The Application of Ultrasound at the Production of the Elements for the Heat-insulated Floor

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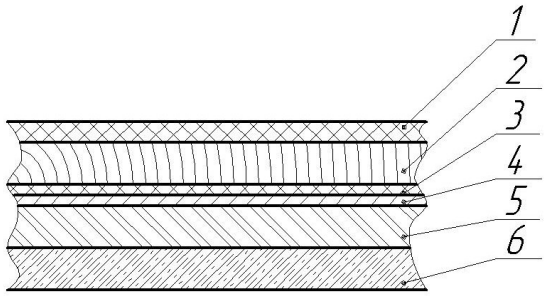
***Annotation* – The article is devoted to solution of problem of quality increase of special coverings providing heating of the buildings due to the creation of the new technology of the production of heating elements for flooring on the base of stone flags, ceramic tiles. The particular feature of the technology is the application of high-intensity ultrasonic vibrations at all stages of the production begining with degassing of epoxy resin, impregnation of the surfaces and final treatment of the element of heat-insulated floor. The use of new technology let up-grade the production of final products and increase heat transfer.**

***Index Terms* – Cavitation, degassing of epoxy resin, ultrasonic vibrations.**

I. INTRODUCTION

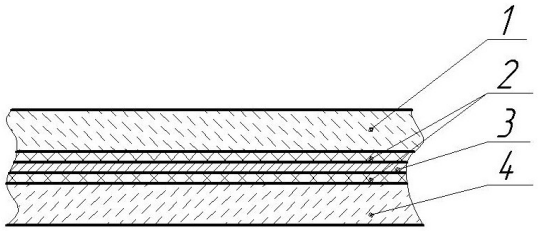
KNOWN TRADITIONAL methods of the production of the elements of heat-insulated floor are in the placement of heating elements under floor surface, e.g. under stone flags, ceramic tiles, parquet elements or laminated sheets [1]. At this heating elements can consist of electrically heated foil, as it is shown in Fig. 1.



1 – linoleum, 2 – fibreboard or veneer wood, 3 – polyfilm, 4 – thermofilm, 5 – reflector-heat insulation, 6 – primary floor.
Fig. 1. The composition and the structure of heat-insulated floor with the reflective elements.

At the realization of the traditional technology of the production of heating elements generated heat should firstly penetrate into stone flags of ceramic tiles, before the room will be heated up to necessary level. To supply quickly generated heat to the accomodation intended for heating the heating elements are located inside the coverings (in the stone flags, parquet element or laminated sheet).

Such approach is realized in the technology of the production of floor heating elements [2], at which heating element is located insude the covering in the stone flag or ceramic tile. Liquid resin is applied on the bearing stone flag, the film heated element as located on the the surface of the resin and after taht it is covered with the layer of resin, the flag stone with decorative or special covering are laid on the surface of the resin and polymerization of resin is provided, as it is shown in Fig. 2.



1 – stone flag with decorative or special coating, 2 – layer of epoxy resin, 3 – thermofilm, 4 – bearing stone flag
Fig. 2. The composition and the structure of heat-insulated floor with epoxy resin.

The resin used at the production of the heating elements can penetrate into the structure of the surface of stone flags and film heating elements. That provides mechanically strong surface, the resistance to shock load of the surface and thermal stress reduces. Limited thermal dilatation provides the stability of final product.

The main disadvantage of such technology is the application of epoxy resin, which has restricted density of polymer mesh. Epoxy resin contains large number of gas occlusions, which quantity rises, when epoxy resin is coated the surface of bearing stone flag and film heating element. During the polymerization heating with the liberation of gas takes place and in the places of joining of film heating elements with stone flag there are delaminations (foliation) in the form of flat gas occlusions. The presence of gas occlusions (delaminations) reduces

the efficiency of heat transfer, causes heterogeneity of heating of stone flag providing delivery of heat in the room, and also decreases durability of heating elements.

In this connection there is a need to design new technology, which will be able to provide removal of gas occlusions from epoxy resin during the production of the heating elements.

II. PROBLEM STATEMENT

The main point of proposed technology is inthe following, epoxy resin is preliminary influenced by ultrasound with the frequency of 22±1.65 kHz and the intensity of no less than 15–20 W/cm^2 in a specified period of time.

Moreover during the coating by epoxy resin and its polymerization ultrasonic influence is realized with the amplitude of no less than 10 micromicron on the surface of the stone flags and the layer of epoxy resin.

To check the efficiency of new technology based on the application of ultrasonic vibrations it was realized at the production of heating elements with the use of stone flags.

III. PRACTICAL REALIZATION OF THE METHOD

Preliminary prepared epoxy resin (mas of no less than 5 kg, without hardener, in the metal container) was exposed to ultrasound with the help of the ultrasonic device series «Volna–M» model UZTA-1/22-OM produced by «Center of ultrasonic technologies» ltd [3]. The influence was carried out at the operating frequency of 22±1.65 kHz with the help of piezoelectric vibrating system with the working ending 40 mm in diameter. The entering of ultrasonic vibrations was provided with the intensity of no less than 15-20 W/cm^2 (Figure 3).

As a result of such influence the viscosity of epoxy resin was reduced, the formation and the collapse of cavitation bubbles united and floated took place. It provides degassing and activation of epoxy resin. The duration of ultrasonic treatment was determined by the degree of degassing.

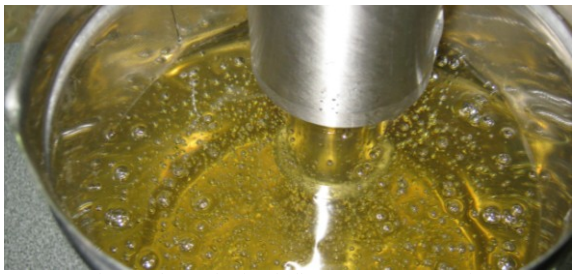


Fig. 3. The cavitation influence on epoxy resin.

At electric power in 1000 VA consumed by the ultrasonic device no less than 300 W of acoustic power was entered into epoxy resin. At the specified power during the treatment of 5 kg of epoxy resin for 5 minutes the temperature of processed medium rose up to 50-60 degrees centigrade and no less than 95% of dissolved gases was removed.

The production of the element of heat-insulated floor consisted of depositing of epoxy resin on bearing stone flag and internal surface of stone flag with decorative or special coating, placing of heating element on surfaec of the layer of epoxy resin, removal of air bubbles from film heating element, coating it with aditional layer of epoxy resin, placing of stone flag with decorative or special coating on the surface of epoxy resin and providing of polymerization of epoxy resin. During the deposition of epoxy resin and its polymerization ultrasonic influence on stone flags and layers of epoxy resin was realized with the amplitude of no less than 10 micromicron.

Ultrasonic influence was carried out at providing of mechanical contact of the working ending of the ultrasonic radiator with the layer of epoxy resin or the surface (e.g. internal) of the stone flags and motion of the ultrasonic radiator over processed surface, as it is shown in Fig. 4-6.

Fig. 4. The influence on the layer of epoxy resin deposited on the internal surface of the stone flags.

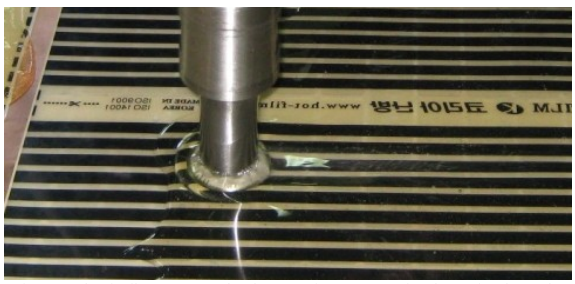


Fig. 5. The influence on the layer of epoxy resin deposited on the surface of the heating element.

Fig. 6. The influence on external surface of the stone flags

At that the stone flags make mechanical vibrations, and epoxy resin is exposed to additional ultrasonic influence. Generated gas occlusions become smaller, move along heating element and leave the space between the stone flags.

Th treatment of external surfaces was carried out by moving of working tool of the ultrasonic vibrating system by the circular motions begining with the center of the surface with the use of intermediate acoustic medium, e.g. vegetable oil.

Final polymerization of epoxy resin between the stone flags was realized during the day under the pressure.

VI. CONCLUSION

Ptoduced samples of the elements of heat-insulated floor passed comparison tests, which proved appropriateness of proposed and mature technology. Inparticular the time of achieving of specified heating temperature decreased in 18%.

At present limited liability company «Center of ultrasonic technologies» prepares the ultrasonic technological equipment intended for realization of proposed metod for the application to serial production.

REFERENCES

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