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MANUFACTURE OF BITUMINOUS ROAD MATERIAL

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This invention relates to the manufacture of bituminous road material and to the application thereof.

Although there are important exceptions, in general, the processes are for the production of road units consisting of nuclei of large aggregate surrounded with fine matter to fill interstices.

The principal object of the invention is the production of material for road surfacing which may be stocked and laid cold and rolled down in a cold state to form a surface for roads and the like; by a cold state I mean the atmospheric temperature at which the road is to be made. My material, may, however, be rolled down in a warm state as made. Briefly the objects are to prevent binding before laying, to bind on crushing and prevent extrusion of binder. In the following description by the word "dry" I mean capable of being easily broken by hand, and by the word "manipulation" I mean the material can be readily handled and placed in position for road forming.

In accordance with the present invention I provide a method of manufacture of bituminous road making material consisting in absorbing bituminous binder by coke, the binder being liquefied by fusion and absorbed by the coke present in the mix to a degree effective for allowing manipulation of the manufactured road material on cooling, the coke being caused to form foci of concentration for the binder the binder being concealed, masked or retarded, whereby on crushing by rolling the coke is reduced to powder and the binder is dispersed for fulfilling its intended function of binding.

Filler may be added either to the completed units or with sand and coke as hereinafter described.

I mention coke as an example of a suitable absorbent material. As further examples of suitable substances I mention brick crushed and dressed to the size wanted, and for purposes of description hereinafter the term "coke" is intended to include such.

The absorbent material should have about the dimensions of sand.

When binder, mineral matter for example sand, and the porous material mentioned are mixed together the absorbent material takes relatively much more binder than the same volume of sand and much more than the same weight and the binder may be said to be concealed or reserved. On crushing by rolling and traffic the binder absorbed by the porous material is released and dispersed into the mineral matter. Before crushing, that is to say in the state in which the compound is made, it is portable and can be manipulated. After crushing of the absorbent, the binder agent is released and dispersed and the coke being reduced to the dimensions of filler by rolling, the filler is produced in situ, and it occupies an ideal position, that is to say it is exactly where it is wanted. The porous material or absorbent has several effects. The initial effect is to prevent binding, the second effect is to bind, and a third effect is the prevention or diminution of extrusion. The smaller a given mass is subdivided, the greater is the ratio between total surface and volume of the particle of the mass. As the crushing and comminution of the absorbent increases, so is the surface of the absorbent enormously increased; and it constitutes a filler but an unsaturated filler, i. e. unsaturated with binder. The binder present as a film on the surface of the mineral matter extrudable by closer approach of particles thereof is absorbed into the unsaturated filler. The friction on the binder is increased and hence its movement further is hindered, that is to say extrusion is prevented. It is desirable that the quantity of absorbent used be such that it will not become saturated by the quantity of binder extrudable. In order to show the kind of reasoning to determine a suitable quantity of absorbent, the case of the coke will be considered.

A dry coke all through one-tenth inch mesh and 66% through one-twentieth has a loose weight of 37 lbs. per cubic foot and will absorb binder to the extent of 60% of its volume. It may be taken that in the case of a flint aggregate composed of 52% of stones ¼" to 1", with 30% of sand and 8% binder and also filler, 70% of the binder-plus-filler (the latter total being say 12%) would be inextrudable. The extrudable material would therefore be 3.6% of the composition, and the indication is that 6% of coke would be a suitable quantity. The factors to be taken into account would be fusion point of binder and its viscosity, the properties of the absorbent, the character of the surface of the mineral matter and the sun temperature to be experienced and the class of road to be made. An excess of absorbent would produce material which would be too dry. By the use of absorbent as described the production of integral road units consisting of aggregate surrounded with binder and fine mineral matter adapted to fill interstices is facilitated.

Example I

In this and the following examples of manufacture according to my invention the type of road material made is the well-known type of aggre-

gate surrounded with sand mix forming integral road units, and the general method of treatment is the same.

The temperature of all the mineral matter is 240° F. delivered to the mixers and the binder is at 320° F., these temperatures being usual in hot mixes.

The aggregate mix, consisting of stone, 1" to ¼", 25%, and binder 1%, is separately made in any convenient mixer while the sand mix is made preferably in a mixer of the well known trough type with a longitudinal shaft carrying fingers spirally arranged.

The composition of the sand mix and its method of formation is

Sands of the usual grading	38% at 240° F.
Coke through 1/20" mesh	5% at 240° F.
Binder 45 penetration	8% at 320° F.

Mix the above and then add

	Percent
Cold sand (45° F.)	18
Filler (45° F.)	5

The latter may be added together or separately. It should be mixed until it becomes substantially uniform as shown by appearance. A suitable temperature of the final mix would be 130° to 160° F. depending on the rapidity of the operations. If the complete mix is too cold the binder is over-concealed. If it is too hot the mix tends to set and would be difficult to separate or manipulate, when cold.

The sand mix is added to the aggregate mix. With different temperatures of hot mineral matter, and air temperatures, adjustment would be made of the ratios of hot to cold material in order to secure a final temperature of the complete mix suitable for securing the production of material manipulative cold. However, wide variations are possible. For example, if warm mineral matter is at 130° F. no cold mineral matter is necessary. The aggregrate mix should be, for the example given, at about 200° F. If it is too cold the aggregate will stick together rendering a covering with sand mix impossible while if it is too hot, concealed binder of the sand mix will become operative and the manufactured material become less manipulative cold. The sand mix is added to the aggregate mix in any convenient way. The binder may be further masked by adding a very small proportion, say 0.5% of the filler, to the completed units and giving a mix of a few seconds duration. A good working ratio of hot to cold, when mineral matter is at 240° F., is from 0.6 to 0.5 of hot to 0.4 to 0.5 of cold.

Example II

The above example is of a two phase mix which is considered preferable but the process may be used on the same principles in a one mix process. This single mix method is workable more easily with a smaller aggregate and example will be given later. But with aggregate of the size described in the last example the production of nuclei of stone surrounded with fines is less satisfactory. The reason is apparent by stating that with a two phase mix consisting of an aggregate mix and a sand mix the length of time of contact when the two are afterwards added together need only be a few seconds for the one to come into contact and adhere to the other thus building up integral road units. But in a one phase mix integral road units are less efficiently built up.

For economy of binder it is obvious the proportion of aggregate should be increased, and the following percentage table shows economies by a progressive increase of stone:—

	1	2	3	4	5
Aggregate mix:—	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Stone	35	45	55	65	75
Binder	1	1.3	1.6	1.9	2.3
Sand mix:—					
Filler	5	5.3	3.5	2.7	1.8
Coke	5	4.3	3.5	2.7	1.8
Sand	46	37.4	31.0	23.5	16.3
Binder	8	6.7	5.4	4.2	2.8
Total binder	9	8	7	6.1	5.1

The sand mix forms an efficient surfacing alone. The composition of the sand mix which constitutes the cementitious binder is the same in each case, but each complete mix may be made according to my invention in a simple and economical manner yet ensuring stones are separated from each other by fine material which is a condition for efficiency.

Example III

Another example of a standard hot process composition of the usual kind, known as binder course, is as follows:—

	Per cent
Binder	5
Sands	25
Stone graded 1¼" to ⅜"	70

According to my invention this is made in the following manner:—Aggregate mix at 200° F.

	Per cent
Stone 1"–1¼"	35.0
Stone ½"	17.5
Binder (45–65 penetration)	1.25

Sand and small stone mix

	Per cent at 230° F.
Stone ⅜"	17.5
Coke through 1/20"	2.0
Sands	12.0
Binder (45–65)	3.9

mix these and add

	Per cent
Cold sand (45° F.)	10.85

These two mixes are added together as before.

The temperature of the completed sand and small stone mix is 160° F. In this and Examples IV, V and VI the addition of cold sand is unnecessary if the main mix is cooler, for example 160° F.

The sand and small stone mix are an example of a single mix surfacing made according to my invention, as it forms alone an efficient surfacing.

Example IV

A further example of a standard hot process composition unmanipulative cold in use known as a topping course is as follows:—

	Per cent
Binder (45–65 penetration)	12
Filler	12
Sands	61
Stone ½"–⅜"	15

According to my invention this may be made in the following manner:—

	Per cent at 240° F.
Sand	35
Stone	15
Coke through 1/20"	8
Binder 46 penetration	12

The above are mixed and add

	Per cent
Cold sand 45° F	23
Filler 45° F	7

The foregoing examples show how standard mixes may be rendered manipulative, using exactly the same mineral matter customary for those processes, and the same binder in the same proportions.

I find, however, equally good results may be obtained with less binder of higher penetration number and coarser sand. The following is an example:—

Example V

Aggregate mix:

	Per cent
Stone ¾''–¼''	45
Binder 65 penetration	1.25

Sand mix:

Coarse sand 1/10'' to 1/30''	22.5% at 240° F.
Coke through 1/20''	6.5% at 240° F.
Binder 65 penetration	6.0% at 320° F.

Mix and add:

	Per cent
Fine road sands	17.75
Filler	3.0

The temperature of the sand mix is 150° F. The sand mix is added to the aggregate in the usual way.

The last example shows the best method of carrying out the invention by adding the materials in order of their size, that is to say the larger particles come first. This promotes the building of integral road units which may be based on large particles of sand or small particles of stone and an example of the latter will be given later.

Example VI

The application of the invention to the employment of large sand or small stone is given in the following example, which is a single mix case:—

Stone or sand 1/5'' to 1/10''	65% at 230 deg. F.
Coke through 1/20''	8% at 230 deg. F.
Binder of 65 penetration	8% at 320 deg. F.

The above mixed then add

	Per cent cold
Fine road sand	11
Filler	8

The temperature after mix is 130° F.

Example VII

In a single mix example of which the proportions are by weight, aggregate mix is made in a concrete or similar type mixer:

	Per cent
Stone 1''–¼''	55.0
Binder	2.0

The sand mix is as follows and is made in a stirrer-mixer:

	Per cent
Graded sand	31.0
Binder	6.0
Coke	6.0

Example VIII

I apply the invention to the employment of fines from quarries and mineral matter of similar dimension which are usually a waste and give another single mix example. A type of such waste fines has the following grading:—

	Per cent
Retained on 1/10''	24
1/10'' to 1/20''	28
1/20'' to 1/30''	12
1/30'' to 1/100''	24
Through 1/100''	12

It may be treated as follows:—

It is divided by screening through 1/20'' mesh and the following proportions used:—

Screenings retained on 1/20''	50% at 230° F.
Coke through 1/20''	6% at 230° F.
Binder of 65 penetration	8% at 320° F.

Mix and add

	Per cent cold
Screenings below 1/20''	36

However satisfactory results are obtained when constituents are added in a different order of size and the absorbent may be added in the last stage of the sand mix; the absorbent may replace its weight of cold sand.

In all the preceding examples, where the addition of cold mineral matter is mentioned, the same effect can be produced, and it comes within the scope of the invention to produce it, by suitable reduction of temperature of the main body of the mineral matter.

In considering the employment of absorbent the factors are property of absorbing and proportion. In the case of coke 1/20'' does not differ much from 1/10'' the absorptive qualities of which have already been mentioned. Direct experiment is necessary in determining proportions of other absorbents.

Continuous production of fine mixes or sand mixes may be arranged in mixers of the trough type the various constituents being added at appropriate points in the trough, and where aggregate is to be coated with fine mix the aggregate may be coated in continuous apparatus of the well-known type, the operation of the two mixes being synchronized and the necessary contact of the two provided for.

As to the character of the binder its penetration and proportion, decisions are within the scope of those accustomed to the art of formation of bituminous compounds, and regulated according to cost and duty required.

The use of absorbent according to my invention, however, safely enables lower melting point binders and lower proportion of binder to be used, and the highest class of surfacing made in an economical manner. Penetration may be as low as 156 and even softer, but for the best kind of roads 65 is preferable and a suitable proportion of binder is 7.25%. Coal pitches and petroleum residual are suitable.

In all cases of the production of sand-type mixes a suitable duration of mixing after the addition of the final constituents is 15–30 seconds.

By the methods of my invention hot mix material may be produced which is easily manipulative so that it may be stocked, transported and laid in a cold state and yet be compressible to form a dense road, although cold lay is the object of the invention, the principle object is the production of the usual hot-mix manipulative and cold lay in the sense previously mentioned. My material, however, may be laid in a warm state.

The state of the filler made in situ and in ac-

cordance with my invention is different to the state of filler employed in the usual process, which is saturated with binder in the beginning, and in which the binder acts as a filler as well as adhesive; and also differs from a mere cindery surfacing impregnated with tar or liquid asphalt, for in accordance with the present invention the binder is almost wholly adhesive and it is on this account that lower proportions can be used. Very strong blocks can be and have been made with 6% of binder of 65 penetration.

The crushing of the porous material by rolling and traffic is immediately effected at the surface which closes rapidly. In the lower portions the process is progressive until complete densification is arrived at.

What I claim and desire to secure by Letters Patent is:—

1. The method of manufacturing a bituminous road material comprising liquefying a bituminous binder by heat, saturating and coating a mineral-coke mix with said binder, coating an aggregate in a heated condition with the said binder, combining and mixing the mineral-coke mix and coated aggregate, applying pressure to the combined mixture, crushing the coke, extruding the binder therefrom and dispersing said binder throughout the combined mixture.

2. The method of manufacturing a bituminous road material, comprising liquefying a bituminous binder by heat, saturating and coating a mineral-coke mix of the size of sand with said binder, coating an aggregate in a heated condition with said binder, adding the aggregate mix and the mineral-coke mix to each other, the final temperature of the mixes, respectively, being substantially 200° F. and 150°–160° F., and crushing the coke to reduce it to powder and disperse the binder therefrom, whereby the binder performs its intended function of binding.

3. The method of manufacturing a bituminous road material, consisting in liquefying a bituminous binder by heat, saturating and coating a mineral-coke mix of the size of sand with said binder, coating an aggregate in a heated condition with the said binder, adding the aggregate mix and the mineral-coke mix to each other, the coke being substantially from 1.8% to 8% of the total, and crushing the coke to reduce it to powder and disperse the binder therefrom, whereby the binder performs its intended function of binding.

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