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(54) **Title:** METHOD FOR MANUFACTURING EMULSION PAINT

(57) **Abstract:** Paint is recycled in a method comprising the steps of: (a) providing a paint precursor, comprising degraded paint; and (b) treating the paint precursor by: testing the pH of the paint precursor and, if necessary, adjusting the pH to lie within a predetermined range; and testing one or more of the following properties of the paint precursor and, if necessary, adjusting the property or properties to lie with a predetermined range: (i) specific gravity; (ii) solids content; (iii) viscosity; and (iv) opacity, whereby at least one of the pH, specific gravity, solids content, viscosity, and opacity of the paint precursor is adjusted, thereby producing useable paint, recycled from degraded paint.



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Method for Manufacturing Emulsion Paint

Field

The present invention relates to a method for manufacturing paint, particularly from reclaimed paint, to apparatus for manufacturing paint and to paint made from reclaimed paint. The present invention relates especially to recycling of paint.

Background

There is increasing environmental and moral pressure to reuse and recycle as high a percentage as possible of consumable products, one of which is paint. Landfill and other disposal costs are increasing, providing further incentive to reduce overall wastage, in the context of the invention, of paint and similar products.

It is known to carefully sort old and unused paint, to identify paint that is still in an acceptably useable condition, sorted paint above a certain quality threshold then being blended to provide paint that can be re-used instead of being wasted.

The supply of waste paint is variable and so there may be a variable proportion of paint that is suitable to be reused, there remaining a significant amount of paint that must be disposed of. Known methods may include rudimentary processing such as filtering but such methods are not capable of processing paint that has degraded, which must be discarded. The sorting must be done carefully and can be time consuming.

Problem

An object of the present invention is to overcome or at least ameliorate one or more of the above-identified problems and in addition embodiments of the invention allow a higher proportion of the waste paint to be utilised. An object of particular embodiments of the invention is to provide methods of manufacture of paint that can be used for recycling of reclaimed or degraded paint. An object of specific embodiments is to provide a method for recycling of degraded, water-based emulsion paints, together with the paint obtained thereby.

Invention

Accordingly, the present invention provides a method for manufacturing paint, comprising the steps of providing a paint precursor comprising degraded paint, treating it to restore degraded properties, and optionally, dispensing the manufactured paint into containers and sealing the containers for storage and/or distribution.

Methods of the invention enable degraded paint to be recycled to produce paint that has substantially or entirely similar properties to non-degraded paint. Thus, degraded paint can be obtained from local amenity paint disposal sites and recycled. This source provides an abundant amount of hitherto unusable, waste paint, much of which would otherwise be disposed of as general refuse or at waste destruction or landfill sites. Degraded/waste paint can also be obtained from commercial sources.

The degraded paint is typically degraded water-based emulsion and is further typically characterised by one or more or in extreme cases all of the following degradations: the presence of large foreign objects (e.g. rubber gloves, paint brushes or parts thereof or container opening tools); uneven texture, at least in part caused by the presence of pieces of hardened paint; paint that has split or separated into its component parts; the presence of paint breakdown products (some of which may create an unpleasant odour, often sulphurous); a pH outside a predetermined range (generally degraded paint has a pH that is too low); a solids content outside a pre-determined range (generally slightly high in degraded paint); a viscosity outside a pre-determined range (generally too low in degraded paint); and a specific gravity outside a pre-determined range (generally too high in degraded paint).

The degraded paint is regarded as unusable in its supplied form and the quality of the feedstocks naturally varies according to supply. However, the present invention enables accurate restoration of one or more of the degraded properties of the paint to produce a recycled paint that is usable and acceptably consistent in quality. A high percentage of recycling of degraded paint becomes possible.

The precursor paint of the invention typically comprises paint derived from one batch of degraded paint, or several batches of paint of similar or differing quality and degradation, which are combined. At larger scales, a multitude of paint feedstocks with varying degrees of degradation are combined in recycling methods of the invention.

The paint precursor is preferably treated by testing the pH of the paint precursor and, if necessary, adjusting the pH to lie within a predetermined range.

In embodiments of the invention, the paint precursor is subjected to a preliminary step of treating the paint precursor by adding a pH adjusting material and blending the material into the paint precursor. This preliminary step can be carried out prior to pH testing and may advantageously minimise the number of subsequent steps. It typically comprises treating the paint precursor with 5% w/w or less, preferably 2% w/w or less, more preferably 1 – 2% w/w pH adjusting material.

The pH indicates the stability, viscosity and safety of the paint. If the pH of the paint is too low then it may separate or may become too thin to be usable and, if very acidic, the paint may become corrosive, and may be an indication of adverse biological degradation. In extreme cases, if the pH of the paint is too high then the paint may be regarded as too hazardous to use. The predetermined pH range for the paint of the invention is typically pH 7.5 or above, or pH 8 or above, preferably pH 8 – 10, more preferably pH 8.2 – 9.7, most preferably pH 8.4 – 9.

The pH is typically adjusted by adding to the paint precursor a material that alters its pH and blending the material into the paint precursor. To check this process, the paint can be remixed and retested, and if necessary re-adjusted, until a suitable pH is achieved. As the pH of degraded paint often becomes too low in storage, the pH-adjusting material is typically alkaline, preferably alkaline clay, ground marble and/or alkaline solution for example ammonium hydroxide, NaOH, KOH, calcium carbonate or triethanolamine, all optionally in solution. In an example described below, ammonium hydroxide was used. In another example described below, ground marble was used. However, the invention may, as appropriate, include correcting the

pH of overly alkaline degraded paint by adding an acidic material. In this case, the pH-adjusting material is suitably acidic clay and/or acidic solution, preferably HCl.

The pH is optionally retested and if necessary readjusted after subsequent processing steps, for example testing and adjusting of specific gravity, solids content and/or viscosity as described below.

Treating the paint precursor may also comprise testing one or more of the following properties of the paint precursor and, if necessary, adjusting the property or properties to lie with a predetermined range:

- (i) specific gravity;
- (ii) solids content; and
- (iii) viscosity.

The specific gravity, solids content and viscosity of the paint each contribute to the thickness of the paint. In storage, paint can degrade in one or more different ways. Paint may become less viscous due to a drop in pH and degradation. Paint may become thicker due to loss of water or other solvents.

Paint thinning can yield a paint that has poor opacity, and thus a poor ability to cover, for example, dirt, unwanted colours, graffiti and other marks on the surface to be painted. In addition, paint thinning can produce a paint that does not adhere well to the painting tool, resulting in inconvenient application, or to the surface to be painted, resulting in sagging or dripping of the applied paint. Paint thickening can yield paint that has poor spreading properties or is otherwise unusable.

By following methods of the present invention, it is possible to test and restore each thickness property to produce a paint of comparable quality to non-degraded paint, and determining the thickness properties enables the manufacturing of paint of a predetermined and acceptable specification from reclaimed paint of variable and unacceptable quality. The specific gravity, solids content and viscosity of the paint may interact to produce an overall thickness and hence adjusting one property may

mean a related property needs no or reduced adjustment to produce acceptably thick paint.

The predetermined specific gravity range of paint of the invention is typically 1 – 2. A predetermined specific gravity range of paint of the invention for matt grade paint is typically 1.2 – 2, preferably 1.3 – 1.6, more preferably 1.38 – 1.5. A predetermined specific gravity range of paint of the invention for silk/soft sheen (soft sheen also known as eggshell) grade paint is typically 1 – 1.4, preferably 1.1 – 1.3, more preferably 1.14 – 1.2.

The specific gravity is typically adjusted by adding to the paint precursor a material that alters the specific gravity, and blending the material into the paint precursor. This material may be one or more of particulate solid matter, an aqueous suspension of particulate solid matter, thicker paint, thinner paint and water. The particulate solid matter preferably comprises one or more of clay, chemically or heat modified clay, talcs, and calcium carbonate. Suitable clays may comprise attapulgite and/or may be kaolin-type clays. Material of higher specific gravity than the paint precursor may be added to raise the specific gravity of the paint precursor, and material of lower specific gravity than the paint precursor may be added to lower the specific gravity of the paint precursor. In an example of the invention, set out below in more detail, an aqueous suspension of particulate solid matter, specifically clays, and having relatively low specific gravity was mixed into degraded paint having too high a specific gravity, to yield paint having acceptable specific gravity.

The predetermined solids content range of the paint of the invention is typically 20% w/w or more. A predetermined solids content range of the paint for matt grade paint of the invention is typically 30% w/w or more, preferably 35 – 55% w/w, more preferably 38 – 50% w/w. A predetermined solids content range of the paint for silk/soft sheen grade paint of the invention is typically 20% w/w or more, preferably 25 – 45% w/w, more preferably 27 – 40% w/w.

The solids content is typically adjusted by adding to the paint precursor a material that alters the solids content, and blending the material into the paint precursor. This

material may be one or more of particulate solid matter, an aqueous suspension of particulate solid matter, thicker paint, thinner paint and water. The particulate solid matter preferably comprises one or more of clay, chemically or heat modified clay, talc, and calcium carbonate. Suitable clays may comprise attapulgite and/or may be kaolin-type clays. Material of higher solids content than the paint precursor may be added to raise the solids content of the paint precursor, and material of lower solids content than the paint precursor may be added to lower the solids content of the paint precursor.

The viscosity of the paint may change according to how it is handled and the time elapsed since handling has stopped. Accordingly, the present invention comprises testing and adjusting the viscosity of the paint precursor and, if necessary, adjusting the viscosity at one or more time points after the paint precursor has been mixed. Performing this procedure at more than one time point advantageously gives a more accurate impression of how the paint will perform after a period of storage. In the Examples below, the viscosity was measured using a Brookfield DV-II viscometer installed with a LV-4 spindle rotating at 0.6 revolutions per minute. This produced a shear rate of around 0.125 sec^{-1} .

A first predetermined viscosity range of the paint of the invention is typically 2×10^3 centipoise or more, preferably 13×10^3 centipoise or less, more preferably 9×10^3 centipoise or less, measured after the paint precursor is allowed to stand for 5 minutes. Separately, a second predetermined viscosity range of the paint of the invention is typically 3×10^3 centipoise or more, preferably 22×10^3 centipoise or less, more preferably 20×10^3 centipoise or less, measured after the paint precursor is allowed to stand for an hour. Preferably, the paint meets both viscosity tests, i.e. the first after standing for 5 minutes and the second after standing for an hour.

For matt grade paint, a first predetermined viscosity range of the paint of the invention is typically 5.5×10^3 centipoise or more, preferably 6×10^3 centipoise or more, preferably $6 - 8 \times 10^3$ centipoise, optionally 8×10^3 centipoise or more, preferably $8.5 - 13 \times 10^3$ centipoise, measured after the paint precursor is allowed to stand for 5 minutes. Separately, a second predetermined viscosity range of the matt

paint of the invention is typically 10×10^3 centipoise or more, preferably 12×10^3 centipoise or more, more preferably 22×10^3 centipoise or less, yet more preferably $12 - 18 \times 10^3$ centipoise, measured after the paint precursor is allowed to stand for an hour. Preferably, the paint meets both viscosity tests, i.e. the first after standing for 5 minutes and the second after standing for an hour.

For silk/soft sheen grade paint, a first predetermined viscosity range of the paint of the invention is typically 2×10^3 centipoise or more, preferably 2.5×10^3 centipoise or more, preferably $2.5 - 4 \times 10^3$ centipoise, measured after the paint precursor is allowed to stand for 5 minutes. Separately, a second predetermined viscosity range of the silk/soft sheen paint of the invention is typically 4×10^3 centipoise or more, preferably 5×10^3 centipoise or more, more preferably $5 - 9 \times 10^3$ centipoise, measured after the paint precursor is allowed to stand for an hour. Preferably, the paint meets both viscosity tests, i.e. the first after standing for 5 minutes and the second after standing for an hour.

In an alternative embodiment for silk/soft sheen grade paint, a first predetermined viscosity range of the paint of the invention is typically 5×10^3 centipoise or more, preferably 6×10^3 centipoise or more, more preferably 7×10^3 centipoise or more, preferably 10×10^3 centipoise or less, measured after the paint precursor is allowed to stand for 5 minutes. Separately, a second predetermined viscosity range of the silk/soft sheen paint of the invention is typically 7×10^3 centipoise or more, preferably 8×10^3 centipoise or more, more preferably 10×10^3 centipoise or more, preferably 15×10^3 centipoise or less, measured after the paint precursor is allowed to stand for an hour. Preferably, the paint meets both viscosity tests, i.e. the first after standing for 5 minutes and the second after standing for an hour.

The viscosity is typically adjusted by adding to the paint precursor a material that alters the viscosity, and blending the material into the paint precursor. This material may be one or more of more viscous paint, less viscous paint, clay, cellulose or derivatives thereof, polysaccharide and acrylic. Examples of materials that may be used are carboxymethylcellulose, modified carboxymethylcellulose, carboxypropylcellulose, modified carboxypropylcellulose, hydroxyethylcellulose,

modified hydroxyethylcellulose, xanthan gum and Additol (RTM) VXW 6388 (Cytec Industries Inc., Woodland Park, NJ, USA). Certain additives, e.g. modified hydroxyethylcellulose are further advantageous as they are resistant to bacterial degradation. Material of higher viscosity than the paint precursor may be added to raise the viscosity of the paint precursor, and material of lower viscosity than the paint precursor may be added to lower the viscosity of the paint precursor. As the pH also affects viscosity, the material to adjust the viscosity may also preferably be one or more of ammonium hydroxide, triethanolamine, NaOH, KOH, calcium carbonate, each optionally as a solution, and ground marble.

In embodiments of the invention, the opacity of the paint is directly monitored and adjusted as necessary at one or more points in the process. The opacity is typically monitored by painting out a sample of paint or paint precursor onto a surface onto which a standard high contrast pattern is printed, then the paint or paint precursor is allowed to dry. The extent to which the pattern is visible through the dried paint provides a measure of opacity. The apparent level of opacity is compared to samples of known opacity, and adjusted, as appropriate to achieve the required opacity, by adding materials which adjust the specific gravity and/or solids content. Preferred additives include one or more of modified clays and titanium dioxide.

An embodiment of the invention accordingly provides a method for manufacturing paint, comprising the steps of:

(a) providing a paint precursor, comprising degraded paint; and

(b) treating the paint precursor by:

testing the pH of the paint precursor and, if necessary, adjusting the pH to lie within a predetermined range; and

testing one or more of the following properties of the paint precursor and, if necessary, adjusting the property or properties to lie with a predetermined range:

(i) specific gravity;

(ii) solids content;

(iii) viscosity; and

(iv) opacity,

whereby at least one of the pH, specific gravity, solids content, viscosity and opacity of the paint precursor is adjusted, thereby producing paint.

Typically, pH and at least one of the specific gravity, solids content, viscosity and opacity of the paint precursor is tested and, if necessary, adjusted. Two or more, or in certain cases three or more, of pH, specific gravity, solids content, viscosity and opacity of the paint precursor may be tested and, if necessary, adjusted. As some of the materials used to adjust the pH and/or other paint properties affect more than one of pH and/or other paint properties, then it is preferable to test the pH and/or other paint properties after each pH and/or other paint property adjustment. It will be understood that the testing and adjusting to obtain recycled paint having values for pH, specific gravity, solids content, viscosity and opacity falling within acceptable ranges is generally iterative.

To produce a paint of a specific colour, the present invention preferably comprises a pre-processing step, wherein the paint precursor is prepared by combining two or more feedstocks, selected so as to produce, when combined, a paint precursor of a desired colour. This reduces the necessity to use additional colorants in the final product. For example, white paint may be mixed with other white paint, magnolia paint may be mixed with other magnolia paint, and so on. The colour may also be adjusted by the addition of colouring agents such as pigments, or colours chosen from the waste paints.

To produce a paint having a specific finish on the painted surface when dry, such as matt, eggshell or silk, the present invention preferably comprises a pre-processing step, wherein the paint precursor is prepared by combining two or more feedstocks, selected so as to produce, when combined, a paint precursor that will produce the desired finish. Accordingly, matt paint may be mixed with other matt paint, eggshell paint may be mixed with other eggshell paint, and silk paint may be mixed with other silk paint, for example.

To minimise the amount of processing to correct one or more of pH, viscosity, solids content, specific gravity and opacity of the paint, the method may comprise a pre-

processing step, wherein the paint precursor is prepared by combining two or more feedstocks, selected so as to produce, when combined, a paint precursor that has pH and/or properties falling in the preferred ranges of one or more of pH, viscosity, solids content, specific gravity and opacity.

To simplify subsequent processing, it has been found that it is advantageous to include in the process a preliminary step of treating the paint precursor with a pH adjusting material.

The present invention may further comprise adding one or more preservatives to prevent the paint from degradation, enhancing shelf life. Suitable "in-can" preservatives comprise an antimicrobial agent, preferably an antibacterial agent and/or antifungal agent, more preferably a broad-spectrum antibacterial agent. Such preservatives prevent the degradation of the paint by avoiding the breakdown of the paint components (e.g. cellulose or derivatives thereof) by microbes, and are distinguished from preservatives that primarily alter properties of the finished painted surface.

A suitable preservative may comprise one or more of 1,2-benzisothiazolin-3-one (BIT), zinc 2-pyridinethiol-1-oxide (zinc pyrithione), 2-methyl-4-isothiazolin-3-one (MIT), formaldehyde and formaldehyde-releasing preservatives. In addition to preventing the new growth of bacteria in the paint, BIT also kills bacteria that have already grown in the paint feedstock. Similarly, in addition to preventing the new growth of fungus in the paint, zinc pyrithione also kills fungus that have already grown in the paint feedstock.

It is an option to use a combination of two or more preservatives to control microbes that may already be present in the degraded paint. One such combination is BIT and zinc pyrithione. A preferred combination is BIT and MIT.

The method of the invention may optionally comprise the addition of up to 1% w/w of one or more in-can preservative, preferably up to 0.5% w/w, more preferably up to 0.3% w/w.

Optionally, alternative antimicrobial agents may be used to prevent the growth of, or simply kill, microbes, e.g. viruses, bacteria (such as MRSA) and/or fungi, that come into contact with the finished painted surface. Suitable "surface" antimicrobial agents may comprise one or more of silver, silver-containing compounds, zinc pyrithione (zinc 2-pyridine-thiol-1-oxide), 1,2-benzisothiazolin-3-one (BIT) and 2-methyl-4-isothiazolin-3-one (MIT), and may form a dry-film preservative. This produces a paint that is particularly suitable for specialist applications, such as painting of damp areas (e.g. bathrooms), external areas or places where aseptic conditions are preferred (e.g. hospitals).

The method of the invention may optionally comprise the addition of up to 1% w/w of one or more surface antimicrobial agent, preferably up to 0.5% w/w, more preferably up to 0.3% w/w.

In particular methods of the invention, preservatives to enhance shelf-life and to prevent microbial growth on the finished painted surface are both added during manufacture of the paint.

The invention preferably comprises mixing of the paint precursor by blending prior to treating. The blending preferably homogenises the paint. The blending further preferably is carried out so as to reduce the mean particle size of the paint. In examples carried out a shear mixer is used to reduce particle size in the degraded paint. Homogenising, as well as combining the feedstocks well, also, in part, may temporarily reverse the effects of any paint degradation, enabling further processing to take place.

Reducing the mean particle size of the paint advantageously enables the method of the invention to recycle the material present in the pieces of hardened paint in the degraded paint, which would otherwise be required to be taken out of the finished product and disposed of in landfill. This particle size reduction is separate from filtration and may be used in conjunction with prior or subsequent filtration steps.

The shear-mixing of the invention is preferably carried out using one or more mixing heads, each comprising a rotor and a stator. The shearing force is provided at the clearance between the rotor and stator, which is preferably 1 mm or less, more preferably 0.5 mm or less, most preferably 0.3 mm or less. Referring to examples carried out in operation of the invention, good homogenisation and particle size reduction have been achieved using a rotor spinning at 1,000 rpm or faster, 2,000 rpm or faster, more preferably 3,000 or faster. Indeed, shear-mixing is more efficient at rotor speeds of 5,000 rpm or faster. However, it is preferred not to shear for too long as this may damage the stability of the emulsion. Accordingly, the duration of shear-mixing should typically not exceed 30 minutes of high shearing action.

The method of the invention optionally comprises filtering the paint, before and/or after treating the paint, preferably at least after treating the paint. The filtering is typically carried out using a sieve and the filter preferably has a pore size of 300 μm or less, more preferably 250 μm or less, even more preferably 200 μm or less, still more preferably 150 μm or less. The pore size of filter used will be in part a trade off between the desired finish of the paint product and filtering speed. For example, to make paint for spray applications filtering is generally through a finer sieve (e.g. 200 μm or less, or 150 μm or less) to avoid blocking the spray apparatus, whereas paint filtered through larger pores is generally suitable for the manufacture of paint for brush or roller only application.

The filtering is preferably mechanically-assisted to, for example, increase the filter flow rate. Typically, the filtering is assisted by vibrating the filter, preferably in an axis approximately perpendicular to the paint flow. The filtering may also be assisted by mixing the paint or by other means of inputting energy into the paint, such as sonication.

The filtering is driven preferably by gravity under atmospheric pressure, although it may be driven by pressure, preferably less than 10 bar, more preferably less than 1 bar, even more preferably less than 500 mbar, still more preferably less than 300 mbar.

The present invention may further comprise adding one or more odour-reducing materials to reduce the typically sulphurous odour released by the paint breakdown products and/or other components. The odour-reducing material preferably comprises clay, clay-like material or talc. For example, the odour-reducing material comprises fuller's earth, attapulgite type clay or molecular sieves, e.g. zeolites. The odour-reducing materials are preferably present in the range 0.5 – 30% w/w, more preferably, 1 - 10% w/w, still more preferably 1 - 5% w/w.

The present invention may further comprise the addition of materials to the paint to obtain a more durable, harder paint finish. Suitable materials for this purpose include resin, preferably acrylic. When resin is added to increase durability and hardness, it is typically added to a level of up to 20% w/w, preferably up to 10% w/w, more preferably up to 5% w/w. Other materials include PTFE dispersions, heat, mica or chemically modified clays.

Additionally provided by the invention is apparatus for manufacturing paint from paint precursor. The apparatus may comprise the following components in fluid connection:

- 1) a chamber for blending paint, comprising:
 - a) means for blending paint precursor in the chamber;
 - b) means for testing the pH of the paint precursor and, if necessary, adjusting the pH to lie within a predetermined range;
 - c) means for testing one or more of the following properties of the paint precursor and, if necessary, adjusting the property or properties to lie with a predetermined range:
 - (1) specific gravity;
 - (2) solids content; and
 - (3) viscosity,
- 2) a filter; and
- 3) a dispenser.

Preferably a reservoir of pH adjusting material is in fluid connection with the chamber. This enables easy pH adjustment and is suitable for large scale and even continuous processing.

Preferably the means for adjusting the property or properties is one or more reservoir of property or properties adjusting material in fluid connection with the chamber. Similarly, this enables easy adjustment of paint properties and is suitable for large scale and even continuous processing.

In preferred apparatus the blending means is a shear-mixer, suitably in accordance with optional and other preferred features as described in relation to the methods of the invention.

The filter of the apparatus suitably has a pore size of 300 μm or less. The chamber may also comprise means for measuring the volume or weight of the paint in the chamber. Other optional and preferred features described in connection with methods of the invention apply mutatis mutandis to the apparatus, being suitable for carrying out those methods.

Still further, the present invention provides recycled paint, made according to the methods disclosed herein. Paint is hence provided which comprises:

- (i) one or more odour producing paint breakdown products; and
- (ii) one or more odour-reducing agents.

The pH of the paint is preferably pH 8 or more. Paint of the invention generally has the following properties: the pH of the paint is within the range pH 8 – 10, the viscosity of the paint is at least 2×10^3 centipoise measured after being allowed to stand for five minutes, the viscosity of the paint is at least 3×10^3 centipoise measured after being allowed to stand for an hour, the solids content of the paint is at least 20% w/w, and the specific gravity of the paint is within the range 1 – 2.

The viscosity of matt paint is at least 6×10^3 centipoise, preferably at least 8×10^3 centipoise, more preferably at least 8.5×10^3 centipoise, measured after being

allowed to stand for five minutes, the viscosity of the paint is at least 10×10^3 centipoise measured after being allowed to stand for an hour, the solids content of the paint is within the range 35 – 55% w/w, and the specific gravity of the paint is within the range 1.3 – 1.6. The viscosity of silk/soft sheen paint is at least 2.5×10^3 centipoise, preferably at least 6×10^3 centipoise, more preferably at least 7×10^3 centipoise, after standing for 5 minutes and at least 5×10^3 centipoise, preferably at least 8×10^3 centipoise, more preferably at least 10×10^3 centipoise, measured after standing for an hour, the solids content of the silk/soft sheen in the range 27 – 40% w/w and the specific gravity of the paint in the range 1.0 – 1.4.

Paint may also comprise one or more in-can preservatives, each preferably present at up to 1% w/w, preferably up to 0.5% w/w, more preferably up to 0.3% w/w, being an antifungal agent and/or an antibacterial agent.

Paint may optionally comprise one or more surface antimicrobial agent, each preferably present at up to 1% w/w, preferably up to 0.5% w/w, more preferably up to 0.3% w/w, being an antifungal agent and/or an antibacterial agent.

The odour-reducing agent may be present in the range 0.5–10% w/w, comprising clay, clay-like material, zeolite and/or talc.

Other optional and preferred features of the method apply equally to the paint of the application.

EXAMPLES

Protocol for recycling paint

Sort degraded paint according to colour, whether the paint was originally intended to produce a matt, soft sheen or silk finish, whether the paint was originally intended for the trade or non-trade retail markets (an indication of original properties), and also the volatile organic content (VOC) of the paint, indicated on the original packaging.

Select degraded paint approximately of the desired colour, finish and quality and remove obvious detritus.

Transfer paint into a container to form the paint precursor and add from 1 to 10 % w/w antibacterial agent as preservative and, if desired, from 1 to 10 % w/w surface antimicrobial agent.

Blend thoroughly using particle size reduction apparatus, ensuring all paint is thoroughly homogenised.

- For matt paint

Test the pH and if needed adjust to be within the range pH 8.4–9; reblend.

Test and adjust one or more of specific gravity and viscosity:

Specific gravity

Test the specific gravity and if needed adjust to be within the range 1.38-1.5; reblend.

Viscosity

Allow to settle for 5 minutes and test the viscosity and if needed adjust to be within the range $6-8 \times 10^3$ centipoise; reblend.

Allow to settle for an hour and test the viscosity and if needed adjust to be within the range $12-18 \times 10^3$ centipoise; reblend.

pH

Optionally, retest and readjust if necessary.

Add 1–3% w/w odour-absorbing agent; reblend.

Optional: to obtain a more durable, harder finish, add resin to a level of up to 10% w/w and reblend.

Optional: carry out final testing of pH, colour and specific gravity and if needed make fine adjustments to be within the above desired predetermined ranges, and reblend.

Filter the final product according to its intended use (e.g. 150 or 200 μm filter) under atmospheric pressure using vibrating sieve, then package in standard paint containers, label and seal.

- For silk or soft sheen paint

Test the pH and if needed adjust to be within the range pH 8.4–9; reblend.

Test and adjust one or more of specific gravity and viscosity:

Specific gravity

Test the specific gravity and if needed adjust to be within the range 1.14-1.2; reblend.

Viscosity

Allow to settle for 5 minutes and test the viscosity and if needed adjust to be within the range $2.5\text{--}4 \times 10^3$ centipoise; reblend.

Allow to settle for an hour and test the viscosity and if needed adjust to be within the range $5\text{--}9 \times 10^3$ centipoise; reblend.

pH

Optionally, retest and readjust if necessary.

Add 1–3% w/w odour-absorbing agent; reblend.

Optional: to obtain a more durable, harder finish, add resin to a level of up to 10% w/w and reblend.

Optional: carry out final testing of pH, colour and specific gravity and if needed make fine adjustments to be within the above desired predetermined ranges, and reblend.

Filter the final product according to its intended use (e.g. 150 or 200 µm filter) under atmospheric pressure using vibrating sieve, then package in standard paint containers, label and seal.

Alternative protocol for recycling paint

Sort degraded paint according to colour, whether the paint was originally intended to produce a matt, soft sheen or silk finish, whether the paint was originally intended for the trade or non-trade retail markets (an indication of original properties), and also the volatile organic content (VOC) of the paint, indicated on the original packaging.

Select degraded paint approximately of the desired colour, finish and quality and remove obvious detritus.

Transfer paint into a container to form the paint precursor and add up to 1% w/w antimicrobial agent as preservative and, if desired, up to 1% w/w surface antimicrobial agent.

Add 1 – 2% w/w pH adjusting material to adjust and/or buffer the pH.

Blend thoroughly using particle size reduction apparatus, ensuring all paint is thoroughly homogenised.

- For matt paint

Test the pH and if needed adjust to be within the range pH 8.2–9.7; reblend.

Test and adjust one or more of specific gravity, viscosity and opacity:

Specific gravity

Test the specific gravity and if needed adjust to be within the range 1.38-1.5; reblend.

Viscosity

Allow to settle for 5 minutes and test the viscosity and if needed adjust to be within the range $8 - 13 \times 10^3$ centipoise; reblend.

Allow to settle for an hour and test the viscosity and if needed adjust to be within the range $10 - 22 \times 10^3$ centipoise; reblend.

Opacity

Optionally, paint a sample onto card on which a high-contrast pattern is printed, allow to dry and compare level of visibility of pattern against standards; increase opacity by adding materials that increase solids content and/or specific gravity; reblend.

pH

Optionally, retest and readjust if necessary.

Add 1–3% w/w odour-absorbing agent; reblend.

Optional: to obtain a more durable, harder finish, add resin to a level of up to 10% w/w and reblend.

Optional: carry out final testing of pH, colour and specific gravity and if needed make fine adjustments to be within the above desired predetermined ranges, and reblend.

Filter the final product according to its intended use (e.g. 150 or 200 μm filter) under atmospheric pressure using vibrating sieve, then package in standard paint containers, label and seal.

- For silk or soft sheen paint

Test the pH and if needed adjust to be within the range pH 8.2–9.7; reblend.

Test and adjust one or more of specific gravity, opacity and viscosity:

Specific gravity

Test the specific gravity and if needed adjust to be within the range 1.14-1.2; reblend.

Viscosity

Allow to settle for 5 minutes and test the viscosity and if needed adjust to be within the range $6 - 10 \times 10^3$ centipoise; reblend.

Allow to settle for an hour and test the viscosity and if needed adjust to be within the range $8 - 15 \times 10^3$ centipoise; reblend.

Opacity

Optionally, paint a sample onto card on which a high-contrast pattern is printed, allow to dry and compare level of visibility of pattern against standards by eye or using a reflectometer; increase opacity by adding materials that increase solids content and/or specific gravity; reblend.

pH

Optionally, retest and readjust if necessary.

Add 1–3% w/w odour-absorbing agent; reblend.

Optional: to obtain a more durable, harder finish, add resin to a level of up to 10% w/w and reblend.

Optional: carry out final testing of pH, colour and specific gravity and if needed make fine adjustments to be within the above desired predetermined ranges, and reblend.

Filter the final product according to its intended use (e.g. 150 or 200 μm filter) under atmospheric pressure using vibrating sieve, then package in standard paint containers, label and seal.

Example 1

Pots of degraded paint were collected from local amenity waste paint disposal centres and sorted according to colour, degree of degradation, whether the paint was originally intended to produce a matt, eggshell or silk finish, and whether the paint was originally intended for the trade or non-trade retail markets (an indication of original properties).

Degraded paint (~250 kg) that was all water-based, white matt emulsion was selected and obvious detritus was removed from the pots.

The paint was transferred and combined in a 220 litre barrel to form the paint precursor and 1.25 kg of Arch (RTM) Proxel (RTM) BZ Plus Preservative, a mixture of 1,2-benzisothiazolin-3-one (antibacterial agent) and zinc 2-pyridine-thiol-1-oxide (anti fungal agent), was added to act as an in-can preservative.

The resulting mix was blended by shear-mixing for 15 minutes using a single mixing head, moved throughout the mix sideways and up and down to ensure complete mixing. The clearance of the mixing head's rotor and stator was 0.5 mm, rotor speed was 3,500 rpm.

After blending, the pH was measured and adjusted to be approximately pH 8.7 by addition of ammonium hydroxide, retesting and repeating until this pH was reached.

The specific gravity was next measured and adjusted to be approximately 1.45 by addition of an aqueous suspension of heat-modified attapulgate, retesting and repeating until this level was reached.

The paint precursor was blended again and allowed to settle and five minutes after blending had finished the viscosity was measured using a Brookfield DV-II viscometer installed with an LV-4 spindle rotating at 0.6 revolutions per minute. The

viscosity was slightly lower than 6×10^3 centipoise and was adjusted by addition of carboxymethylcellulose, retesting and repeating until after 5 minutes of settling the viscosity was approximately 6×10^3 centipoise.

The viscosity was next measured an hour after blending had last finished and further carboxymethylcellulose added so that the viscosity after an hour of settling was approximately 15×10^3 centipoise.

The paint precursor was then re-blended, while adding 1% w/w attapulgite-containing clay to act as an odour-absorbing agent.

The paint was then filtered using a 200 μm vibrating sieve filter (Russell Finex), under atmospheric pressure and lateral vibration, then dispensed into standard 1L paint containers and sealed and labelled, ready for use.

Example 2

Pots of degraded paint were collected from local amenity waste paint disposal centres and sorted according to colour, degree of degradation, whether the paint was originally intended to produce a matt, eggshell or silk finish, and whether the paint was originally intended for the trade or non-trade retail markets (an indication of original properties).

Degraded paint (~250 kg) that was all water-based, white matt emulsion was selected and obvious detritus was removed from the pots.

The paint was transferred and combined in a 220 litre barrel to form the paint precursor and 0.5 kg Thor Acticide (RTM) MBS biocide, a mixture of 1,2-benzisothiazolin-3-one and 2-methyl-4-isothiazolin-3-one, was added to act as an in-can preservative.

Then 0.5 kg white ground marble was added to the paint to adjust and/or buffer the pH.

The resulting mix was blended by shear-mixing for 15 minutes using a single mixing head, moved throughout the mix sideways and up and down to ensure complete mixing. The clearance of the mixing head's rotor and stator was 0.5 mm, rotor speed was 3,700 rpm.

After blending, the pH was measured and adjusted to be approximately pH 9.0 by addition of ground marble, retesting and repeating until this pH was reached.

The specific gravity was next measured and adjusted to be approximately 1.35 by addition of an aqueous suspension of heat-modified attapulgite, retesting and repeating until this level was reached.

The paint precursor was blended again and allowed to settle and five minutes after blending had finished the viscosity was measured using a Brookfield DV-II viscometer installed with an LV-4 spindle rotating at 0.6 revolutions per minute. The viscosity was around 5.5 and was adjusted by addition of carboxymethylcellulose, retesting and repeating until after 5 minutes of settling the viscosity was approximately 8.5.

The viscosity was next measured an hour after blending had last finished and further carboxymethylcellulose added so that the viscosity after an hour of settling was approximately 14×10^3 centipoise.

The opacity was then assessed and adjusted. To do this, a sample of the paint was painted onto a standard test card on which a high-contrast pattern is printed (Zehntner, Sissach, Switzerland), allowed to dry and the level of pattern visibility against standards was compared by eye. The opacity of the paint was increased by adding modified clay, the paint was reblended and the opacity retested using the same method. This was repeated iteratively until the required opacity was achieved.

The paint precursor was then re-blended, while adding 1% w/w attapulgite-containing clay to act as an odour-absorbing agent.

The paint was then filtered using a 200 µm vibrating sieve filter (Russell Finex), under atmospheric pressure and lateral vibration, then dispensed into standard 1L paint containers and sealed and labelled, ready for use.

The present invention hence provides methods for recycling emulsion paint, to obtain consistent quality useable paint from a feed comprising degraded paint, together with apparatus therefor and the paint thus obtained.

Claims

1. A method for manufacturing paint, comprising the steps of:
 - (a) providing a paint precursor, comprising degraded paint; and
 - (b) treating the paint precursor by:
 - testing the pH of the paint precursor and, if necessary, adjusting the pH to lie within a predetermined range; and
 - testing one or more of the following properties of the paint precursor and, if necessary, adjusting the property or properties to lie with a predetermined range:
 - (i) specific gravity;
 - (ii) solids content; and
 - (iii) viscosity,whereby at least one of the pH, specific gravity, solids content and viscosity of the paint precursor is adjusted, thereby producing paint.
2. A method for manufacturing paint according to claim 1, comprising:
 - testing one or more of the following properties of the paint precursor and, if necessary, adjusting the property or properties to lie with a predetermined range:
 - (i) specific gravity;
 - (ii) solids content;
 - (iii) viscosity; and
 - (iv) opacity,whereby at least one of the pH, specific gravity, solids content, viscosity and opacity of the paint precursor is adjusted, thereby producing paint.
3. A method according to claim 1 or 2, wherein the paint precursor is prepared by combining two or more feedstocks, selected so as to produce when combined a paint precursor of a desired colour.

4. A method according to any preceding claim, comprising a preliminary step of treating the paint precursor with a pH adjuster.
5. A method according to claim 4, wherein the paint precursor is treated with 5% w/w or less pH adjuster.
6. A method according to any preceding claim, comprising dispensing the manufactured paint into containers and sealing the containers.
7. A method according to any preceding claim, wherein the predetermined range for the pH is pH 8 or above.
8. A method according to claim 7, wherein the predetermined range for the pH is pH 8.2–9.7.
9. A method according to claim 7 or claim 8, wherein the predetermined range for the pH is pH 8.4–9.
10. A method according to any preceding claim, wherein the predetermined range for the specific gravity is 1 – 2.
11. A method according to any preceding claim, wherein the predetermined range for the solids content is 20% w/w or more.
12. A method according to any preceding claim, wherein the predetermined range for the viscosity is 2×10^3 centipoise or more, measured after the paint precursor is allowed to stand for 5 minutes.
13. A method according to any preceding claim, wherein the predetermined range for the viscosity is 3×10^3 centipoise or more, measured after the paint precursor is allowed to stand for an hour.
14. A method according to any preceding claim for manufacturing matt paint.

15. A method according to claim 14, wherein the predetermined range for the specific gravity is 1.2 – 2, the predetermined range for the solids content is 30% w/w or more, the predetermined range for the viscosity is 5.5×10^3 centipoise or more, measured after the paint precursor is allowed to stand for 5 minutes, and the predetermined range for the viscosity is 10×10^3 centipoise or more, measured after the paint precursor is allowed to stand for an hour.
16. A method according to claim 14, wherein the predetermined range for the specific gravity is 1.2 – 2, the predetermined range for the viscosity is 8×10^3 centipoise or more, measured after the paint precursor is allowed to stand for 5 minutes, and the predetermined range for the viscosity is 10×10^3 centipoise or more, measured after the paint precursor is allowed to stand for an hour.
17. A method according to any of claims 1 – 13 for manufacturing silk or soft sheen paint.
18. A method according to claim 17, wherein the predetermined range for the specific gravity is 1 – 1.4, the predetermined range for the solids content is 20% w/w or more, the predetermined range for the viscosity is 2×10^3 centipoise or more, measured after the paint precursor is allowed to stand for 5 minutes, and the predetermined range for the viscosity is 4×10^3 centipoise or more, measured after the paint precursor is allowed to stand for an hour.
19. A method according to claim 17, wherein the predetermined range for the specific gravity is 1 – 1.4, the predetermined range for the viscosity is 6×10^3 centipoise or more, measured after the paint precursor is allowed to stand for 5 minutes, and the predetermined range for the viscosity is 8×10^3 centipoise or more, measured after the paint precursor is allowed to stand for an hour.

20. A method according to any preceding claim, comprising adding one or more preservatives.
21. A method according to claim 20, wherein the preservative is an antibacterial agent.
22. A method according to any preceding claim, comprising blending the paint prior to treating.
23. A method according to claim 22, comprising homogenising the paint.
24. A method according to claim 22 or claim 23, comprising reducing the mean particle size of the paint.
25. A method according to claim 24, wherein the blending is carried out using shear-mixing.
26. A method according to claim 25, wherein the shear-mixing is carried out using one or more shear-mixer heads, each comprising a rotor and a stator.
27. A method according to claim 26, wherein there is a clearance between the rotor and stator of 1 mm or less.
28. A method according to claim 27, wherein the clearance between the rotor and stator is 0.5 mm or less.
29. A method according to any preceding claim, comprising filtering the paint.
30. A method according to claim 29, wherein the filter has a pore size of 300 μm or less.
31. A method according to claim 30, wherein the filter has a pore size of 250 μm or less.

32. A method according to any of claims 29 to 31, wherein the filtering is mechanically-assisted.
33. A method according to claim 32, wherein the filtering is assisted by vibrating the filter.
34. A method according to claim 32 or claim 33, wherein the filtering is assisted by mixing the paint whilst filtering the paint.
35. A method according to any preceding claim, wherein adjusting the pH comprises adding to the paint precursor a material that alters its pH and blending the material into the paint precursor.
36. A method according to claim 35, wherein the material is alkaline.
37. A method according to claim 36, wherein the material is alkaline clay, ground marble and/or alkaline solution.
38. A method according to claim 36 or claim 37, wherein the material is ammonium hydroxide, NaOH, triethanolamine, calcium carbonate and/or KOH.
39. A method according to any preceding claim, wherein adjusting the property or properties comprises adding to the paint precursor a material that alters the property, and blending the material into the paint precursor.
40. A method according to claim 39, wherein the property, or one of the properties, is specific gravity and the material is particulate solid matter, thicker paint, thinner paint and/or water.

41. A method according to claim 39 or 40, wherein the property, or one of the properties, is solids content and the material is one or more of clay and calcium carbonate.
42. A method according to any of claims 39 to 41, wherein the property, or one of the properties, is viscosity and the material is clay, cellulose or derivatives thereof, ground marble, acrylic, triethanolamine, ammonium hydroxide, NaOH, calcium carbonate and/or KOH.
43. A method according to any preceding claim, further comprising the addition of an odour-reducing material.
44. A method according to claim 43, wherein the odour-reducing material comprises clay, clay-like material and/or talc.
45. A method according to claim 43 or claim 44, wherein the odour-reducing material comprises fuller's earth.
46. A method according to any of claims 43 to 45, wherein the odour-reducing material comprises attapulgate.
47. An apparatus for manufacturing paint from paint precursor, comprising the following components in fluid connection:
 - 1) a chamber for blending paint, comprising:
 - a) means for blending paint precursor in the chamber;
 - b) means for testing the pH of the paint precursor and, if necessary, adjusting the pH to lie within a predetermined range;
 - c) means for testing one or more of the following properties of the paint precursor and, if necessary, adjusting the property or properties to lie with a predetermined range:
 - (1) specific gravity;
 - (2) solids content; and
 - (3) viscosity,

- 2) a filter; and
 - 3) a dispenser.
48. An apparatus according to claim 47, comprising a reservoir of pH adjusting material in fluid connection with the chamber.
 49. An apparatus according to claim 47 or claim 48, wherein the means for adjusting the property or properties is one or more reservoir of property or properties adjusting material in fluid connection with the chamber.
 50. An apparatus according to any of claims 47 to 49, wherein the blending means is a shear-mixer.
 51. An apparatus according to claim 50, wherein the shear-mixer comprises one or more mixing heads, each comprising a rotor and a stator.
 52. An apparatus according to claim 51, wherein the clearance between the rotor and stator is 1 mm or less.
 53. An apparatus according to claim 52, wherein the clearance is 0.5 mm or less.
 54. An apparatus according to any of claims 47 to 53, wherein the filter has a pore size of 300 μm or less.
 55. An apparatus according to claim 54, wherein the filter has a pore size of 250 μm or less.
 56. An apparatus according to any of claims 47 to 55, wherein the filter is a mechanically-assisted filter.
 57. An apparatus according to claims 56, wherein the filter is a vibration-assisted filter.

58. An apparatus of any of claims 47 to 57, wherein the chamber comprises means for measuring the volume or weight of the paint in the chamber.
59. Paint comprising:
- (i) one or more odour producing paint breakdown products; and
 - (ii) one or more odour-reducing agents.
60. Paint according to claim 59, wherein the pH of the paint is pH 8 or more.
61. Paint according to claim 59 or claim 60, wherein the pH of the paint is within the range pH 8–10, the viscosity of the paint is at least 2.5×10^3 centipoise measured after being allowed to stand for five minutes, the viscosity of the paint is at least 5×10^3 centipoise measured after being allowed to stand for an hour, the solids content of the paint is within the range 25 – 55% w/w, and the specific gravity of the paint is within the range 1.1 – 1.6.
62. Paint according to any of claims 59 to 61, comprising one or more preservatives.
63. Paint according to claim 62, wherein the preservative is present at up to 1% w/w.
64. Paint according to claim 62 or claim 63, comprising an antifungal agent and/or an antibacterial agent.
65. Paint according to any of claims 59 to 64, wherein the odour-reducing agent is present in the range 0.5–10% w/w.
66. Paint according to any of claims 59 to 65, wherein the odour-reducing material comprises clay, clay-liked material and/or talc.
67. Paint made according to the method any of any of claims 1 to 46.

68. A method as hereinbefore described with respect to the examples.
69. An apparatus as hereinbefore described.
70. Paint as hereinbefore described with respect to the examples.