SINOYQX YDNFoam

Melamine Acoustic Foam Solution for Energy Storage Container Noise Control

Application White Paper

Applicable applications: energy storage containers, BESS battery cabins, PCS equipment cabins, industrial control cabinets, fan compartments, HVAC and duct areas, equipment acoustic enclosures, and other metal enclosure noise control applications.

Executive Summary

As renewable energy storage systems, especially containerized battery energy storage systems (BESS), continue to develop rapidly, operating noise has become an important issue in project design, site acceptance and long-term maintenance.

Energy storage containers typically integrate battery modules, inverters, PCS equipment, HVAC systems, cooling fans, fire protection units and electrical control systems. Because the container body is usually made of metal and the internal space is relatively enclosed, noise generated by fans, HVAC systems and electrical equipment can easily reflect, overlap and resonate inside the container, resulting in higher overall noise levels.

Melamine foam is a lightweight acoustic material with a three-dimensional open-cell structure. It offers broadband sound absorption, intrinsic flame retardancy, low density, easy processing and fiber-free installation. It is suitable for inner acoustic lining, fan-area noise reduction, local acoustic enclosures and equipment cabin acoustic optimization inside energy storage containers.

This white paper introduces the application of melamine foam for energy storage container noise control, covering noise sources, application challenges, material advantages, installation structures, recommended installation areas, thickness selection, acoustic performance reference, material comparison and installation considerations.

1. Application Overview

Containerized energy storage systems are widely used in grid peak shaving, commercial and industrial energy storage, solar and wind power integration, microgrids, data center backup power and large-scale energy projects due to their modular design, easy transportation, fast installation and high integration level.

As the power density of energy storage systems increases, the operating load of internal thermal management systems, HVAC systems and electrical conversion equipment also increases. To keep battery systems within a safe operating temperature range, energy storage containers are typically equipped with multiple cooling fans, HVAC units and forced ventilation structures. These systems continuously generate noise during operation.

Unlike an open space, the interior surfaces of energy storage containers are mostly metal. Sound waves repeatedly reflect between the metal inner walls, ceiling and equipment surfaces, which can lead to sound-energy superposition and local resonance. As a result, fan noise, motor noise and mid-to-high frequency airflow noise can become more noticeable.

Therefore, properly arranged acoustic materials inside the energy storage container can reduce sound reflection, weaken container resonance, improve the internal acoustic environment and support better site comfort and compliance.

Figure 1. Application Scenario of Acoustic Insulation in Energy Storage Containers

2. Main Noise Sources in Energy Storage Containers

Noise inside an energy storage container is not generated by a single device. It is typically formed by the combined operation of multiple systems.

2.1 Cooling Fan Noise

Cooling fans are one of the main noise sources in energy storage containers. Battery modules, PCS units, inverters and electrical cabinets generate heat during operation and require forced ventilation for cooling.

Fan noise usually includes:

- Blade rotation noise
- Motor operating noise
- Airflow impact noise
- Duct turbulence noise

Among these sources, mid-to-high frequency noise is often prominent and may create a sharp and continuous noise perception.

2.2 HVAC Noise

Energy storage containers require stable internal temperature control, so they are commonly equipped with industrial HVAC systems or auxiliary liquid-cooling systems. HVAC equipment can generate compressor noise, fan noise and airflow noise during operation.

When HVAC inlet or outlet areas are close to metal walls or equipment cabinets, sound waves can reflect and amplify within the local space.

2.3 Inverter and Electrical Equipment Noise

PCS units, inverters, transformers and electrical control cabinets may produce electromagnetic noise, low-frequency humming or high-frequency tones during operation. Although the sound pressure level of a single unit may not be very high, the total noise may increase when multiple devices operate at the same time.

2.4 Airflow Turbulence and Structural Reflection

The internal space of an energy storage container is compact, with many equipment racks, ducts, cable trays and structural parts. Airflow passing through these structures can easily generate turbulence noise.

In addition, the metal container itself has strong sound reflection and weak sound absorption. Repeated sound reflections inside the container can increase reverberation time and make the noise more obvious.

Figure 2. Noise Propagation and Reflection inside an Energy Storage Container

Figure 3. Main Noise Sources in an Energy Storage Container

3. Application Challenges

Noise control inside energy storage containers is not simply a matter of attaching one layer of acoustic material. It requires consideration of safety, space, heat dissipation, installation, durability and maintenance requirements.

3.1 Limited Space without Affecting Heat Dissipation and Maintenance

The interior of an energy storage container is compact, with densely arranged equipment, limited ventilation routes and restricted maintenance passages. Acoustic material installation must not block airflow, affect battery heat dissipation or interfere with later maintenance.

Therefore, the material needs to provide high acoustic efficiency and effective noise reduction within a limited thickness.

3.2 High Fire Safety Requirements

Energy storage systems contain a large number of battery cells and electrical devices, so safety requirements are high. Acoustic materials must have good flame-retardant properties, must not act as a source of flame propagation and must not create significant safety risks at elevated temperatures.

Compared with ordinary polyester fiber or rubber foam materials that often require additional flame-retardant treatment, melamine foam has intrinsic flame-retardant properties, making it more suitable for high-safety applications such as energy storage containers.

3.3 Complex Operating Environment

Energy storage containers are often installed outdoors or in semi-outdoor environments and may face:

- Temperature fluctuations
- Humidity changes
- Dust exposure
- Vibration
- Long-term continuous operation

As a result, acoustic materials must remain stable over time, resist powdering and fiber shedding, and provide good processing adaptability.

3.4 Balance between Lightweight Design and Acoustic Efficiency

Energy storage systems have requirements for total weight, transportation cost and installation convenience. Traditional glass wool provides good acoustic performance, but it is relatively heavy and may have fiber-shedding issues. Polyester fiber is lightweight, but its flame retardancy and heat resistance are often limited.

Melamine foam has a low density and can provide good mid-to-high frequency sound absorption with relatively low added weight, making it suitable for container inner walls and local equipment areas.

Figure 4. Key Challenges for Acoustic Materials in Energy Storage Containers

4. Why Melamine Foam

Melamine foam is a three-dimensional open-cell material produced from melamine resin. Its unique open-cell structure allows sound waves to enter the material and dissipate through continuous friction, reflection and attenuation within the pore network, converting acoustic energy into heat and achieving sound absorption.

4.1 Broadband Sound Absorption

Melamine foam has a high open-cell structure and can effectively absorb mid-to-high frequency noise, especially fan noise, airflow noise and electrical equipment operating noise.

In energy storage containers, this type of noise is often concentrated in the mid-to-high frequency range, so melamine foam can help improve the internal acoustic environment in a targeted way.

4.2 Intrinsic Flame Retardancy

The base material of melamine foam has a high nitrogen content and provides natural flame-retardant characteristics. It can achieve good fire behavior without requiring a large amount of halogenated flame retardants.

For high-safety environments such as energy storage systems, battery cabins and equipment compartments, material flame retardancy is a critical factor.

4.3 Lightweight Structure

Melamine foam has low density, commonly around 7-12 kg/m³, which is much lower than many traditional acoustic materials. When installed over a large area inside a container, it can help reduce the overall system load.

Its lightweight nature also supports easier transportation, on-site installation and later maintenance.

4.4 Fiber-Free and Cleaner Installation

Fiber-based materials such as glass wool and rock wool may release fibers or dust during cutting and under long-term vibration. Melamine foam is a foam structure rather than a fibrous blanket, offering better cleanliness and making it more suitable for equipment cabins and electrical spaces.

4.5 Easy Cutting and Installation

Melamine foam can be cut, die-cut, laminated and installed according to inner walls, ceilings, fan covers, equipment partitions and other structures. It can be combined with adhesive backing, nonwoven fabric, aluminum foil, fiberglass cloth, perforated panels and other facing materials to form different application structures.

4.6 Suitable for Fan Noise and Mid-to-High Frequency Noise Control

Fan and airflow noise are major contributors to overall noise inside energy storage containers. Melamine foam has strong sound absorption in the mid-to-high frequency range and is suitable for fan areas, ducts, equipment partitions and inner wall acoustic treatment.

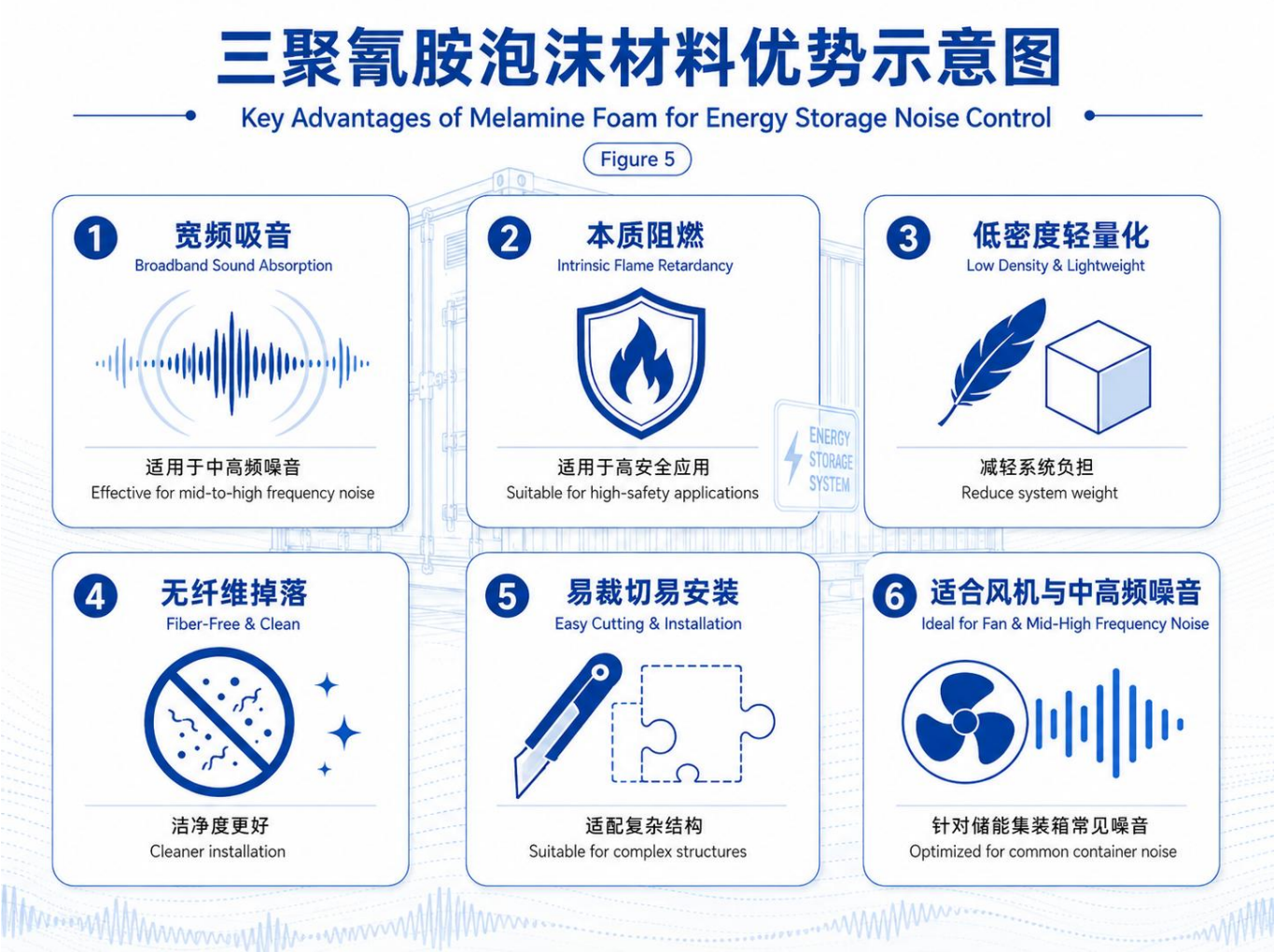

Figure 5. Key Advantages of Melamine Foam for Energy Storage Noise Control

5. Typical Installation Structure

In energy storage containers, melamine foam is typically used as an inner acoustic lining. It can be installed on metal inner walls, ceilings, fan surrounding areas, partitions, local enclosures or the inner surfaces of equipment cabins.

A typical structure may include the following layers:

5.1 Metal Container Wall

Energy storage containers usually use steel structures or metal panels as the main container body. Metal surfaces strongly reflect sound and provide weak sound absorption, making them one of the main causes of internal reverberation and noise amplification.

Adding an acoustic layer to the metal inner wall can reduce sound reflection and decrease internal sound-energy buildup.

5.2 Adhesive Layer

The adhesive layer is used to fix melamine foam to the container wall or equipment surface. Depending on the application environment, adhesive backing, temperature-resistant adhesive, flame-retardant adhesive or mechanical fixing methods may be selected.

For high-temperature, humid or vibration-prone environments, a bonding solution with better heat resistance, flame retardancy and long-term adhesion stability is recommended.

5.3 Melamine Acoustic Foam Layer

Melamine foam is the main sound absorption layer. After sound waves enter the foam, friction and attenuation occur within the open-cell structure, reducing reflected sound energy.

Foam thickness can be selected based on noise frequency, space limitations and target noise reduction. In general, thicker foam can improve absorption at lower frequency ranges, but available installation space and airflow requirements must also be evaluated.

5.4 Optional Protective Facing

In some applications, a protective facing can be laminated onto the foam surface, such as:

- Nonwoven fabric
- Fiberglass cloth
- Aluminum foil
- Perforated aluminum panel
- Flame-retardant fabric
- Dust-resistant facing

The protective facing can help prevent dust, scratches and damage, improve appearance, support cleaning and enhance durability. However, the facing should not completely seal the foam pores, as this would reduce acoustic performance. If a metal protective panel is used, a perforated structure is recommended.

5.5 Equipment and Airflow Zone

The acoustic structure should avoid blocking equipment cooling paths. It must not cover fan inlets and outlets, HVAC return air openings, exhaust vents or key cooling channels.

The final design should consider airflow direction, equipment layout and maintenance space to select appropriate installation areas.

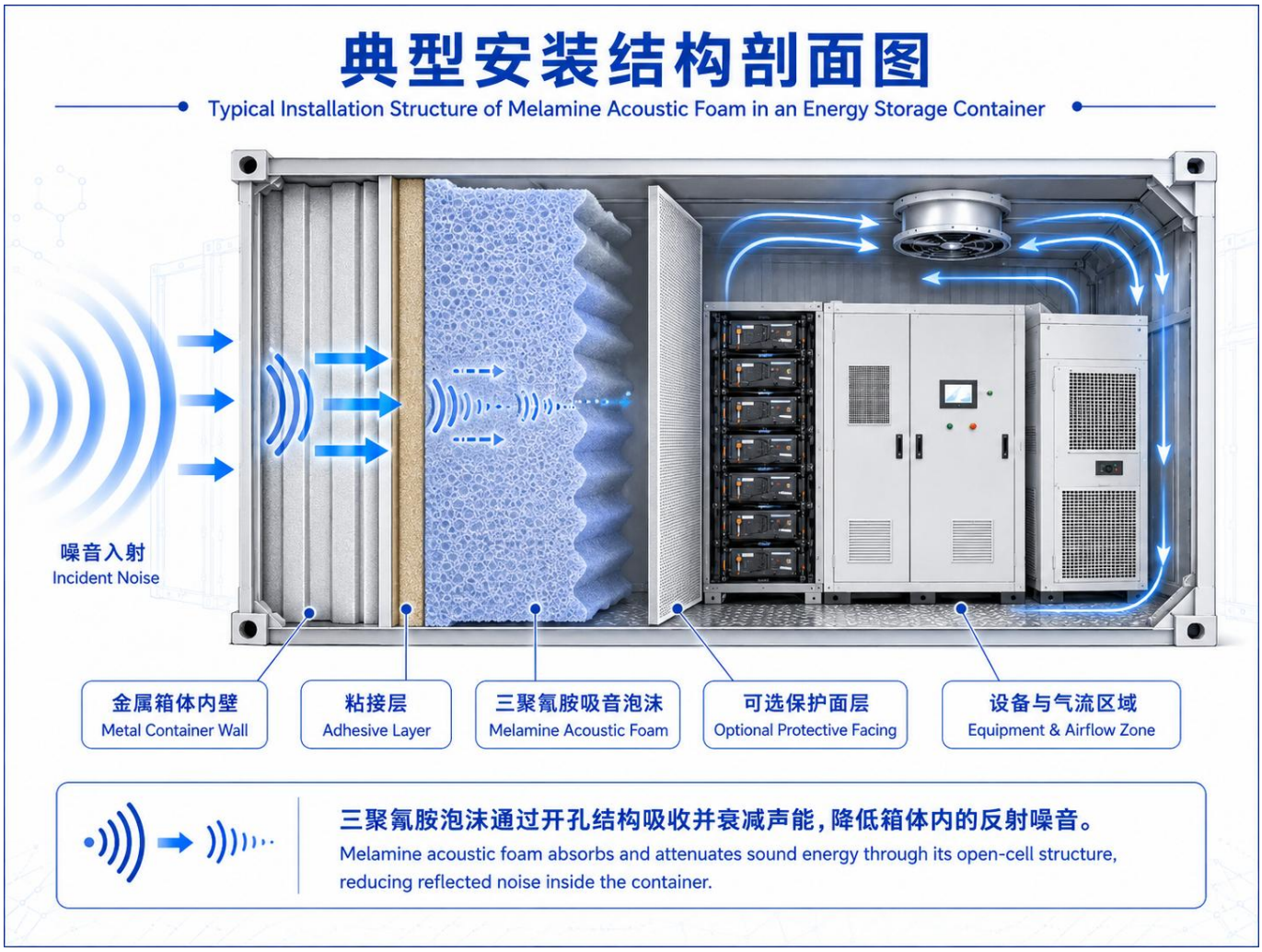

Figure 6. Typical Installation Structure of Melamine Acoustic Foam in an Energy Storage Container

6. Recommended Installation Areas

Inside an energy storage container, acoustic material does not need to cover every surface. A more effective approach is to install it in key areas based on noise source location, sound reflection paths and maintenance requirements.

6.1 Side Walls

Side walls are one of the main sound reflection surfaces. For equipment-dense areas, areas opposite fan outlets and zones with obvious reflection, melamine foam can be installed locally or over a larger wall area.

When installing on side walls, avoid electrical interfaces, access doors, cable openings and fire protection equipment.

6.2 Ceiling

The ceiling is another important sound reflection surface, especially when fan, HVAC and equipment cabinet noise propagates upward. Ceiling reflection can increase internal reverberation.

Installing acoustic material on the ceiling helps reduce the overall internal sound energy.

6.3 Fan and Duct Area

Fan and duct areas are key noise reduction zones. Acoustic material can be installed near fans on non-inlet and non-outlet surfaces, on duct exteriors, on the inner side of fan covers and on local reflective surfaces.

It is important that the acoustic material does not block air vents and is not drawn directly into high-speed airflow. If strong airflow impact is present, perforated panels or mesh protective facings are recommended.

6.4 Partitions and Local Enclosures

For PCS, inverters or other local high-noise equipment, partitions, local enclosures or equipment housing linings can be used to reduce noise transmission.

This method is suitable for local acoustic optimization, reducing outward transmission from critical noise sources without affecting the overall equipment layout.

6.5 Door Panels and Maintenance Access Areas

If the inner surface of the door creates obvious sound reflection, thin acoustic material can be installed on the door inner panel without affecting door operation or maintenance access.

Figure 7. Recommended Installation Areas for Melamine Foam inside an Energy Storage Container

7. Thickness and Structural Recommendations

The appropriate thickness of melamine foam should be determined according to noise spectrum, installation space, target noise reduction value and safety requirements.

7.1 Standard Noise Reduction: 20-25 mm

For energy storage containers with limited space and mainly mid-to-high frequency fan noise, 20-25 mm melamine foam can be selected as the preferred thickness.

This solution is suitable for:

- Container side walls
- Ceilings
- Door inner panels
- Local reflective surfaces
- Space-limited areas

This option provides moderate thickness, low weight and flexible installation.

7.2 Enhanced Sound Absorption: 30-50 mm

If the project has higher noise reduction requirements, or if fan and equipment noise are significant, 30-50 mm thickness can be selected.

This solution is suitable for:

- Fan surrounding areas
- Duct surrounding areas
- Equipment partitions
- Local acoustic enclosures
- Critical zones close to noise sources

As thickness increases, absorption at lower frequency ranges can improve. However, installation space and heat dissipation paths should also be evaluated.

7.3 Facing and Lamination Options

Option A: Bare Foam Structure

Suitable for clean internal areas with no strong airflow impact and no frequent contact. This option offers good sound absorption and lower cost.

Option B: Nonwoven Fabric / Fiberglass Cloth Laminated Structure

Suitable for areas requiring improved appearance, abrasion resistance and dust protection. This option balances acoustic performance and surface protection.

Option C: Perforated Panel Protective Structure

Suitable for fan areas, duct areas or locations where contact is likely. A perforated panel can protect the foam from damage while preserving acoustic performance as much as possible.

Option D: Aluminum Foil Laminated Structure

Suitable for applications requiring heat reflection, dust resistance or easier surface cleaning. However, if aluminum foil completely seals the foam surface, it may reduce acoustic performance. The final structure should be selected carefully according to the application.

Figure 8. Recommended Thickness Selection for Melamine Acoustic Foam

8. Acoustic Performance Reference

The acoustic performance of melamine foam is related to material thickness, density, open-cell structure, mounting method, backing air gap and surface facing.

In energy storage container applications, melamine foam is mainly used to reduce mid-to-high frequency noise, especially fan noise, airflow noise and equipment operating noise.

Typical sound absorption performance is shown below:

Frequency (Hz)	Sound Absorption Coefficient
500 Hz	0.30-0.45
1000 Hz	0.65-0.85
2000 Hz	0.80-0.95
4000 Hz	0.85-1.00

Actual sound absorption performance may be affected by installation structure, foam thickness, backing air gap, use of facing materials and noise source spectrum. For specific projects, targeted design should be carried out based on the customer equipment noise spectrum and container structure.

In typical applications, a properly arranged system may achieve approximately 8-18 dB of overall noise improvement. The actual noise reduction should be verified according to the specific equipment, installation area, noise source location and test method.

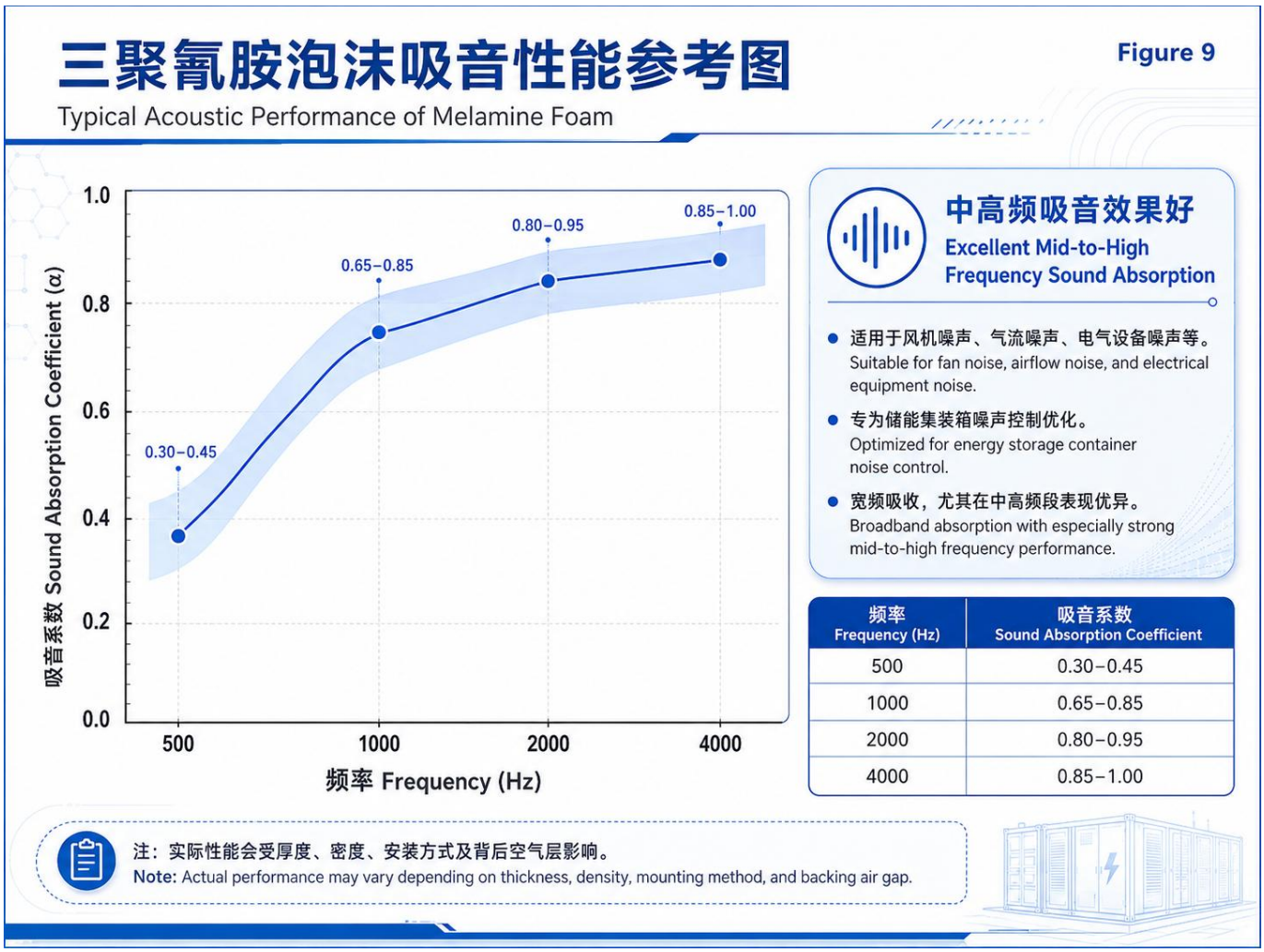

Figure 9. Typical Acoustic Performance of Melamine Foam

Figure 10. Typical Noise Reduction Effect in Energy Storage Container Applications

9. Comparison with Traditional Acoustic Materials

Common acoustic material options for energy storage containers include glass wool, polyester fiber, rubber foam and melamine foam. These materials differ significantly in sound absorption, fire safety, weight, cleanliness and installation adaptability.

Material	Sound Absorption	Flame Retardancy	Weight	Cleanliness	Typical Use
Glass Wool	High	Medium	Heavy	Fiber shedding risk	Traditional building and industrial insulation/acoustics
Polyester Fiber	Medium	Low to Medium	Light	General	General indoor acoustic treatment
Rubber Foam	Medium	Low to Medium	Medium	Relatively good	Mainly thermal insulation, limited acoustic performance
Melamine Foam	High	High	Ultra-light	Excellent	Energy storage containers, equipment cabins and fan noise reduction

From a comprehensive performance perspective, melamine foam is more suitable for energy storage container applications that require fire safety, lightweight design, cleanliness and mid-to-high frequency sound absorption at the same time.

Figure 11. Comparison of Melamine Foam with Traditional Acoustic Materials

10. Recommended Solutions

For energy storage container acoustic treatment, the following solutions can be selected according to project noise level, available installation space and safety requirements.

10.1 Standard Inner Wall Acoustic Lining

Recommended structure:

- Metal container wall
- Flame-retardant adhesive layer
- 20-25 mm melamine foam
- Optional nonwoven or fiberglass cloth facing

Recommended locations:

- Side walls
- Ceiling

- Door inner panels
- Non-high-airflow impact areas

Main purposes:

- Reduce internal reflected noise
- Improve reverberation
- Optimize the overall acoustic environment

10.2 Enhanced Noise Reduction around Fans

Recommended structure:

- Metal wall or equipment housing
- Adhesive layer or mechanical fixing
- 30-50 mm melamine foam
- Perforated panel or protective mesh facing

Recommended locations:

- Fan surrounding areas
- Duct exterior
- Non-blocking areas near HVAC outlets
- Local equipment enclosures

Main purposes:

- Reduce mid-to-high frequency fan noise
- Reduce airflow noise reflection
- Improve acoustic performance around equipment cabins

10.3 Local Equipment Acoustic Enclosure

Recommended structure:

- Metal enclosure or partition
- Inner lining with melamine foam
- Perforated protective facing
- Reserved ventilation and maintenance space

Recommended locations:

- Around PCS equipment
- Inverter cabins
- Local high-noise equipment
- Inside fan enclosures

Main purposes:

- Control local high-noise sources
- Reduce outward noise transmission
- Maintain equipment serviceability

Figure 12. Recommended Melamine Foam Solutions for Energy Storage Containers

11. Installation Considerations

To ensure long-term performance of melamine foam in energy storage containers, the following installation points should be considered during design.

11.1 Do Not Block Air Ducts or Cooling Paths

Acoustic materials must not cover fan inlets and outlets, HVAC return air openings, exhaust vents or equipment cooling holes. Airflow direction and maintenance passages should be confirmed before installation.

11.2 Select an Appropriate Fixing Method

Depending on the operating environment, adhesive backing, temperature-resistant adhesive, flame-retardant adhesive or mechanical fixing can be selected. For high-temperature, humid, vibration-prone or long-term operating environments, a more stable fixing solution is recommended.

11.3 Pay Attention to Surface Protection

In areas that are exposed to contact, abrasion or airflow impact, a protective facing such as a perforated panel, mesh, fiberglass cloth or flame-retardant fabric is recommended.

11.4 Keep the Open-Cell Acoustic Structure Effective

When using facing materials, avoid completely sealing the foam surface. A sealed surface will prevent sound waves from entering the foam and reduce acoustic performance.

11.5 On-Site Testing and Optimization

For large energy storage projects, noise testing is recommended during the prototype or sample installation stage. Foam thickness, installation area and installation location can then be further optimized based on the measured noise spectrum and actual results.

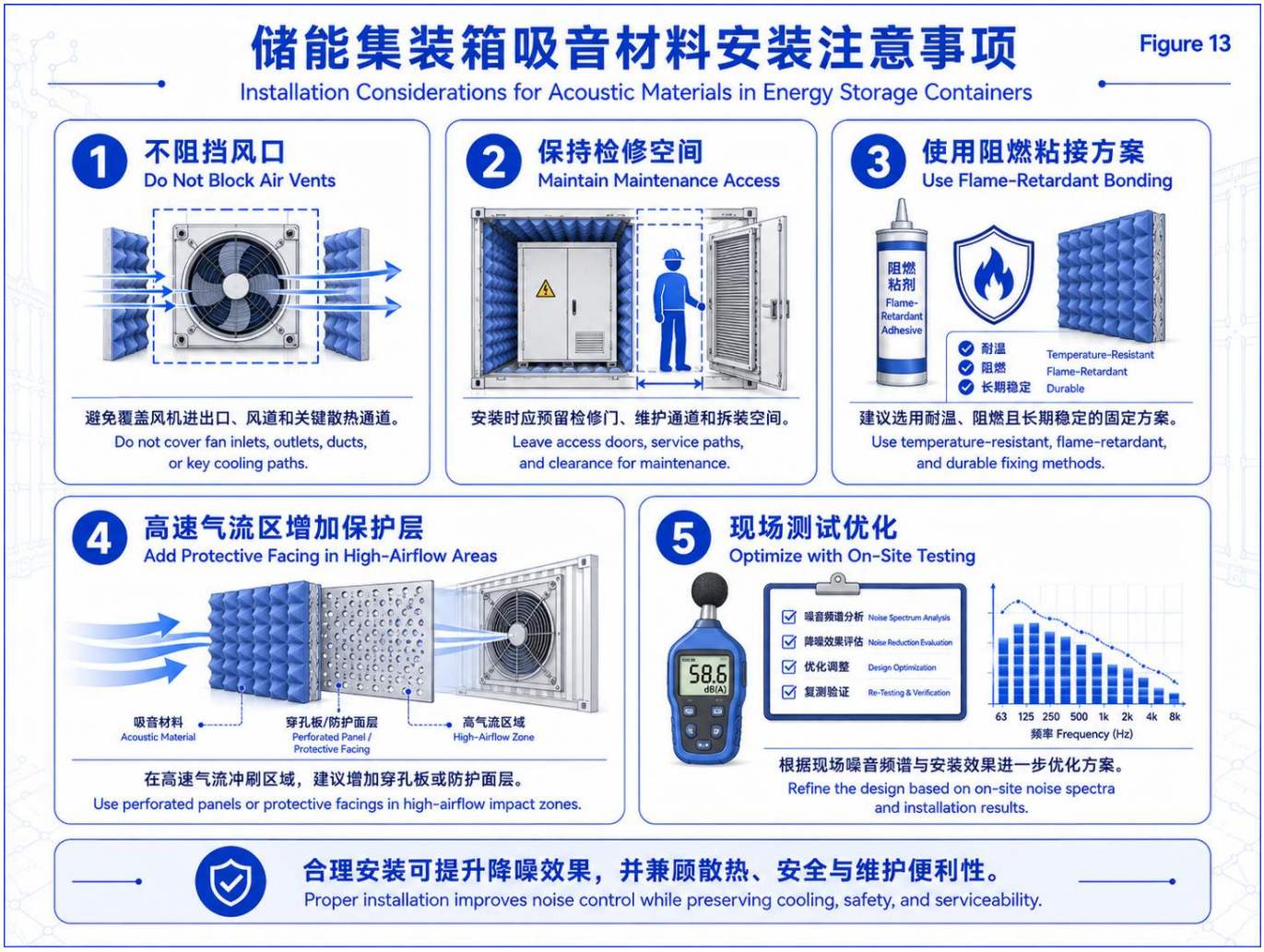

Figure 13. Installation Considerations for Acoustic Materials in Energy Storage Containers

12. Application Value

Using melamine foam as an acoustic material inside energy storage containers can provide the following benefits:

12.1 Reduce Equipment Operating Noise

By reducing sound reflection from metal surfaces and internal reverberation, melamine foam can help reduce perceived noise inside and outside the container.

12.2 Improve Project Environmental Adaptability

For energy storage projects located near industrial parks, commercial areas or residential areas, noise control can improve project acceptance and operational stability.

12.3 Improve Safety

Melamine foam has good flame-retardant characteristics and is suitable for electrical equipment and energy storage environments with higher safety requirements.

12.4 Reduce System Weight

Compared with traditional materials such as glass wool and rock wool, melamine foam is much lighter, helping reduce additional container weight and transportation load.

12.5 Improve the Maintenance Environment

After noise reduction, maintenance personnel can work more comfortably near equipment, supporting long-term maintenance and inspection.

13. Conclusion

The main noise sources inside energy storage containers include cooling fans, HVAC systems, inverters, electrical equipment and airflow turbulence. Because the metal container body has strong sound-reflective characteristics, noise can easily reflect, overlap and resonate inside the container.

With its high open-cell ratio, broadband sound absorption, intrinsic flame retardancy, low density, fiber-free structure and easy processing, melamine foam is suitable for acoustic design inside energy storage containers.

By properly arranging melamine foam on side walls, ceilings, fan surrounding areas, partitions and local enclosures, reflected noise can be reduced, the internal acoustic environment can be improved, and fire safety, lightweight design and installation flexibility can be maintained.

For renewable energy storage systems, BESS battery cabins, PCS equipment cabins and other industrial metal enclosures, melamine foam is a preferred acoustic material that combines safety, acoustic performance and engineering adaptability.

14. Suggested Product Specification

Item	Recommended Range
Material	Melamine Acoustic Foam
Density	7-12 kg/m³; adjustable according to project requirements
Thickness	20-25 mm / 30-50 mm
Structure	Bare foam, adhesive-backed foam, fabric-laminated foam, perforated protective structure
Application Area	Side walls, ceiling, fan surrounding areas, ducts, partitions, local enclosures
Main Function	Sound absorption, noise reduction, reflection reduction, internal acoustic environment improvement
Processing	Cutting, die-cutting, adhesive backing, lamination, custom-shape fabrication
Optional Facing	Nonwoven fabric, fiberglass cloth, aluminum foil, perforated aluminum panel, flame-retardant fabric

15. Contact / Technical Support

For material selection in a specific energy storage container project, please provide the following information so that an appropriate solution can be recommended:

- Container dimensions
- Internal equipment layout drawing
- Fan quantity and position
- HVAC system position
- Current noise level
- Target noise reduction value
- Available installation space
- Fire safety requirements
- Whether a protective facing is required
- Whether adhesive backing or lamination processing is required

We can provide melamine foam thickness recommendations, installation area suggestions, laminated structure options and processing solutions according to the actual project.

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Websites: www.sinoyqx.com | www.ydnfoam.com

Available support: TDS, SDS, test reports upon request, sample evaluation and project-specific acoustic / thermal design suggestions.