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A NOISE AND VIBRATION PROTECTION BY MIXED POLYMER WASTE

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Introduction

The extensive development of the environment has been connected with an extremely high consumption of raw materials and energy and accompanied by water and air pollution and excessive production of wastes. The industrial production represents both in quantity and diversity of wastes the main producer of ecologically harmful matter.

The basic aim of ecological policy is to re-establish of the dynamic balance between the society and environment. In the implementation of the aims of ecological policy the adequate combination of two strategies will be used:

1. ecological strategy "ex-post" - measures aiming above all at elimination or at least reduction of existing pollution sources.
2. ecological strategy "ex-ante" - preventive measures aiming at the ideal of relatively closed production and consumption cycles with minimum negative effects on the environment.

By now, "ex-post" strategy has been prevailing in taking care of environment. That is why we are trying to help with solving ecological problems caused by wastes. We are developing suitable technology processing extremely contaminated polymer wastes from plastics and rubber productions. The result of this activity should be projects of utilizing these recyclates, mainly for noise and vibrations reducing products.

Technology processing polymer wastes

There are two main possibilities of rubber wastes processing:

- cure (vulcanization),
- physical-chemical rubber-to-other material bonding.

We are presenting three recyclates (numbered 1, 2, 3 in our faculty catalogue) as an example of the first alternative of processing. They were made from rubber compound from non-vulcanized waste rubber crumb and non-vulcanized scraps from the tyres production with textile or wire cord. Other 3 materials numbered 15, 16, 17 represent recyclates from scorched rubber, rubber crumb and non-metallic, mainly polymer waste from scrap cars [1-3].

We measured air-borne sound insulation of materials numbered 1, 2, 3, 15, 16 and 17. The property expresses the ability of a parting element to prevent air-borne sound transmission. These materials (which are produced from rubber and plastics wastes) exceeds common building materials in sound insulating properties. Airborne sound insulation of building elements of the recyclates of numbers 1, 2, 3 is by about 10 dB better in a large frequency range. It means that they attenuate ten times more acoustic energy than compared building materials.

One of the main causes of these favourable sound insulating properties of the recyclates we have developed is their high critical frequency (it is the lowest frequency when airborne sound insulation of building elements decreases significantly as a result of coincidence). This frequency should be as high as possible. As you can see from Table 1., where there are critical frequencies of the recyclates and of some building materials, for the recyclates the critical frequency is very high, in our case off the audible frequency band.

Table 1.: The critical frequency and the loss factor of the recyclates and of some building materials (for the square weight of 20 kg/sqm)

Materials	The critical frequency [Hz]	The loss factor
Recyclate 1	26 637	0.0700
Recyclate 2	24 876	0.0700
Recyclate 3	31 140	0.0700
Recyclate 15	20 522	0.1500
Recyclate 16	21 071	0.1400
Recyclate 17	22 696	0.1500
Aluminium	1 766	0.0001
Steel	4 250	0.0001
Lead	25 046	0.0150
Concrete	2 332	0.0050
Bricks	2 214	0.0100
Plywood	601	0.0100
Beech wood	519	0.0100
Glass	1 605	0.0020
Polymetylmetacrylate	2 378	0.0020

Another material we used for our experiments was rubber waste with plastic melt as a binder. A melted polymer waste with various composition is used binder. This variant is less money and time consuming and the material is also easier to process than the other one.

The actual material was a mixture of rubber and plastic crumb from scrap cars and wood fines. This was jointed by mixture of melted polymer crumb from conductor insulation. The aim was to find the technologic conditions of the bonding (such as temperature, pressure and the time of pressing and also optimum weight percentages of wastes). The most convenient material was designated as 790115 (in the catalogue of FT VUT). Its mechanical properties meet the requirements for its application to the Variable blocks.

Fibrous reinforcing materials

Beside above mentioned materials there is another one that has not been recycled by now, fibrous reinforcing material.

We searched for a way of processing this fibriform waste with the aim to get substance for production of sound-absorbing, solid-matter-borne sound deadening and heat-insulating materials [4].

The three areas of their utilization can be characterized by the following application properties:

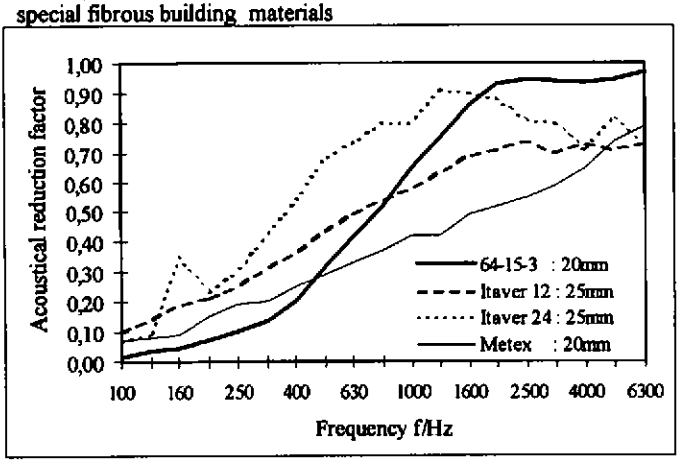
- high sound reduction
- suitable dynamic stiffness or modulus of elasticity
- low heat conductivity.

Nine basic recyclates have been developed (in the catalogue of FT VUT marked materials of series "64"). They differ in density, optimum weight percentage of bonding agent and thickness. These 9 recyclates represent the result of various technological processes where temperature, time of bonding, way of pressing etc. were changed.

In essence, the recyclates are made up by synthetic fibres and remains of unseparated rubber crumb mixed with polymer bonding agent. Besides these basic recyclates, their modifications have also been developed namely non-hygroscopic and non-flammable. The incombustibility is caused by a certain biopolymer waste from leather processing.

As an example we present the recyclate 64-15-3. Its sound absorption coefficient is comparable or even better than special sound absorptive fibrous materials Metex, Itaver12, Itaver24 (Fig. 1.). In addition, the data published for Itavers refer to the thickness of about 25% higher than our specimen was. The other recyclates had similar advantageous characteristics.

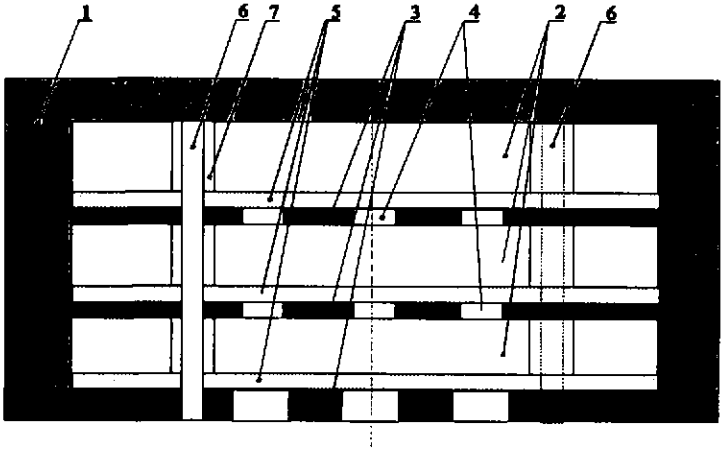
Fig. 1.: Comparison of the frequency responses of the acoustical reduction factor - the recyclates made from the contaminated fibrous waste textiles and some special fibrous building materials



The application

These recycled materials were used to produce parting elements (position 3 in Fig. 2.) for Variable antinoise blocks (registered model [5]) (Fig. 2.). It is possible to build antinoise shields along roads, railways and at airports or in industrial plants from these blocks. Their setting-up can be changed to attenuate the frequencies that are to be attenuated. They can also absorb several frequencies at a time (depending on the number of chambers (position 2)). The fibrous materials (position 5) which were acquired during our experiments from recycled fibrous reinforcing materials, will be used for attenuation.

Fig. 2.: The variable antinoise block



Position:

1. the supporting skeleton of the block
2. the chambers
3. the parting elements
4. the vents in parting elements
5. the sound absorbing material
6. guide bars
7. the distance piece

The conclusion

It is evident from our results that suitable technology of vulcanization enables to process the wastes from rubber production and non-metallic parts of scrap cars into materials used for soundproof constructions, and for elements with low sound emission. Various polymer or non-polymer wastes can be recycled with suitable bonding materials and the result are materials which can meet our requirements in a narrow specific field of application. These new materials have much better acoustic properties than present building materials. In this way we save expensive classic materials and get rid of wastes that are very difficult to process which protects the environment.

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