THERMALY ACTIVE INTERIOR PANELS WITH AN INTEGRATED ACTIVE AREA

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Abstract

Panels with an integrated active area can be used for interior applications for walls, ceilings and floor heating, and alternatively as a wet or dry type of construction. At present, most panels with an integrated active area are made of gypsum boards with milled channels and embedded pipes. Some manufacturers already supply these panels with thermal insulation (Radwan et al., 2021; Zhang et al., 2020). Certain limitations, mainly regarding the diameter and material of the pipes, apply to the panels with channels milled in the gypsum board and embedded pipes. These limitations are closely related to the high cost of such panels and to the limited heat/cooling output. The disadvantages of these panels are eliminated by the construction of a thermal insulation panel with active thermal protection for application with an active heat transfer control system (indoor thermally active panel (ITAP)) in accordance with European Patent No. EP 2 572 057 B1 (Kalús, 2011).

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Key words

- Indoor thermally active panels (ITAP),
- Active heating/cooling surface.

1 INTRODUCTION

Patented panels with integrated active areas for interior applications mainly use thermo-insulation slabs with milled channels and embedded pipes (Figs. 1, 2) or system boards with embedded pipes. The panels can be furnished with a surface treatment in the form of, e.g., gypsum boards, which are used for dry construction. The panels can be made without a surface treatment as well; such panels can be used for wet construction. The application of capillary mats instead of pipes is also possible (Fig. 3). Panels with an active area for interior applications can be used as a heat carrier as well. Such panels are not constrained by the diameter of the pipes, and the thickness of the thermal insulation into which the pipes are integrated can be from 50 mm, depending on the requirements for thermal protection of the building construction. In this case the heat/cooling output has greater variability, thanks to the possibility of greater flows of the heat/cool carrier (Boccardo et al., 2019).

Fig. 1 Prototype of an ATIP panel - EPS, dimensions: 2000 x 1000 x 100 mm; heat transfer medium: water (Kalús, 2011)

Fig. 2 Prototype of an ATIP panel - supporting frame - mineral wool, dimensions: 2000 x 1000 x 100 mm; heat transfer medium: water (Kalús, 2011)

Fig. 3 Prototype of an interior panel with an integrated capillary mat; heat transfer medium: water (Kalús, 2011)

2 CURRENT SITUATION WITH LARGE AREA APPLICATIONS RADIANT HEATING/COOLING

In the case of large-area radiant heating/cooling, we recognize two basic solutions for the design of the heating surface:

- *wet method* - the heating surface is built-in, so it is an integral part of the building construction,
- *dry method* - the heating surface is separate; it is a heated plate, namely:
 - fixed to one of the building structures,
 - placed freely in the heated interior.

Thus, the heating/cooling system formed from the tube registers is concreted directly in the building structure, possibly under a plaster (Fig. 4), or, if the radiant heating is completed additionally, for

example, these registers can be hung under the load-bearing ceiling and covered with a plaster layer in the ceiling, i.e., the wet method, or panels with integrated tubular or capillary systems (e.g., in SD boards), i.e., the dry method, are used (Cvičela, 2011; Janík, 2013; Janík and Kalús, 2012).

2.1 Application of interior heating active panels for walls

Thermally active interior wall panels can be applied to an auxiliary structure (Fig. 5) and also by directly gluing them to the masonry (Fig. 6), as shown in principle in the company documents of plaster-board manufacturers, respectively, radiant large-area heating/cooling panels with integrated tubes in SDK boards (Figs. 7, 8).

Fig. 4 Concealed wall energy system (Cvičela, 2011; <https://slovensko.wolf.eu>)

1 – wall, 2 – thermal insulation, 3 – interior plaster, 4 – heating/cooling pipe, a – interior surface temperature, b – outer surface temperature, c – heat transfer medium temperature, Q_e – heat flow from the pipe towards the exterior, Q_i – heat flow from the pipe towards the interior

Fig. 5 Principle of the application of interior wall panels with an integrated oven to the auxiliary structure (<https://slovensko.wolf.eu>)

Fig. 6 Principle of the application of interior wall panels with an integrated glue oven (<https://www.knauf.sk>; <https://www.rigips.sk>)

Fig. 8 Principle of the connection of thermally active interior wall panels with an integrated oven by means of a Tichelmann connection (<https://slovensko.wolf.eu>)

Fig. 7 Principle of the installation of thermally active interior wall panels with an integrated oven in thermal insulation boards covered with a top plate, e.g., pasteboard (Kalús, 2011)

Fig. 9 Principle of the connection of thermally active interior ceiling panels with an integrated oven (<https://slovensko.wolf.eu>)

Fig. 10 Details of the anchoring of the ceiling panels with integrated pipes (Kalús, 2011)

Fig. 11 Floor plan of interior floor panels with integrated pipes (Kalús, 2011; Cvičela and Kalús, 2008)

WET CONSTRUCTION METHOD

Fig. 12 Details of the wet construction of floor heating by interior panels with integrated pipes – accumulation heating (Kalús, 2011; Cvičela and Kalús, 2009)

2.2 Application of thermally active interior ceiling panels

Figure 9 shows the application of thermally active interior ceiling panels with an integrated oven to an auxiliary structure. This procedure, respectively, radiant large-area heating / cooling panels with integrated pipes in plasterboard, is generally known from gypsum board manufacturers.

Details of the anchoring of the interior ceiling panels are shown in Fig. 10.

2.3 Application of thermally active interior floor panels

Interior panels with integrated pipes can also be applied to floor heating, by either wet or dry constructions. Fig. 11 shows a floor plan for heating the floor of a room. Fig. 12 shows the details of the wet construction of the floor heating by interior panels with integrated pipes, and Fig. 13 shows the details of a dry construction.

Thermally active interior panels with an integrated active area formed by channels with thermally treated air as the heat carrier can be used for large-area heating/cooling of floors, walls and ceilings. Fig. 14 shows a floor plan for heating the floor of one room. Fig. 15 shows the details of the dry and wet construction of floor heating by interior panels with integrated air channels.

3 CONCLUSIONS

Thermally active interior panels (ITAP) with an integrated active surface combine existing building and energy systems in an innovative way into one compact unit and thus create combined building and energy systems. These are building structures with an internal energy source. Low heat losses, respectively thermal gains, predict the application of low-temperature heating, respectively high temperature cooling systems such as heating/cooling large floor areas, walls and ceilings. The main benefit of ITAP panels is the possibility of unified and prefabricated production. At the same time, they represent a reduction of production costs due to their technological production process, a reduction in assembly costs due to the reduction of steps, their implementation on the construction site, and a reduction in the implementation time due to their method of application.

DRY CONSTRUCTION METHOD

Fig. 13 Details of the dry construction of floor heating by interior panels with integrated pipes – direct heating (Kalús, 2011; Cvičela and Kalús, 2009)

Fig. 14 Floor plan of interior floor panels with an integrated air channel (Kalús, 2011; Cvičela and Kalús, 2010)

Fig. 15 Details of the dry and wet construction of floor heating by interior panels with integrated air channels (the panel consists of an insulation board with channels, which is covered by and glued to a large-area board, made, e.g., of gypsum) (Kalús, 2011; Kalús and Cvičela, 2013; Janík and Kalús, 2013)

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