GTB®

MOTIVE POWER *Silencer Infill Options*

FOR AUTOMOTIVE, LOCOMOTIVE AND MARINE SILENCERS

Fibrous materials produced from mineral, glass and metal sources are well known for achieving effective acoustic absorption within **automotive, locomotive** and **marine silencers** of the absorptive or absorptive/reactive type. Frequently encountered materials are 434 (ferritic) fibrous stainless steel, basalt mineral fibre and A-glass or E-glass fibres. Each of these materials has properties pertinent to motive silencing applications and this note aims to clarify the situation in respect of materials selection, ***None of the materials discussed here are classifiable under EU Directive 97/69EC and are thus considered non-carcinogenic.***

Fibrous stainless steel may be used either as a screen around perforated tubes or as an infill material in its own right. The limiting temperature of '434' stainless steel is 800'C.

Basalt mineral fibre comprises spun fibres formed into "wool". The process results in a wide distribution of fibre sizes within the air/fibre matrix in terms of diameter and length The majority of the fibres have a diameter within the range 6-30um. The mean length of the fibres will typically be 75mm, although there is a significant distribution in respect of individual fibre length. Basalt fibre is typically packed at circa 130kg/m3. The supply is as bagged wool, rolled blanket or individual pads pre-cut to required size and contained within ultra-lightweight micro-perforated polypropylene "bread wrap". On start-up the wrap degrades rapidly to a small quantity of water and carbon dioxide. The limiting temperature for the **GTB Basalt** fibre is circa 775'C.

E-glass fibres originate as continuous drawn strands, subsequently twisted together to form round yarn or lightly bonded together to form flat "roving".

The diameter range for these fibres is narrow, with glass fibre yarn and roving being specified according to the diameter and the number of strands making up the thread. E-glass fibres used for textile yarn are typically of 6um or 9um in diameter, whilst fibres for roving are typically 11um or 22um. E-glass fibres used in mufflers may be chopped from yarn to a length of between 50-100mm and fluffed into high bulk "wool". This wool can either be packed directly into mufflers or subjected to mechanical needling to produce a consolidated felt (needlemat). The individual fibres of roving material may be separated by compressed air, forming a continuous string of high bulk fibre for packing into muffler boxes. Limiting temperatures are circa 650'C for E-glass fibre and circa 700'C for the boron-free variant.

A-glass fibres are produced as drawn strands in a similar process to E-glass fibres, but differ in that the fibres are wound on to a large drum as single strands (monofilaments. A-glass monofilaments are typically in the diameter range 22-26um. For use in mufflers, the fibres are fluffed by ravelling from a hank to form a robust glass wool comprising continuous fibres with highly torsional properties. The limiting temperature for ravelled A-glass fibre is circa 560'C.

ACOUSTIC CONSIDERATIONS

Fibrous stainless steel is very effective when used as an overwrap for internal perforated tubes in conjunction with basalt mineral fibre as core absorber. It not only acts as a fibre retainer but, due to its extremely low flow resistivity (high porosity), it also functions as a “sound guide”, maximising the dissipation of acoustic energy into the bulk fibrous material located immediately behind. Due to the high fibre diameter (typically 60-120um), the use of **fibrous stainless steel** as a core absorber in smaller mufflers is acoustically less effective than either mineral or glass fibre, making the material better suited for larger muffler boxes.

In achieving acoustic performance, the spun **Basalt mineral fibre** matrix, with its wide range of fibre diameters (typically 6um-30um), has an advantage over drawn **E-glass fibre** with its narrow diameter range. Over the pertinent frequency range of 400-1600Hz, the coarser fibres absorb acoustic energy more effectively in the lower half of the frequency range, whilst the finer fibres absorb more effectively in the upper half of the frequency range. In relatively small muffler boxes, spun **Basalt mineral fibre** will deliver the highest acoustic performance. As the size of the muffler box increases, differentials in acoustic performance between **Basalt mineral fibre** infill and **E-glass fibre** infill become progressively less significant.

Provided that the absorbing thickness is sufficient, relatively low flow resistivity and highly torsional (bending) characteristics of ravelled **A-glass fibre** produce exceptionally good acoustic attenuation in the 125-250Hz frequency range. This makes ravelled A-glass fibre especially suitable for motive power silencing applications involving commercial/marine diesel engines.

DURABILITY

The durability of fibrous infill in an exhaust muffler is dependent upon four criteria - **chemical resistance**, **thermal stability**, **physical robustness** and **packing density**.

Fibrous stainless steel offers very high durability at high operating temperatures (to 800’C). However, with fibrous stainless steel as the sole infill material the specified acoustic performance can be difficult to achieve in small mufflers whilst in larger silencing applications it represents the most costly option.

Glass fibres are perceived as having greater durability than **Basalt mineral fibres**. This perception arises from their physical robustness (especially continuous glass fibres) and by concern over inconsistency in the chemical resistance of basalt materials. **Continuous glass fibres** can be safely packed at lower density because locational stability is not so important. However, to achieve optimum acoustic performance the packed density of all glass fibre materials should be around the same as for **Basalt mineral fibres**. The chemical resistance of **Basalt mineral fibre** in acidic condensates can be expected to be slightly lower than that of **E-glass fibre**, whilst In alkali conditions, the situation can be reversed., **A-glass fibre** is the most durable of the man made vitreous fibres (MMVF’s) in respect of resistance to chemical attack.

The basis for concern over the chemical resistance of **Basalt mineral fibres** arises from basalt rock being a naturally occurring material, whilst glass is a “manufactured” material. As a consequence of this, not all basalt deposits have the same composition. For example, basalt fibres formed from source rock which contains mineralogical calcium carbonate (Calcite) will inevitably have poor acid resistance. However, basalt fibres formed from Calcite-free source rock melted in an oxidising furnace atmosphere can be expected to exhibit very good chemical resistance. An example of this is **GTB Basalt mineral fibre** supplied by MC Resources Ltd. Spun from appropriate source rock under oxidising firing conditions, **GTB®** material has been proven in gas turbine, aero engine test cells and all types of motive power exhaust application over more than 25 years.

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