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# Comprehensive Technical Handbook: Phosphate-Free Alumina Ceramic Foam Filter (CFF)

**Advanced Molten Metal Filtration Solutions for High-Purity Aluminum Casting**

**Manufacturer:** AdTech Metallurgical Materials Co., Ltd. (AdTech China)

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## 1. Executive Summary

The global aluminum industry is shifting towards higher purity standards, particularly in the aerospace, automotive, and high-end electronics sectors. Traditional ceramic foam filters often utilize phosphate-based binders, which can release phosphorus into the molten aluminum, leading to "phosphorus pickup" and compromising the mechanical properties of sensitive alloys.

AdTech's **Phosphate-Free Alumina Ceramic Foam Filter** represents the pinnacle of green metallurgical technology. By utilizing a proprietary phosphate-free bonding system, this filter ensures zero contamination, superior thermal stability, and exceptional filtration efficiency for non-metallic inclusions.



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## 2. The Science of Phosphate-Free Technology

### 2.1 The Problem with Phosphorus in Aluminum

Phosphorus is a known detrimental element in specific aluminum alloys (such as high-magnesium alloys or Al-Si casting alloys). Even trace amounts of phosphorus can:

Neutralize the effect of strontium (Sr) modifiers, leading to poor grain refinement.

Induce "pinhole" defects in ultra-thin aluminum foil production.

Reduce the fatigue resistance of aerospace-grade components.

### 2.2 AdTech's Innovation

Our R&D team has developed a high-temperature sintering process using advanced inorganic binders that provide high mechanical strength without the need for phosphoric acid or phosphate salts. This ensures that the molten metal remains chemically pure throughout the filtration stage.

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## 3. Product Specifications & Material Properties

### 3.1 Chemical Composition

The purity of the filter material is critical for avoiding secondary inclusion formation.

**Table 1: Chemical Composition Analysis**

Component	Standard CFF (Phosphate-Bonded)	AdTech Phosphate-Free CFF
Al <sub>2</sub> O <sub>3</sub> (Alumina)	85% - 90%	≥ 92.5%
SiO <sub>2</sub> (Silica)	5% - 8%	≤ 4.5%
P <sub>2</sub> O <sub>5</sub> (Phosphorus Pentoxide)	2% - 4%	≈ 0% (Trace-free)
Fe <sub>2</sub> O <sub>3</sub> (Iron Oxide)	< 0.5%	≤ 0.2%
Others (Binder/Additives)	Balance	Optimized Inorganic Matrix

## 3.2 Physical and Mechanical Attributes

Table 2: Physical Properties and Performance Metrics

Property	Value/Specification	Test Method
Normal Pore Size	10, 20, 30, 40, 50, 60 PPI	Visual/Microscopy
Porosity (Void Volume)	80% – 90%	Archimedes Principle
Bulk Density	0.35 – 0.55 g/cm <sup>3</sup>	Standard Calculation
Compressive Strength	≥ 1.0 MPa (Room Temp)	ASTM C133
Thermal Shock Resistance	1200°C to Room Temp (5+ Cycles)	Air Quench Test
Max Service Temperature	1200°C (2192°F)	Continuous Load Test

## 4. Geometric Dimensions and Customization

AdTech provides a wide range of standard sizes and the ability to manufacture custom shapes (square, rectangular, circular, or tapered).

### 4.1 Standard Dimensions Table

Table 3: Common Commercial Sizes and Tolerances

Size (Inches)	Dimensions (mm)	Thickness (mm)	Tolerance (mm)
7"	178 × 178	50	± 1.5
9"	229 × 229	50	± 1.5
12"	305 × 305	50	± 2.0
15"	381 × 381	50	± 2.0
17"	432 × 432	50	± 2.0
20"	508 × 508	50	± 2.5
23"	584 × 584	50	± 2.5
26"	660 × 660	50 / 65	± 3.0

### 4.2 Edge Sealing Gaskets

To prevent bypass leakage (unfiltered metal flowing around the filter), AdTech offers three types of sealing gaskets:

**Fiber Gasket (Non-Expansive):** General purpose.

**Expansible Gasket:** Swells upon contact with heat to create a hermetic seal.

**Ceramic Fiber Blanket:** For high-temperature, long-cycle casting.

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## 5. Filtration Performance & Flow Dynamics

The effectiveness of a Ceramic Foam Filter is determined by its "Tortuous Path" structure.

### 5.1 Filtration Mechanisms

**Sieving (Cake Filtration):** Large inclusions (> pore size) are trapped at the surface.

**Flow Restriction:** Changes in flow direction cause particles to collide with the ceramic struts.

**Deep Bed Filtration:** Fine inclusions are captured within the internal pores via Brownian motion and chemical affinity to the alumina.

### 5.2 Flow Rate and Capacity

**Table 4: Flow Capacity Guidelines by Pore Size (PPI)**

Pore Size (PPI)	Application Sensitivity	Flow Rate (kg/min·in <sup>2</sup> )	Total Capacity (Tons/in <sup>2</sup> )
10	Low (Ingots/Billets)	1.5 – 2.5	0.8 – 1.2
20	Medium (Extrusions)	1.0 – 1.8	0.6 – 0.9
30	High (Automotive/Wheels)	0.8 – 1.4	0.4 – 0.7
40	Ultra-High (Foil/Cans)	0.5 – 1.0	0.3 – 0.5
50 / 60	Specialized (Aerospace)	0.3 – 0.6	0.2 – 0.4

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## 6. Comparison Analysis: Why Phosphate-Free?

**Table 5: Comparative Advantage Matrix**

Feature	Traditional CFF	AdTech Phosphate-Free CFF
Environmental Impact	Phosphate runoff in waste	Eco-friendly / REACH Compliant
Metal Purity	Potential P-contamination	Zero Chemical Contamination
Slag Resistance	Moderate	High (Inert Alumina Matrix)
Dimensional Stability	Prone to slight warping	High Precision (Sintered Logic)
Cost-Benefit	Lower initial cost	Higher ROI through reduced scrap

## 7. Operational Guidelines (Standard Operating Procedures)

### 7.1 Installation Process

**Filter Box Inspection:** Ensure the filter bowl/box is clean and free of debris from previous casts.

**Placement:** Gently place the AdTech filter into the seating area. The tapered edges should fit snugly.

**Gasket Check:** Verify that the gasket is intact and covers the entire perimeter.

### 7.2 Pre-heating Protocols

Pre-heating is vital to prevent "freezing" when the first batch of molten metal hits the cold filter.

**Method:** Use a gas burner or electric heater.

**Target Temperature:** 200°C – 400°C.

**Duration:** 15–30 minutes depending on filter size.

### 7.3 Priming and Metal Head Height

The initial flow requires a "head height" (pressure) to overcome the surface tension of the molten aluminum.

**Min Priming Head:** 150mm – 300mm depending on PPI.

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## 8. Quality Control and Compliance

AdTech China adheres to rigorous international quality standards to ensure every filter batch is consistent.

**ISO 9001:2015 Certification:** Full traceability from raw materials to finished products.

**Appearance Inspection:** No cracks, slag inclusion, or uneven pore distribution allowed.

**Strength Sampling:** 1 out of every 50 filters is tested for compressive strength.

**Dimensional Verification:** Every filter is measured for size and wedge angle.

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## 9. Troubleshooting Common Issues

**Table 6: Troubleshooting Guide for CFF Users**

Symptom	Probable Cause	Recommended Action
Filter Floating	Improper sealing or no gasket.	Use expansible gaskets; ensure proper seating.
Metal Freeze-off	Insufficient pre-heating.	Increase pre-heating time/temp.
Slow Flow Rate	PPI too high or metal temp too low.	Reduce PPI or increase casting temperature.
Filter Breakage	Mechanical impact during loading.	Handle with care; use tongs for placement.
Inclusion Bypass	Gasket bypass or filter bypass.	Check seal integrity; ensure no gaps in bowl.

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## 10. Frequently Asked Questions (FAQ) for Procurement & Engineering

**Q: Can AdTech filters be reused?**

A: No. Ceramic foam filters are designed for single-use to ensure maximum filtration efficiency and prevent cross-contamination between batches.

**Q: How do I determine the right PPI for my process?**

A: This depends on your final product. For 7xxx series aerospace alloys, 50-60 PPI is recommended. For general architectural extrusions, 20-30 PPI is usually sufficient.

**Q: What is the shelf life of these filters?**

A: If stored in a dry, ventilated environment in their original packaging, they have an indefinite shelf life. However, we recommend use within 24 months.

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## **11. About AdTech Metallurgical Materials Co., Ltd.**

Founded in 2002, **AdTech China** is a high-tech enterprise specializing in the research, development, and production of new metallurgical materials. Our core products include Ceramic Foam Filters, Degassing Units, Refining Fluxes, and Casting Equipment for the global aluminum industry.

We serve customers in over 50 countries, providing technical support and optimized filtration solutions that reduce production costs and improve metal quality.

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## **12. Contact Information**

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