

GRAPHITE-CONTAINING PLATE AND METHOD FOR PRODUCING A  
GRAPHITE-CONTAINING PLATE

The invention relates to a graphite-containing plate according to the preamble of claim 1 and a method for producing a graphite-containing plate.

Known from DE 103 41 255 B4 is a light-weight heat conduction plate and a method for the manufacture thereof. This heat conduction plate is produced from expanded graphite known per se (expanded graphite) by compression. The production of expanded graphite is sufficiently known from the prior art, inter alia, from US 3,404,061 A. In order to produce expanded graphite, graphite intercalation compounds or graphite salts such as, for example, graphite hydrogen sulphate or graphite nitrate are heated in a shock-like manner. The volume of the graphite particles is thereby increased by a factor of about 200-400 and at the same time, the bulk density decreases to values of 2-20 g/l. The expanded graphite thus obtained consists of worm- or concertina-shaped aggregates. In the light-weight heat conduction plate of DE 103 41 255 B4, such expanded graphite is compacted under directional action of pressure so that the layer planes of the graphite are preferably arranged perpendicular to the direction of action of the pressure and the individual aggregates become entangled with one another. By this means self-supporting flat structures such as webs or plates can be produced without adding binders. Such compacted heat conduction plates without binders are fundamentally dimensionally stable but have a low strength and therefore readily break apart under relatively low loads. Thus, for example, rectangular heat conduction plates having a weight per unit area of 1000 g/m<sup>2</sup>, a thickness of 13 mm and the size 11 x 13 cm only have a bending strength of 0.1 MPa. Therefore, dimensionally

stable plates having relatively small dimensions, e.g. 50 x 50 cm can only be produced since larger plates can no longer be handled. In particular the intrinsic weight of larger plates has the result that the plate only ruptures on one lateral edge under wear. These plates are therefore not suitable for use in the construction area without additional stiffening.

In order to overcome this disadvantage, DE 103 41 255 B4 proposes that after pressing, the heat conduction plates should be completely or partially impregnated with plastics, for example, resins or thermoplastics, in order to increase the density and the resistance to mechanical and other environmental effects. This subsequent liquid impregnation of the pressed expanded graphite plates has the disadvantage, however, that the infiltration of the expanded, compressed graphite with the liquid binders takes place non-uniformly. It has already been established in films of compressed expanded graphite that they are only uniformly infiltrated in the near-surface region. The binder only penetrates inadequately or not at all into the regions of the films located further inwards. The same applies to an even greater extent for the significantly thicker plates of compressed expanded graphite compared with films. This non-uniform distribution of the binder results in a non-uniform stiffness and stability of the plates so that the plates break more easily at places not identifiable from the outside than at other places.

Figure 1 shows a schematic cross-section through such a light-weight heat conduction plate 1. There pressed, expanded graphite 2 has been infiltrated subsequently with a liquid binder 3 from the lateral surfaces of the plate 1. However, the binder 3 has only penetrated non-uniformly into the plate so that in particular a region 4 identified by the oval dashed boundary is binder-free

and therefore significantly less stiff and stable than adjoining regions of the plate 1. This region 4 is therefore more liable to break than the adjoining regions of the plate 1.

It is therefore the object of the invention to provide a graphite-containing plate and a method for producing a graphite-containing plate which overcomes the above-mentioned disadvantages and provides a uniformly stiff and dimensionally stable plate.

This object is solved by a graphite-containing plate having the features of claim 1 and a method for producing a graphite-containing plate having the features of claim 10. Advantageous further developments and preferred embodiments of the plate and the method are given in the subclaims.

A graphite-containing plate according to the invention is characterised in that this contains a solidified mixture of largely uniformly distributed graphite particles and plastic particles, where this plate according to the invention can be produced by firstly mixing graphite particles and plastic particles to form a mixture having a largely uniform distribution of graphite particles and plastic particles, and then solidifying the mixture.

In a preferred embodiment, the graphite particles and plastic particles can be homogeneously distributed in the mixture, which can be achieved inter alia by sufficiently long mixing of the particles.

In an advantageous embodiment from the production engineering viewpoint, the plate can consist exclusively of the mixture of graphite particles and plastic particles without other additives needing to be

added. They are not required to obtain a dimensionally stable plate.

Advantageously, the mixture can contain 5 to 90 weight %, preferably 15 to 60 weight % and particularly preferably 20 to 50 weight % of plastic particles in order to obtain a sufficiently stable plate.

The graphite particles can advantageously contain expanded graphite and particularly advantageously expended graphite. The plastic particles can advantageously contain thermoplastics and/or thermosetting plastics.

In a preferred embodiment PVC can be used as plastic since it can be used at temperatures above 80°C. This is particularly advantageous in the advantageous use of the plates according to the invention as a thermally active component for heating rooms since temperatures of heating media are usually up to 60°C.

Advantageously polypropylene (PP), polyamides (PA), acrylonitrile butadiene styrene (ABS), polyether ketone (PEEK), polyvinylidene fluoride (PVDF), fluoropolymers, benzoxazines and/or polysulphone (PP) can be used as other suitable thermoplastics for the plastic particles.

A suitable thermosetting plastic is preferably epoxy resin, which is widely used, easy to process, relatively cost-effective and temperature-resistant. For higher demands, phenol resins can advantageously be used, likewise also melamine resin, urea resins and polyester resins, in particular unsaturated polyester resins (UP resins).

The solidification of the mixture can preferably be accomplished by compression, in particular by means of pressing. The solidification can also comprise a melting and a cooling step in order, for example, to partially or completely melt thermoplastics. By this means a good bond can be achieved between graphite particles and plastic particles. In particular, when using thermosetting plastics, the solidification can comprise a curing step. The solidification can also be accomplished by an alternative or additional sintering of the mixture.

In an advantageous embodiment, the plate is plastically deformable so that it can be moulded simply at the installation site to predefined contours of walls or ceilings of rooms, for example, edges, curves, corners, friezes etc. The plate can then be finally solidified at the installation site, for example, by heating the still plastically deformable plate in the installed state.

For the advantageous use of the plate according to the invention as wall or ceiling cladding and/or as thermally active component for cooling or heating rooms, the mixture can initially be pre-solidified so that it remains plastically deformable. Then at least one component, advantageously pipes or pipelines for receiving a fluid cooling or heating medium can be pressed into the plastically deformable mixture.

Additionally or alternatively, the plastically deformable mixture or the thus plastic deformable plate can be moulded to a predefined contour, for example in order to be able to be moulded to non-flat wall or ceiling profiles. The plastically deformable mixture or plate can then be finally solidified. Alternatively, it can advantageously be provided that before

solidification of the mixture, at least one aforesaid component can be introduced into the mixture and the mixture subsequently finally solidified. However, fixing elements, anchors etc. can advantageously be embedded as components.

Plates according to the invention can be used in the construction area, for example, as a ceiling or wall element for fixing to a ceiling or wall. The plates according to the invention are thus suitable, for example, for use in room temperature control systems and in acoustic elements for improving sound absorption.

Further particular features and advantages of the invention are obtained from the following description of preferred exemplary embodiments by reference to the drawings. In the figures:

Figure 1 shows a graphite-containing plate known from the prior art;

Figure 2 shows a cross-section through a graphite-containing plate according to the invention according to a first exemplary embodiment;

Figure 3 shows a cross-section through a graphite-containing plate according to the invention according to a second exemplary embodiment;

Figure 4 shows a cross-section through a graphite-containing plate according to the invention according to a third exemplary embodiment.

A graphite-containing plate 5 according to the invention, shown in Fig. 2 consists of graphite particles 6 made of expanded graphite which are worm- or concertina-shaped in a known manner. Instead of expanded graphite, natural graphite or synthetic graphite, preferably in powder form, can also be used.

However, expanded graphite has the advantage that on the one hand it can be readily pressed to give a dense, dimensionally stable plate to a small extent and on the other hand, can be readily mixed with solid plastic particles 7.

The graphite particles 6 are initially mixed largely uniformly with the solid plastic particles 7, here PVC. This can be accomplished in a known manner by mixing devices known per se for powdery materials. The graphite particles 6 are in this case mixed largely uniformly, that is advantageously at least 85%, with the plastic particles 7 in order to obtain a plate 5 which is as uniformly stable as possible. The particles 6, 7 are preferably mixed homogeneously with one another.

After mixing, the mixture is pressed in a known manner by action of pressure to form the plate 5. In order to increase the binding between the plastic particles 7 amongst one another and with the graphite particles 6, the mixture is additionally heated so that the plastic particles 7 begin to melt or even melt completely, then fuse with one another and bind with the graphite particles. In a cooling process that can take place by active cooling or passive cooling of the mixture, the molten plastic particles 7 solidify whilst retaining their molten shape so that a uniformly dimensionally stable plate 5 is obtained.

The two aforesaid steps - pressing and heating - can also be carried out successively. Alternatively or additionally, the solidification or compression can also take place by hardening and/or sintering. These different types of compression can also be combined with one another.

As a result of the mixing according to the invention of the graphite particles 6 and the plastic particles 7 to form a mixture having a largely uniform distribution of particles before the solidification, an advantageous plate 5 which is uniform over its surface, dimensionally stable, stiff, robust and easy to handle can be produced compared with the known graphite-containing plates 1.

Figures 3 and 4 show preferred examples of use of the plate according to the invention and the method of manufacture according to the invention. The same parts are provided with the same reference numbers as in Fig. 2.

Figure 3 shows the advantageous use according to the invention of a plate 5 according to the invention as a thermally active component in the form of a ceiling/wall cladding plate for heating and/or cooling a room. In this case, after mixing the graphite particles 6 and the plastic particles 7 but before solidification of this mixture, two pipes 8 are inserted centrally in the mixture. Then the mixture was finally solidified subsequently as described above. By this means simply pre-assembled wall cladding plates prepared for use as heating and/or cooling elements can be produced so that the manufacture of these plates and their use in the construction field can be carried out on an industrial scale. As a result of the large dimensional stability and stiffness of these plates, the handling and assembly of the plates in the building site area is made easier, in particular dimensionally stable plates having larger dimensions can be manufactured and used without needing to fear any damage to the plates during transport and handling.

Such a plate with embedded pipes 8 can be used, for example, in a device for temperature control of a room where the device has at least one component such as, for example, a concrete ceiling or wall which forms a thermal storage device and has a surface pointing into the room and where the pipes 8 are coupled to the thermal storage device and can be acted upon with a heating or cooling medium.

Such a device for the temperature control of a room makes it possible to use the mass of the ceilings or walls as thermal storage devices without pipes for carrying a heating or cooling medium for thermal activation of the storage device needing to be inserted in the ceilings or walls. An energy-efficient temperature control system having short response times is thereby provided which can also be installed subsequently when renovating old buildings.

Figure 4 shows the advantageous use according to the invention of a plate 5 according to the invention as a thermally active component in the form of a ceiling/wall cladding plate for heating and/or cooling a room. In this case, unlike the embodiment in Fig. 3, after mixing the graphite particles 6 and plastic particles 7, the mixture is initially pre-solidified so that it is still plastically deformable and only then are two pipes 9 pressed into the plastically deformable plate 5 and the plate 5 or the mixture is then finally solidified as described above. In the embodiment according to Fig. 4, the advantages are obtained as in the embodiment according to Fig. 3.

In a further development of the plate 5 from Fig. 4, this can advantageously be pre-solidified in a plastically deformable manner during manufacture, then transported to the place of use, for example, a

building site, and only there are the pipes 9 pressed into the plate 5 at suitable locations. The final solidification is then carried out on site, for example, by heating the still plastically deformable plate 5 when already installed. By this means the laying of the pipes 9 can be simply adapted to the special conditions on site.

PATENT CLAIMS

1. Graphite-containing plate (5), characterised in that this contains a solidified mixture of largely uniformly distributed graphite particles (6) and plastic particles (7).
2. The plate (5) according to claim 1, characterised in that the graphite particles (6) and plastic particles (7) are homogeneously distributed in the mixture.
3. The plate (5) according to claim 1 or 2, characterised in that at least one component (8; 9) is embedded in the plate (5).
4. The plate (5) according to claim 1 or 2, characterised in that this consists exclusively of the mixture of graphite particles (6) and plastic particles (7).
5. The plate (5) according to any one of the preceding claims, characterised in that the graphite particles (6) contain expanded graphite.
6. The plate (5) according to any one of the preceding claims, characterised in that the mixture contains 5 to 90 weight %, preferably 15 to 60 weight % and particularly preferably 20 to 50 weight % of plastic particles (7).
7. The plate (5) according to any one of the preceding claims, characterised in that the plastic particles (7) contain thermoplastics and/or thermosetting plastics.

8. The plate (5) according to any one of the preceding claims, characterised in that the plastic particles (7) contain polyvinylchloride (PVC), polypropylene (PP), polyamides (PA), acrylonitrile butadiene styrene (ABS), polyether ketone (PEEK), polyvinylidene fluoride (PVDF), fluoropolymers, benzoxazines and/or polysulphone (PP).
9. The plate (5) according to any one of the preceding claims, characterised in that the plastic particles (7) contain epoxy resin, phenol resin, melamine resin, urea resins and/or polyester resins, in particular unsaturated polyester resins (UP resins).
10. The plate (5) according to any one of the preceding claims, characterised in that it is plastically deformable.
11. The plate (5) according to any one of the preceding claims, characterised in that it is formed in a predefined contour.
12. Method for producing a graphite-containing plate (5), wherein graphite particles (6) and plastic particles (7) are mixed to form a mixture having a largely uniform distribution of graphite particles (6) and plastic particles (7) and the mixture is then solidified.
13. The method according to claim 12, characterised in that the mixture has a homogeneous distribution of graphite particles (6) and plastic particles (7).

14. The method according to claim 12 or 13, characterised in that the solidification of the mixture comprises a compression step.
15. The method according to claim 14, characterised in that the compression is accomplished by pressing the mixture.
16. The method according to any one of claims 12 to 15, characterised in that the solidification comprises a melting and a cooling step.
17. The method according to claim 16, characterised in that the plastic particles (7) are completely melted in a melting step.
18. The method according to any one of claims 12 to 17, characterised in that the solidification comprises a curing step.
19. The method according to any one of claims 12 to 18, characterised in that the solidification comprises a sintering step.
20. The method according to any one of claims 12 to 19, characterised in that the mixture is initially pre-solidified so that it remains plastically deformable.
21. The method according to claim 20, characterised in that at least one component (9) is pressed into the plastically deformable mixture.
22. The method according to claim 20 or 21, characterised in that the plastically deformable mixture is moulded to a predefined contour.

23. The method according to claim 21 or 22, characterised in that the plastically deformable mixture is subsequently finally solidified.
24. The method according to any one of claims 12 to 19, characterised in that before solidification of the mixture at least one component (8) is introduced into the mixture and the mixture is subsequently finally solidified.
25. The method according to any one of claims 10 to 21, characterised in that the plate (5) is configured according to any one of claims 1 to 9.