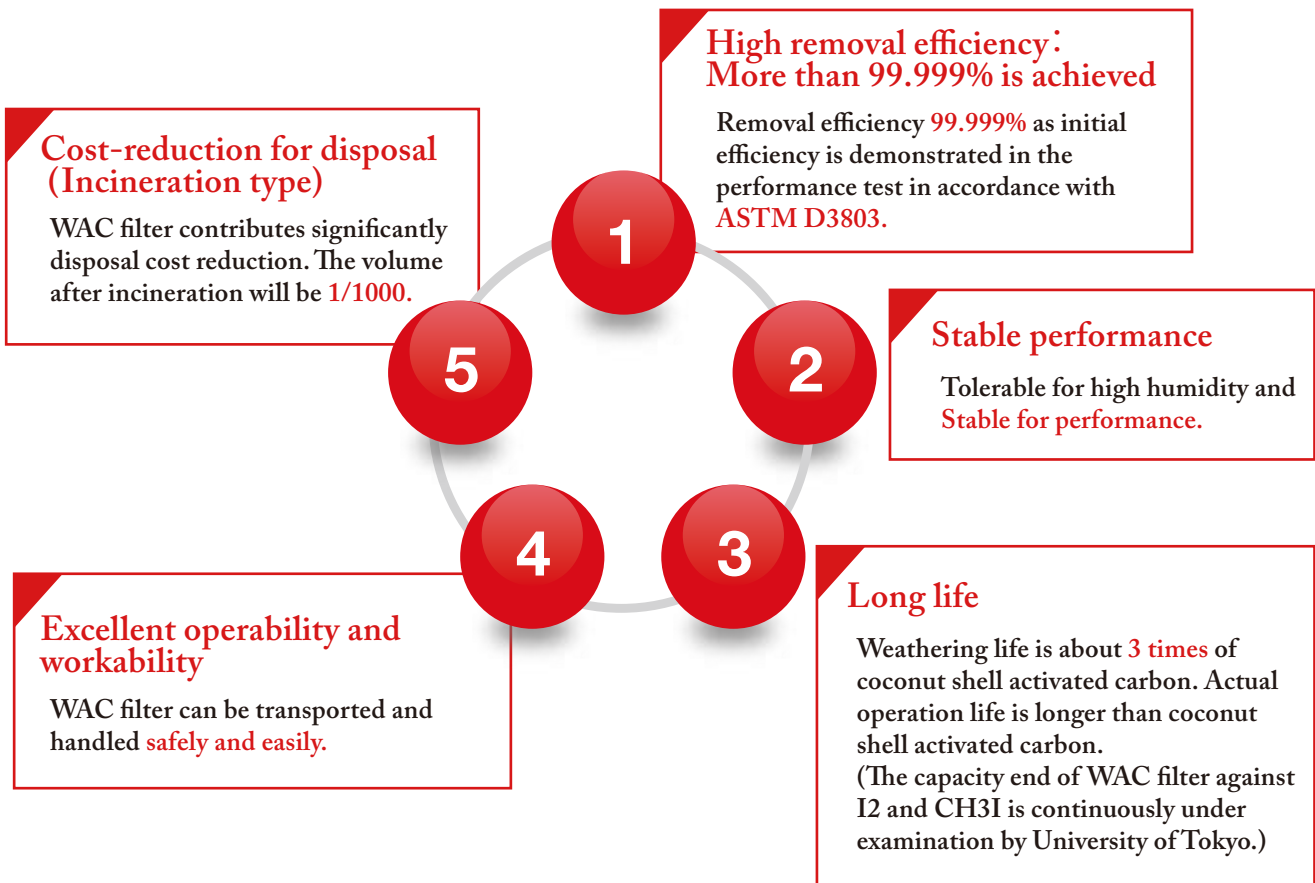


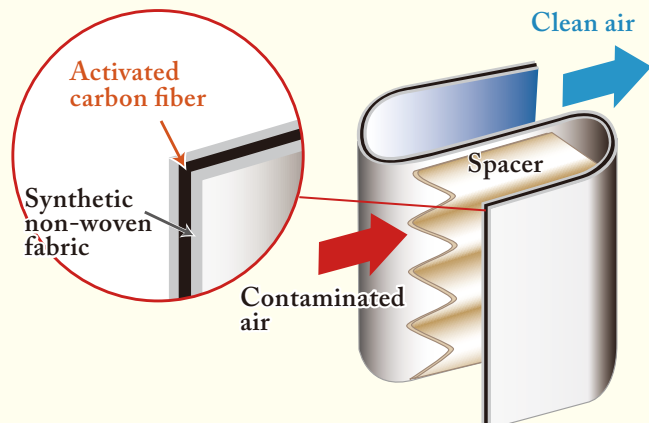
WAC Filter

[Main excellences of activated carbon fiber by comparison with a conventional granular activated carbon (coconut shell)]



Wakaida Engineering Inc. has developed collaboratively the activated carbon fiber filter, which can remove 99.999% for radioactive iodine, by academic-industrial alliance of Tokyo university and Toyobo Inc. We call it WAC Filter as product name.

The WAC filter is a product that has been worked on the theme of developing a “lightweight, easy-to-use, moisture resistance and high-removal efficiency” filter for radioactive iodine removal, and has been achieved its purpose over the past ten years. The filter medium is a black fiber at the center of the above figure, which is the carbonized and activated felt-like chemical fiber. WAC filters have excellent performance in all respects comparing to conventional granular activated carbon filter.



Patent No.: 4549388

WAC Series



The weight of WAC Filter is one-fifth of granular activated carbon filter used in the past, and the removal efficiency for radioactive iodine is 99.999 %. It is used at RI handling facilities throughout the country.

The filter that a removal efficiency for CH_3I achieved 99.999%

Responses to various requests from customers



■ Incineration type of WAC Filter

Model number: WAC-292
Size: 610 x 610 x 292 (mm)
Volume: 108.7 L
Weight: 13.0 kg
Iodine removal efficiency: 99.999% or more
Volume after incineration: 1/1000 or less

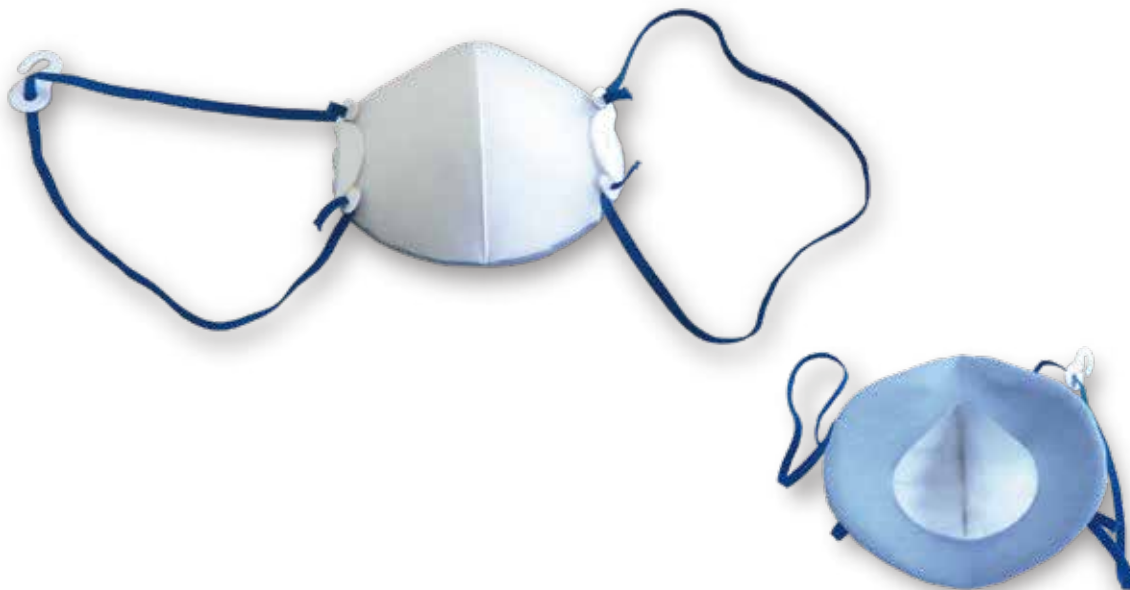


■ Tray type of WAC Filter

Model number: WAC-702
Size: 620 x 163 x 702 (mm)
Volume: 69 L
Weight: 9.5 kg
Iodine removal efficiency: 99.999% or more
Volume after incineration: 1/300 or less

※ Sizes and specifications can be manufactured according to facilities other than the above products.

WAC Mask



WAC mask is a high-performance and simple mask that removes radioactive iodine, PM2.5, and dust. WAC mask should be worn to avoid inhalation of radioactive iodine gas and other radioactive substances when evacuating in the event of a nuclear disaster.

▶ Mask with built-in WAC filter for nuclear disaster prevention

Built-in WAC filter



■ WAC Mask

Model number: W3000

Size: 170 x 90 (mm)

Material: polypropylene non-woven fabric, WAC filter, polyester rubber (Ear hook part)

Removed substance: I-131, Cs-137, Sr-90, PM2.5, etc.

WAC Sampling filter



■ WAC Sampling filter

This filter is an iodine gas sampling filter that uses activated carbon fiber as the filter medium. No carbon dust is generated from the filter media because it is activated-carbonized after knitting of chemical fiber.

This filter is flexible enough to be rolled up and inserted into a test tube. Therefore, we can easily measure radio activity with a well type gamma counter. Since self-absorption rate of itself is less than AC filter, the measurement accuracy is relatively high.



For environmental radioactivity measurement (Filter sampling a radioactive iodine gas in air)

The filter does not easily deteriorate because it is packed one by one.



C248TA, C260TA, C348TA, C360TA are generally used with low flow rate samplers (about 30-60 ℓ/min), and C2110TA, C3110TA are used with high flow rate samplers (700 ℓ/min). C560TA becomes as same shape as cartridge filter of conventional granular activated carbon by using a spacer (sold separately).

Each is individually wrapped to prevent weathering deterioration. And it can be disposed as combustible material of radioactive waste.

It is possible to manufacture various filter size and specifications according to customer's request.

C348TA, C360TA, C3110TA, C548TA, C560TA, C5110TA correspond to "woven fabric type" of classification with Annex A (filter material for iodine collection) of JIS Z 4336 (radioactive iodine sampler).

Lineup of WAC Sampling filter (Impregnated TEDA: 10%)

| Size | Activated Carbon fiber in Knit | | |
|--------------------|--------------------------------|----------|----------|
| | 2 layers | 3 layers | 5 layers |
| 48mmφ | C248TA | C348TA | C548TA |
| 60mmφ | C260TA | C360TA | C560TA |
| 110mmφ | C2110TA | C3110TA | C5110TA |
| Removal efficiency | 44% | 65% | 76% |

※In accordance with the method defined in JIS Z 4336 (radioactive iodine sampler)-Annex A (filter material for iodine collection).

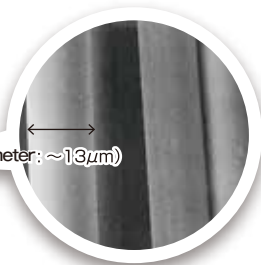
WAC Filter Technical information

Comparison between WAC Filter (activated carbon fiber) and conventional granular activated carbon

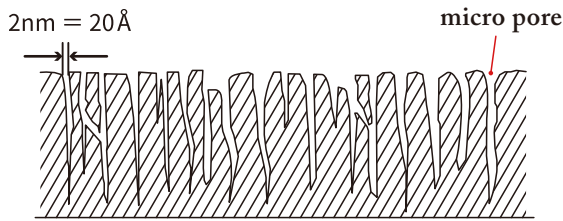
■ Activated carbon fiber



Activated carbon fiber (10~20μmφ)



Microscope picture 1200 times

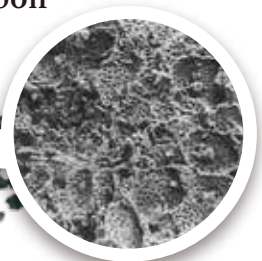


The surface is extremely smooth and homogeneous, even at 1200 times magnification. There are no macropores or transitional pores, and only micropores effective for the adsorption of radioactive iodine.

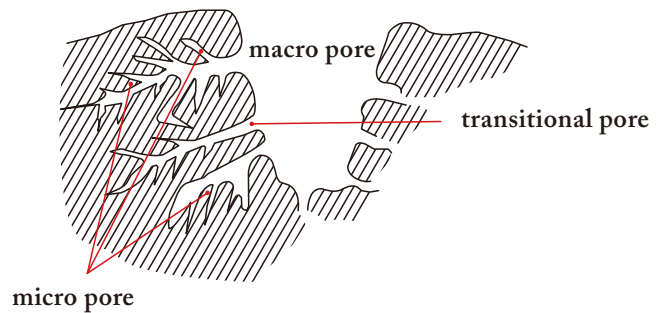
■ Granular activated carbon (coconut shell)



Granular activated carbon (4~6mmφ)



Microscope picture 100 times



There are pores of various sizes, and micropores are inside the macropores. Many macropores that take easily in water can be seen on the surface

Macro pore

50 to 100,000 nm in diameter, 2,500 nm on average

Transitional pore

2 to 50 nm in diameter

Micro pore

About 2 nm in diameter

3 points for removal capability of WAC filter

The WAC filter developed by our company has much higher removal capability for methyl iodine than granular activated carbon filter.

1 Large adsorption surface

All pores of activated carbon fiber contribute to adsorption, and the surface area is said to be 1000 to 2000 m² / g. The number of micropores is more than 200 times that of granular activated carbon.

2 Large ventilation area

Because the filter media of WAC filter is thin and elastic, a filter with a large filtering area (filter media area) can be made. Because the filter passing speed of adsorptive material becomes slower, the chance of adsorption reaction increases and can be expected to increase removal efficiency.

3 High removal efficiency

As a result of the removal efficiency test of the WAC filter, the removal efficiency for methyl iodide has been proved to be 99.999% or more, and the efficiency is completely cleared for the value required for the nuclear field.

Results of removal efficiency examination for WAC Filter

There is no performance test standard for activated carbon for removing radioactive substances in Japan. Therefore, we conducted a performance test of the WAC filter with ASTM D-3803, the US "standard test method for nuclear-grade activated carbon," which is the practical world standard (but only for initial efficiency).



Test result by U.S.A NUCON in accordance with ASTM D3803.

Test condition

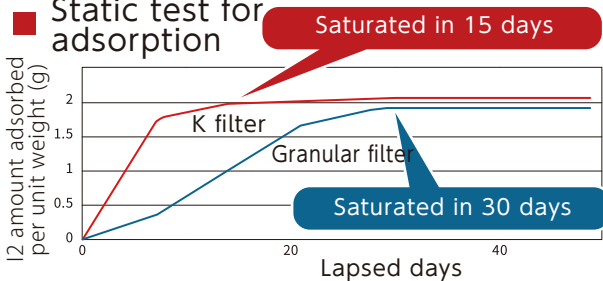
| | |
|---------------------------------|--|
| Pre-equilibration Time | 960min (16hour) |
| Equilibration Time | 120min |
| Challenge Time | 60min |
| Elution Time | 60min |
| Challenge Agent | CH ₃ ¹³¹ I (Radioactive) |
| CH ₃ I Concentration | 1.75mg/m ³ |
| Challenge Temperature | 36°C |
| Relative Humidity | 95% |

Removal efficiency requirements for **more than 97%** application to the nuclear industry

Test result

| | |
|-------------------------------|------------------------|
| Surface velocity | 8cm/sec |
| Thickness (laminate number) | 1.05cm(3layers) |
| ASTM D3803 removal efficiency | More than 99.9999% |
| Penetration rate | <math>< 0.001\%</math> |

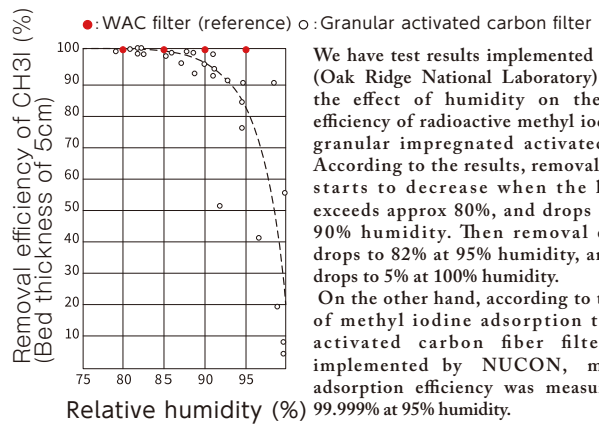
Static test for adsorption



<Test method> Activated carbon fiber and granular activated carbon were set in the desiccator filled with Methyl iodine.

<Test result> Adsorption speed of activated carbon fiber was very high, more than 3 times higher than granular activated carbon at initial stage. Iodine amount adsorbed was equal to 83TBq/cm² for activated carbon fiber.

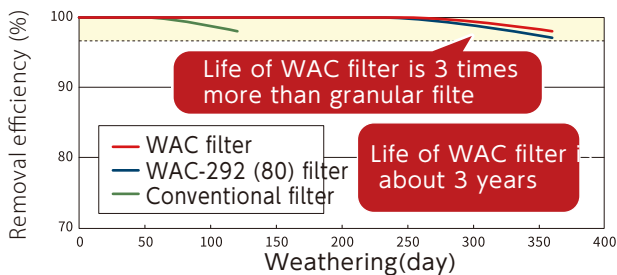
Effect by relative humidity



We have test results implemented by ORNL (Oak Ridge National Laboratory) regarding the effect of humidity on the removal efficiency of radioactive methyl iodine using granular impregnated activated carbon. According to the results, removal efficiency starts to decrease when the humidity exceeds approx 80%, and drops to 95% at 90% humidity. Then removal efficiency drops to 82% at 95% humidity, and rapidly drops to 5% at 100% humidity.

On the other hand, according to the results of methyl iodine adsorption test using activated carbon fiber filter (WAC) implemented by NUCON, marvellous adsorption efficiency was measured to be 99.999% at 95% humidity.

Weathering Test



Activated carbon fiber: Felt type, Type-K
Surface velocity: 8cm/sec, humidity: 60%,
Impregnant: TEDA (triethylenediamine)

<Test method> TOYOBO research institute tested under 25°C and 60% humidity. University of Tokyo isotope center tested under room temp and more than 90% humidity

<Test result>

| Kind of Filter | Test area | Temperature | humidity | Result |
|-------------------------|--|--------------------|---------------|--|
| Activated carbon filter | Japan Atomic Energy Research Institute | 15-25°C | 40-80% | Granular activated carbon filter (50mm thickness layer) is deteriorated to 98% in 4 months |
| WAC filter | Toyobo Research Institute | 25°C | 60% | Activated carbon fiber (WAC) filter kept more than 98% of performance for 12 months. |
| | Isotope Center of University of Tokyo | Normal temperature | more than 90% | |