Directive (2004) on laboratory practices in assisted conception” Reproductive Biomedicine Online 11: 162-176. Mortimer D, Mortimer ST (2005) “Quality and Risk Management in the IVF Laboratory” Cambridge University Press, Cambridge (UK), 232pp.

Sparks LE, Guo Z, Chang JC, Tichenor BA (1999) “Volatile Organic Compound emissions from latex paint - Part 1 - Chamber experiment and source, model development” Indoor Air 9:10-17.

Srivastava PK. Pandit GG. Sharma S. Mohan Rao AM (2000) “Volatile organic compounds in indoor environments in Mumbai, India” Science of the Total Environment 255: 161-168.

Stillman RJ, Rosenburg MJ, Sachs BP (1986) “Smoking and Reproduction” Fertility and Sterility 46: 545-566.

Vrashney CK, Padhy PK (1998) “Total volatile organic compounds in the urban environment of Delhi” J Air Waste Management Association 48: 488-453.

Wolkoff P (1999) “How to measure and evaluate volatile organic compound emissions from building products - a perspective” Science of the Total Environment 277: 197-213.

SOUTHWEST RESEARCH INSTITUTE

Chemistry and Chemical Engineering Division, Dept. of Analytical and Environmental Chemistry
1220 Culebra Road, Post Office Drawer 28510 San Antonia, Texas USA 78228-0510

SUMMARY REPORT FOR AIR PURIFIER MODEL (HEPS & PORTABLE HEPS)

Report date: October 9th 2000
Report to: Ultrasun Technologies, 4225 Prado Road, Corona CA 92807

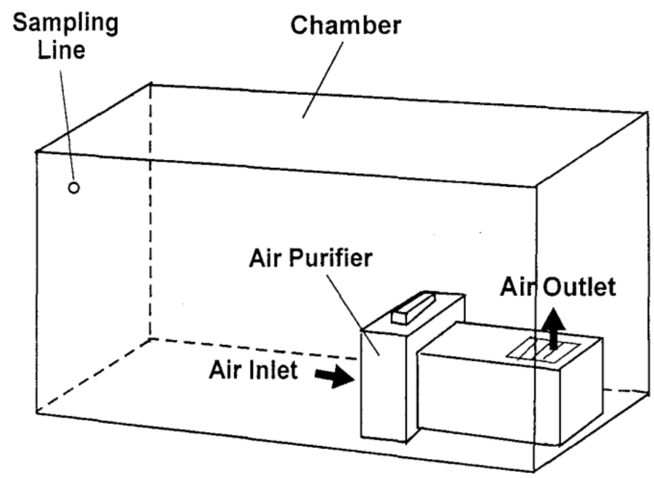
1. Case Narrative
A research project was conducted by GD Air Testing Inc and Southwest Research Institute (SRI) for Air Tech International from 25/09/2000 to 27/09/2000. This research project consisted of setting up a 6' x 6' x 4' air tight chamber and testing the effectiveness of an air purifier, supplied by Air Tech International for VOCs.

A standard consisting of 39 unknown compound concentrations was injected into the chamber. Samples were taken into Summa canisters by different time periods with the purifier unit running. The analysts and engineers from Southwest Research Institute (SRI) and GD Air Testing Inc have been working together to finish this research project.

2. Chamber Structure
Figure 1 shows the structure of the chamber. The chamber (6' x 6' x 4') was constructed using a plastic board reinforced by an aluminium foil on one side. The frame of the chamber was constructed using steel angle pods.

The boards were placed on all sides of the chamber with the aluminium foil tape. The air purifier was placed in the one end of the chamber. The sampling line was located at the upper level in the other side of the chamber. The total volume of the chamber is 144 cubic feet.

Figure 1:
Structure of the testing chamber



3. Experiment

A standard gas with volatile organic compounds (VOCs) was injected into the chamber through the sampling line. The VOCs were collected into 61 stainless steel canisters at 0, 0.083, 0.25, 0.5,1,2,3,4,6,8,10,12,24,29.5 and 48 h respectively. Moulds were collated into specific agar plates.

The VOCs were analysed using Hewlett Packard GC/MS. Moulds were submitted to an outside lab for incubation and reading.

The first two samples were taken at 0 minutes and 20 minutes after the standard was injected into the chamber before turning on the air purifier. Subsequent samples were taken at different intervals from 5 minutes to 48 hours after turning 'on' the air purifier system.

4. Results and Discussion

The analytical data are tabulated in the data summary sheet. The concentrations comparison between initial 20 minutes shows that the VOCs added into the chamber will not be adsorbed significantly by the inside wall of the chamber.

The analytical results show that most of the added VOCs were significantly decomposed by the UV photo-catalysed mechanism of the air purifier after 48-hour operation time.

The decomposition efficiency of the air purifier for 1,2,4-chlorobenzene, 1,2,4-trimethylbenezene, hexachlorobutadiene, chlorobenzene, 1,2-dichlorobenezene, 1,3-dichlorobenezene was very high which can reach as high as above 95%.

The removal efficiency for some compounds is not as good as the best ones but it also can reach 30% removal. Figures 2 and 3 show the decomposition ability of the air purifier for some VOCs. Because of the interference of tetra-methyl benezene from the sealing tapes, the results for toluene, ethyl benzene, m & p-xylene and o-xylene are not available after one-hour time.

But from the reference data of 0 to 60 minutes, one still can see that the unit can remove this kind of compound like others. The other sealing tape will be chosen for further study to avoid the interference.

Conclusion

The research results show that the air purifier can remove most of the toxic chemicals at lower ppbv level from the room air and/or air cycling system. The removal efficiency of most compounds is better than 50% within 48 hours.

The health efficiency data for VOCs can be found on TNRCC website.

Removing the air toxic compounds from ambient air or room air can reduce the risk of exposing people to toxic air.

Respectfully submitted,

Dr George Dai Lab Director Dr CK Tan VOC Group Leader
GD Air Testing Inc Southwest Research
Institute

Figure 2
Decomposition process of some VOCs

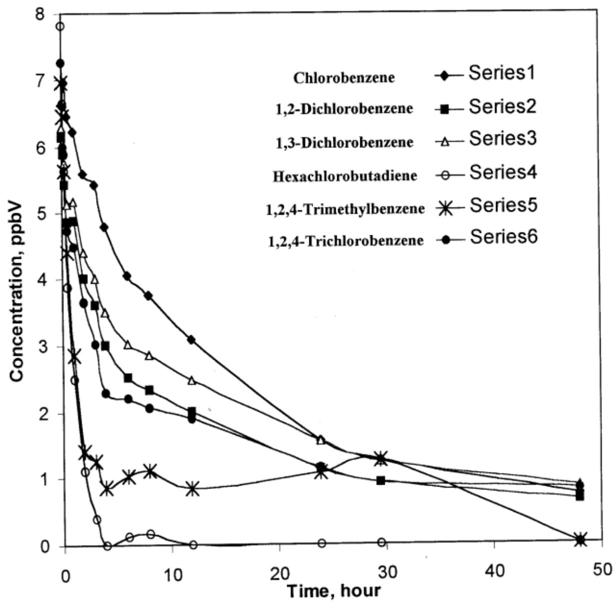
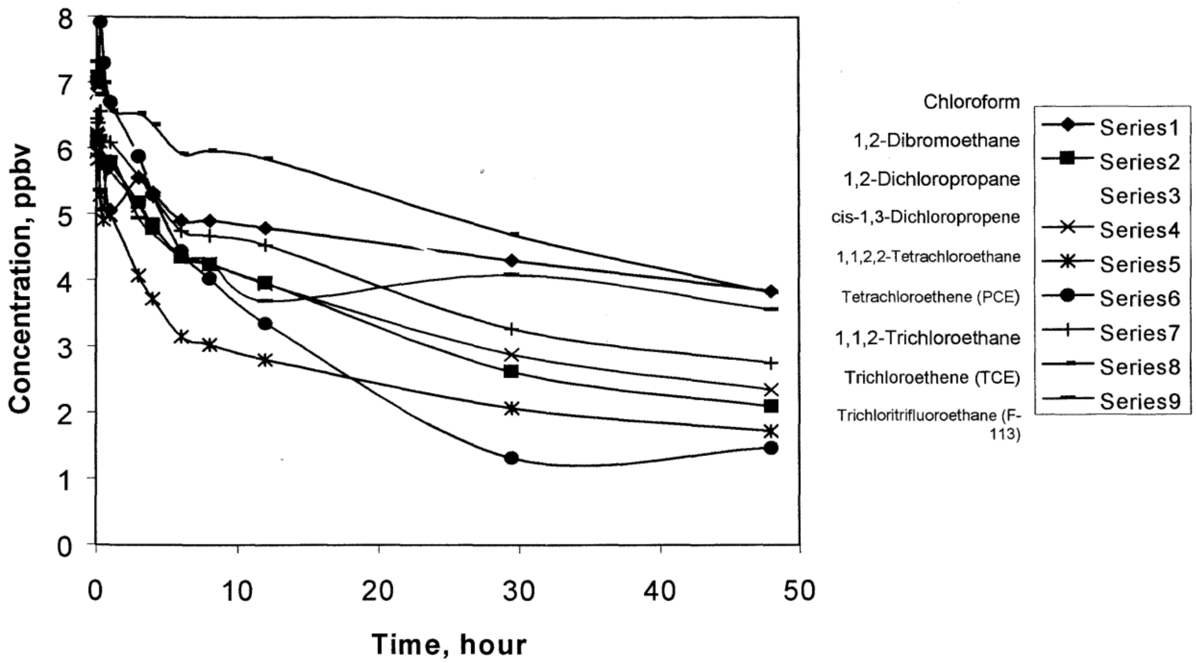


Figure 3
Decomposition efficiency of the air purifier for some VOCs



Test Data

Client:	Ultrasun Technologies
	4225 Prado Road, Bldg 102 Corona, CA 92880
Model:	SP-200/S-30
Project No:	Catalyst TiO_2 Titanium Dioxide
GD Air Testing Lab ID:	GD01-0174
Report date:	2nd June 2001
Date analysed:	1st June 2001
Analysed by:	John GD Air QC
Batch:	QC-060101TO14
Method:	EPATO14

CONSTITUENT	0174-7 0 hr	0174-8 2 hours	0174-9 4hours	0174-10 8hours	0174-11 12hours	0174-12 24hours
Benzene	12	6.45	4.21	2.85	2.45	2.12
Benzylchloride	ND	ND	ND	ND	ND	ND
Bromomethane	12.3	5.76	2.78	0.90	ND	ND
Carbon Tetrachloride	11.4	5.33	2.55	0.80	0.68	ND
Chlorobenzene	11.4	3.73	1.76	0.71	ND	ND
Chloroethane	11.6	5.86	2.92	0.88	ND	ND
Chloroform	11.8	5.57	2.84	1.18	0.58	ND
Chloromethane	11.9	6.59	4.42	1.56	0.98	0.62
1,2-Dibromoethane	11.30	4.15	2.13	1.01	0.58	ND
1,2-Dichlorobenzene	10.90	2.57	1.45	0.85	ND	ND
1,3-Dichlorobenzene	11.2	2.78	1.58	0.91	0.42	ND
1,4-Dichlorobenzene	11.10	2.66	1.57	0.96	0.45	0.40
1,1-Dichloroethane	11.40	5.27	2.57	0.81	0.43	ND
1,1-Dichlorethene	11.7	5.47	2.71	0.82	ND	ND
Dichlorodifluoromethane	12.7	6.3	3.33	1.35	0.63	0.45
Dichlorotetrafluoroethane	11.9	5.69	2.73	0.84	ND	ND
1,2-Dichloroethane (EDC)	11.9	5.17	2.58	0.87	ND	ND
cis-1,2-Dichloroethene	12.4	6.27	3.85	2.43	1.84	1.30
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND
Dichloromethane	11.6	5.78	3.11	1.20	0.61	ND
1,2-Dichloropropane	11.4	5.38	2.56	0.87	ND	ND
cis-1,3-Dichloropropene	11.2	4.49	2.18	0.86	0.57	ND
trans-1,3-Dichloropropene	11.4	4.05	2.02	0.92	0.69	ND
Ethylbenzene	11.7	5.37	3.6	1.97	1.63	1.70
Hexachlorobutadiene	15.3	1.05	0.27	ND	ND	ND
Styrene	12	3.7	1.87	1.07	0.61	0.49
1,1,2,2-Tetrachloroethane	10.6	3.31	1.76	0.93	0.53	ND
Tetrachloroethene (PCE)	11.3	4.02	1.77	0.76	0.54	ND
Toluene	13.2	7.16	5.51	3.49	3.08	3.40
1,1,1-Trichloroethane (TCA)	11.60	5.37	2.65	0.82	ND	ND
1,1,2-Trichloroethane	10.9	4.55	2.24	0.88	0.45	ND
1,3,5-TMB/4-Ethyltoluene	11.3	3.82	2.4	1.25	0.44	0.42
1,2,4-Trimethylbenzene	11.9	4.65	3.39	1.78	0.66	1.18
1,2,4-Trichlorobenzene	13.3	2.44	1.48	1.02	ND	0.50
Trichloroethene (TCE)	11.2	4.92	2.49	0.98	0.44	ND
Trichlorofluoromethane (F-11)	12.5	6.18	3.21	1.19	0.58	ND
Trichloritrifluoroethane (F-113)	12.2	5.73	2.79	0.85	0.54	ND
Vinyl Chloride	11.6	5.59	2.75	0.82	ND	ND
m&p-Xylenes	24.3	11.9	9.59	6.12	5.19	6.69
o-Xylene	12.2	5.58	4.14	2.32	1.70	2.19

About South West Research Institute

South West Research Institute (SwRI) is an independent, non profit applied research and development organisation. The staff of 2700 specialise in the creation and transfer of technology in engineering and the physical sciences.

The Institute occupies 1200 acres in San Antonio, Texas, and provides nearly two million square feet of laboratories, test facilities, workshops and offices. The staff performed more than $300 million in contract research in 1998.

Research areas include

- Aerospace electronics and training systems
- Automation and data systems
- Automotive products and emissions training
- Centre for nuclear waste and regulatory analyses
- Chemistry and chemical engineering
- Engine and vehicle research
- Space science and engineering
- Mechanical and materials engineering
- Signal exploitation and geo-location

- End of Report -

The Hong Kong POLYTECHNIC UNIVERSITY
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6th September 2004

Aparkson Technologies Co. Ltd
Room 1902 Kai Tak Commercial Building
317 – 319 Des Voeux Road Central
Hong Kong

Dear Mr. Lam,

Hi-Velocity HEPS Test Report

Attached is the test report of “HEPS Photo-catalytic Oxidation Air Purification System” with job reference number P04-0055. The report represents the results of the indoor air quality measurements conducted using the HEPS Photo-catalytic Oxidation Air Purification System in accordance with recognized assessment methods on 6th July 2004. The objective is to evaluate the effectiveness of the system in removing Total Volatile Organic Compounds (TVOCs) and airborne bacteria. Results obtained show the TVOCs and airborne bacteria levels dropped significantly at the very initial phases of the test under the experimental condition stated in the test.

Yours sincerely,

Gilbert Chan

TEST REPORT

Hi-Velocity High Efficiency Purification System
(Photo-catalytic Oxidation Air Purification System)

Prepared by: Dr. Y S Gilbert Chan, MSC, PhD, MIOA
Lecturer, Department of Applied Biology and Chemical Technology
The Hong Kong Polytechnic University
Hung Hom, Kowloon, Hong Kong
Date: 6th September 2004

1. Executive Summary

A test was conducted on Photo-catalytic oxidation air purification system (Model HEPS). The objective was to evaluate the effectiveness of the equipment in removing Total Volatile Organic Compounds (TVOCs) and airborne bacteria - two important parameters in managing Indoor Air Quality (IAQ).

The study aims at monitoring quantitative information of the two parameters throughout the test. Sampling and measurements were done in accordance with corresponding assessment methods stated in the Guidance Notes for the "Management of Indoor Air Quality in Offices and Public Places" published by the Hong Kong Environmental Protection Department.

In two separate tests carried out, both the TVOCs and airborne bacteria levels dropped significantly at very initial phases of the test. Results obtained thus are indicative of the effectiveness of the HEPS in removing Total Volatile Organic Compounds and airborne bacteria.

2. Test Objective

Test the effectiveness of the HEPS in removing Total Volatile Organic Compounds and airborne bacteria.

3. Methodology

3.1 Date of Test: July 6th, 2004

3.2 Location: Conference room (7/F), Core G, The Hong Kong Polytechnic University.

3.3 Equipment tested:

3.3.1 One (1) unit of HEPS Photo-catalytic Oxidation Air Purification System, supplied by Aparkson Technologies Company Limited. The unit consists of the following features:

- Electro-statically charged needled fiber MER-11 filter
- UV lamp with aluminum reflector
- Photo-catalytic oxidation converter surface area (of over 70 sq. feet)

3.3.2 The HEPS was connected with flexible hoses at both ends. At the intake side, a 12" booster fan was connected to draw air though the unit.

3.4 Test Method:

3.4.1 Environment and settings - the room had a total floor area of about $30m^2$. Air samples were taken in the middle of the room and at 1.1m above the floor – approximately the height at which people breathe air.

3.4.2 The room was carpeted with dropped ceilings, painted concreted walls and pillars. Furniture used was mostly plastic. No air-conditioning was used.

3.4.3 Air samples were collected throughout an eight-hour normal office period.

3.4.4 Measurements of TVOCs (Total Volatile Organic Compounds) were taken and logged every 5 minutes over a period of 5 hours.

3.4.5 Measurements of airborne bacteria were collected in four sessions evenly spread out during the eight-hour period; each time three air samples were collected and the averages calculated.

3.4.6 Measurements of particulate air pollutants are in accordance with corresponding assessment methods stated in the Guidance Notes for Management of Indoor Air Quality in

Offices and Public Places" published by the Hong Kong Environmental Protection Department.

3.5. Test Equipment:

3.5.1. Measuring TVOCs - Photo-Ionization Detection (PID) Method using a ppbRAE monitor (model PGM-7240)

3.5.1. Measuring airborne bacteria - Surface Air System sampler (Portable High Flow Model 5203) loaded with culture medium, tryptone soya agar at constant airflow rate of 180L /min for three minutes

3.5.1. After sampling, the culture media were put into an incubator maintained at 37°C for bacteria incubation. Airborne bacteria were quantified by counting visible colonies formed. In addition, temperature and relative humidity during the sampling period were recorded.

3.6. Control set:

After the test was completed the air conditioning was turned on. Fifteen minutes later, three air samples were collected for bacteria counts with air-conditioning still running.

4.0 Results and Discussion

The average temperature and relative humidity of the monitoring area during the test period were 31.1ºC and 68.6% respectively. Results on individual test parameters are shown below:

4.1 Total Volatile Organic Compounds (TVOCs)

4.11 There was a significant drop in concentration of TVOCs in the first 60 minutes of the test (see figure 1). This could be attributed to rapid absorption (by the HEPA filter) and decomposition (by photo-catalytic oxidation) one by the HEPS.

4.1.2 Percentage reduction in TVOCs started to level off 60 minutes after the tests started with concentrations fell steadily below 250 ppbv.

4.1.3 The test showed over 90% reduction in TVOCs with the use of air purifications system alone.

4.1.4 Photo-catalytic oxidation demonstrates an ability to remove lighter volatile organic compounds that could not be effectively absorbed by carbon filters.

4.1.5 For offices installed with carpet, use of chemical-based or oxidant-based air purification system could be an alternative to reducing T VOCs.

5. I. Airborne Bacteria

5.1.1 During the first 2-hour session, bacteria count level decreased significantly from pre-test levels of lllcfi/m63 to 7cfu/ m^3 (table l).

5.1.2 In the subsequent three sessions (2 hours each) no traceable bacteria counts were observed, showing extremely low bacterial levels found throughout the test.

5.1.3 In an air-conditioned building, water or condensation in ventilation system can act as breeding grounds for bacteria that are dispersed through ventilation system. This can be demonstrated by the rapid significant rise in bacteria count when only the air-conditioner was working after the test.

5.1.4 Comparison of test results with that of using only air-conditioning shows the impressive bacteria removal ability of the HEPS air purification system.

Figure 1 Removal efficiency of TVOC using the HEPS air purification system

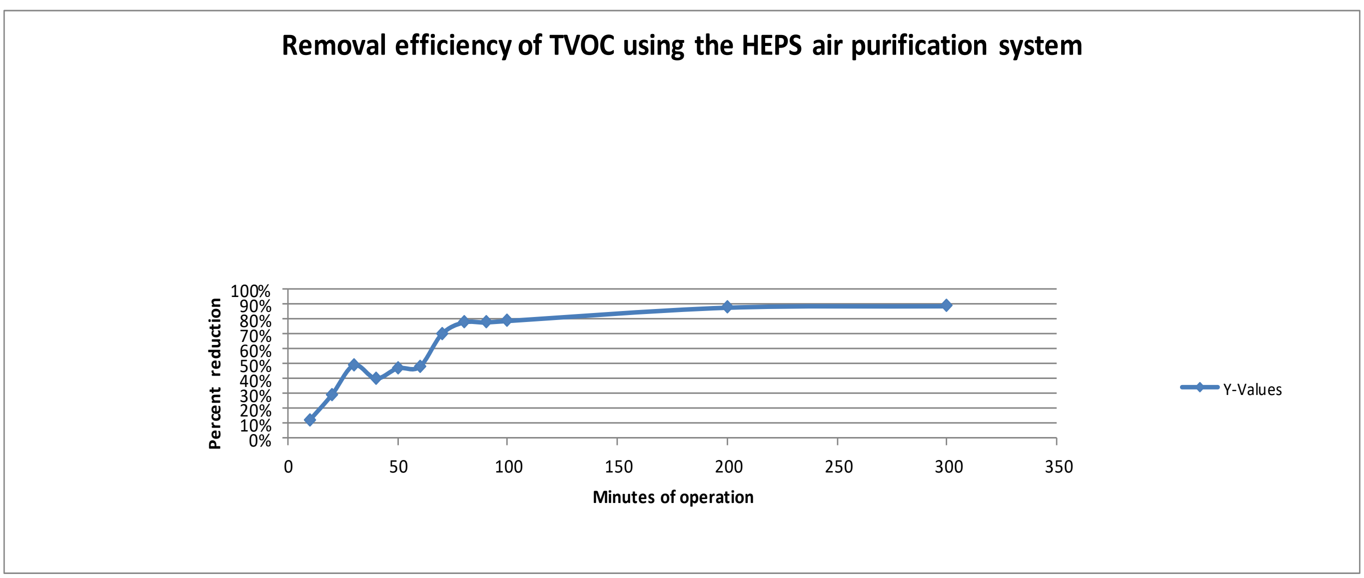


Table 1
Average airborne bacteria level (cfu/m3) of the four-time sections with the operation of the HEPS air Purification system.

	Average bacteria level (cfu/m^3)
Background level	111
9.00 – 11.00	7
11.00 – 13.00	LOD*
13.00 – 15.00	LOD
15.00 – 17.00	LOD
AC on (Sun-Pure SP200 off)	39

* Under the lower detection limit of the sampling method

5. Conclusion

Results gathered during the test are indicative of the effectiveness of the HEPS Air Purification System in removing airborne pollutants (volatile organic compounds) and airborne bacteria.

Appendix: About Indoor Air Quality

Good indoor air quality depends on various complex factors, including indoor sources of pollutants, design, operating and maintenance of building ventilation systems and outdoor environment.

The Guidance Notes released by the Hong Kong SAR Government specify 12 measurable parameters for the assessment of IAQ (Indoor Air Quality) in offices and public places. These include:

- 3 physical parameters (room temperature, relative humidity, and air movement)
- 8 chemical parameters (carbon dioxide (CO_2), carbon monoxide (CO), respirable suspended particulates (PM_{10}), nitrogen dioxide (NO_2), ozone (O_3), formaldehyde (HCHO), Total Volatile Organic Compounds (TVOCs) and radon (Rn)
- 1 biological parameter (airborne bacteria)

Among these parameters TVOCs and airborne bacteria cannot be effectively removed by conventional mechanical ventilation and air-conditioning system.

These two types of air pollutants are commonly found in indoor office environments.

Chronic exposure to TVOCs has been shown to have toxicological effects to occupants.

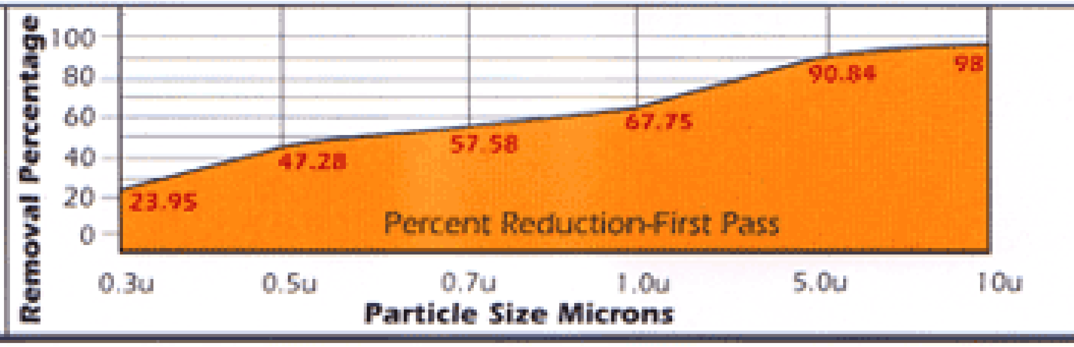
- End of Report -

TEST AND PERFORMANCE DATA

The following test and performance data were compiled by Ultra-Sun technologies for the HEPS model.

Air Flow & Resistance Data:	CFM/FPM	Resistance in w.g	Meters Per Sec.	KPA
	1250/360.2	0.18	1.59	0.045
	1500/432.2	0.25	1.91	0.063
	1750/504.3	0.34	2.23	0.085
	2000/576.3	0.42	2.54	0.105
	2250/648.4	0.55	2.86	0.137
	2500/720.5	0.65	3.18	0.162

Particle Size Efficiency Graph:



References

1. Chan, Dr. GYS (2004) “Test Report on HEPS Photo-catalytic oxidation air purification system” The Hong Kong Polytechnic University.
2. Lawrence, C et al (2007) “VOC levels in a new IVF laboratory with both central and in-laboratory photo-catalytic air purification filters” Alpha Scientists.
3. Tan Dr. CK (2000) “Summary report for air purifier project (model HEPS)” Chemical Engineers Division, Dept. of Analytical and Environmental Chemistry, San Antonio, Texas.

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