AN OVERVIEW ON THE CLASSIFICATION AND PREPARATION OF THE EMULSIFYING WAX

Liu Shu[a]* and You Hongjun[b]

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Classification and preparation of the emulsifying wax have been discussed in the present article. The emulsifying wax is classified into four types of wax such as the cationic emulsified wax, the anionic emulsified wax, the non-ionic emulsifying wax and the amphoteric ionic type emulsified wax based on the properties of surfactant. Further, there are four types of preparation methods for the emulsifying wax are available such as the method of emulsifying agents dissolving in the water, the second in dissolving in the oil, the primary soap method and the taking turns adding method have been introduced also. Effects of the reaction conditions such as choosing the different emulsifying agents, the stirring speed, the emulsifying time and the ratio of emulsifying agents to wax on the emulsifying wax preparation have also been explained.

* Corresponding Author
Fax: 86-24-56860869
E-Mail: liushu-2012@hotmail.com
[a] Liaoning Shihua University, Fushun, Liaoning, P.R. China.
[b] SAIT Polytechnic, Calgary, Alberta, Canada.

Introduction

The emulsifying wax is a cosmetic ingredient. The ingredient name is often conformed by the initials NF, presenting that it follows to the specifications of the National Formulary. The emulsifying wax is produced when a wax material (either a vegetable wax of some kind or a petroleum-based wax) is mixed with a detergent (typically sodium dodecyl sulphate or polysorbates). It makes oil and water mix together into a smooth emulsion. It is a white waxy solid with a low fatty alcohol odour.[1] Wax emulsions do wax distribution evenly into water and change its interfacial tension with additional use of emulsifier. Highly stable wax emulsions are obtained by mechanical energy external forces.[2]

The emulsifying wax is classified into four kinds of wax such as the cationic, anionic, non-ionic and the amphoteric ionic type emulsified wax based on the properties of surfactant.[3] These are having the advantages of melting without heating, evenly becoming a preventive layer, good coverage, easily mixing with other water solutions or emulsion solution. Therefore, the emulsifying wax is widely used in the different areas such as the petroleum industry as a drilling fluid, the wood processing industry as an intensifier, the construction industry as a firming agent, the light and rubber industry as auxiliaries, the textile industry as softening and sizing agents, the medicine industry as auxiliaries of rubber products, the agriculture as an antifreeze of fruit and the paper industry as a pulp sizing agent. [4]

In the present paper, the classification and preparation of the emulsifying wax have been discussed. Four kinds of preparation methods for the emulsifying wax have also been introduced. Effects of the reaction conditions on the emulsifying wax preparation have also been explained.

Discussion

Four types of preparation methods for the emulsifying wax [3]

Four kinds of preparation methods for the emulsifying wax such as the method of emulsifying agents dissolving in the water, dissolving in the oil, the primary soap method and the taking turns adding method have been discussed. The method of emulsifying agents dissolving in the water means that emulsifying agents directly dissolve with water, and then add wax into the water with vigorous stirring. The method of emulsifying agents dissolving in the oil presents that emulsifying agents are added into wax and then the water-in-oil emulsion solution is obtained with additional use of water. When water is continuously added, the water-in-oil emulsion solution is changed to the oil-in-water emulsion solution. This method is called the phase-transfer method. The emulsifying agents dissolving in the oil are firstly transformed to lamellar liquid crystal structure during the process for adding water, and then changed to the oil in water droplets (O/D) gel emulsion structure covered by the continuous phase of surfactant, finally becomes the oil-in-water emulsion solution. The continuous phase of surfactant becomes O/D gel emulsion structure during the process for the emulsifying wax, so a subtle emulsion is obtained because oil droplets evenly distributed and cannot aggregate together to become bigger. The primary soap method describes as the fat and soda are dissolved into wax and water, respectively. When the above two solutions mix together, the primary soap reaction happens. The taking turns adding method presents a little bit of water or wax take turns to be added into emulsifying agents every time. The wax emulsion solution is prepared by the method of emulsifying agents dissolving in the water; however its properties are not stable. On the other hand, the emulsifying wax's properties are very stable by the method of emulsifying agents dissolving in the oil or the primary soap method.

Effects of the reaction conditions on the emulsifying wax preparation

Evaluating the properties of the emulsifying wax includes stability, dispersibility and rheological property, etc. Stability is one of the important properties for the emulsifying wax. The emulsifying wax as an emulsion solution is an unstable

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thermodynamic system. They are easily separated after settling at a long time. The instability of the wax emulsion solution shows breaking of emulsion and delamination. The delamination rate (Eqn.1) is given below. Decreasing V value makes an emulsion solution not to separate. In other words, different density between two phases and radius of emulsion solution particles are decreased and viscosity is increased. It is very difficult for the wax emulsion solution to decrease different density between two phases, so it tries to make the emulsion solution particles become smaller and even in shape and size. These are a lot of the reaction conditions having an effect on the stability of the emulsifying wax, such as the different emulsifying agents, the stirring speed, the emulsifying time and the ratio of the emulsifying agents to wax.

$$V = \frac{\Delta\rho d^2 g}{18\eta} \qquad (1)$$

where

- V the delamination rate, kg m^{-2} s^{-1}
- Δρ- the density difference between two phases, kg m^{-3}
- d the radius of emulsion solution particles, cm
- g 9.81 m s^{-2}
- η the kinematic viscosity, cm^2 s^{-1}

Effects of the different emulsifying agents on the emulsifying wax preparation

Li Guanghui [5] used the conductivity of the emulsion solution to determine the optimized HLB (Hydrophilic-Lipophilic Balance) value of emulsion solution. Figure 1 showed the relationship between HLB and conductivity of emulsion solution. The conductivity of emulsion solution increased with an increase in HLB when HLB values were less than 10. On the other hand, when HLB values were more than 10, the conductivity of emulsion solution almost unchanged. The optimized HLB value for the oil-in-water emulsion solution was determined by its conductivity and HLB value. Table 2 presented the optimized HLB value determined in the system of the emulsifying wax. When HLB values were between 10.25 and 10.75, the wax emulsion solution was very stable based on the below figure 1 and 2.

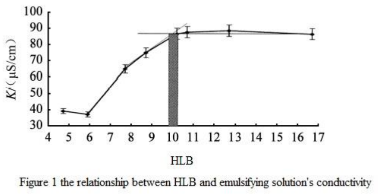

Figure 1. the relationship between HLB and the emulsion solution's conductivity

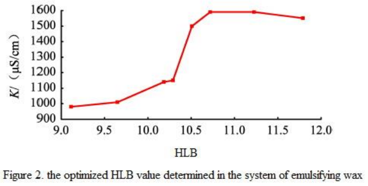

Figure 2. the optimized HLB value determined in the system of the emulsifying wax

Effects of the different stirring speeds on the emulsifying wax preparation

Li Meng [6] introduced the preparation and application of the wax emulsion solution. Effects of the different stirring speeds on the emulsifying wax preparation have been discussed. Table 1 showed that the stirring speed had an effect on the wax emulsion solution. When the stirring speed is less than 600 rpm, the wax emulsion solution freeze. When the stirring speed is between 600 and 800 rpm, the wax emulsion solution had a good mobility. The wax emulsion solution became extremely thick or become solidify with the stirring speed (more than 1500 rpm).

Table 1. Effects of the different stirring speeds on the emulsifying wax preparation

Stirring speed (rpm)	Emulsion's state
300	Freeze
600	Good mobility
800	Excellent mobility
1500	Extremely thick
1500	Caking

Effects of the different emulsifying time on the emulsifying wax preparation

Li Meng [6] has also studied the different emulsifying time having an effect on the emulsifying wax preparation. Table 2 presented the relationship between the emulsifying time and the properties of the emulsifying wax. The experimental results showed that when the emulsifying time was less than 35 minutes, the properties of the emulsifying wax were very poor. On the other hand, the properties of the emulsifying wax had a good mobility with the emulsifying time (more than 35 minutes). Therefore, the optimized emulsifying time was 35 minutes.

Table 2. the relationship between the emulsifying time and the properties of the emulsifying wax

Emulsifying time (minutes)	Stability (%)	Emulsion's state after settling 24 hours
25	70	Caking
30	80	Good mobility
35	95	Excellent mobility
40	95	Excellent mobility

Effects of the ratio of the emulsifying agents to wax on the emulsifying wax preparation

Li Meng [5] has also introduced that the ratio of the emulsifying agents to wax had an effect on the emulsifying wax preparation. The ratio of the emulsifying agents to wax was considered to be one of the important methods for producing the emulsifying wax. Patrick Fernandez [7] explained why the critical value of the emulsifying agents/wax ratio was 0.24. When the emulsifying agents/wax ratio was more than 0.24, the submicron's size in the emulsion solution did not almost change and adding water into this system has no effect on the submicron's size. The ratio of oil phase to water phase after settling a long time determined the stability of the emulsion solution. In other words, the sample was kept at a graduated cylinder with plug. The sample's state was checked at any given time. Its stability (Eqn. (2)) was given as follows.

$$R = 100\frac{H_E}{H_T}\ \% \qquad (2)$$

where

R the ratio of the emulsion phase, %

H_E the height of the emulsion phase, cm

H_T the height of the whole system (the height of the emulsion phase and the water phase), cm

Table 3 showed the ratio of the different emulsifying agents to wax having an effect on the emulsifying wax. The height of the emulsion phase increased with an increase in the concentration of the emulsifying agents. The emulsion solution obtained was very stable. The optimized concentration of the emulsifying agents was 8%.

Table 3. the relationship between the ratio of the different emulsifying agents to wax and the stability of the emulsifying wax

Concentration of the emulsifying agents (%)	H_E, cm	H_T, cm	R, %
3	7.9	13.2	59.85
5	9.2	13.3	69.17
8	11.0	13.9	79.14

Conclusion

Based on the above results and discussion, four kinds of preparation methods for the emulsifying wax such as the method of emulsifying agents dissolving in the water, the method of emulsifying agents dissolving in the oil, the primary soap method and the taking turns adding method have been reviewed. The emulsifying wax obtained is very stable by using the method of emulsifying agents dissolving in the oil or the primary soap method. A large number of reaction conditions have an effect on the stability of the emulsifying wax, such as the different emulsifying agents, the stirring speed, the emulsifying time and the ratio of the emulsifying agents to wax. The optimized reaction conditions show that the HLB values, the stirring speed, the emulsifying time and the concentration of the emulsifying agents were 10.25-10.75, 600-800 r·min^{-1}, 35 minutes and 8% respectively, the wax emulsion solution obtained was very stable.

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