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(19) (CA) **CANADIAN PATENT** (12)

(54) PROCESS FOR INCORPORATING WASTE RUBBER CRUMB INTO ASPHALT EMULSIONS

(72) Thompson, Elaine;
Ferguson, John,
Canada

(73) Granted to Pounder Emulsions Ltd.
Canada

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ABSTRACT OF THE DISCLOSURE

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In a preferred embodiment, a rubber asphalt composition for road construction or maintenance is formed by pretreating ground rubber crumb (from vulcanized, unvulcanized or partially devulcanized rubber) with an anionic emulsifier such as tall oil or vinsol resin and then stirring the treated crumb into an anionic asphalt emulsion. The emulsifier used to coat the rubber crumb is preferably the same as the emulsifier used in the asphalt emulsion.

PROCESS FOR INCORPORATING WASTE RUBBER CRUMB INTO ASPHALT EMULSIONS

BACKGROUND OF THE INVENTION

Rubber asphalt composition for road construction or maintenance using small amounts (0.1 to 10%) of unvulcanized natural or synthetic rubber have been known for over half a century. Compositions of an asphalt emulsion combined with a small amount of rubber latex (under 10%) are also known. However, developments combining asphalt with vulcanized rubber crumb, a waste product from scrap tires, tire buffings and the like, have lagged somewhat.

A patent describing the introduction of up to 15% vulcanized waste rubber particles into hot asphalt for a road surfacing composition was issued in the late 1930's (Fr. 811750, U.S. 2138734) but, for several reasons was ignored by the road construction industry. It was not until the 1960's that work along similar lines was resumed through the efforts of C.H. McDonald, reports of which first appeared in the Highway Research Record, No: 146, published December 1966 by the Highway Research Board in Washington, D.C. The procedures developed are described in Canadian patent 1015882.

Essentially, that process involved stirring in one

part vulcanized rubber crumb into between 2 and 3 parts of asphalt heated between 350 - 500°F (149-260°C). After the reaction between the rubber and the asphalt was complete, kerosene (about 6% by volume) was added to temporarily reduce the viscosity of the mixture. The binder so produced then had to be applied to the road surface within a relatively short period of time (0.5 to 1.5 hours) after which the viscosity of the binder was too high for it to be sprayed even using the special equipment designed to handle the material.

There are a number of disadvantages of the process just described. Firstly, temperatures of 350 - 500°F require higher energy inputs than those normally encountered in asphalt plants involved in construction. Secondly, the addition of kerosene at these temperatures, well above its flash point, presented not only a serious fire hazard, but also an extra energy expense in the road surfacing composition. Lastly, the relatively short period of time during which the rubber asphalt binder remained workable required that the manufacturing plant be situated in very close proximity of the construction site and sophisticated units designed to manufacture, transport and spray this rubber asphalt were costly to purchase.

Recognizing some of these difficulties, the same

inventor, C.H. McDonald, devised a method for emulsifying the rubber asphalt paving material in water. (Canadian Patent 1042145). This emulsion could be stirred, poured and sprayed under ambient temperatures. Thixotropic emulsions thus prepared on a small scale (less than 525 grams) were stabilized by the addition of boiled cornstarch used as a thickener. In this process, the hazards and higher energy inputs associated with the preparation of the rubber asphalt prior to emulsification were not entirely eliminated - temperatures of 350 - 500°F were still required and the addition of kerosene was optional.

The object of the present invention is to provide a new method for introducing vulcanized, unvulcanized or reclaimed rubber crumb into asphalt in a stable emulsion form which would avoid the hazards and energy costs of the existing method.

A suggestion for how this might be accomplished appeared in Canadian patent 435837, where an asphalt emulsion (prepared with bentonite) was combined with a dispersion of ground vulcanized rubber, bentonite, oxalic acid, wetting agent and amphibole in water to produce a sealing composition for joints, seams or crevices in automobile bodies.

SUMMARY OF THE INVENTION

It has been discovered that a rubber asphalt com-

position suitable for use as a road surfacing binder in the form of a stable emulsion can be readily prepared by simply combining an anionic asphalt emulsion with ground rubber crumb whose surface has been pretreated with an anionic emulsifier solution. This emulsion or dispersion is stable for up to four months under ambient conditions, during which time a small degree of reversible settling takes place. Gentle agitation readily redisperses what rubber had begun to settle.

In accordance with the invention there is provided a process for incorporating rubber crumb into asphalt emulsion comprising pretreating the rubber crumb with an anionic emulsifier solution sufficient to wet substantially all of the surfaces of the rubber crumb, and then mixing the pretreated rubber crumb into an anionic asphalt emulsion in the ratio of between 1:1 and 1:19 by weight or rubber to asphalt to form a rubber asphalt emulsion.

A further aspect of the invention consists of a process for incorporating rubber crumb into asphalt emulsion comprising pretreating the rubber crumb with an anionic emulsifier solution sufficient to wet substantially all the surfaces of the rubber crumb, and then mixing the pretreated rubber crumb into an anionic asphalt emulsion to form a rubber asphalt emulsion wherein the emulsifier solution includes an

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emulsifier which effects wetting of the rubber crumb and in which the proportion of the emulsifier in the pretreatment solution is between 0.1% and 25% by weight depending upon the stability of the rubber asphalt emulsion required, and in which the proportion of emulsifier solution to rubber crumb is between 0.3 and 1.2 to 1 by weight.

With the foregoing in view, and other advantages as will become apparent to those skilled in the art to which this invention relates as this specification proceeds, a description of the preferred typical embodiment of the principles of the present invention, is herein described.

DETAILED DESCRIPTION

In a preferred embodiment of this invention, an asphalt emulsion is prepared in a manner known to anyone skilled in the art using whatever hardness of asphalt is desired for the application and an anionic emulsifier such as tall oil, vinsol resin or the like. The resulting emulsion contains preferably between 55% to 70% asphalt by weight.

Suitable rubbers are those which undergo swelling upon exposure to aromatic, naphthenic or aliphatic oils or solvents and include natural rubber, isoprene rubber, butadiene rubber, butadiene-styrene rubber, butyl rubber and ethylene propylene rubbers which may be vulcanized, unvulcanized or reclaimed rubbers.

Depending upon the properties desired in the rubber asphalt emulsion or its residue, the proportions of rubber

to asphalt in the composition may range from 1:1 to 1:19 or even lower.

The particle size of the ground rubber crumb is preferably from about 16 mesh to about 200 mesh USS.

The crumb is treated with a sufficient amount of anionic emulsifier solution to wet its surface. It is then added to the asphalt emulsion and simply stirred in, yielding a stable emulsion or dispersion whose pH should exceed 10 and would preferably be in the range of 11-12.5 for improved storage stability.

The emulsifier used in the solution to precoat the rubber crumb is preferably the same emulsifier as was used in preparation of the anionic asphalt emulsion. While it is possible to use a nonionic emulsifier, an anionic emulsifier other than that used in the asphalt emulsion, or no pretreatment of the rubber crumb at all, experience has shown that in those cases pumping the resultant rubber asphalt emulsion leads to the formation of irreversible agglomerations (lumps), indicating the instability of the emulsion which has begun to break. An exception to this is the addition of rubber crumb directly (without pretreatment) into a very stable slow setting asphalt emulsion prepared with vinsol resin.

The emulsifier solution used in rubber crumb pre-

treatment is prepared by heating a mixture of emulsifier, sufficient sodium or potassium hydroxide to saponify the fatty and resin acids in the emulsifier and water of such quantity to bring the emulsifier content to the desired content.

In all of the following examples, a slight amount of reversible settling of rubber was detected after several days. The settling solids were readily redispersed upon gentle agitation. A thin, nearly clear layer of water formed at the top of the rubber asphalt emulsion after several days of standing undisturbed, demonstrates a process similar to syneresis observed in gels. Water in excess of the emulsion's requirement for a stable structure is expelled. This same phenomenon was observed when an asphalt emulsion was diluted with an aqueous emulsifier solution and allowed to stand for several days.

The following represents the preferred rubber asphalt emulsion formulation used as a seal coat binder applied to a road surface:

Anionic asphalt emulsion (65% asphalt)....3100 gallons
30 mesh rubber crumb.....4945 pounds
5% anionic emulsifier solution..... 280 gallons

EXAMPLE I

30 mesh vulcanized rubber crumb (162.5 grams) was

precoated with a 5% solution of basic tall oil solution (150 grams) then stirred into an anionic asphalt emulsion (250 grams, 65% asphalt) prepared with tall oil as the emulsifier. The resulting dispersion had a viscosity which would enable the product to be pumped and sprayed through a nozzle. After storage overnight, the dispersion was still smooth (not lumpy) but its viscosity had risen to a point where it would not have sprayed evenly through a nozzle.

In preparation of a 5% basic tall oil solution, first a 25% solution was made by heating crude tall oil (500 grams, 25%) with sodium or potassium hydroxide (55 - 200 grams, 2.75 - 10%) and soft water (1445 - 1200 grams, 72.25% - 60%) to 165°F (74°C) while stirring, then diluting 1 part of this solution with four parts soft water.

EXAMPLE 2

30 mesh ground vulcanized rubber crumb (97.5 grams) was precoated with a 5% basic tall oil solution (95 grams) and then stirred into an anionic asphalt emulsion (300 grams, 65% asphalt) prepared with tall oil emulsifier. The viscosity of the emulsion, taken at 77°F (25°C) using the #2 spindle of a Brookfield RVT viscometer, was as follows:

RPM	VISCOSITY (Centipoise)	RPM	VISCOSITY (Centipoise)
0.5	12,000	10	1320
1	7,400	20	810

2.5	3,760	50	448
5	2,400	100	294

EXAMPLE 3

30 mesh rubber crumb (65 grams) was precoated with a 5% basic tall oil solution (63.2 grams) then stirred into an anionic asphalt emulsion (300 grams, 65% asphalt) prepared with tall oil emulsifier. The rheological characteristics of this dispersion were studied over a period of 65 days, as was that of the asphalt emulsion used, using a Brookfield RVT viscometer, Spindle #2, at 77°F.

RPM	VISCOSITY-DAY 1 (centipoise)		VISCOSITY-DAY 4 (centipoise)	VISCOSITY-DAY 65 (centipoise)	
	Rubber dispersion	Asphalt Emulsion	Rubber Dispersion	Rubber Dispersion	Asphalt Emulsion
0.5	8,800	16,400	11,200	34,800	27,600
1	5,600	12,800	6,400	19,400	18,000
2.5	2,800	7,520	3,040	10,400	9,760
5	1,640	4,600	1,760	6,480	5,640
10	960	2,860	1,040		
20	570	-	630	-	-
50	312	-	348	-	-
100	210	-	252	-	-

EXAMPLE 4

16 mesh rubber crumb (216.7 grams) was precoated with a 5% basic tall oil solution (150 grams) then added to an anionic asphalt

emulsion (1000 grams, 65% asphalt). The viscosity of the dispersion and of the asphalt emulsion used was determined at 77°F and at 140°F using Spindle #2 of the Brookfield RVT viscometer.

RPM	DISPERSION VISCOSITY (centipoise)		ASPHALT EMULSION VISCOSITY (centipoise)	
	@ 77°F	@140°F	@ 77°F	@ 140°F
0.5	6400	4400	15,600	6,800
1	3800	2600	9,800	4,000
2.5	1920	1360	4,800	2,000
5	1120	880	2,720	1,280
10	660	560	1,560	820
20	410	380	920	560
50	228	220	488	360
100	168	174	652	506

EXAMPLE 5

30 mesh rubber crumb (48.75) grams) was precoated with a 5% basic tall oil solution (47.5 grams) then added to an anionic asphalt emulsion prepared with tall oil as the emulsifier (300 grams, 65% asphalt). The viscosity of the dispersion was determined, as was that of the asphalt emulsion, using the #2 spindle of a Brookfield RVT viscometer, at 77°F.

RPM	DISPERSION VISCOSITY (centipoise)	ASPHALT EMULSION VISCOSITY (centipoise)
0.5	9200	14,800
1	5800	11,200
2.5	2800	6,240
5	1600	3,720
10	940	2,260
20	570	1,420
50	296	-
100	186	-

EXAMPLE 6

30 mesh rubber crumb (20.6 grams) was precoated with a 5% basic tall oil solution (20 grams) then stirred into an anionic asphalt emulsion (300 grams, 65% asphalt). The viscosity of a sample of the asphalt emulsion and of the rubber asphalt dispersion was determined using the #2 spindle of the Brookfield RVT viscometer at 77°F.

RPM	DISPERSION VISCOSITY (centipoise)	ASPHALT EMULSION VISCOSITY (centipoise)
0.5	12,800	14,800
1	8,000	11,200
2.5	3,920	6,240
5	2,200	3,720
10	1,240	2,260

20	720	1,420
50	380	-
100	252	-

EXAMPLE 7

30 mesh rubber crumb (10.3 grams) was precoated with a 5% basic tall oil solution (10 grams) then stirred into an anionic asphalt emulsion (300 grams, 65% asphalt) prepared with tall oil as the emulsifier. The viscosity of the dispersion was determined over a period of 15 days and compared with the original viscosity of the asphalt emulsion at 77°F using Spindle #2 of the Brookfield RVT viscometer.

RPM	ASPHALT EMULSION VISCOSITY (cps)	RUBBER ASPHALT DISPERSION VISCOSITY (cps)		
		DAY 1	DAY 4	DAY 15
0.5	14,800	15,200	16,400	17,200
1	11,200	9,600	10,600	11,600
2.5	6,240	4,960	5,520	6,320
5	3,720	2,840	3,160	3,760
10	2,260	1,620	1,820	2,220
20	1,420	950	1,090	1,340
50	-	512	600	744
100	-	348	-	-

EXAMPLE 8

30 mesh rubber crumb (16.24 Kg) was precoated

with 5% basic tall oil solution (10.83 Kg) then stirred into an anionic asphalt emulsion (68.1 Kg., 67.2% asphalt) prepared with tall oil as the emulsifier and the viscosity determined at 77°F using the #2 spindle of a Brookfield RVT viscometer.

RPM	VISCOSITY (cps)
0.5	8,000
1	4,400
2.5	2,080
5	1,240
10	760
20	480
50	296
100	234

EXAMPLE 9

30 mesh rubber crumb (4945 lb., 2245 Kg) was pre-coated with a 5% basic tall oil solution (260 gallons, 1180.4 Kg) then stirred into an anionic asphalt emulsion (3100 gallons, 14,074 Kg, 65% asphalt) prepared with tall oil as the emulsifier. The viscosity of this emulsion, taken at 77°F with a #2 spindle of the Brookfield RVT viscometer at 0.5 rpm was 24,400 cps. This product was readily sprayed onto a road surface as a seal coat binder using a conventional emulsion distributor.

EXAMPLE 10

30 mesh rubber crumb (4945 lb., 2245 Kg) was precoated with a 5% basic tall oil solution (280 gallons, 1271.2 Kg) then stirred into an anionic asphalt emulsion prepared with tall oil as the emulsifier (3100 gallons, 14,074 Kg., 65% asphalt). The viscosity of this emulsion, taken at 77°F with a #2 spindle of the Brookfield RVT viscometer at 0.5 rpm was 11,200 cps. This product was readily sprayed onto a road surface as a seal coat binder using a conventional asphalt emulsion distributor.

EXAMPLE 11

30 mesh rubber crumb (183 grams) was added directly to a sample of slow setting emulsion prepared with vinsol resin (1000 grams, 55% asphalt). The emulsion was pumped continuously for 6 minutes at zero pressure and then for 4 minutes at 30 pounds pressure. Passing the dispersion through a screen of 18 x 12 mesh showed it to be free of irreversible agglomerations or lumps.

EXAMPLE 12

30 mesh rubber crumb (184 grams) was precoated with a 10% solution of nonionic emulsifier Igepal CO-990* (200 grams) then stirred into an anionic asphalt emulsion prepared with tall oil as the emulsifier (1000 grams, 60% asphalt). The dispersion was pumped continuously for 6 minutes

* Trade Mark

at 30 pounds pressure then passed through a 12 x 18 mesh screen to collect agglomerated solids. The weight of the precipitate after it had been washed and dried was 105.6 grams.

EXAMPLE 13

30 mesh rubber crumb (184 grams) was precoated with a 20% basic solution of vinsol resin (100 grams) then added to an anionic asphalt emulsion prepared with tall oil as the emulsifier (1000 grams, 60% asphalt). The dispersion was pumped continuously for 6 minutes at 30 pounds pressure then passed through 18 x 12 mesh screen to collect agglomerated solids. After washing and drying, the weight of the precipitate collected was 201.8 grams.

EXAMPLE 14

30 mesh rubber crumb (65 grams) was precoated with a 25% basic solution of tall oil (63.05 grams) then mixed into an asphalt emulsion prepared with tall oil as the emulsifier (300 grams, 65% asphalt). A Brookfield RVT #2 spindle was used to determine the viscosity of the asphalt emulsion used and that of the resulting rubber dispersion at 77°F.

RPM	RUBBER DISPERSION VISCOSITY (centipoise)	ASPHALT EMULSION VISCOSITY (centipoise)
0.5	20,400	15,200
1	14,400	9,760
2.5	8,800	5,040
5	5,960	2,880
10	3,700	1,660
20	-	980
50	-	520
100	-	348

Further examples are as follows:

In cases where the rubber crumb requires pretreatment with an emulsifier solution to form a stable dispersion, the proportions of solution for 30-200 mesh rubber crumb may range between 0.5:1 and 1.2:1, and preferably between 0.6:1 and 1:1. For 16 mesh rubber crumb, the proportions may be lowered to 0.3:1.

The percentage of emulsifier in the pretreatment solution may range between 0.1% and 25%, depending upon the stability required.

EXAMPLE 15

30 mesh rubber crumb (65 grams) was precoated with a 25% basic tall oil solution (63.05 grams, pH 9.8) then stirred into an asphalt emulsion prepared with tall oil as

the emulsifier (300 grams, 65% asphalt, pH 10.8) to yield a dispersion of pH 10.3. The dispersion was allowed to stand at room temperature for a day, aged in a 140°F oven for 22 hours, then allowed to stand at room temperature for another 3 days. Evaporation was prevented by a polyethylene film stretched tightly across the top of the beaker. Viscosity measurements were made on the dispersion as well as on the asphalt emulsion used in its manufacture (and treated in the same manner) using a Brookfield RVT viscometer, Spindle #2, at 77°F.

	DISPERSION VISCOSITY, CPS			ASPHALT EMULSION VISCOSITY, CPS		
RPM	INITIAL	AFTER A DAY	FINAL	INITIAL	AFTER A DAY	FINAL
0.5	20,400	21,600	46,000	15,200	14,800	20,800
1	14,400	15,200	29,800	9,800	9,600	14,000
2.5	8,800	9,400	-	5,040	5,040	7,840
5	5,960	6,000	-	2,880	2,920	4,760
10	3,700	3,640	-	1,660	1,680	2,840

EXAMPLE 16

30 mesh rubber crumb (65 grams) was precoated with a 25% basic tall oil solution (39 grams, pH 13.2) then stirred into an asphalt emulsion prepared with tall oil (300 grams, 65% asphalt, pH 10.8) to give a dispersion of pH 12.4. The dispersion was aged overnight in a 140°F oven then allowed to stand at room temperature for three days, at which point

the viscosity was determined using a Brookfield RVT viscometer, spindle #2 at 77°F.

RPM	VISCOSITY, CPS	
	INITIAL	FINAL
0.5	7,600	26,400
1	4,200	23,400
2.5	2,960	15,840
5	2,880	off scale

EXAMPLE 17

30 mesh rubber crumb (65 grams) was precoated with a 0.1% basic (alkaline) tall oil solution (63.05 grams, pH 9.8) then stirred into an asphalt emulsion prepared with tall oil as the emulsifier (300 grams, 65% asphalt, pH 10.8) to give a dispersion of pH 10.5. The initial viscosity of the dispersion was determined. After aging the dispersion in a 140°F oven for 22 hours, allowing it to cool to room temperature and stirring it, the dispersion was shown to have been broken - irreversible agglomerations of rubber and asphalt had begun to form, producing a lumpy consistency in the dispersion.

RPM	DISPERSION VISCOSITY, CPS AT 77°F, RVT #2
0.5	3200
1	2200
2.5	1120

5	680
10	460
20	290
50	172
100	146

EXAMPLE 18

30 mesh rubber crumb (65 grams) was precoated with 0.5% alkaline tall oil solution (39 grams, pH 11.4) then stirred into an asphalt emulsion prepared with tall oil (300 grams, 65% asphalt, pH 10.8) to give a dispersion of pH 10.75. The dispersion was heated overnight in a 140°F oven then allowed to cool. Upon being stirred, the dispersion was broken.

RPM	VISCOSITY PRIOR TO AGING (CPS) Brookfield RVT #2, 77°F
0.5	6000
1	3600
2.5	1840
5	1120

Since various modifications can be made in our invention as hereinabove described, and many apparently widely different embodiments of same made within the spirit and scope of the claims without departing from such spirit and scope, it is intended that all matter contained in the accompanying specification shall be interpreted as illustrative only and not in a limiting sense.

WHAT WE CLAIM AS OUR INVENTION IS:

(1) A process for incorporating rubber crumb into asphalt emulsion comprising pretreating the rubber crumb with an anionic emulsifier solution sufficient to wet substantially all of the surfaces of the rubber crumb, and then mixing the pretreated rubber crumb into an anionic asphalt emulsion in the ratio of between 1:1 and 1:19 by weight of rubber to asphalt to form a rubber asphalt emulsion.

(2) The process according to Claim 1 in which the emulsifier solution includes an anionic emulsifying agent the same as the emulsifying agent used in the asphalt emulsion.

(3) The process according to Claim 1 in which the pH of the rubber asphalt emulsion is between pH 10 and pH 12.5.

(4) The process according to Claim 2 in which the pH of the rubber asphalt emulsion is between pH 10 and pH 12.5.

(5) The process according to Claim 1 in which the rubber crumb particle size is between 16 mesh and 200 mesh USS.

(6) The process according to Claim 2 in which the rubber crumb particle size is between 16 mesh and 200 mesh USS.

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(7) The process according to Claim 3 in which the rubber crumb particle size is between 16 mesh and 200 mesh USS.

(8) The process according to Claim 4 in which the rubber crumb particle size is between 16 mesh and 200 mesh USS.

(9) The process according to Claim 1 in which the emulsifier solution comprises an anionic emulsifier, a saponifying agent and water with the saponifying agent being selected from the group consisting of sodium hydroxide and potassium hydroxide.

(10) The process according to Claim 2 in which the emulsifier solution comprises an anionic emulsifier, a saponifying agent and water with the saponifying agent being selected from the group consisting of sodium hydroxide and potassium hydroxide.

(11) The process according to Claim 3 in which the emulsifier solution comprises an anionic emulsifier, a saponifying agent and water with the saponifying agent being selected from the group consisting of sodium hydroxide and potassium hydroxide.

(12) The process according to Claim 4 in which the emulsifier solution comprises an anionic emulsifier, a saponifying agent and water with the saponifying agent be-

ing selected from the group consisting of sodium hydroxide and potassium hydroxide.

(13) The process according to Claim 5 in which the emulsifier solution comprises an anionic emulsifier, a saponifying agent and water with the saponifying agent being selected from the group consisting of sodium hydroxide and potassium hydroxide.

(14) The process according to Claim 6 in which the emulsifier solution comprises an anionic emulsifier, a saponifying agent and water with the saponifying agent being selected from the group consisting of sodium hydroxide and potassium hydroxide.

(15) The process according to Claim 7 in which the emulsifier solution comprises an anionic emulsifier, a saponifying agent and water with the saponifying agent being selected from the group consisting of sodium hydroxide and potassium hydroxide.

(16) The process according to Claim 8 in which the emulsifier solution comprises an anionic emulsifier, a saponifying agent and water with the saponifying agent being selected from the group consisting of sodium hydroxide and potassium hydroxide.

(17) The process according to Claims 1, 2 or 3 in which the rubber crumb comprises vulcanized, unvulcanized

or devulcanized rubber selected from the group comprising natural rubber, isoprene, butadiene rubber, butadiene-styrene rubber, butyl rubber and ethylene propylene rubbers.

(18) The process according to Claims 4, 5 or 6 in which the rubber crumb comprises vulcanized, unvulcanized or devulcanized rubber selected from the group comprising natural rubber, isoprene, butadiene rubber, butadiene-styrene rubber, butyl rubber and ethylene propylene rubbers.

(19) The process according to Claims 7, 8 or 9 in which the rubber crumb comprises vulcanized, unvulcanized or devulcanized rubber selected from the group comprising natural rubber, isoprene, butadiene rubber, butadiene-styrene rubber, butyl rubber and ethylene propylene rubbers.

(20) The process according to Claims 10, 11 or 12 in which the rubber crumb comprises vulcanized, unvulcanized or devulcanized rubber selected from the group comprising natural rubber, isoprene, butadiene rubber, butadiene-styrene rubber, butyl rubber and ethylene propylene rubbers.

(21) The process according to Claims 13, 14 or 15 in which the rubber crumb comprises vulcanized, unvulcanized or devulcanized rubber selected from the group comprising natural rubber, isoprene, butadiene rubber, butadiene-styrene rubber, butyl rubber and ethylene propylene

rubber.

(22) The process according to Claim 16 in which the rubber crumb comprises vulcanized, unvulcanized or devulcanized rubber selected from the group comprising natural ruber, isoprene, butadiene rubber, butadiene-styrene rubber, butyl rubber and ethylene propylene rubber.

(23) A process for incorporating rubber crumb into asphalt emulsion comprising pretreating the rubber crumb with an anionic emulsifier solution sufficient to wet substantially all the surfaces of the rubber crumb, and then mixing the pretreated rubber crumb into an anionic asphalt emulsion to form a rubber asphalt emulsion wherein the emulsifier solution includes an emulsifier which effects wetting of the rubber crumb and in which the proportion of the emulsifier in the pretreatment solution is between 0.1% and 25% by weight depending upon the stability of the rubber asphalt emulsion required, and in which the proportion of emulsifier solution to rubber crumb is between 0.3 and 1.2 to 1 by weight.

(24) The process according to Claim 23 in which the emulsifier in the pretreatment solution and in the asphalt emulsion is tall oil.

(25) The process according to Claim 23 in which the emulsifier in the pretreatment solution and in the as-

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phalt emulsion is vinsol resin.

ADE, KENT & ASSOCIATES

402-211 Portage Avenue,
Winnipeg, Manitoba, Canada
R3B 2A2

SUBSTITUTE

REMPLACEMENT

SECTION is not Present

Cette Section est Absente