CLAIMS

1. A bitumen additive comprising :

a wax dispersed in water, the water being in the continuous phase and the wax in the dispersed phase;

the wax comprising a Fischer-Tropsch wax and one or more hydrocarbon waxes ~~selected from the group of petroleum-based waxes, polyolefin waxes and mixtures thereof~~; and

an cationic emulsifier;

wherein the one or more hydrocarbon waxes is a petroleum slack wax;

wherein the wax comprises

20 wt% to 80 wt% of the petroleum slack wax; and

20 wt% to 80 wt% of the Fischer-Tropsch wax,

each relative to a total mass of the mixture of the Fischer-Tropsch wax and the petroleum slack wax.

wherein the Fischer-Tropsch wax has the following properties:

a congealing point according to ASTM D938 of 50°C or higher;

a MEK-oil content according to ASTM D7211-06 below 5 wt%;

a kinematic viscosity at 100°C according to ASTM D7042-11 from 3 mm^2/s to 15 mm^2s;

a needle penetration at 25°C according to ASTM D1321 below 30 1/10mm; and

a n-alkane content above 80 wt%;

wherein the petroleum slack wax has the following properties:

a congealing point according to ASTM D938 below 65°C;

a MEK-oil content according to ASTM D7211-06 above 5 wt%;

a kinematic viscosity at 100°C according to ASTM D7042-11 from 3.5 mm^2/s to 10 mm^2/s;

a needle penetration at 25°C according to ASTM D1321 above 50 1/10 mm; and

a n-alkane content below 70 wt%; and

wherein the bitumen additive comprises from 30 wt% to 70 wt% of the wax, based on the total mass of the bitumen additive.

2. The bitumen additive according to claim 1, wherein the bitumen additive additionally comprises ~~alpha olefins, fatty acids,~~ fatty alcohols~~, esters of fatty acids, amide waxes, or any mixture thereof~~.

~~3. The bitumen additive according to claim 1 or claim 2, wherein the bitumen additive comprises from 5 wt% to 95 wt% of the wax, preferably from 30 wt% to 70 wt% of the wax, based on the total mass of the bitumen additive.~~

~~4~~3. The bitumen additive according to ~~any one of~~ claims 1 ~~to 3~~or claim 2, wherein the bitumen additive comprises from 0.2 wt% to 10 wt% of the emulsifier, preferably from 1 wt% to 6 wt% of the emulsifier, based on the total mass of the bitumen additive.

~~5~~4. The bitumen additive according to any one of claims 1 to 4, wherein the bitumen additive comprises an elastomer, preferably from 1 wt% to 70 wt% of the elastomer, preferably from 20 wt% to 50 wt% of the elastomer, based on the total mass of the bitumen additive.

~~6. The bitumen additive according to any one of claims 1 to 5, wherein the emulsifier is an anionic emulsifier, a cationic emulsifier, a non-ionic emulsifier, or any mixture thereof.~~

~~7. The bitumen additive according to any one of claims 1 to 6, wherein the wax comprises petroleum slack wax and Fischer-Tropsch wax, preferably:~~
~~20 wt% to 80 wt% of the petroleum slack wax; and~~
~~20 wt% to 80 wt% of the Fischer-Tropsch wax,~~
~~each relative to a total mass of the mixture of the Fischer-Tropsch wax and the petroleum slack wax.~~

~~8~~5. The bitumen additive according to any one of claims 1 to ~~7~~4, wherein the Fischer-Tropsch wax has the following properties:

a congealing point according to ASTM D938 of ~~50°C or higher, preferably~~ 60°C or higher, ~~more~~ preferably between 70°C and 110°C, ~~most~~ more preferably between 75°C and 82°C;
a MEK-oil content according to ASTM D7211-06 ~~below 5 wt%, preferably~~ below 2 wt%;
a kinematic viscosity at 100°C according to ASTM D7042-11 from ~~3 mm^2/s to 15 mm^{2}s, preferably~~ 5 mm^2/s to 10 mm^2/s, more preferably from 7mm^2/s to 9 mm^2/s;
a needle penetration at 25°C according to ASTM D1321 ~~below 30 1/10mm, preferably~~ below 10 1/10mm; and
a n-alkane content above 80 wt%.

~~9~~6. The bitumen additive according to any one of claims 1 to ~~8~~5, wherein the petroleum slack wax has the following properties:
a congealing point according to ASTM D938 below 65°C;
a MEK-oil content according to ASTM D7211-06 ~~above 5 wt%, preferably~~ above 15 wt%;
a kinematic viscosity at 100°C according to ASTM D7042-11 ~~from 3.5 mm^2/s to 10 mm^2/s, preferably~~ from 5 mm^2/s to 10 mm^2/s, ~~more~~ preferably from 6 mm^2/s to 8 mm^2/s;
a needle penetration at 25°C according to ASTM D1321 above 50 1/10 mm; and
a n-alkane content ~~below 70 wt%, preferably~~ below 40 wt%.

~~10. A method to produce a foamed bitumen composition, the method comprising: adding the bitumen additive according to any one of claims 1 to 9 to a bitumen feedstock in a bitumen foaming device thereby to produce the foamed bitumen.~~

~~11.~~10. ~~The method according to claim 10, wherein the bitumen additive is added to the bitumen feedstock in an amount of from 0.1 wt% to 10 wt%, preferably from 2 wt% to 6 wt%, based on the total mass of the bitumen feedstock.~~

~~12~~7. A method to produce ~~an~~ a warm asphalt mix, the method comprising:
adding a bitumen feedstock and the bitumen additive according to any one of claims 1 to 9 to an aggregate in an asphalt mixer thereby to produce the warm asphalt mix, wherein the bitumen feedstock~~.~~

a. is added to the aggregate prior to adding the bitumen additive to the aggregate; or

b. is added to the aggregate concurrently with adding the bitumen additive to the aggregate.

~~13. The method according to claim 12, wherein the bitumen feedstock:~~

~~a. is added to the aggregate prior to adding the bitumen additive to the aggregate; or~~

~~b. is added to the aggregate after adding the bitumen additive to the aggregate; or~~

~~c. is added to the aggregate concurrently with adding the bitumen additive to the aggregate.~~

8. The method according to claim 7, wherein the bitumen additive is added to the bitumen feedstock in an amount of from 0.1 wt% to 10 wt%, preferably from 2 wt% to 6 wt%, based on the total mass of the bitumen feedstock.

~~14~~9. The method according to claim ~~12~~ 7 or ~~13~~claim 8, where in the bitumen feedstock is foamed in the asphalt mixer when the bitumen feedstock is contacted withthe bitumen additive.

10. The method according to any one of claims 7 to 9, wherein the additive is added directly to the asphalt mixer using a liquid additive dosing system.

~~15~~11. The method according to any one of claims ~~12~~ 7 to ~~14~~9, wherein the bitumen additive is added to the bitumen feedstock in a bitumen foaming device thereby to form a foamed bitumen composition, and the foamed bitumen composition is then added to the aggregate in the asphalt mixer.

~~16. The method according to any one of claims 12 to 15, where in the foamed bitumen is produced according to any one of claims 11 to 13.~~

~~17. The method according to any one of claims 12 to 16, wherein the asphalt mix is a warm mix asphalt.~~

~~18~~12. The method according to any one of claims ~~12~~ 7 to ~~17~~11, wherein the aggregate comprises recycled or reclaimed asphalt pavement (RAP).

~~19. A foamed bitumen composition obtainable according to claim 10 or claim 11.~~

~~20. An asphalt mix obtainable according to the method of any one of claims 12 to 18.~~

~~21~~13. Use of a foamed bitumen composition obtainable according to the method of claim ~~10 or claim~~ 11 to produce ~~an asphalt mix, preferably~~ a warm mix asphalt.

~~22~~14. Use of the bitumen additive according to any one of claims 1 to ~~9~~ 6 for producing ~~a bitumen composition, preferably~~ a foamed bitumen composition.

~~23. Use of the asphalt mix obtainable according to the method of any one of claims 12 to 18 for paving.~~