Reuse of textile powder remainders for acoustic applications using the Wet-Laid technology

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Nowadays, the sound insulation and the acoustic conditioning are problems to arise in the building constructions and in the design of certain enclosures. Last years the legislative scene in terms of noise and vibrations has been changed supposing, the final approval of the DB-HR of the CTE in Spain, the most important change. Within this new legislative framework, besides to increased sound insulation requirements appear new requirements related to the acoustic conditioning of certain enclosures.
So that, gradually, has been created the need for look for new materials with acoustic properties which meet the new acoustics requirements. Moreover, are well known the economic problems, storage problems and environmental problems that entail the remainders in a production process. Specially, in the textile industry, tones of remainders are generated in the manufacturing processes. Many of these residues are like a powder with difficult recycling, but it can be recycled by means of Wet-Laid Technology. This work evaluates the feasibility of include, as solutions to the new acoustics requirements, woven nonwovens made with textile remainders using Wet-Laid Technology.

1 Introduction

Nowadays, there are more and more noise sources which generate high noise levels and we can find these kinds of sources into buildings or out of them. Moreover, in Spain have been increasing the demands by people for a better quality of life, from the acoustic point of view. These demands are directly related with changes in the legislative framework.

To come into effect the Basic Document about Noise (DB-HR), people become more concerned with the acoustic and with the effects that high levels of noise can produce on our health. The Basic Document about Noise (DB-HR) is part of the Technical Edification Code (CTE) in Spain [1].

Within this new legislative framework, besides to increase the sound insulation requirements, appear new requirements related to the acoustic conditioning of certain enclosures, where the Reverberation Time is an acoustic parameter that we have to know [2]. Moreover, the society requires more and more new materials that can meet all of our needs, from the acoustic point of view.

These days, there are new materials with acoustic properties which have been obtained from textile wastes. These kinds of materials suppose an important breakthrough. On the one hand, materials made from wastes can become a great tool to conserve the environment; on the other hand, these kinds of materials can also represent a source of saving for the manufacturing company, using its own wastes as a new raw material.

Textile industries generate large amounts of waste, some of them like a powder difficult to re-use. On this matter, the Wet-Laid Technology allows us re-use these kinds of remains and turn them into new materials.

In this work we have focused in two objectives. The main objective is study the acoustic behaviour of several samples of woven nonwovens. These nonwoven materials have been manufactured using Wet-Laid Technology. The raw materials used to manufacture these woven nonwovens have been wastes of powder, produced in a textile industry, and a little percentage of binding agents to form the new material. The other objective of this work is to carry out a preliminary study about the acoustic behaviour of nonwoven materials combined with recycled polyester. The recycled polyester used in these combinations has been manufactured from remains of plastic bottles (PET). This recycled polyester was already studied [6] and nowadays is being used as solution and improvement for acoustic insulation and acoustic conditioning.

2 Wet-Laid Technology and Acoustic Characterization

2.1 Wet-Laid Technology

Wet-Laid Technology is a technology used to obtain woven nonwovens. There are several characteristic stages in the manufacture of nonwoven fabrics by the Wet-Laid Technology:

- First of all, the remains of fibers to be used in the manufacture of nonwovens are suspended in water, which acts as the carrying agent. The dilution factor must be high to ensure proper dispersion of the fibers to avoid tangling or clumping. This suspension of fibers is called the *Slurry*.
- The nonwoven sheet is made by the drained of this Slurry through a forming wire/screen to remove the water.
- Once most of the water has been removed, the sheet must be dried and must be passed over the heated drum called dryers. At this point, further chemical treatments can be added to give each nonwoven its distinct characteristics colorants and binders.
- Finally, the last step of the process is carrying out the winding of the nonwovens.

Figure 1 shows a diagram of the Wet-Laid Technology process for the nonwoven manufacturing.

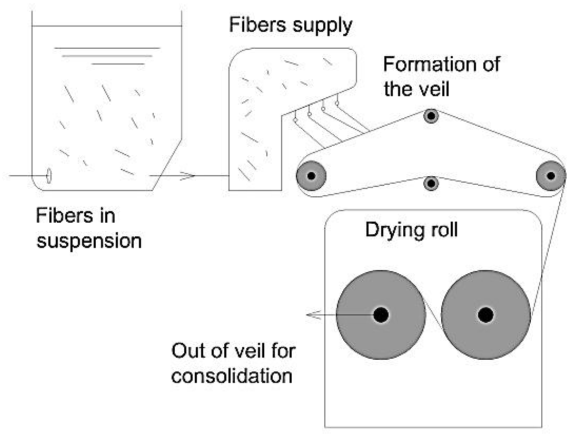

Figure 1. Wet-Laid Technology process for the nonwoven manufacturing.

2.2 Acoustic characterization

In order to carry out our objective and study the feasibility of using nonwovens as acoustic materials we have tested thirteen different materials and we have obtained the sound absorption coefficient of normal incidence for each of them. This parameter, normalized to unity, uses to characterize a material as an absorbent acoustic material. It will be considerate absorbent acoustic material if the sound absorption coefficient value is higher than 0.2.

The sound absorption coefficient is defined as the ratio of the acoustic energy absorbed by the material and the incident energy. This parameter has been obtained according to specifications of the Standard ISO 10534-2:1998 [5].

Figure 2 shows a picture of the experimental device that we have used to obtain this parameter and figure 3 shows a picture of one of the materials that we have tested in this work.

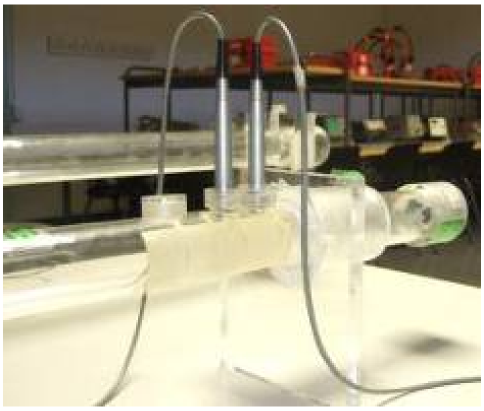

Figure 2. Experimental device to obtain the sound absorption coefficient of normal incidence according to standard ISO 10534-2:1998 [5]

Figure 3. One of the woven nonwovens tested in this work.

3 RESULTS

In table 1 we can see the characteristics of materials manufactured with Wet-Laid Technology that have been studied in this work. We can see the thickness and density of each of them.

We have tested samples of nonwovens composed by 60% of textile remainders, 30% of cellulose remainders and a 10% of HDPE as binding agents. These samples are known in this work as Test 1, Test 2, Test 3 and Test 4. The rest of the samples are composed by 90% of textile remainders and 10% of HDPE as binding agents.

Table 1. Thickness (mm) and densities (g/m^2) of the samples tested in this work.

Name of sample	thickness (mm)	Density (g/m^2)
TEST-1	2.003	150
TEST-2	2.682	200
TEST-3	3.832	250
TEST-4	5.38	300
TEST-5	1.168	200
TEST-6	1.105	300
TEST-7	2.949	475
TEST-18	3.393	650
TEST-19	0.581	150
TEST-20	0.640	80
TEST-21	0.640	45
TEST-22	0.701	45
TEST-23	0.682	300
TEST-23NC	3.210	300

As well as the samples of nonwovens that we can see in table 1, we have studied different combinations of these nonwovens with polyester wools. In order to obtain this purpose, we have used polyester wool with 2cm of thickness and 400g/m2 of density.

Combinations conformed by Test 23NC and Test 23 with polyester wool have been studied as a preliminary study.

Figure 4 shows the sound absorption coefficient of normal incidence values obtained for each of nonwoven materials tested.

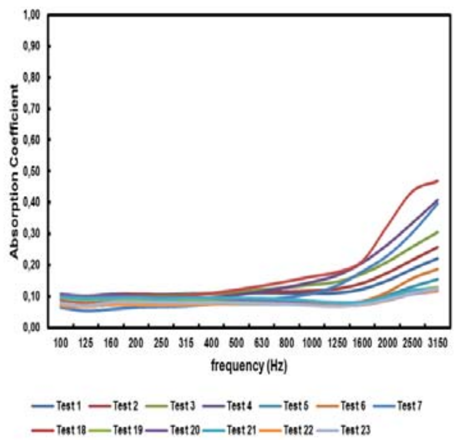

Figure 4. Sound absorption coefficient of normal incidence obtained according to standard ISO 10534-2:1998 [5] for all samples studied.

Figure 5 compares the value of the sound absorption coefficient of normal incidence obtained for TEST 23 and the value obtained for TEST 23NC. Figure 6 compares the results obtained for the combinations of these samples with polyester wool.

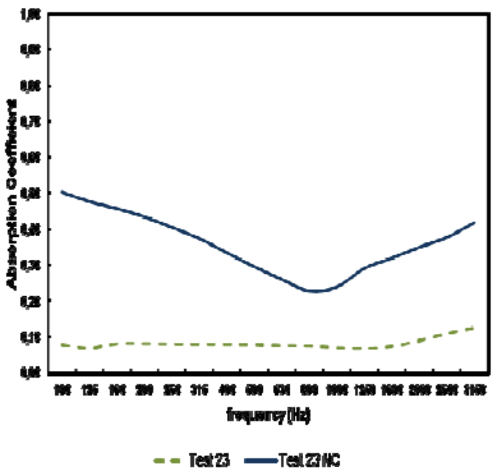

Figure 5. Sound absorption coefficient of normal incidence obtained according to standard ISO 10534-2:1998 [5] for calendering nonwovens and no calendering nonwovens.

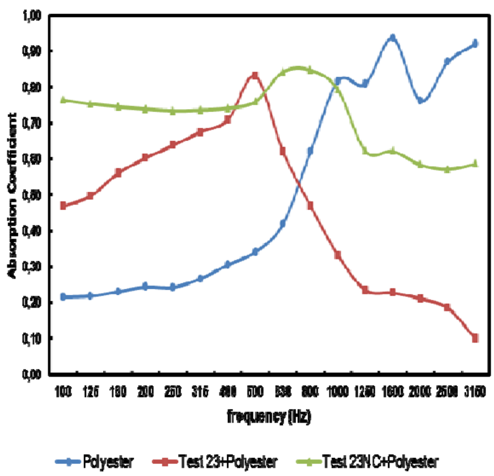

Figure 6. Sound absorption coefficient of normal incidence obtained according to standard ISO 10534-2:1998 [5] for sample of polyester and combinations of this with Test 23 and Test 23 NC

4 DISCUSSION

As you can see in figure 4, the studied nonwovens samples don't have a trend with the frequency typical of acoustic absorbent material that is the normal incidence absorption coefficient increases according to the increases frequency. However, the combination of these materials with other absorbent materials like polyester wools produces a resonance effect, as shown in Figure 5. Therefore, if you put these kinds of nonwovens on rigid surfaces they behave as sound-reflective materials but if we place it on acoustic absorbent materials, can produce a resonance that will depend on the thickness of the material and its density. These materials can be used to adapt an absorbent material to mid and low frequencies, covering the range of frequencies that typical absorbent materials don't cover. Moreover, an excess of high frequency absorption effect, could be corrected covering a percentage of the absorbent materials already installed with these kinds of materials.

5 CONCLUSIONS

The global conclusions to this work are listed below:

- Materials studied in this work have sound-reflective characteristics. Due to these characteristics and the appearance like a woven that these materials present, we can use them as a solution in acoustic conditioning. If we combine these nonwovens with absorbent acoustic materials, like polyester, we can use these combinations as a solution to problems generated in an acoustic conditioning, for mid and low frequencies. It depends on the choice of the absorbent material used. These kinds of combinations can be also used for acoustic barriers.
- Nonwovens studied in this work are fully applicable in the field of room acoustics as a solution to problems of acoustic design, for example, we can use them to solving a problem of too much sound absorption coefficient in a room at mid and high frequencies. These kinds of mistakes in acoustic design are often detected when the room is totally finished, with furniture, screens, fitted carpet, etc. For this reason, nonwovens are good solutions due to their appearance, flexibility, low thickness and acoustic properties. Moreover, these kinds of materials can be made from textile remains thanks to Wet-Laid Technology, so we are going to use recycled and sustainable materials for acoustic applications.
- We have studied combinations of woven nonwovens, made using Wet-Laid Technology, with polyester wools and we have obtained values of sound absorption coefficient of normal incidence over 0.50 (at times around 0.7 or 0.8) at mid – low frequencies. These results are due to the behavior of acoustic resonator that it combinations presented.
- The study of different combinations between nonwoven and polyester is a preliminary study. Nevertheless, is a starting point to start the study of different combinations using calendering and no calendering nonwovens and then obtain a sound absorption coefficient which we can control, moving the peak of the resonance frequency according our requirements.

Acknowledgments

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