

PAINT FORMULATIONS

The present invention relates to paint formulations based on alkyd resins. More specifically, the present invention relates to paint formulations comprising long oil alkyd resins and a specific paraffinic solvent.

Paint formulations based on alkyd resins have been known for a long time. In general terms an alkyd resin can be defined as the reaction product of a dibasic acid or anhydride and a polyol to which sufficient monofunctional acid or alcohol has been added to prevent gelation during processing. If an excess of dibasic acid or anhydride relative to the polyol is used, an alcohol will generally be used to esterify the acidic carboxyl groups of the reaction product of the acid or anhydride and the polyol. If, on the other hand, an excess of the polyol is used, a monofunctional acid will be used to esterify the free hydroxyl groups. Commonly applied dibasic acids and anhydrides are maleic acid and phthalic acid and their anhydrides, while commonly applied polyols are pentaerythritol and glycerol. The monofunctional acid or alcohol used for esterification purposes usually is a long chain fatty acid or alcohol. Usually a long chain fatty acid or a mixture of several long chain fatty acids is used in the form of an oil, i.e. esterified with glycerol into a triacylglycerol that melts below room temperature. Examples of commonly applied oils are linseed oil and soybean oil. The alkyd resin thus is a polymeric network of chemically linked dibasic acid or anhydride, polyol and monofunctional acid or alcohol entities. The term "long oil" in long oil alkyd resins indicates that a relatively high amount of oil has been incorporated into the alkyd resin, i.e. approximately

between 55 and 80% by weight based on total weight of alkyd resin. Examples of commercially available long oil alkyd resins are URALAC AD10 and URALAC AD43. URALAC AD10 and URALAC AD43 are Trade Marks.

The alkyd resin is responsible for an increased hardness of the final paint layer after drying thus making it inter alia water-resistant and outdoor-durable. It also contributes to the gloss of the paint layer and has a positive influence on the colour retention of the paint.

Alkyd resins as such, however, are stiff and highly viscous at room temperature. In order to get a processable paint it is therefore necessary that a solvent is added. Suitable solvents must on the one hand have sufficient solvency power to dissolve the alkyd resin and must, on the other hand, have an appropriate boiling point or boiling point range in order to be sure that the paint layer becomes dry within an acceptable period of time. It is therefore essential that the solvent is inert towards the substrate and evaporates from the paint layer within a reasonable time, or, in other words, the solvent must have such vapour pressure at ambient temperature that it can pass through and leave the polymeric network forming the paint layer sufficiently fast. It will be understood that a too short drying time is undesirable from a processing point of view, since this would make it difficult to spread the paint evenly over its substrate. A too long drying time, on the other hand, is also undesired, since this would cause the paint to start dripping after having been brought onto its substrate. A too long drying time would also make it very time-consuming to cover a substrate with more than one paint layer and moreover, it would cause the paint layer to be soft and sticky for a relatively long period, thus leading to a paint layer of

inferior quality (beside dripping, pick up of dust, less gloss and decreased hardness). Hence, the choice of the solvent is very important.

The traditional solvent used for paint formulations is white spirit, which is a mixture of alkanes, cycloalkanes and aromatic compounds and is obtained as a distillation fraction from crude oil. Its boiling point range runs from approximately 150 °C to 200 °C at atmospheric pressure. An example of a commercially available and widely used white spirit is LAWS (Trade Mark). White spirit contains significant amounts of aromatic hydrocarbons. In view of the rather penetrating odour of these solvents, as well as from environmental considerations, there have been proposed in the past other solvents containing no or only low amounts of aromatic hydrocarbons. Despite the generally recognised principle that the order of solvent power or cutting power decreases from aromatics to cycloalkanes to alkanes, dearomatised white spirit, cycloalkanes and isoparaffins (i.e. branched alkanes) have been used as solvents for specific resin systems, including long oil alkyd resin systems. Such solvents are commercially available. For instance, a widely used commercially available dearomatised white spirit is SHELLSOL D40 (SHELLSOL is a Trade Mark). In general, for alkyd resin-based paint formulations the cutting power of a solvent is the amount of alkyd resin which can be dissolved in the solvent whilst the solution has the appropriate viscosity, i.e. the right viscosity to be readily processed using a brush, that is, in the range from 250 to 500 mm²/s at 20 °C. It will be clear that a solvent having a high cutting power is advantageous, since this implies that only a small amount of this solvent is needed for obtaining the right viscosity.

Dearomatised white spirit is white spirit from which substantially all the aromatics have been removed or of which substantially all the aromatics have been converted into cycloalkanes. Due to the presence of cycloalkanes, the dearomatised white spirit still has a good cutting power. Although, from an environmental point of view dearomatised white spirit is preferred above aromatic white spirit, a major disadvantage remaining is the penetrating odour.

Cycloalkanes have a slightly lower cutting power than aromatic hydrocarbons, so that more cycloparaffinic solvent is needed for dissolving an amount of long oil alkyd resin than would be the case when an aromatic solvent is used. Their penetrating odour, however, is the major disadvantage as far as their use as solvents in paint formulations is concerned. An example of such a solvent is NAPPAR 9 (NAPPAR is a Trade Mark).

Isoparaffins are normally produced by alkylation reactions between C3 and C5 alkenes and the corresponding alkanes followed by hydrogenation. A wide range of different isoparaffinic solvents for different purposes is available on the market. Examples of such commercially available isoparaffinic solvents include ISOPAR J and SHELLSOL TD. ISOPAR J and SHELLSOL TD are Trade Marks. Although isoparaffinic solvents are useful for application in paints, there is still room for improvement. In particular, the viscosity and the retention properties of isoparaffinic solvents are not optimal in relation to their cutting power. One known way of adjusting the viscosity of isoparaffinic solvents to the desired value is the addition of viscosity modifiers, which typically are oxygenated hydrocarbons. However, viscosity modifiers are expensive and, moreover, tend to have a negative influence on the quality of the paint layer, e.g. in terms of gloss, hardness and/or adhesion.

Another drawback of isoparaffinic solvent is that the retention properties are insufficient, that is, a relatively large quantity of the solvent is left in the paint layer. It has been found that for an optimum quality as little as possible solvent should remain trapped in the paint layer.

The present invention aims to overcome the drawbacks described above. It is therefore an object of the present invention to provide long oil alkyd resin-based paint formulations having improved viscosity and retention properties as compared with isoparaffinic solvent-based long oil alkyd resin-based paint formulations. More specifically, the present invention aims to provide long oil alkyd resin-based paint formulations, wherein the solvent used (i) is essentially free of penetrating odour, (ii) gives the paint formulation the appropriate viscosity without the need of using viscosity modifiers and (iii) has excellent evaporation properties, i.e. has a suitable boiling point range. Furthermore, the present invention aims to provide long oil alkyd resin-based paint formulations, wherein the solvent used can diffuse relatively easy through the alkyd resin network, i.e. has good retention properties. The solvents to be used must also have a low odour level which is at least equally low as the isoparaffinic solvents.

Accordingly, the present invention relates to a paint formulation comprising at least one long oil alkyd resin and a solvent consisting essentially of one or more linear alkanes having a boiling range from 160 to 250 °C, preferably from 170 to 200 °C.

For the purpose of this invention, solvents consisting essentially of one or more linear alkanes having a boiling range from 160 to 250 °C, preferably from 170 to 200 °C, are defined as containing at least

80% by weight of linear alkanes in the applicable boiling range.

Other components present usually include primarily isoparaffins and small amounts of olefins, sulphur and other impurities.

In a preferred embodiment the solvent contains at least 85% by weight, preferably at least 90% by weight, more preferably at least 94% by weight of linear alkanes in the applicable boiling range.

Linear alkanes as such, also referred to as normal alkanes or n-alkanes, are known as solvents. For instance, in the food industry, n-hexane is a well known extracting solvent, while in solvent deasphalting techniques for removing heavy asphaltenic compounds from residual hydrocarbon oils, n-butane and n-pentane are often applied as extracting solvents. In the adhesive and rubber industry, n-pentane and n-hexane are known solvents. These lower n-alkanes, however, are not suitable for application in paint formulations because of their volatility. Although higher n-alkanes are less volatile, their application as solvents in paint formulations was generally considered inadequate, since their solvency power for alkyd resins was considered too low and since their availability on the market is rather restricted due to the limited number of applications. It has now surprisingly been found that linear alkanes having a boiling range from 160 to 250 °C and mixtures of two or more of these alkanes are very suitable as solvents in paint formulations and exhibit excellent properties when used for this purpose.

Linear alkanes having a boiling point from 160 to 250 °C comprise C10 to C14 linear alkanes. However, since 100% pure linear C10, C11, C12, C13 or C14 alkanes cannot be produced individually at such costs that their use as solvent in paint formulations is economically feasible,

the alkane solvent used in the present invention is most adequately defined via its boiling range, i.e. the temperature range over which the solvent is boiling. By fixing this range at 160 to 250 °C, it is sure that any linear alkane solvent within this boiling range contains a major amount, i.e. at least 90% by weight and preferably at least 94% by weight, of at least one of the linear C10 to C14 alkanes. Particularly suitable n-alkane solvents are those having a boiling range of 170 to 200 °C, which in practice are solvents containing a major amount of linear C10 and/or C11 alkane. The linear alkanes which can suitably be applied in the paint formulations of the present invention can be prepared by methods known in the art. For instance, one known method for preparing higher n-alkanes is by extraction from paraffin-rich hydrocarbon refinery streams, using molecular sieves, like zeolites. The most preferred method, however, is the Fischer-Tropsch synthesis reaction for preparing hydrocarbons from a mixture of carbon monoxide and hydrogen at elevated temperature and pressure in the presence of a suitable catalyst. Such catalysts usually comprise one or more metals of Group VIIIB of the Periodic Table of Elements, a carrier material and optionally one or more promoters.

Preferably, the catalyst comprises cobalt on a refractory oxide support, typically alumina, zirconia, kieselguhr, silica or titania; preferably silica or titania. Examples of suitable promoters include zirconium, rhenium, platinum, ruthenium or palladium.

The alkanes suitable for use as solvents in paint formulations in accordance with the present invention, can be obtained as distillate fractions from the product mixture of the Fischer-Tropsch synthesis reaction. Fischer-Tropsch synthesis reactions and the conditions under which such reactions are carried out are known in

the art, e.g. from British patent application No. 2,077,289 and European patent applications Nos. 0,104,672; 0,147,873; 0,153,780; 0,153,781 and 0,167,215. The alkanes can be obtained via this method in a relatively pure form and contain over 90% and suitably more than 94% by weight of the linear alkanes and only very small amounts of sulphur, olefins, isoparaffins and other impurities.

As already has been discussed, the boiling range of a solvent in combination with the cutting power of this solvent for long oil alkyd resins largely determines its suitability for use in paint formulations. Suitable solvents have a boiling range between 160 and 250 °C and such cutting power that sufficient alkyd resin can be dissolved whilst the viscosity of the paint still allows smooth processing. For most painting techniques, such as using a brush or a paint bath, the appropriate long oil alkyd resin concentration in the paint formulation amounts to between 30 and 60% by weight based on total paint formulation.

Beside the long oil alkyd resin and the solvent the paint formulation may contain conventional amounts of additional ingredients usually applied in paint formulations. Such ingredients include for instance pigments and siccatives.

The invention is further illustrated by the following examples.

Example 1

The n-paraffinic solvents used were prepared using the Fischer-Tropsch synthesis according to the following general procedure.

A cobalt/zirconium/silica catalyst was prepared following the procedure described in European Patent Application No. 0,428,223. The catalyst was loaded into a reaction vessel and reduced by contacting the catalyst

with a hydrogen-containing gas. The activated catalyst was then contacted with a mixture of carbon monoxide and hydrogen having a hydrogen/carbon monoxide ratio of 1.1 at a gas inlet pressure of from 37 to 39 bar, a temperature of from 210 to 220 °C and a gas hourly space velocity of from 1110 to 1130 Nl/l/h to yield a hydrocarbon product.

The hydrocarbon product of the Fischer-Tropsch synthesis was then subjected to a mild hydrotreatment using a commercially available nickel-containing hydrogenation catalyst (ex Harshaw Catalysts) at a temperature of 220 °C and a pressure of 30 bar. The resulting product was then subjected to a conventional distillation to yield a range of n-paraffinic fractions to be applied as solvents.

The properties of the various n-paraffinic solvents obtained, i.e. solvents based on linear alkanes, are listed in Table I.

TABLE I Properties of n-paraffinic solvents

	nC10	nC11	nC12	nC13-14
(% area)				
C9	2.5			
C10	90	1	<1	
C11	7.5	97.5	7.5	<1
C12		1.5	91	9
C13			1	58.5
C14			<1	32.5
Total n-alkane (%wt)	96	96.5	94.5	95
Aromatics (ppm)	0	0	0	0
Sulphur (mg/l)	<0.1	0.10	0.15	0.15
Boil. range (°)	171-181	193-197	212-217	234-249
Bromine index (mg Br/100 g)	<10	<10	<10	<10

The percentages of the various hydrocarbon molecules having 9 to 14 carbon molecules present in the n-paraffinic solvents were determined by measuring the areas under the peaks in the gas chromatogram.

The content of linear alkanes (total n-alkanes, in % by weight) in each solvent fraction was determined according to ASTM D2140.

The content of aromatics (in parts per million) was determined using UV spectrophotometry: the ultraviolet absorption of the sample is measured either by scanning the spectrum in the region from 230 to 310 nm, or at three fixed wavelengths. The aromatics content is calculated with the aid of the baseline absorbance at 268 nm and an empirically established absorptivity value.

The sulphur content was determined according to ASTM D3120.

The bromine index was determined according to ASTM D2710.

From Table I it is clear that the n-paraffinic solvents listed in Table I contain high levels of linear alkanes (for all solvents the total n-alkanes content is above 94% by weight) and meet the requirements of essentially zero aromatic hydrocarbon content and low level of sulphur, while the content of olefinically unsaturated compounds (as indicated by the bromine index) is also very low.

Example 2

Alkyd resin solutions were prepared with the nC10 and nC11 solvents listed in Table I and with several commercially available hydrocarbon solvents having a boiling range which is similar to the boiling ranges of the nC10 and nC11 solvents. Alkyd resin solutions were also prepared with the nC12 and nC13-14 solvents listed in Table I.

The alkyd resins used were the commercial long oil phthalic anhydride-pentaerythritol-based resins URALAC AD10 (about 63% wt linseed oil) and URALAC AD43 (about 65% wt soybean oil) and they were used in concentrations of 47.8% by weight and 55.3% by weight, respectively.

The commercial solvents used were:

LAWS, a white spirit widely used in the paint industry, SHELLSOL D40, a dearomatised white spirit, SHELLSOL TD, an isoparaffinic solvent, and ISOPAR J, an isoparaffinic solvent.

The properties of the alkyd resin solutions listed in Table II are:

Boiling range, Dynamic Viscosity at 25 °C (DynV) expressed in mPa.s and measured with the Brookfield viscometer, and Kinematic Viscosity at 25 °C (KinV) expressed in mm²/s and determined according to ASTM D445.

TABLE II Properties of long oil alkyd resin solutions

Solvent	Boiling range (°C)	47.8% w AD10		55.3% w AD4	
		DynV	KinV	DynV	Kin
LAWS	160 - 198	279	324	303	303
SHELLSOL D40	162 - 192	484	523	374	378
nC10	171 - 181	540	635	362	392
nC11	193 - 197	835	842	498	529
SHELLSOL TD	182 - 200	1050	1340	708	727
ISOPAR J	172 - 190	1110	1139	768	741
nC12	212 - 217	1160	1275	545	566
nC13-14	234 - 249	1790	1997	854	820

From Table II it can be concluded that in the boiling range 160 to 200 °C, long oil alkyd resin solutions comprising solvents consisting essentially of nC10 and nC11 have significantly lower viscosities than those comprising isoparaffinic solvents SHELLSOL TD and ISOPAR J at the same long oil alkyd resin concentration. The lower viscosities of the solutions comprising the nC10 and nC11 solvents imply that less solvent is required for dissolving a given amount of long oil alkyd resin than would be the case with a comparable isoparaffinic solvent, i.e. an isoparaffinic solvent having a similar boiling range. It will be understood that this is beneficial for the drying of the paint.

It can also be seen from Table II that the currently widely used aromatic solvent LAWS and the cycloaliphatic solvent SHELLSOL D40, which both have boiling ranges comparable with the nC10 and nC11 solvent, are still the solvents having the highest solvency power. However, these solvents are less desirable, particularly due to their bad odour, but also from an environmental point of view. The fact that at a given concentration of long oil

alkyd resin some more n-paraffinic solvent is necessary in order to obtain a processable paint, i.e. a paint having the right viscosity, as would be the case when using an aromatic or cycloaliphatic solvent, does not counterbalance the beforementioned drawbacks of aromatic and cycloaliphatic solvents.

For applications where the drying time of the paint should not be too short, the nC12 and nC13-14 solvents can be used. Table II demonstrates that in such a case these solvents are very useful. The formulation with the nC12 solvent comprising 55.3% wt AD43 has even better viscosity properties than the formulations containing isoparaffinic solvents (SHELLSOL TD or ISOPAR J), despite the fact that these isoparaffinic solvents have a lower boiling range.



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1. Paint formulation comprising at least one long oil alkyd resin and a solvent consisting essentially of one or more linear alkanes having a boiling range from 160 to 250 °C.
2. Paint formulation according to claim 1, wherein the solvent consists essentially of one or more linear alkanes having a boiling range from 170 to 200 °C.
3. Paint formulation according to claim 1 or 2, wherein the solvent is obtained from a distillate fraction having the indicated boiling range resulting from a Fischer-Tropsch hydrocarbon synthesis reaction.
4. Use of linear alkanes having a boiling range from 160 to 250 °C, preferably from 170 to 200 °C, or mixtures of two or more of such alkanes in paint formulations.