Engineering Clean Air

E-Newsletter Brought to You by Purafil Technical Services

June 2011

Purafil's scientists and researchers publish this monthly e-newsletter specifically for the engineering community. This exclusive newsletter will include information and explanations on the latest technology changes, regulations, standards, solutions, research findings and other information of value to consulting and specifying engineers.

Please feel free to forward to your engineering colleagues and have them join the Engineering Clean Air e-newsletter community by clicking the link to the right.

Sincerely,
Technical Services Department
Purafil, Inc.

About Purafil, Inc.

For more than 40 years, Purafil has been a world leader in the development of gas-phase air filtration media and systems designed to eliminate and control gaseous contaminants. We were the first to propose standards for industrial facilities using electronic process controls. Today, these standards are used worldwide.

Purafil offers the widest variety of gas-phase air filtration media and award-winning systems for the control of any Indoor Air Quality (IAQ) challenge. Purafil provides engineered, clean air solutions in an array of markets including commercial, industrial, water wastewater, museums and cleanrooms. Purafil's dry-chemical air cleaning media removes specific gases and contaminants from high-volume facilities in order to control corrosion, improve process reliability and IAQ, as well as save money.

Purafil's state-of-the-art laboratory and research facility offers valuable customer services, such as media life analysis, air quality assessment, and circuit board failure evaluation. In addition to those valued process, Purafil also offers a variety of technical services to ensure clean air and customer satisfaction. Purafil's ongoing commitment to quality, customer satisfaction and safety are exemplified by earning the latest ISO 9001:2008 certification, numerous industry awards and an obligation to the research and development of new clean air technologies.

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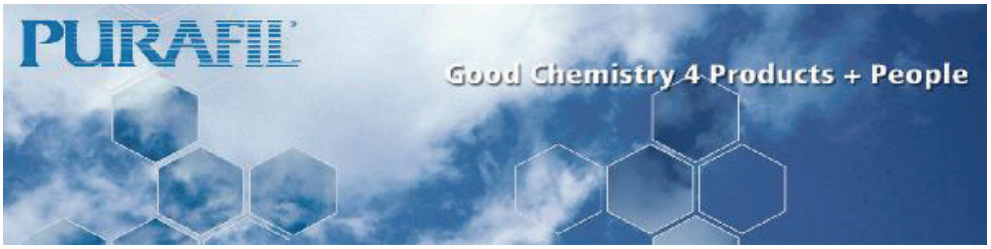


In This Issue

Technical Resources for Gas-Phase Air Filtration

Gas-phase air filtration is a highly specialized branch of air filtration with a very short list of reputable and knowledgeable companies manufacturing the dry-scrubbing media, filters, and systems in which they are employed. The list becomes even shorter when considering where to go for the technical resources necessary to specify, design, test, build, install, operate, and maintain the appropriate gas-phase air filtration media, filters, and systems for specific applications.

Purafil is asked every day by engineers, consultants, customers, etc. "Where do I go to learn about gas-phase air filtration and related topics?" We can of course refer them to Purafil's own large technical library, but sometimes a more "independent" source of information is requested. There are more than a few technical resources on this topic and not surprisingly, Purafil has had a hand in developing several. Some of the more comprehensive resources with which Purafil has helped to develop are listed below.

ASHRAE

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE, www.ashrae.org) was founded in 1894, and is an international organization of over 50,000 members. ASHRAE fulfills its mission of advancing heating, ventilation, air conditioning and refrigeration to serve humanity and promote a sustainable world through research, standards writing, publishing and continuing education.

The ASHRAE Handbook (http://ashrae.org/publications/page/158) is published in a series of four volumes. One is revised each year, ensuring that no volume is older than four years. Two of the volumes provide information pertinent to the application and use of gas-phase air filtration. These volumes and some of the more relevant chapters are described below.

HVAC Applications Handbook
The *2011 ASHRAE Handbook – HVAC Applications* comprises over 60 chapters covering a broad range of facilities and topics, and is written to help engineers design and use equipment and systems described in other Handbook volumes. Main sections cover comfort, industrial, energy-related, and general applications, as well as building operations and management. ASHRAE Technical Committees have revised nearly every chapter to cover current requirements, technology, and design practice.

Chapter 18 – Clean Spaces. The design of clean spaces or cleanrooms covers much more than traditional temperature and humidity control. Other factors may include control of particle microbial electrostatic discharge (ESD), ***molecular and gaseous contamination***; airflow pattern control; pressurization; Saddam vibration control; life safety; industrial engineering aspects; and manufacturing equipment layout. The objective of good cleaner design is to control these variables while optimizing installation and operating cost. Clean Spaces has updated content on standards, filters, barrier technology, sustainability, and a new section on installation and test procedures.

Chapter 19 – Data Processing and Telecommunication Facilities. Datacom (data processing and telecommunications) facilities are predominantly occupied by computers, networking equipment, electronic equipment, and peripherals. The most defining HVAC characteristic of data and communications equipment centers is the potential for exceptionally high sensible heat loads (often orders of magnitude greater than a typical office building). In addition, the equipment installed in these facilities typically:

- Serves mission-critical applications (i.e., continuous operation)
- Has special environmental requirements (temperature, humidity, particulate control, and ***gaseous contamination control***)
- Has the potential for disruptive overheating and equipment failure caused by loss of cooling.

Design of any datacom facility should also address the fact that most datacom equipment will be replaced multiple times with more current technology during the life of the facility. Typical datacom equipment product cycles are one to five years, whereas facilities and infrastructure have lifecycles of 10 to 25 years. Replacement equipment has historically required more demanding power and cooling requirements.

Understanding these critical parameters is essential to datacom facility design. Chapter 19 has a new title and revised and/or new content on design temperatures, change rate, humidity, power usage effectiveness (PUE), aisle containment, economizer cycles, and computer room air-handling (CRAH) units.

Chapter 23 – Museum, Libraries, Galleries, and Archives. Understanding and appreciating humanity's diverse cultures and history dictates preserving objects including books and documents, works of art, historical artifacts, specimens of national history, examples of popular culture, once common trade goods, technological accomplishments, the products of various technologies, as well as historic buildings and sites. Collections are vulnerable to many threats because they must be preserved indefinitely; the steps taken to protect them are sometimes extraordinary. ***Air pollution (or contaminants) includes outdoor-generated gaseous contaminants that infiltrate the building and indoor-generated gaseous pollutants***. Even very low levels of pollutants can adversely affect the condition of the collections.

Chapter 46 – Control of Gaseous Indoor Air Contaminants. The purpose of gas-phase air filtration is to remove from the air contaminants that would adversely affect the occupants, processes, or contents of a space. The effects are problematic at different concentration levels for different contaminants. There are four categories of harmful effects: toxicity, odor, irritation, and material damage. In most cases, contaminants become annoying through irritation or odor before they reach levels toxic to humans, but this is not always true.

This chapter covers design procedures for gaseous contaminant control for occupied spaces. Procedures discussed are appropriate to control odors and gaseous irritants. Control of contaminants for the express purpose of protecting building occupants (whether against deliberate attack or industrial accidents) or to protect artifacts (such as in museums) requires application of the same design principles, but applied more rigorously and with great emphasis on having specific design and performance data, providing redundancy, and adding engineering safety factors. Designed for protection is not a focus of this chapter, although published design guidance is included and referenced.

Chapter 59 – HVAC Security. This chapter is intended to be an overview of HVAC security considerations relative to chemical, biological, radiological, and explosive (CBRE) incidents that do not cause major structural damage to a building or its infrastructure. The focus is on CBRE incidents whether occurring by accident (e.g., industrial spill) or premeditated occurrence.

A chemical incident is defined as the accidental or intentional release of the gaseous or vapors compound into breathable air. The release may occur inside or outside of a building, and may be of short duration (e.g., from a broken container, and accidental valve opening, or a terrorist incident) or sustained (e.g., from a leaking storage tank or broken supply line). Descriptions of classes and individual air contaminants, including chemicals, are found in Chapter 11 of the 2009 ASHRAE Handbook – Fundamentals, and removal techniques are covered in Chapter 29 of the 2008 ASHRAE Handbook – HVAC Systems and Equipment and in Chapter 46 of this volume.

Fundamentals Handbook

The *2009 ASHRAE Handbook - Fundamentals* covers basic principles and data used in the HVAC&R industry. The ASHRAE Technical Committees that prepare these chapters strive not only to provide new information, but also to clarify existing information, delete obsolete materials, and reorganize chapters to make the Handbook more understandable and easier to use.

Chapter 11 – Air Contaminants. Air contamination is a concern for ventilation engineers when it causes problems for building occupants. ***Engineers need to understand the vocabulary used by the air sampling and building air cleaning industry***. This chapter focuses on the types and levels of air contaminants that might enter ventilation systems or be found in indoor contaminants. Industrial contaminants are included only for special cases.

The terms gas and vapor are both used to describe the gaseous state of the substance. Gas is the correct term for describing any pure substance or mixture that naturally exists in the gaseous state and normal atmospheric conditions. Examples are oxygen, helium, ammonia, and nitrogen. Vapor is used to describe a substance in the gaseous state whose natural state is a liquid or solid normal atmospheric conditions. Examples include benzene, carbon tetrachloride, and water.

Harmful effects of gaseous contaminants may be divided into four categories: toxicity, irritation, odor, and material damage. The concentration of these contaminants must be measured to determine whether indoor air quality conforms to occupational health standards (in industrial environments) as acceptable (in non-industrial environments).

Some air contaminants are commonly encountered and addressed as groups or single components, originating from a source, or have other common characteristics. Outdoor air contaminants vary widely between locations, are regulated uniformly across United States. These can usually be considered as a separate category worthy of common consideration.

Chapter 12 – Odors. Various factors make odor control an important consideration in ventilation engineering: (1) contemporary construction methods resulted in buildings that allow less air for infiltration through the building envelope; (2) indoor sources of odors associated with modern building materials, furnishings, an office equipment have increased; (3) outdoor heirs often polluted; and (4) energy costs encourage lower ventilation rates at a time when requirements for relatively odor-free environments are greater than ever.

Based on some early studies, the philosophy behind ventilation of non-industrial buildings had been mainly to provide indoor air that is acceptable to occupants. Air is evaluated by the olfactory sense, although the general chemical sense, which is sensitive to irritants in the air, also plays a role. This chapter reviews how odoriferous substances are perceived. Chapter 46 of the 2011 ASHRAE Handbook – HVAC Applications covers both methods. Chapter 10 of this volume has more information on indoor environmental health.

HVAC Systems and Equipment Handbook
The *2008 ASHRAE Handbook – HVAC Systems and Equipment* discusses various systems and the equipment (components or assemblies) that comprise them, and describes features and differences. This information helps system designers and operators in selecting and operating equipment.

Chapter 29 – Industrial Gas Cleaning and Air Pollution Control. Industrial gas cleaning performs one or more the following functions:

- Maintains compliance of industrial process with the laws or regulations for air pollution
- Reduces nuisance or physical damage from contaminants to individuals, equipment, products, or adjacent properties
- Prepares clean gases for processes
- Reclaimed usable materials, heat, or energy
- Reduces fire, explosion, or other hazards

Equipment that remove particulate matter from a gas stream may also remove or create some gaseous contaminants; on the other hand, equipment primarily intended for removal of gaseous pollutants might also remove or create objectionable particulate matter to some degree. In all cases, gas cleaning equipment changes the process stream, and it is therefore essential that the engineers evaluate the consequences of those changes to the plan's overall operation.

Many industrial processes produce large quantities of gaseous or vaporous contaminants that must be separated from gas streams. ***Removal of these contaminants is usually achieved through*** absorption into a liquid or ***adsorption onto a solid medium***. Incineration of the exhaust gas has also been successfully used to remove organic gases and vapors. Low vapor pressure odorous materials that condense and form submicron condensation aerosols after being emitted from hot industrial processes can sometimes be successfully controlled by a well-designed condensing filter or condensing precipitate or submicron particulate collection systems.

ASHRAE Standard 62.1-2010 User's Manual
The explanatory material, detailed information, figures, and examples contained within this User's Manual are provided to aid the user in designing, installing, and operating buildings in accordance with ASHRAE Standard 62.1-2010. This Manual does not reproduce the requirements of the standard, but rather paraphrases and explains them.

Intended to be used in conjunction with the standard, this Manual:

- Offers information on the intent and application of Standard 62.1;
- Explains the standard through the use of sample calculations and examples;
- Encourages the user to apply the principles of good indoor air quality and effective ventilation when designing buildings and building systems;
- Provides useful reference material to assist designers in efficiently completing a successful and compliant design;
- Gives guidance to building operation and maintenance personnel.

This Manual also instructs the user in the application of tools used for compliance with Standard 62.1-2010. In particular, three newly revised spreadsheets are distributed with this User's Manual that assist in the Ventilation Rate Procedure calculations.

This User's Manual is intended to be used by:

- Architects and engineers who must apply the standard to the design of their buildings;
- Those manufacturers of systems and components who choose to provide the industry with complying equipment;
- Plan examiners and field inspectors who will be charged with enforcing the standard in areas where it is adopted as code;
- General and specialty contractors who must construct buildings in compliance with the standard; and
- Operators and maintainers who must ensure the compliance of the building throughout its lifespan

Purafil was involved in the development in the first User's Manual published in 2004 and was responsible for writing the sections on outdoor air quality and the Indoor Air Quality Procedure (IAQP). The latter section described in detail how the IAQP could be used with air cleaning and recirculation to lower outdoor air ventilation rates and provide for energy savings and improved indoor air quality.

American Water Works Association

AWWA

The American Water Works Association (AWWA, www.awwa.org) is an international nonprofit educational association dedicated to safe water. Founded in 1881 as a forum for water professionals to share information and learn from each other for the common good, AWWA has evolved into the world's largest organization of water professionals – and the most respected.

AWWA brings together people from the water community with a variety of backgrounds, skills, perspectives, and experience and their 50,000 members represent every segment of the profession. AWWA serves as the authoritative resource for knowledge, information, and advocacy for improving the quality and supply of water in North America and beyond.

The Technical & Educational Council promotes the objectives of AWWA through its divisions, standing committees, task forces, and working committees. It develops and presents the Annual Conference technical program, specialty conferences, teleconferences, workshops, and seminars. This council also is responsible for the development of manuals, handbooks, videos, and other materials and products.

Instrumentation and Control Manual. The mission of the Instrumentation & Control (I&C) Committee is to assemble and disseminate information on automatic and remote operation and on instrumentation of water utility facilities. The I&C Committee is responsible for the development and maintenance of the Instrumentation & Control manual. Currently in its 3rd Edition (http://apps.awwa.org/EbusMain/Default.aspx?TabID=55&ProductId=6696), this operations manual

explains the basic principles of electrical power distribution, automation, and instrumentation in water distribution, treatment, and storage systems.

Purafil is a standing member of this committee and is working with the I&C Committee on the 4th Edition of this manual with responsibility for developing materials for the sections on air contamination and control and RoHS in the chapter on Environmental Concerns. The next edition of the Instrumentation and Control Manual is scheduled for publication in 2012.

NAFA

The National Air Filtration Association (NAFA, www.nafahq.org) is a dynamic, non-profit trade association whose members include air filter and component manufacturers, sales and service companies, and HVAC and indoor air quality professionals across the United States and in several foreign countries. NAFA is comprised of individuals and companies engaged in the sale, service and manufacture of the air filtration products. NAFA actively promotes its members' products and services to building owners, facility managers and other users of HVAC air filtration products. Marketing materials are also available to members for customer education.

NAFA Guide to Air Filtration, 4th Edition (2007). Air filtration is one of the most important considerations involving the design, installation and maintenance of HVAC systems, yet it is one of the least understood concepts in the HVAC industry. Thus, the need for the NAFA Guide to Air Filtration, which is the most informative and comprehensive manual ever published in the air filtration industry. This 200-page, hard back book covers principles of air filtration, applications of all types of air filter products, filter testing methods, indoor air quality, filter owning and operating costs, and more. Over 80 tables, photos and illustrations help to educate the reader on the mechanics and elements of air filtration. The NAFA Guide to Air Filtration is required reading for anyone wishing to become a NAFA Certified Air Filter Specialist, and the certification examination is based on material in the manual. It is also suggested reading for anyone involved in the design, installation or maintenance of HVAC systems (http://store.nafahq.org/merchant2/merchant.mvc?Screen=PROD&Store_Code=NS&Product_Code=NGTAF3E2001&Category_Code=P8).

Purafil wrote the chapter on Gaseous Contaminants and their control, ***and contributed to the chapter on Indoor Air Quality***. This guide is currently being revised and Purafil will again be involved in updating these two chapters as well as others where the application of gas-phase air filtration may be appropriate.

Carrier Corporation

Applications Technical Development Program: TDP 903 – Filtration
Carrier's Technical Development Programs (TDPs) are modules of technical training on HVAC theory, system design, equipment selection and application topics. They are targeted at engineers and designers who wish to develop their knowledge in this field to effectively design, specify, sell or apply HVAC equipment in commercial applications.

When Carrier needed to update their technical document on filtration, ***Purafil was asked to provide information*** on indoor air quality, gaseous contaminants, air cleaning, gas-phase air filtration, Standard 62.1, energy conservation, and ASHRAE Standards 145.1 and 145.2. (http://www.docs.hvacpartners.com/idc/groups/public/documents/marketing/tdp_06-796-063_preview.pdf).

McGraw Hill

Semiconductor Manufacturing Handbook
The goal of this semiconductor Manufacturing handbook is to provide readers with the essential knowledge needed for working in a semiconductor wafer fab: for problem solving, establishing manufacturing processes, and improving existing manufacturing lines and microchips for apps. This handbook embraces both conventional and emerging wafer processing, final manufacturing, yield management, and ancillary facilities used in the semiconductor industry. It also covers fundamentals of nanotechnology,

microelectromechanical systems (MEMS) and flat-panel displays (FPD) that share similar wafer processing technologies and facilities (http://www.mhprofessional.com/product.php?cat=113&isbn=0071445595).

The book is organized in the six major sections that comprise 43 chapters. In general, each chapter includes three components - principles, operational consideration, and references. The principles cover the fundamentals of the technology and its application. Operational considerations include operations, safety, environmental issues, maintenance, and economics. There are useful tips for planning, implementing, and controlling manufacturing processes. The References and Further Reading sections are lists of relevant books, technical papers, and websites for additional reading.

This handbook covers topics ranging from wafer processing, final manufacturing, yield management, wafer fab and cleaner design and construction, contamination control, and facilities management. ***Purafil wrote the chapter on airborne molecular contamination*** (AMC) which included sections on classification of AMC, AMC control considerations, implementing AMC control, gas-phase air filtration principles, dry-scrubbing air filtration media, chemical filtration equipment designs, monitoring, application areas, control specifications and standards, and specifying an AMC control system.

SUMMARY

Although some may find the application, design, use, and operation of gas-phase air filtration daunting tasks, there are many technical resources available that can provide information and guidance that will allow for success. Purafil, Inc. has been and continues to be sought out by many professional and trade organizations to share our expertise and knowledge because we are acknowledged as the industry leader and a primary source for much of this information.

In addition to the technical resources described above, Purafil maintains a comprehensive technical library that includes current and historical information on gas-phase air filtration media, filters, and systems. Contact Purafil directly (1-800-222-6367 or www.purafil.com) or you local representative for copies of information relevant to your application.

Related Links/Information/Events

2011 Air & Waste Management Association's Annual Conference & Exposition, June 21-24, Orlando, Florida, brings together more than 2,000 environmental industry professionals for three days of the best technical program in the industry. 500 presentations, two poster sessions with over 150 posters displayed, over 150 exhibitors and networking events.

- **Purafil presented a paper titled "Waste Electronics, RoHS, and Unintended Consequences" on Tuesday, June 21 at 5:40 pm.** This discussed RoHS compliance issues and the increased potential for corrosion-related problems in industrial environments. Data was also presented from locations showing that corrosive environments exist in locations that would otherwise be considered benign if not for the changes mandated by RoHS legislation.

- **Purafil also had a poster presentation on "Beyond Ozone: Cleaning Outdoor Air for Improved IAQ" on Thursday, June 23 from 2:00 – 3:20 pm.** This poster presented information on ozone in ambient air, effects on human health, current standards and guidelines, and provided examples of how air cleaning is being used to control ozone, improve IAQ and reduce energy costs.

2011 ASHRAE Annual Conference, June 25-29, Montreal PQ Canada - Bienvenue à Montréal, known for bringing a bit of European charm to North America. This is a city that blends cultures, languages and people from all over the world, culminating in a unique and vibrant joie de vivre.

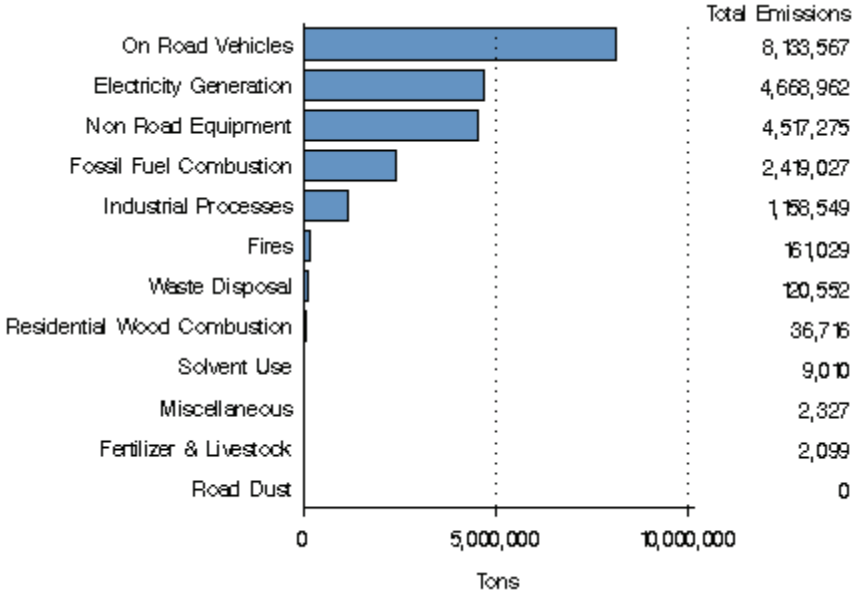
In the same way, the 2011 ASHRAE Annual Conference will bring together members from all over the world to share their knowledge of HVAC&R. Their desire to create a more sustainable and energy efficient building industry surpasses language barriers and knows no borders. Vive la difference!

- **Purafil moderated a seminar on "Mission Critical Data Centers: Keeping Contamination at Bay" as well as presented a paper titled "*Controlling Gaseous and Particulate Contamination in Data Centers*" on Monday, June 27 at 11:00 AM.** The EU directive "on the Restriction of the use of certain Hazardous Substances in electrical and electronic equipment" (RoHS) was implemented in July 2006, and was the first of many similar regulations that have been passed. Research has shown that printed circuit boards made using lead-free materials can be more susceptible to corrosion and it has been reported that many lead-free products will creep corrode in high sulfur environments. Now data centers in many urban locations have reported failures of servers and hard disk drives due to sulfur corrosion. In the corrosion of electronic components, sulfur oxides, active sulfur compounds, oxides of nitrogen, and inorganic chlorides are the primary culprits. Particulates and gaseous contaminants can be drawn in through the building's air handling system(s) causing corrosion of electronics. This presentation will discuss application of gas-phase and particulate filtration for the data center environment. General aspects of data center design and air filtration technology were presented with descriptions of various filters and systems and where these may be employed within the data center environment to provide for enhanced air cleaning.

- **Purafil also moderated a forum on "*Moving Closer to Net Zero Buildings with the IAQ Procedure of Standard 62.1-2010*" on Tuesday, June 28 at 9:45 AM.** This forum presented and discussed the current status of the Indoor Air Quality Procedure of Standard 62.1-2010 - specifically as related to its potential for significant energy savings when used to determine outside air ventilation rates for HVAC systems. This forum solicited input as to what can be done to validate the IAQ Procedure and make it more useful to the engineering community when designing "net zero" energy buildings.

Contaminant of the Month

Nitrogen Dioxide (NO_2, molecular weight 46.05) belongs to a family of highly reactive gases collectively called nitrogen oxides (NOx). These gases form when fuel is burned at high temperatures, and come principally from motor vehicle exhaust and stationary sources such as electric utilities and industrial boilers (see figure below).



U.S. Nitrogen Oxides Emissions by Source

A suffocating, brownish gas, nitrogen dioxide is a strong oxidizing agent that reacts in the air to form toxic organic nitrates. Nitrogen oxides are the substances that react in sunlight to start off the very complicated series of reactions that produce photochemical smog (Los Angeles type smog). In cool damp conditions, it can alternatively react with water droplets to produce nitric acid, and acid rain.

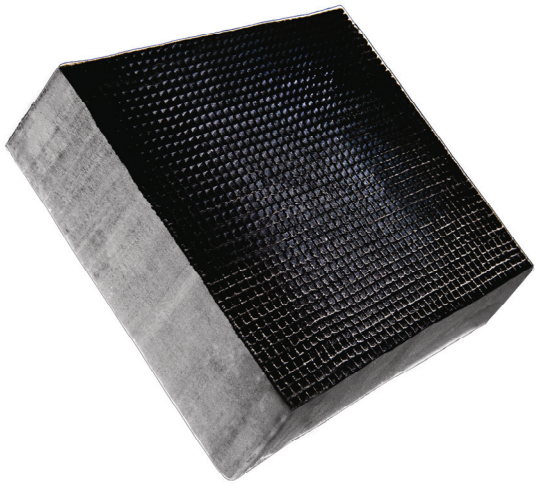
Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infections such as influenza. The effects of short-term exposure are still unclear, but continued or frequent exposure to concentrations that are typically much higher than those normally found in the ambient air may cause increased incidence of acute respiratory illness in children. The U.S. EPA's health-based national air quality standard for NO_2 is 0.053 ppm (measured as an annual average). The presence of this gas is a significant driver of the production of low-level ozone, which is itself a harmful toxic pollutant, and a major ingredient of photochemical smog. NOx in the air is a potentially significant contributor to a number of environmental effects such as acid rain and eutrophication in coastal waters.

Nitrogen dioxide is believed to have a catalytic effect on corrosion of base metals by chlorides and sulfides. NO_2 dissolves in water eventually forming nitric acid, an acid as strong as sulfuric, and on top of that is a strong oxidizing agent. All the same problems encountered with sulfuric acid will be seen with nitrogen dioxide, particularly the corrosion of metals.

The control of nitrogen dioxide and other nitrogen oxides can be achieved using Purafil's dry-scrubbing media products including Puracarb® and Purafil® SP. Visit the Purafil website for more information on the control of nitrogen dioxide and many other corrosive gaseous contaminants.

Purafil Solutions – GridBLOK™ and PuraGRID™ Filter

The GridBLOK is composed of essentially 100% adsorbent materials that allows the entire composite structure to function as a gas filter. Because of the large number of channels, the contact area between the adsorbent layer and the contaminated airstream is very large. Further, the channels are straight and parallel so that the flow is not obstructed and the pressure drop across the filter is extremely low. The size of the cells leads to turbulent flow and forces contaminated air into and through the gas-permeable cell walls of the structure. It also provides the residence time necessary to assure optimum contact efficiency and the associated high initial and average removal efficiencies. As the air is forced through the block, removal of chemical contaminants takes place.



GridBLOK extruded carbon composite structure.

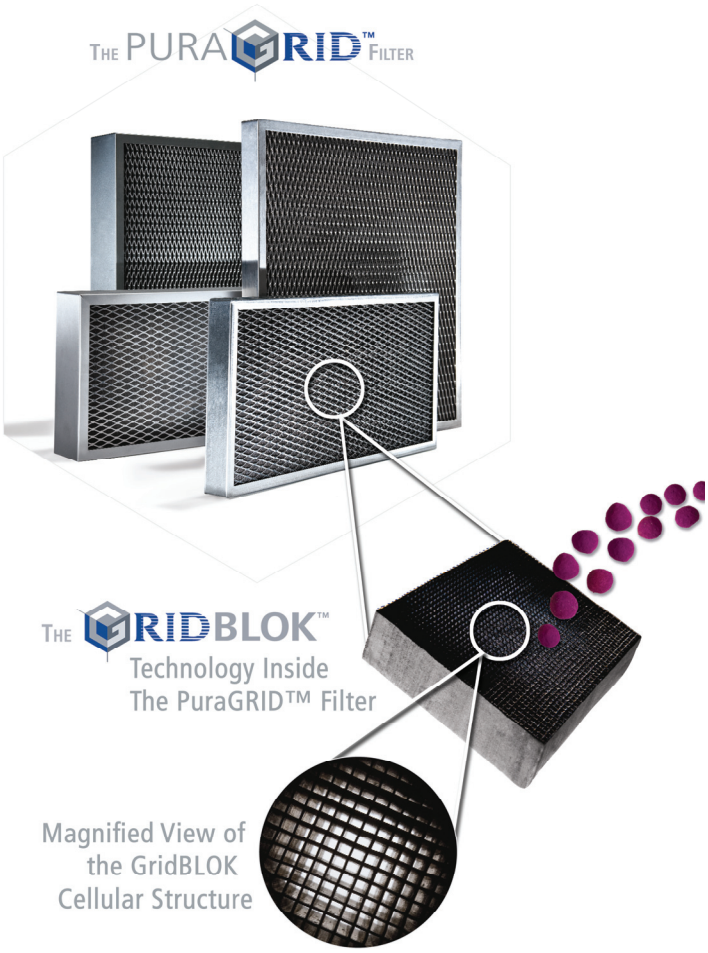
It is desirable to obtain high gas removal efficiencies from small bed volumes. Due to the high rate of contaminant diffusion to the interior of the cell wall and empty adsorption sites being continuously available for adsorption, the GridBLOK provides better adsorption efficiencies and capacities than prior attempts with monolithic structures. This has resulted in a product with the highest adsorbent content on the market today and is the only monolithic filter element that does not rely solely on activated carbon for contaminant removal.

The new GridBLOK delivery system has exhibited the potential to provide better economics and performance than 1", 2", and 12" commercial pleated-type chemical filters and comparable economics and performance to 12" heavy duty pleated-type chemical filters and 1" deep granular media systems. Comparison test data is shown in below.

Gas Challenge Test Results for Hydrogen Sulfide (H_2S).

Sample	Volume	Weight	Density, g/cc		H_2S Removed	H_2S Capacity, g/cc	ΔP
1" Media Bed	62.5 cc	42.1 g	0.6736	42.05	8.259 g	0.1305	187.5 Pa
GridBLOK	82.5 cc	36.4 g	0.4412	27.54	7.200 g	0.0873	75.0 Pa

Green Technology



The GridBLOK is manufactured using a proprietary process that produces no waste, as raw materials can be recycled through the process. The PuraGRID filters use recycled aluminum and steel in the frames and screens and the compressible partition is made with from recycled materials with a minimum 75% post-consumer content. All of the PuraGRID components can be recycled with the exception of the GridBLOKs. However, these may be used as a fuel additive due to a high BTU value in solid fuel boilers or incinerators to help reduce operating costs.

The PuraGRID filters have a significantly lower pressure drop than traditional 1" granular media systems which means lower data center HVAC operating costs. Further, by using the PuraGRID as part of our Enersave program, further reductions in HVAC operating costs can be realized. All this leads to less energy being used to heat and cool the air coming into and being recirculated through the data center. Finally, by using recycled / recyclable and post consumer content materials in the PuraGRID filter, less energy is used in the manufacturing of this product which also reduces the total carbon footprint of the data center.

Companion Paper

Beyond Ozone: Cleaning Outdoor Air for Improved IAQ