QTA Systems

DIY Loudspeaker Components

Article: How to use Loudspeaker Cabinet Damping Materials

1. A Review of Damping Materials used in Speaker Designs

The selective use of foams and damping materials within a loudspeaker cabinet can significantly alter / enhance it's acoustic performance. These materials fall into two basic types, those that can selectively absorb energy over a limited range and those that can shift / move the energy elsewhere. All vibrating objects produce sound pressure waves. These can act as a form of airborne interference and spoil the overall listening experience. For best cabinet acoustics we require a speaker cabinet to be acoustically dead and a number of designs exist to meet this criteria with varying degrees of success. These range from using very heavy panelling materials, e.g. concrete or marble slabs to sand-filled double-walled panels. A variety of materials attached to the interior of the cabinet can also modify it's response. The fact that there are so many options suggests no one approach is optimum for all occasions, disregarding the cost considerations of course.

Vibrating panels effectively act as large speaker cones with a small peak amplitude. These have selective modes of vibration, (resonances), and can be of sufficient amplitude to colour the overall sound. In addition the rear radiation from the speaker cone may be reflected around the inside of the cabinet and then back out through the speaker cone. This all contributes to a background noise which tends to distort the listener's sound experience and give rise to what's known as a 'box sound'. Low priced manufactured items are more prone to this problem as it's an easy area in which to make economies. Increasing the signal volume does little to help as the cabinet noise is increased also. So ----- what to do?

At this stage, it is important to realise that light weight materials can only be effective at high frequencies and that the heavier damping materials progressively take effect at the lower end of the frequency spectrum. So, lets look at the options.

2. Long Haired Sheep's Wool Loudspeaker Damping

Traditionally used to stuff transmission lines, at a density of around 450gms wool per 28L of enclosure volume, the wool is used as a moderator to the line velocity and thereby tune the line to some desired end result. Historically it was based on Dr Baileys processing prescription and was called Dr Baileys Long Haired Wool. Also used to stuff loudspeaker cabinets in which the acoustic properties are applied to provide a small dampening effect on medium frequency output, (HF Tweeters often sit in their own enclosure and are therefore unaffected). In addition, the propagation delay through the material is used, to some effect, in closed box designs to acoustically increase the box volume and hence change the characteristics of the box. The mathematics of this is complicated and is not investigated here.

Because of the relatively small usage for this application it is now difficult to obtain such material and consequently has to a large extent, been replaced by BAF, (Bonded Acetate Fibre), although the performance of this material is not as good. View or **Buy loose Sheep's Wool** damping materials here.

3. Close-up Herdwick Sheep's Wool Fibres

The loose wool fibres settle in volume after a period and a number of ways have been invented by DIYer's to keep it suspended within the cabinet and hence maintain performance. These range from using wooden dowel rods as a suspension medium, small stuffed parcels of modified fine denier tights and trapping the wool using plastic mesh. See

picture below.

QTA can supply wool from Herdwick Sheep which has been cleaned / scoured but not moth proofed. This is a close equivalent to the original Dr. Baileys, although the fibres are not quite as long.

4. Close-up Bonded Acetate Fibre (BAF)

A white, man-made synthetic material commonly known as 'BAF' , Bonded Acetate Fibre Wadding, and now often used as a replacement for wool-based acoustic applications. The fibres are all of a similar diameter and therefore have a different sonic performance to the more randomly distributed fibre diameters of wool. In this respect it is inferior to sheep's wool. Available in a number of weights, gms per sq metre and fibre thickness, (denier), the material is easy to cut, self supporting and moderately cheap. Available from good quality stores where it is often used as stuffing (insulation), for outdoor clothing. However, from most outlets there is no choice in specification.

5. Close-up Closed Cell Acoustic Foam

Generally available in two shapes / profiles, flat and egg box, the foam family are usually grey, opaque in colour and have a closed cell construction. The foam cells are chosen to be a specific size / diameter in order to provide a bulk material characteristic suitable for acoustic damping, i.e. the cells are mostly airtight and provide resistance to the passage of air if you try to blow through the material. This closed cell structure absorbs energy when the cell content, air, is compressed and rarefied due to the sound pressure wave. This type of damping foam is used to alter the high frequency response of cabinets and transmission line speakers. It does not work well for low frequencies as the amount of damping / energy absorption which the foam can support is relatively small. These are available from QTA Systems in flat sheets which can easily be cut using a sharp craft knife or similar.

6. Fibre Felts for Loudspeakers

Fibre Felts have similar absorption characteristics to foam but, due to their heavier structure, alter the sound quality at lower frequencies. There are no closed cells present but the felt fibres adsorb energy, raising their temperature. The technical study of this is complicated but the degree of effect, is dependent on the fibre thickness, types of materials used and the felt density. Usually specified in weight by oz per sq yard e.g. 35oz or 50oz etc. These Sound Absorbent Felts of mixed cotton and wool felts provide a good starting point for lower, budget orientated projects. Some felts are even manufactured to a dual density whereby the inner section has a lower density than the outer walls. This material is however hard to source.

7. Pure Wool Loudspeaker Felts

Similar in construction to the Mixed material felt shown above this felt has a Jute central base upon which is woven / needle stitched one or two layers of pure wool yarn. The basic material thickness determines whether a one of two layer construction is required. Available in similar weights as cotton and wool mixed felts these wool felts equate very roughly to felts ranging from 7.5mm to around 19mm thick. The **wool felts** have a more uniform density and hence better performance. The finished felt, although not rare, is price sensitive to the cost of the available raw wool material.

8. Custom Dual Density Speaker Felt

Similar in basic construction to single layer felts this type of felt has two differing layers bonded together to form a dual density layer. In this way it can provide a more flexible performance although it is not often used and is difficult to source.

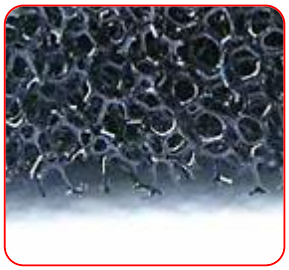
9. (High Mass Bitumastic Sheet

The second variety of damping makes use of high mass materials e.g. **Bitumastic Damping Sheet**, (self adhesive), to physically alter / lower the mass of a panel. Other materials such as laminated hardboard panels are also effective. The volume of these materials should be considered when constructing cabinets as they will modify the free volume box calculations. Heavier panels vibrate at lower frequencies and hence their noise spectrum is shifted. In this they do a good job but such damping will not be effective at high frequencies. A mixture of the two types of approach (high mass and low mass), is often used in the more expensive cabinets along with strategically placed bracing struts. One should note however, it is possible to move Bass Bin out-band resonances, which occur by way of their design, into their 'working' sound spectrum, hence making the problem worse so.....some care is needed. The picture shows a typical assembly with part peeled backing paper and fixing tacks which prevents the material from creeping in warm weather.

10. Loudspeaker Sheep's Wool: Internal support with netting

Light mass damping materials require both trapping and support if they are not to ultimately settle inside the cabinet, with a subsequent reduction in performance. Some mention of this has been made regarding the use of wool fibres. For containment purposes simple lightweight plastic mesh may be used, commonly purchased from hardware stores as mesh for garden use and moulded into appropriate shapes / volumes. Alternatively, the nylon mesh used to package fruit and vegetables is also suitable, the contents being healthy too.

11. Reticulated Grille Foam



Grille foams are, by nature, acoustically transparent. Also known as reticulated foam, the cell-like structure is of an open weave arrangement and easily permits the passage of air. Each cell is around 0.7mm in diameter and the number of cells per linear inch specifies / defines the cell structure. For this application 35ppi, (particles per inch). Usually black in colour the open cell structure has little intrinsic strength and the material usually needs to be supported on some type of frame.

The material will not take to stretching as the restoring force is minimal and once stretched the original dimensions cannot be recovered. The minimum usable thickness is around 10mm which requires frame support. At 20 / 25mm the material becomes self supporting, (depending on area and hence avoids the acoustic effects of grille frames). Susceptible to UV light, sunlight, the material slowly crumbles and has a usable lifetime of 10 / 15 years before requiring complete replacement. Often used on designs of the 70's and 80's. Used as a repair for legacy devices QTA Systems still have a small number of offcuts available. **Grille Foam OFFCUTS**.

Buy from a selection of Damping Materials

12. Use Sound-Damping and Acoustic Materials in DIY Loudspeakers

Cabinet Stuffing's.

In order to further moderate / tune a cabinet's response, loose volume stuffing may be used. For a closed box design the design often relies on the stuffing to moderate the cabinet volume to produce a specific acoustic response. The cabinet volume is effectively altered / increased by some (5 -10)%.

Stuffing's generally fall into two types, man-made and natural fibres. They have different characteristics but the most commonly used is man made, of which Bonded Acetate Fibre, BAF Wadding for short is the front runner. Polyamide fibre as used in jacket stuffing's is also practical. The second type is Sheep's wool. This has superior characteristics but is more difficult to use.

The application of....Foams and Felts.

Unwanted sounds are generally called colorations and these should be minimised to an acceptable level. There is no specific definition of coloration limits so... Different cabinet designs and shapes, have differing colorations, some leading to what is well known as 'the box sound'. In this respect small cabinets can be worse. Its actually more difficult to make a 'good', small, speaker than a larger one.

To prevent / reduce internal cabinet reflections from emerging out through the speaker cone, creating coloration, a thick wad of felt, say (20 - 25) mm, may be placed on the rear cabinet wall, behind the drivers. In addition, a similar thickness may be glued to the rear of the driver magnet assembly. This reduces internal reflections. If you have vented rear pole assemblies don't forget to cut a hole in the material to allow the vent to breathe. This should be augmented by foam damping on the other interior cabinet walls of say (10 - 16)mm. Small cabinet boxes may need to be slightly larger in volume to offset the lost volume due to the damping materials. There is no easy way to guess or measure the actual felt / foam volume, some experimentation and listening trials are required The use of Bitumastic Damping in small cabinets is not often required, as small boxes are very stiff and hence flex much less than larger panels.
Read about Bitumastic Damping.

Telephone: +44 (0) 1223-891091 Email:- Sales, and Support to Contacts.