



## Hydrogen Fuel Cell Solutions

# Supporting the Drive to Zero Emissions





## FUEL CELL AIR INTAKE FILTRATION

### The Challenge

Fuel cells have very specialized needs for clean air. Both particulate and chemical contaminants can significantly degrade fuel cell performance and lifespan, making it critically important that contaminants are removed from the air they use.

### Donaldson Solutions

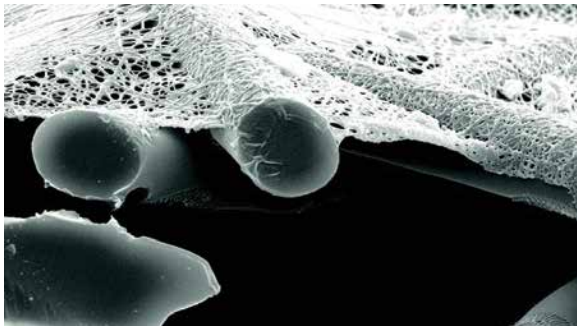
In addition to filtering dust and other particulate contaminants from the airflow (similar to the requirements for internal combustion engines), the use of a carbon layer for chemical contamination capture allows the fuel cell to operate effectively.

Donaldson offers tailored solutions that incorporate high-efficiency media and carbon layers to effectively address the sources of fuel cell contamination.



#### Particulate Filtration

Donaldson draws on a range of proprietary filtration media, including our proven Ultra-Web® technology, to engineer the best solution for your application, delivering clean air and long filter life to support your return on investment.



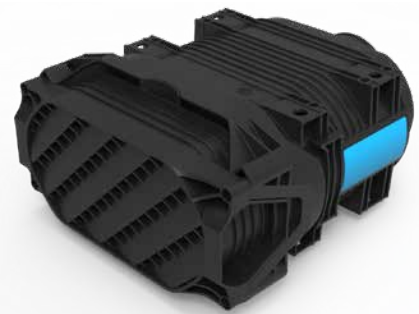
Air intake filters eventually reach capacity and need to be replaced. Replacement interval will vary depending upon environmental conditions and use. Work with your fuel cell supplier to determine appropriate replacement interval.

#### Chemical Filtration

Donaldson tailored media options include effective filtration for:

- Sulfur Dioxide (SO<sub>2</sub>)
- Toluene (C<sub>6</sub>H<sub>5</sub>CH<sub>3</sub>) – representative of VOC
- Butane (C<sub>4</sub>H<sub>10</sub>) – representative of VOC
- Siloxane species

For ion removal or filtration of additional chemical contaminants, including Ammonia (NH<sub>3</sub>), Hydrogen Sulfide (H<sub>2</sub>S), Oxides of Nitrogen (NO<sub>x</sub>), contact Donaldson directly.



## THE DONALDSON ADVANTAGE

As a global leader in innovative engine filtration solutions, Donaldson has more than 105 years of filtration expertise and more than 20 years' experience developing and producing air cleaners and filters that specifically offer this dual level of protection for fuel cells.

We can incorporate these systems into our proven single-stage or multi-stage air cleaners, or they can be integrated into proprietary OEM- or Tier 1/Tier 2-supplier designed systems, customized to meet your precise specifications.



## PROTON EXCHANGE MEMBRANES

### The Challenge

In order to reduce the overall cost of fuel cells, OEMs are requiring smaller fuel cell stack sizes; the smaller the stack, the lower the cost of the cell and its related batteries and cooling systems.

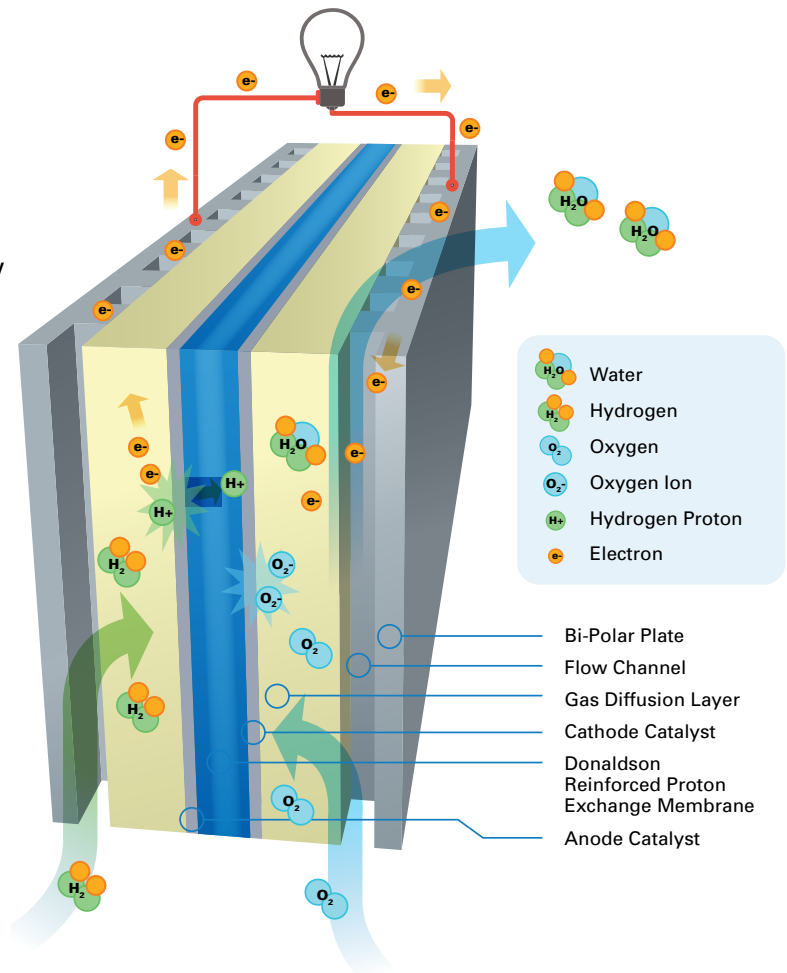
Proton Exchange Membranes within fuel cells allow only positive ions to pass from anodes to cathodes, generating electrical power in the process. While durability depends in part on the thickness of these membranes, smaller, thinner membranes are required to reduce fuel cell weight and cost.

Expanded polytetrafluoroethylene (ePTFE) membranes are used as a structural reinforcement within the Proton Exchange Membrane and need to balance mechanical durability with current density. In this way or as a result the power and efficiency of the fuel cell are optimized. Generally, thinner membranes result in higher current densities (e.g., more power), but can sacrifice mechanical durability.

### Donaldson Solutions

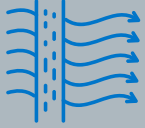
By offering multiple ePTFE options to meet a range of specifications and applications, Donaldson provides OEMs and Tier 1/Tier 2 suppliers with:

- Thin membranes that support requirements for high current density while maintaining mechanical durability of stack
- Reduced stack size and weight
- Outstanding mechanical durability and high strength for long service life
- Consistent, reliable performance
- Flexibility to specify the ePTFE membrane independent of the coating, allowing OEMs to choose the optimal membrane/coating solution, rather than a pre-set (unoptimized) solution



## THE DONALDSON ADVANTAGE

Donaldson's extensive portfolio of membranes has evolved over decades of research and development, continuing to meet strict industry performance requirements, while supporting OEM appeals for reduced stack size.



## FUEL CELL AND BATTERY VENTS

### The Challenge

Fuel cell enclosures need to vent. This provides continuous pressure equalization and adequate ventilation while preventing ingress of water and contaminants.

### Donaldson Solutions

#### Fuel Cell Vents

While fuel cell enclosures need to be sealed, the cell stacks also need to vent in order to equalize internal and ambient pressure. Donaldson expertise in ePTFE membrane and enclosure venting technologies provide solutions for helping equalize pressure within the stack, while helping keep water and other environmental contaminants out.

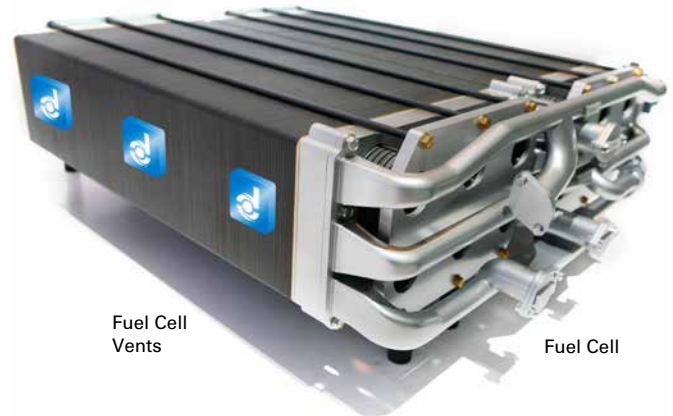
Donaldson's proprietary Tetratex® ePTFE membrane combines durability and breathability in a single package. This ePTFE membrane can also be integrated directly into the housing to create vent assemblies that meet specific application requirements.

#### Dual-Stage Battery Vents

With the growth of electric, hybrid and hydrogen fuel cell powered vehicles, lithium-ion batteries play an increasingly critical role in the automotive and heavy-duty equipment worlds. With fuel cell powered equipment, lithium-ion batteries are used to capture and store the electrical energy generated and deliver that power to drive systems.

Donaldson's line of dual-stage battery vents are proven effective in meeting the critical needs of automotive/heavy-duty battery packs. The first stage equalizes pressure while preventing the ingress of water and contaminants. In the case of rapid pressure and heat buildup, the second stage helps maintain internal enclosure pressures by allowing gases to escape by either bypassing the membrane with the umbrella flex or bursting the membrane. This helps prevent deformation to the battery pack enclosure.

We offer a series of standard vents for a wide range of applications.



Dual-Stage Burst Battery Vent



Dual-Stage Flex Battery Vent

## THE DONALDSON ADVANTAGE

Donaldson has decades of experience developing effective, efficient filtration and venting media for a variety of OEMs and Tier 1/Tier 2 suppliers.

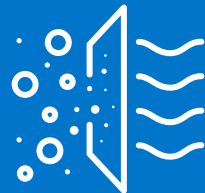
Our proven solutions for cathode intake air filtration, ePTFE membranes, and battery and fuel cell venting are backed by world-class proprietary technology and years of engineering expertise.

Hydrogen fuel cells represent a powerful resource as the world moves to reduce its reliance on carbon-based energy sources.

Donaldson's Hydrogen Fuel Cell Solutions support ongoing advancements in fuel cell technology by promoting effective ion transfer, while simultaneously helping protect highly sensitive fuel cell and system components from a range of real-world contaminants.

### **EXPERIENCE. EXPERTISE. PERFORMANCE.**

For more than 20 years, Donaldson engineers and advanced materials experts have worked collaboratively with leading OEMs and Tier 1/Tier 2 suppliers to develop customized solutions that meet specific fuel-cell application requirements in three critical areas:



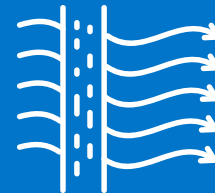
#### **Fuel Cell Air Intake Filtration**

Donaldson's innovative filtration technologies promote system longevity by protecting fuel cell components from harsh contaminants including dust, water and chemicals.



#### **Proton Exchange Membranes**

Donaldson proton exchange membranes provide optimal structural support to promote efficient ion transfer within fuel cell electrode assemblies.



#### **Fuel Cell and Battery Vents**

Advanced venting and media technologies from Donaldson support a wide range of applications including fuel cell enclosures and associated EV battery systems.



For more information about Donaldson's Hydrogen Fuel Cell Solutions, or to speak with a specialist regarding a custom solution for your application, visit [donaldson.com/hydrogen-fuel-cell](https://donaldson.com/hydrogen-fuel-cell) or contact us at [hydrogenfuelcell@Donaldson.com](mailto:hydrogenfuelcell@Donaldson.com).

**Important Notice**

Many factors beyond the control of Donaldson can affect the use and performance of Donaldson products in a particular application, including the conditions under which the product is used. Since these factors are uniquely within the user's knowledge and control, it is essential the user evaluate the products to determine whether the product is fit for the particular purpose and suitable for the user's application. All products, product specifications, availability and data are subject to change without notice, and may vary by region or country.



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