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(54) Soil improving material based on polyurethane.

(57) Desintegrated,irregularly formed polyurethane flakes which are used for draining purposes,especially in soil which is exposed to high temperatures for sterilisation.The material, which may be a scrap material at the manufacture of thermo hardened polyurethane with closed cells,is desintegrated to the desirable shape by a special hammer mill treatment. It is also useful in an enclosure of an inert, water permeable plastic woven layer.

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Soil-improving polyurethane based materials

The invention relates to soil-improving materials, especially for draining purposes, based on particulate plyurethane foam materials which may be held together by a cover. It is known to keep the soil in warehouses,nursery-gardens etc in condition by means of draining pipes and thus advantageously influence the water management. The materials used thus far all have certain objections.If one uses draining pipes then material has to be put on top of it to prevent deposition, blocking, which often arises in connection with the clay layer etc present.The use of materials, like filted PVS-foam further has the object that they themselves imbibe water and retain it and thus retard continuous flow. Up to now methyl bromide was used to disinfect the soil.This however has environmental disadvantages and thus one returns to steaming of the soil. Therefore still other propertiesare of interest for the present materials, such as resistance against the relatively high temperatures which occur during steaming of the soil.Further of course a relatively low weight is of importance.

The invention is aimed at a foamed material inparticulate form, which during use as draining materal doen not require maintenance and which indefinitely retains its water repellant capacity.Thus long term use is possible without occurrence of blocking or layer formation.

Furthermore the invention is aimed at a foamed material in particuate and possible covered form, which is resistant against the relatively high temperatures which may arise in warehouses when steaming the soil.

The foamed material especially consists of a famed particulate thermohardable polyurethane polymer which does not melt or is shrinking of changes shape at the temperatures experienced.

It is known from German Offenlegungsschrift 2041192 to use polyurethane foam particles mixed with feed materials and bound together by a binder into a carrier product for the roots of plants. This publication does not disclose a specific shape of the polyurethane particles and equally the purpose is different.Furthermore the German Offenlegungsschrift 2213053 describes an apparatus for the detection of draining pipes consisting of an intermediate layer ofhard foam particles loosely laying on top of each other covered by an outer layer of fibrous materiaal.

There is no mention of polyurethane foam flakes and equally not of a specific irregular shape thereof.The use of polyethylene or polystyrene has objections because of the temperature sensitivity and also in the course of time deposition may occur.

According to the invention a material is provided which is used as a soil improving material, especially as a drain, material or soil strengthening material, which is characterized in that it is built up of a thermo hardend polyurethane foam,which by means of a desintegrating process, as defined, is comminuted to irregular flakes.As is known polyurethane consists of polymers obtained by the polyaddition of isocyanate containing molecules to polyvalent alcohols, acids or amines.

By variation of the staring materials polyurethanes with different properties are obtainable.The invention starts from thermohardenable polyurethanes for processing into foam, like polyester and polyether foam,wherein foaming occurs by CO_2 or water dosing or by other foaming gases.The polyurethane foams can be obtained as blocks by foaming in a mold or as sheets when foaming takes place on a belt.The foams may be flexible or rigid dependent on the reactions used. In the present invention rigid polyurethane foams with closed cells are used which are thermo hardable and during higher temperatures, especially above 140°C do not soften or otherwise loose their favourite properties .

Thus especially thermohardend polyurethane foam with dense cells is used, which in a desintegration process is comminuted to irregular flakes, of which in fact none has the same shape, by means of for this purpose known apparatuses, like hammer mills, ball mills, beaters, vibration mills etc.One uses especially a hammer mill provided with a perforated screen with adjustable screen openings with which the flake size can be adjusted.The flakes should have an irregular form in such a way that in use always opening remain between the stacked flakes because of their non-fitting shape.These opening are of course necessary for a good draining. In case of a dense packing of the flakes there may arise the danger of layer forming.

The form most suitable of the irregular flakes is obtained by disintegrating sheet- or block materials, which are the startingmaterials,in a hammer mill of which the screen distance between the screen or grid bars is adjusted to 20 mm to 50 mm (square openings).The material is beaten through the screen openings by the hammers of the mill so that very irregular shapes of the flakes arise, of which the mean dimensions are lying about th4 screen distance. It is of course to be understood that no exact measures can be indicated, such as a mean diameter etc, because the flakes per se possess too great deviations and may have tortuous forms.However, when the indicated screen distances are maintained a material is obtained

which satisfies the objects of the invention. The revolutions of the axis with hammers is in the range of 500 to 1100 rpm.The hammers are fixed to one or more axis, according to the type of mill, which are revolving with the afore mentioned rpm.The hammersgenerally have the shape of straight metal bars, which in numbers of 2-6 are mounted on the axis. It is to be understood that variations are possible but that it is decisive that the hammers are beaten with enough force against the material and that the screen distance is the determinative factor for the desired form of the flakes.If the dimensions of the screen are too small dusting takes place and also the material is smaller resulting in the danger of layer formation during drainage.If the screen distances are too large too little interrelated channels are formed and thus the draining effect gets lost and also faster depostion en layer formation is taking place.

The flakes may be obtained possibly in another way than by a hammer mill treatment provided they meet the desired criteria of irregularity of the flakes, shape of the flakes and size thereof. According to the invention one starts from material having the shape as obtained by the said hammer mill treatment of plates of blocks thermohardened pol polyurethane foam, with which material the benefits of the invention can be attained.

The invention is in particular beneficial for the processing of polyurethane foam scrap which is formed during the polyurethane manufacturing process and which normally cannot be used anymore and is disposed off. Thus in a particular process the mixture to be polymerized, consisting of the needed mixed chemicals, is sprayed on a cover layer, which is passed through a continuous roller band , there also being passed a sealing cover layer through the roller band . During the passage the foam made is confined and adhered between the cover layers and at the exit of the roller band a continuous foam layer is formed. During this process inevitably there is formed scrap when the bales are cut into measured pieces. These per se non usable pieces of scrap are suited as starting material for the invention. The enclosure of the foam, which may comprise several materials, like glass mat, glass mat covered with plastic etc is per se not objective because only a relatively small amount is present.

This material may be present during the mill processing and be processed; if desired it may be removed.The same holds also for foam obtained in another way, like foam blocks, in which case mostly no enclosure is present.

It is important that the endproduct has an irregular shape,by which the water permeability is increased. water runs smoothly and easily through the irregular ducts in the material without the material itself taking up water.The ducts must be irregular, not align with each other and be of sufficient size, because too small ducts may be easily blocked and the water permeating capacity could become totally lost. As already mentioned a satisfactory product is obained by the hammer mill treatment as above described.

In another embodiment for soil improving purposes the foam material according to the invention is inserted in a water permeable strong enclosure of inert material, such as plastic so that one obtains mattresses und such forms.These mattresses have dimensions of e.g. 2-3 meter length and 1,5-2 meter width at a height of 20-25 cm. They are lightweight and as such easily conveyable. Their bearing capacity is good and thanks to their water repellent properties no layer forming takes place and the water is faster removed.

Owing to their light weight the possibility of settling is minimal and there is also less setting.It appears that the fragmentation of the foamed blocks or plates has no adverse effect on the draining properties; i.e. the water take-up of the product treated is indeed higher because of the pulverisation of the surface cells, but not that high that as a consequence thereof the draining properties diminish. It has been found that only at the edges where there are cut open cells there occurs water take-up of the product.This amounts to not more than 0,5 vol % at 20°C. Thus the desintegration has no adverse effect and the water permeating properties are improved. The bulk density of the foamed material is about 32-35 kg/m^3. Furthermore the material has sufficient strength for use for soil improving purposes (tensile strenght about 2200-2600 kg/m^3.

The flaked polyurethane foam according to the invention is especially suitable for draining purposes.The material is porous and of light weight and easily transmits water.Thus it can be used for draining pipes or coils, in which case the flakes are arranged on top of the pipes or coils.The material as such can be mixed with the soil, in particular hard soil to improve the draining properties thereof. In a

In a special embodiment the material is shaped to a mattress, it being enclosed by a strong,inert and porous material, especially woven materials, like woven plastics.These mattresses are put in the soil with a soft condition as an underlayer to combat soil settling and deficient water removal, in particular with a view to the weight. In comparison sand has a weight of about 1300-1600 kg/m^3, just as debris. This has to be compared with with the about 30 kg/ 30 m^3 of the present materials.The material is for instance brought in the soil to a depth of 20 to 50 cm and then covered with soil or sand.The condition of the soil appears to be

strongly improved owing to the favorable properties of the mattresses described, i.e. there is practically no soil setting and the water transport has been improved. As enclosure material a commercially available polypropylene weaving that has the required properties and works as a filter is especially suited. The flaked polyurethane foam material has an additional advantage that it is easily transportable in a loose form and it does not stick to the walls of the transporting means in contrast with other plastic materials. The flaked polyurethane foam according to the invention is resistant to fungus and moulds and does not form a nutrient for micro-organisms. The invention will now be illustrated by the accompanying drawing, wherein figures 1 and 2 schematically in section through the soil illustrate a water drain with and without a draining pipe and figure 3 illustrates a similar section for a draining layer with drain pipe. In the figures 1 denotes the polyurethane flake material according to the invention that is taken up in an enclosure of permeable polypropylene material (e.g. Propex^{R}), reference number 2.In figure 1 a drain pipe (3) is enclosed by the polyurethane flakes (1). The arrows 4 indicate the groundwater flow,arrows 5 the flow of polyurethane flakes. A clay layer is indicated by ,6. The flakes present prevent the clay layer from blocking the draining by forming a plate layer.In figure 3 3 again denotes the drain pipe, above which a continuous layer of polyurethane flakes ,as defined is arranged, enclosed by the polypropylene water permeable layer.The arrows denote the water flow.ABove the flakes a sand layer 8 or another layer (tile path) may be placed.

Example

On starts from polyurethane foam material which arose as scrap during the production.The polyurethane was prepared by means of spraying of the chemicals on a band which after covering by another band was conveyed through a roll mill.This material had the following properties: Heat conduction coefficient calculated at 20^{0}C: 0,020 W/km.
Heat resistance: during a long time resistant against 15 °C.
Linear expansion coefficient: 27 x 10^{-6} m/mK in the tmeperature range of + 20 to + 70°C.
Bending strength withour cover: 38.10^{-2} N/mm^{2}.
Strength: about 11-20.10^{-2}N/mm^{2},determinded at a deformation of 10% (DIN 18164).
Tensile strength: without cover parallel to the foam direction 35.10^{-2} N/mm^{2}.
Water take-up:when immersing the foam in water at a temperature of 20^{0}C during 24 hours the water absorption is about 0.5 vol %. Especially at the edges where there are open cells which were formed during the processing.Apart form this boundary effect the water absorption is zero. The material is resistant against chemicals apart from very concentrated alkaline materials and inorganic acids and it is further resistant against moulds and fungus. the material as obtained was processed in a hammer mill of which the screen was adjusted to square openings with a dimension of 3 cm. All flakes passing through the sieve were collected.The flakes obtained after this processing had very irregular ,tortuous shapes and none of them has substantially the same shape. The product obtained was processed into mattresses by enclosing it in an inert, water permeable plastic foil.For this purpose use was made of polypropylene weave material, commercially available as Propex^{R}, which possesses sufficient strenght. As a consequence of the woven structure it acts like a filter and thus is water permeable. It is not attacked by acids and bases. The thickness was about 1 to 2 mm. Of course another similar woven material of other plastics within similar properties may be used. These mattresses were put in a soil with soft condition as a lower layer to combat soil settleing and deficient water transport.The material was put in the soil to a depth of 20-50 to 80 cm and then covered by soil or sand.It appeared that the condition of the soil was strongly improved by the favourable properties of the matresses as described, relating to the lower weight compared with the raw material,i.e. there was substantially no settling of the soil and thus the water removal was improved as well.

The material is also applicable in road building or in streets as an under layer. It is to be understood that various types of hard polyurethane foams (thermoset PUR-foam), obtained dependent on the chosen starting materials and additives, are suitable for the present purposes,provided they are subjected to the desintegration step to get irregularly formed angular flakes.The properties of the utmost importance for the hardened foam are a low (volume) weight, a good strength, a low water absorption and a high resistance, especially against steam temperatures. As a consequence of the desintegration step the enclosed pressure gas,if any, is substantially removed.

The general dimensions of the flakes can be adjusted by changing the screen distance of the hammer mill.For use as a draining material the screen distance (square) is set at about 40 mm. The rectangular shape of the screen is op importance to give the flakes an angular form.

Polyurethanes are well known polymers obtained by the stepwise polymerisation of alcohols (HO-(CH_2)-OH) and isocyanates (O=C=N-R-N=C=O), which are appear to be important as

hard and soft foams. For the present purposes the thermosetting polyurethane foams are of interest. Because of the fact that the preparation processes of these foams are generally known a further description is regarded as superfluous.

Claims

1. Soil improving material based on flaked, foamed polymers which possible are hold together by an enclosure, wherein one starts from a thermoset polyurethane foam with closed cells, which is comminuted to irregular flakes, as defined.

2. Material according to claim 1, wherein this is comminuted to irregular flakes by a treatment with a hammer mill with a screen distance of 20-50 mm.

3. Material according to claim 1-2, wherein one starts from thermoset foamed polyurethane with closed cells with a bulk density of 30-35 kg/m^3 and a pressure resistance of 11-20 10^{-2} N/mm, of which the water absorption when immersed in water of a temperature of 20^0C during 24 hours is not more than 0,5 vol % at the edges.

4. Material according to claim 3,wherein this originates from scrap material obtained during the preparation of foamed polyurethane.

5. Material according to claims 1-4, wherein thsi has the shape of a mattress, enclosed by a water permeable inert woven material of plastic or another synthetic or natural woven material.

6. Use of a material according to claims 1-5, as draining material on a draining pipe or as a mattress.

7. Use of a material according to claims 1-5, as draining material in soil which is exposed to high steam temperatures during sterilization.

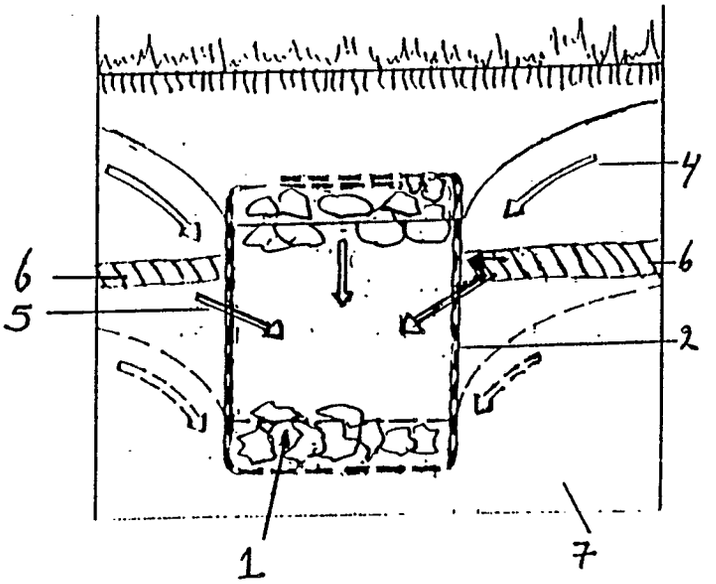

FIG 1

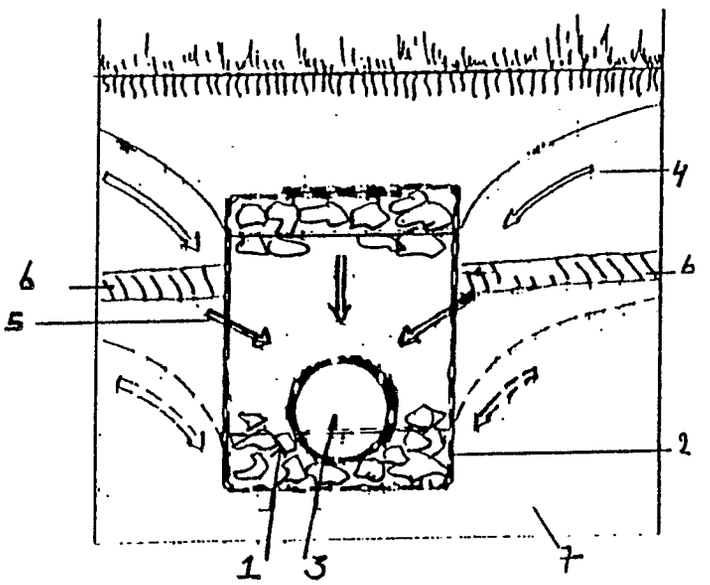

FIG 2

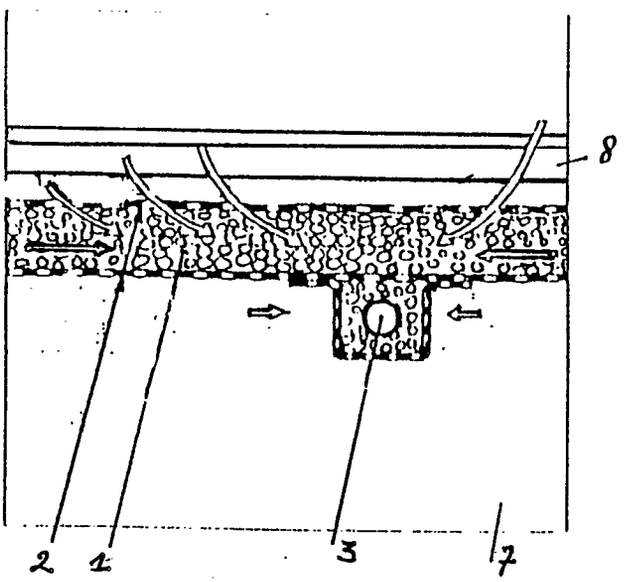

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number

EP 90 20 0501

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-0 052 526 (UNIVERSITY COLLEGE CARDIFF CONSULTANTS) * Page 1, lines 16-23; page 2, lines 1-8; page 3, lines 1-12; page 5, lines 5-8; claims 1,3,4,5,7,18 *	1,4,5	E 02 D 3/00 E 02 B 11/00 A 01 G 31/00
X,D	DE-A-2 041 192 (DEUTSCHE SEMPERIT GUMMIWERK) * Page 1, lines 6-23; page 5, lines 8-13; page 10, lines 9-17; page 13, paragraphs 1-4; figure 1 *	1	
A	WO-A-8 102 968 (METZELER) * Page 1, lines 13-23; page 3, lines 8-10; page 8, lines 2-10 *	1	
A	DE-U-8 606 742 (TECHNOFLOR DEUTSCHLAND) * Page 1, paragraph 1; page 3, paragraphs 1,2; page 4, lines 1-4; page 7, lines 3-14; fig. *	1,5	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	DE-A-3 636 207 (LENTIA) * Column 2, lines 6-26; column 3, lines 60-68; column 4, lines 1-10 *	1,2,3,6	E 02 D E 02 B E 01 C A 01 G
A	FR-A-2 204 201 (FRIEDLAND) * Page 1, lines 28-34; page 2, lines 29-35; page 4, lines 1-11; page 7, lines 8-20; page 8, lines 2-8; page 9, lines 4-14; figures 1-4,6 *	1,3,6	
A	EP-A-0 280 629 (UNIVERSITE CLAUDE BERNARD) * Column 3, lines 8-14; column 4, lines 22-38; column 5, lines 32-52; column 6, lines 6-14; figure 4 *	1,2,4,6	

-/-

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	08-06-1990	RUYMBEKE L.G.M.

CATEGORY OF CITED DOCUMENTS

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EUROPEAN SEARCH REPORT

Application Number

EP 90 20 0501

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	DE-A-3 313 053 (COLANGELO) * Page 4, lines 5-16; figures 1,2 *	1,5,6	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

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