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An agency of Industry Canada

CA 2393191 A1 2004/01/12

(21) 2 393 191

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(22) Date de dépôt/Filing Date: 2002/07/12

(41) Mise à la disp. pub./Open to Public Insp.: 2004/01/12

(51) Cl.Int.[7]/Int.Cl.[7] C11C 5/00

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(54) Titre : BOUGIES A FLAMMES DE COULEUR
(54) Title: CANDLES WITH COLOURED FLAMES

CANDLES WITH COLOURED FLAMES

Field of the Invention

The present invention relates to the field of candle making, and provides a method of manufacturing candles capable of producing coloured flames, and the candles thereby produced.

Background of the Invention

It is well known that "white" light can be dispersed into the colours of the rainbow according to the wavelengths of the component parts of the light. Colour associated with an object can be due to the reflection, transmission or scattering of light, e.g. the orange colour of the skin of an orange observed in white light results from the absorption of certain parts of the visible spectrum by the skin of the orange giving the impression of orange, in viewing the light reflected from the orange's surface by the normal human eye. On the other hand, one may consider the emission of characteristic wavelengths of light, e.g. the yellow-orange light emitted by sodium in a flame.

Each element burns in a particular flame with its own characteristic colour. The colour is due to the emission of light of a unique set of wavelengths, resulting from individual atoms that have been elevated to discrete excited states after absorbing energy from the flame, as they spontaneously return to a lower energy level state or the ground state. The wavelengths of light emitted are related to the difference in the energy levels of the atomic energy state and are characteristic of each element. The relationship of wavelength and colour is given below, for the wavelength spectrum visible to the human eye.

WAVELENGTH VS COLOUR

Wavelength region, nm	Colour
<400	ultraviolet (not visible)
400-435	violet
435-480	blue
480-500	blue-green
500-560	green
560-580	yellow green
580-595	yellow
595-650	orange
650-750	red
>750	infrared (not visible)

A candle flame consists of 3 parts, an inner cone of unburnt gases; a middle luminous zone of unburned gases or vapour, full of glowing particles of carbon and is where carbon monoxide and water are forming by combustion; and an outer mangle of hot non-luminous gases where the products of complete combustion (carbon dioxide and water) mingle with air. The middle zone has an excess of fuel, hence it is reducing, and is cooler than the outer zone, which is oxidizing due to the excess of oxygen provided by the air.

The candle flame is normally a yellow-orange colour, being the colour associated with the burning of hydrocarbons (candle wax being a hydrocarbon). It is known that if a material containing certain elements is introduced into the candle flame, characteristic colours are emitted from the flame and seen by an observer as those colours. The following flame colours are those characteristic of low temperature flames, such as a candle, using a blowpipe.

Colour	Shade	Substance
Red	Crimson	strontium
Red	Crimson	lithium
Red	Yellowish to orange	calcium
Yellow	Intense	sodium
Green	Yellowish	barium
Green	Bright	thalium
Green	Emerald	copper oxide, copper iodide
Green	Bluish	zinc
Blue	Azure	copper chloride
Blue	Indigo	selenium
Violet	Pale	potassium

Sufficient energy (high enough temperature) must be present in the flame to first separate the metals into individual atoms and then elevate the individual ground state atoms to their excited states to allow their characteristic emission wavelengths to be observed, as the atoms return to their lower energy states. A higher concentration of the element in the burning zone will result in more intense emission as will a higher temperature flame (since more of the atoms present will be elevated to their excited states as they pass through the burning zone). For these reasons only elements that are most easily raised to their excited states will provide significant colour in a low temperature (hence low energy) flame, such as produced by a burning candle.

In addition to element emission lines, low temperature flames may give rise to molecular emission lines when the flame energy is insufficient to dissociate molecular species such as volatile oxides and hydroxides. A good example is CaOH (calcium hydroxide), which emits light in the green range. These emission bands are much broader in wavelength that atomic emission lines but may still produce coloured flames or alter the colour of a flame in which they are present with other elements.

The object of the present invention, therefore, is to utilize the colour emitting characteristics of certain elements to produce colour flames in candles.

The relatively low temperature of paraffin- and wax-based flames as found in candles requires that only easily excited elements be used to create colour. These are dominantly the alkali and alkaline earth metals, but other metals may also be utilized.

In a broad aspect, then, the present invention relates to a method of manufacturing a candle with the property of producing a flame of a desired colour upon ignition, comprising introducing a metallic element into wax from which said candle is produced.

In another broad aspect, the present invention relates to a method of manufacturing a candle with the property of producing a flame of desired colour upon ignition comprising introducing a metallic element into the wick of said candle.

The factors that influence selection of appropriate additives for the production of candles according to the present invention include delivery of the individual elements into the hottest temperature zone of the flame, where the largest quantity of excited state atoms can be achieved to produce an internal colour. This is achieved by adding the element to the candle wick, and adding the element to the fuel (paraffin/wax), or both. The element may also be added to the candle via a separate component, such as a solution holder that might deliver small amounts of the element-saturated solution to the flame, by capillary action.

Compounds that easily dissociate into free metal atoms are the preferred elements to be added. As a generalization, the simple chlorides, e.g. sodium or other alkaline chloride, is appropriate.

Compounds that form stable molecular species that can be excited and emit light in a useful range, e.g. the various copper compounds listed above (CuO and CuI (emerald green) and $CuCl$ (azure blue)) are also appropriate.

Some compounds may also provide more oxygen to the flame, such as metal nitrates, and thereby provide a hotter burning zone and more intense emission of the characteristic light.

Compounds must also be selected to mix well with the paraffin or wax. Organometallic compounds will tend to “dissolve” in the fuel, and are therefore more easily entrained along with the fuel.

Compounds that are volatile at low temperatures are preferred, as they will vapourize easily and be transported into the burning zone. For example, CuI (copper iodide) melts at 606°C and boils at 1290°C (less than the flame temperature of a candle) and is therefore more easily vapourized into the candle’s flame, than other compounds of copper.

A variety of colours can be created by adding mixtures of elements to the flame with different characteristic emission wavelengths, in the same way new paint colours are achieved by mixing the primary colours. However, it must be borne in mind that some compounds or elements produce such intense effects that they cannot easily be combined with other. For example, the intense sodium emission lines may swamp out less intense colours. It is recognized that each element will behave individually and the relative intensity of their emission will vary in different parts of the flame (hence the mixed colour will vary within the temperature zones in the flame).

In this regard it should be noted that in the production of candles producing coloured flames, extreme care must be taken to ensure that unwanted chemicals are not also added. However, it is in many circumstances also desired to add aromatherapy oils, such as amgris, bergamot, citronella, lavender, or any other aromatherapy oil, or other scents, such as spice or fruit scents to the candles, without departing from the spirit of the invention. In some instances, moreover, specific colours, such as yellow, can be combined with scents such as lemon or citronella to strengthen the effect of each through a mutual energy.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A method of manufacturing a candle with the property of producing a flame of a desired colour upon ignition, comprising introducing a metallic element into wax from which said candle is produced.

2. A method of manufacturing a candle with the property of producing a flame of desired colour upon ignition comprising introducing a metallic element into the wick of said candle.

3. A method as claimed in claim 1 or 2, wherein said metallic element is an alkali metal or an alkali earth.

4. A method as claimed in claim 1 or 2, wherein said metal is copper.

5. A method as claimed in any one of claims 1 to 4, wherein said metal is in an organometal compound.

6. A method as claimed in any one of claims 1 to 5, wherein said metal is in a salt.

7. Candles produced by the method of any of claims 1 to 6.

8. Candles as claimed in claim 7, further including aromatherapy oils selected for volatility at or below the ignition temperature of the candle flame.