Ceramic Fiber Filter
Clean Air Technology Ltd (FLKCAT) is an innovative manufacturer of ceramic fiber filter for monitoring and controlling air pollution (dust removal, acid gas removal, catalyst filter for NOx and dioxin removal etc.).

Based in Taiwan, FLKCAT is a wholly privately owned enterprise, employing the experienced ceramic filtration specialists who have been active in the business for many years.

FLKCAT manufacture two product lines: PureTek (Bi-Functional ceramic filter) and PureMax (Multi-Functional ceramic catalyst filter).
Product Introduction
Ceramic Fiber Filter

- **Replace Traditional Filter Bag**: Compatible with standard bag filter design concepts.
- **High Temperature & Corrosion Resistance**: Better performance than traditional filter bag.
- **Long Lifetime**: Longer lifetime than Traditional filter bag.
- **Thermal Recovery**: After removal of dust & acid, the clean exhaust can improve the value of thermal recovery
<table>
<thead>
<tr>
<th>File No.</th>
<th>Approval Date</th>
<th>Description</th>
<th>Status</th>
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<tbody>
<tr>
<td>M531544</td>
<td>2016/09/01</td>
<td>Strengthen the Ceramic Fiber Filter</td>
<td>Approval</td>
</tr>
<tr>
<td>M529558</td>
<td>2016/07/28</td>
<td>High Temperature Waste Gas Treatment Equipment</td>
<td>Approval</td>
</tr>
<tr>
<td>M530924</td>
<td>2016/08/30</td>
<td>Sludge Incineration and Air Pollution Control Equipment</td>
<td>Approval</td>
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<tr>
<td>M534301</td>
<td>2016/10/19</td>
<td>Ceramic Filter with Removal of Dioxin Function</td>
<td>Approval</td>
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<tr>
<td>M535785</td>
<td>2016/12/02</td>
<td>Waste Incineration with Removal of Dioxin Function</td>
<td>Approval</td>
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<tr>
<td>PK14453</td>
<td>2017/02/14</td>
<td>Strengthen the Ceramic Fiber Filter</td>
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<tr>
<td>PK14626</td>
<td>2017/03/10</td>
<td>Filter for Metallurgical Converter</td>
<td>Approval</td>
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<tr>
<td>M539026</td>
<td>2017/01/25</td>
<td>Filterable Suspended Aerosols &amp; Gas like Pollutants</td>
<td>Approval</td>
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<tr>
<td>PK14733</td>
<td>2017/02/23</td>
<td>Waste Gas Treatment Equipment for Thermal Power Generation</td>
<td>Approval</td>
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<tr>
<td>PK14732</td>
<td>2017/02/13</td>
<td>Waste Gas Treatment Equipment for Glass Industry</td>
<td>Approval</td>
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<tr>
<td>PK14734</td>
<td>2017/03/17</td>
<td>Waste Gas Treatment for Cement &amp; Brick Kiln</td>
<td>Approval</td>
</tr>
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</table>
1. The ceramic fiber filters are directly installed on the plate of dust collector and can be operated under high temperature. The solid structure provides high filtration efficiency and stability under long-run use.

2. Assist to DeSOx: Use dry & semi-dry FGD and variety of Alkali sorbent, such as Sodium Hydroxide (NaOH) or Calcium Hydroxide (Ca(OH)2) to remove acid gas (SO2, HCl, HF...). Ceramic filter can be regarded as a DeSOx reactor. The surface of filter is full of Lime cake to increase the reaction efficiency.

3. Normal operating Temp.: 250-375°C
Max operating Temp.: 600°C
Peak Temp.: Below 900°C
(The correct design and auxiliary equipment are necessary for high temperature operation.)
### Specification

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Dimension</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Element outer diameter</td>
<td>150 mm</td>
<td>Maximum 152 mm</td>
</tr>
<tr>
<td>B</td>
<td>Element inner diameter</td>
<td>110 mm</td>
<td>Minimum 104 mm</td>
</tr>
<tr>
<td>C</td>
<td>Flange outer diameter</td>
<td>195 mm</td>
<td>Maximum 196 mm \ Minimum 190 mm</td>
</tr>
<tr>
<td>D</td>
<td>Flange height/thickness</td>
<td>30 mm</td>
<td>± 2 mm</td>
</tr>
<tr>
<td>E</td>
<td>Element length</td>
<td>3000 mm</td>
<td>Minimum 2950 mm</td>
</tr>
<tr>
<td>F</td>
<td>Puretek weight</td>
<td>11.5 kg</td>
<td>± 1.0 kg</td>
</tr>
<tr>
<td></td>
<td>Puremax (with Catalyst) weight</td>
<td>12.5 kg</td>
<td>+1.0 kg / -1.5 kg</td>
</tr>
<tr>
<td>G</td>
<td>Element filtration area</td>
<td>1.4 m²</td>
<td>n/a</td>
</tr>
</tbody>
</table>
Material properties

- High porosity
  - Low density of 0.4 g / cm³
  - Heat & shock resistance
    (Not impact of thermal expansion and contraction)
- High removal efficiency comes from very fine ceramic fiber (about 2-3 microns in diameter)
- Chemically almost inert
- High temperature resistance
- Rigid Structure

- One-piece Construction
  - Self-supporting / No need of frame
  - Cylinder
  - The basic material consists of aluminum silicate fiber and inorganic adhesive
Operating Drop Pressure & Filtration Efficiency

**Operating Drop Pressure Control**

- In room temperature, the drop pressure value of new ceramic filter element will be approx. 500Pa at filtration velocity 1.2m/min.
- Between temp. 300-350℃, the drop pressure of cleaning target will be approx. 2000Pa at filtration velocity 1.2m/min.
- The drop pressure in use depends on cleaning parameters, gas composition, gas temperature and filtration property of the particle.
- As for the efficiency of particulate filtration, the typical emission condition is lower than the standard working condition 5mg/Nm³, usually less than 2mg/Nm³.
Puremax – With catalyst

Removal of:
Particulate/Acid Gas/Nitrogen Oxides/ Dioxin

1. Not only dust, but also the acid gas (SO₂, HCl, HF...) can be removed by injection of alkali sorbent, Ammonia / urea added to gas stream to remove nitrogen oxides (Nox).

2. Catalyst distributed throughout filter element structure to accelerate removal of nitrogen oxides reaction.


\[4\text{NO} + 4\text{NH}_3 (\text{Ammonia}) + \text{O}_2 \rightarrow 4\text{N}_2 + 6\text{H}_2\text{O}\]

\[4\text{NO} + 2(\text{NH}_2)_2\text{CO (Urea)} + \text{O}_2 \rightarrow 4\text{N}_2 + 4\text{H}_2\text{O} + 2\text{CO}_2\]
The distribution of catalyst on the ceramic fiber filter

- Catalyst distributed evenly throughout element wall and the contact area is wide, so the reaction time and removal efficiency are maximized.
- The left image is the nano-catalyst particles, increasing the active surface area and reaction efficiency.
Avoid Catalyst Failure / Dry DeSOx

- Due to the formation of dust cake on the surface of the filter element, catalyst is protected against the poisons such as arsenic (As), selenium (Se) and mercury (Hg).
- Catalyst distributed throughout filter element avoid dust clogging.
- As the catalyst distributed throughout ceramic filter element, the lifetime of catalyst can be longer. The residence time will be long and maintain high efficiency of performance.
- The even distribution of catalyst helps to improve the efficiency of reaction.
- In order to reduce ABS, the Pre-spray can use dry DeSOx.

Dust Clogging
The total temperature of PCDD/F Toxicity equivalent concentration (I-TEQ Nm^{-3}) and its removal efficiency graph.

Note: TEQ (Toxic Equivalents Quantity): Toxic Equivalent Quantity is used to calculate the total toxicities of dioxin compounds in media such as soil, air, water, organisms and food. The sum of the concentrations of the dioxins homologues multiplied by the sum of the toxicity equivalents represents the total toxic equivalent of 2,3,7,8-TeCDD. I-TEQ: including 7 kinds of dioxin and 10 kinds of furan, used for environmental pollution equivalent calculation.
Catalyst-Removal of Dioxin

Catalyst are not only used to remove NOx, but also can remove the dioxin. Under the reaction of vanadium-based catalyst, the reaction of dioxin and oxygen will be decomposed into $\text{CO}_2$, $\text{H}_2\text{O}$, $\text{HCl}$ and other non-toxic substances.

The formula of removal of dioxin's reaction:

$$\text{C}_{12}\text{H}_n\text{Cl}_{8-n}\text{O}_2 + (9 + 0.5n)\text{O}_2 \to (n-4)\text{H}_2\text{O} + 12\text{CO}_2 + (8-n)\text{HCl}$$

The disadvantage of activated carbon are as follows,

① Activated carbon requires expensive spray device. The removal efficiency is affected by fluctuation of feeding work.
② Activated carbon will absorb dioxin and just transfer to the fly ash. The total emission of dioxin do not decrease.
③ The adsorption efficiency and specific surface area of activated carbon are closely related to the degree of mixing flue gas. It's difficult to control the process and stability.
④ Fly ash contain dioxin and need to be sent to the waste plant for secondary treatment.
⑤ It's possible that the existing carbon will cause spontaneous combustion inside the dust collector.
⑥ Basically dioxin are just absorbed by activated carbon and they are unable to decompose, so the workers are in dangerous working environment.
Pollutant Removal Efficiency

Performance of Catalyst Ceramic Filter

Pollutants to treat in one stage:
- Particulates
- HCl
- SOx
- NOx
- Dioxins

- Less than 2 mg/Nm³ outlet particulates
- Up to 97% HCl removal
- Up to 95% SOx removal
- Up to 95% NOx removal

Multi-Pollutant Control
System Design and Engineering
Traditional System (SCR/EP/Wet-Scrubber)

(1) A lot of ash is produced
(2) ABS blockage and blinding
(3) Slip-NH₃ increased
(4) Catalyst life is shortened
(5) DeNOₓ efficiency is reduced

(1) Not easy to maintain
(2) Open Channel
(3) High energy consumption
(4) Easy to corrode

(1) Wastewater treatment & sludge (CaSO₄ · 2H₂O)
(2) Corrode (tower, equipment, pipe)
(3) Energy consumption (water, heat, electric power (mixer, pump, fan etc.))
Ammonium sulfates are formed when the NH₃ content of the flue gas exceeds that of the sulfur (SO₃).

(1) Wastewater treatment & sludge (CaSO₄ · 2H₂O)
(2) Corrode (tower, equipment, pipe)
(3) Energy consumption (water, heat, electric power (mixer, pump, fan etc.))
Compare: Dry FGD - DeDust/DeSOx/DeNOx/HEX

Simple System
ALL IN ONE

- Urea/Ammonia
- Lime
- Ceramic Filter
- WHB

Pollutants to treat in "ONE" stage:
1. SOx
2. NOx
3. Particulates

Advantage:
1. Simple system
2. Reduced running costs
3. Excellent performance

- Heat Recovery
  1. Energy saving
  2. Corrosion reduction
  3. Ash reduction

Reduce catalyst failure: ABS ↓
Energy saving: Heat recovery
No wastewater: dry/semi DGD

Furnace Tail Gas or WHB

Dry FGD
Reactor
Catalyst Ceramic Filter
Heat Recovery
Filter can be cleaned using CDA reverse flow (backwash)

- CDA: eliminates the oil / water / dust
- Pulse pressure: 4~6 kg/cm²
- Influence factors of backwash system:
  - system pressure, operating pressure drop, position of pulse
  - nozzle use of cleaning aids such as venturi, peak pulse pressure
  - period of pulse etc.
ABS Dew Point and DeNOx Performance

- The injected NOx reducing agent, ammonia, reacts with the acid gases in the flue gas forming ammonia salts, i.e. \((\text{NH}_4)_2\text{SO}_4(\text{ABS}) \, \text{and} \, \text{NH}_4\text{HSO}_4\) °.

- Below the dew point ammonia and sulphuric acid condenses as liquid ammonium bisulphate(ABS), in the catalyst filter which inhibits the performance °.

<table>
<thead>
<tr>
<th>Product</th>
<th>Item</th>
<th>Temperature</th>
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</thead>
<tbody>
<tr>
<td>PureTek</td>
<td>Maximum operating temperature</td>
<td>600°C</td>
</tr>
<tr>
<td></td>
<td>Minimum operating temperature</td>
<td>Acid dew point +20°C</td>
</tr>
<tr>
<td></td>
<td>Economic operating temperature</td>
<td>250~375°C</td>
</tr>
<tr>
<td>PureMax</td>
<td>DeNOx maximum temperature</td>
<td>350°C</td>
</tr>
<tr>
<td></td>
<td>DeNox working temperature</td>
<td>250~340°C</td>
</tr>
<tr>
<td></td>
<td>DeNOx minimum operating temperature</td>
<td>ABS dew point (normal 240~270°C)</td>
</tr>
<tr>
<td></td>
<td>Dioxin</td>
<td>210~230°C</td>
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</tbody>
</table>
Key Markets and Advantage
Key Markets, such as

- Glass Furnaces
- Cement Production
- Boiler
- Gasification Processes
- Soil Remediation
- Ship/ Harbor APC
- Catalyst/HM Recovery
- Waste Incineration
- Mineral Processing
- Metal smelting
- Power plants & WHB
- Product Collection
Applications and Case Studies
Applications – City Refuse Incineration Plant

Diagram showing various components of a city refuse incineration plant, including a NaHCO3 catalyst, ceramic filter, and systems for refuse handling, charging, and processing.
## Applications – City Refuse Incineration Plant

<table>
<thead>
<tr>
<th></th>
<th>Catalyst Ceramic Filter</th>
<th>Bag Filter</th>
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</thead>
<tbody>
<tr>
<td><strong>De-dioxin</strong></td>
<td><strong>Catalyst direct decomposition</strong></td>
<td><strong>Activated carbon adsorption toxic waste in fly ash</strong></td>
</tr>
<tr>
<td><strong>Dust removal efficiency</strong></td>
<td>$&lt; 5 \text{mg/Nm}^3$ (normal $&lt; 2 \text{mg/Nm}^3$)</td>
<td>$10\sim20 \text{mg/Nm}^3$</td>
</tr>
<tr>
<td><strong>Operational pressure</strong></td>
<td><strong>180$\sim230^\circ \text{C}$</strong></td>
<td><strong>140$\sim170^\circ \text{C}$ near the dew point (corrosion)</strong></td>
</tr>
<tr>
<td><strong>Heat resistance</strong></td>
<td><strong>Max.350$^\circ \text{C}$</strong></td>
<td><strong>Max.260$^\circ \text{C}$</strong></td>
</tr>
<tr>
<td><strong>Benefit</strong></td>
<td>X Activated carbon</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>X Dioxin fly ash</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>○ Heat recovery</td>
<td></td>
</tr>
<tr>
<td><strong>Life</strong></td>
<td><strong>Potential for long life (&gt;5 years)</strong></td>
<td><strong>Only 1.5$\sim3$ years</strong></td>
</tr>
</tbody>
</table>
### Glass Furnaces Tail Gas -- CSYP, China, 2015/2016

烟气净化处理系统设计要求：

<table>
<thead>
<tr>
<th>名 称</th>
<th>Plant #1 550t/d</th>
<th>Plant #2 600t/d</th>
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<tbody>
<tr>
<td><strong>Fuel Type</strong></td>
<td>NG 天然气</td>
<td>NG 天然气</td>
</tr>
<tr>
<td><strong>Flowrate</strong></td>
<td>62000</td>
<td>70000</td>
</tr>
<tr>
<td><strong>Dust (inlet)</strong></td>
<td>≤200</td>
<td>≤200</td>
</tr>
<tr>
<td><strong>Dust (outlet)</strong></td>
<td>≤30</td>
<td>≤30</td>
</tr>
<tr>
<td><strong>NOx (inlet)</strong></td>
<td>≤2500</td>
<td>≤2500</td>
</tr>
<tr>
<td><strong>NOx (outlet)</strong></td>
<td>≤500</td>
<td>≤500</td>
</tr>
<tr>
<td><strong>DeNOx Eff.</strong></td>
<td>≥80</td>
<td>≥80</td>
</tr>
<tr>
<td><strong>Slip NH3</strong></td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>H2O, vol%</strong></td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td><strong>O2, vol% wet</strong></td>
<td>8.3</td>
<td>8.3</td>
</tr>
<tr>
<td><strong>Temp.</strong></td>
<td>350–380</td>
<td>350–380</td>
</tr>
<tr>
<td><strong>SOx (inlet)</strong></td>
<td>640</td>
<td>640</td>
</tr>
<tr>
<td><strong>SOx (outlet)</strong></td>
<td>≤50</td>
<td>≤50</td>
</tr>
<tr>
<td><strong>DeSOx Eff.</strong></td>
<td>≥92.5</td>
<td>≥92.5</td>
</tr>
</tbody>
</table>
Applications - Glass Furnaces, CSYP China

Plant #1 (catalyst ceramic filter (PureMax) applied, 2015)

Plant #2 (PureMax not applied)

Glass Furnaces Tail Gas -- CSYP, China, 2015
Applications - Glass Furnaces, CSYP China

Ceramic Filter & Stack

Ceramic Filter Reactor

Ammonia Storage Tank

WHB

Glass Furnaces Tail Gas -- CSYP, China, 2016
Applications - Sludge Incinerator (CFB), Japan

Turbocharged Fluidized Bed Incinerator (new generation system)

Diagram:
- Sewerage sludge enters the incinerator.
- Heavy oil is added to aid in combustion.
- Air preheater increases the temperature of the air.
- Turbocharger boosts the air pressure.
- Heat exchanger exchanges heat between air and exhaust gases.
- Dust collector filters out particles.
- Air blower (Start-up Only) and Air blower (White smoke prevention) control airflow.
- Scrubber removes any remaining pollutants.
- Ash is collected at the bottom of the incinerator.

Temperature notes:
- 850°C (138kPaG)
- 140°C (165kPaG)
- 420°C (5kPaG)
- 570°C (133kPaG)
- 620°C (136kPaG)
- 650°C (160kPaG)

Induced draft fan is unnecessary.
### Advantages of Sludge Incinerator (CFB), Japan

**Capacity:** 100t-wet/Day (300 days/year)

<table>
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<th>Traditional fluidized bed incinerator</th>
<th>Turbocharged fluidized bed incinerator</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fuel Requirements</strong></td>
<td>54 L/H</td>
<td>40 L/H (↓26%)</td>
</tr>
<tr>
<td><strong>Power Consumption</strong></td>
<td>350 KW</td>
<td>180 KW (↓48.6%)</td>
</tr>
<tr>
<td><strong>CO₂ Emission -fuel</strong></td>
<td>1,054 ton-CO₂/Year</td>
<td>780 ton-CO₂/Year</td>
</tr>
<tr>
<td><strong>CO₂ Emission -power</strong></td>
<td>1,399 ton-CO₂/Year</td>
<td>719 ton-CO₂/Year</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>2,453 ton-CO₂/Year</td>
<td>1,499 ton-CO₂/Year (↓39%)</td>
</tr>
<tr>
<td><strong>Fuel Cost (80 JPY/L)</strong></td>
<td>31.12 million JPY/Year</td>
<td>23.04 million JPY/Year</td>
</tr>
<tr>
<td><strong>Electrical Cost (12 JPY/KWh)</strong></td>
<td>30.24 million JPY/Year</td>
<td>15.55 million JPY/Year</td>
</tr>
<tr>
<td><strong>Total Running Cost</strong></td>
<td>61.36 million JPY/Year</td>
<td>38.59 million JPY/Year (↓37%)</td>
</tr>
</tbody>
</table>

### The advantage of Sanki’s turbocharged fluidized bed incinerator

- Low loading operation · High operating efficiency
- The volume of incinerator is reduced over 40% and no main fan required
- Low fuel & electrical cost
Conclusions

- Verified technology
- Scalable technology to suit your needs
- Has been applied for more than 10 years
- Long life of product
- Excellent performance
- Technical back up from first class team
- Reduced total costs of ownership
- Lower capex, opex & energy cost
~ THE END ~

THANK YOU!

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