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OBTAINING LIQUID EMULSIONS MARINE FUEL-WATER

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Abstract. Increasing the efficiency of burning liquid fuels used in naval heating installations is possible by burning them in water-liquid fuel emulsions. The emulsion is a heterogeneous system, consisting of at least one immiscible liquid, intimately dispersed in another in the form of droplets, whose diameter exceeds 0.1 microns. These systems have minimum stability that can be increased by the addition of additives such as surfactants, finely ground solid particles, etc. Emulsions are considered heterogeneous systems that belong to the category of pseudo-acids. Knowledge of the physical phenomena that accompany the emulsification and demulsification processes can create the predictive premise of the two phenomena mentioned above. This paper refers to this and tries to lay the foundations of an analytical-predictive interpretation of the processes in the realization of water-naval fuel emulsions.

Keyword: liquid fuels, burning emulsion, water-naval fuel emulsions, analytical-predictive interpretation.

1. Definition of emulsions

The emulsion is a heterogeneous system, consisting of at least one immiscible liquid, intimately dispersed in another in the form of droplets, the diameter of which exceeds 0.1 microns. These systems have minimum stability that can be increased by the addition of additives such as surfactants, finely ground solid particles, etc. Emulsions are considered heterogeneous systems that belong to the category of pseudo acids.

2. Terminology of emulsions

In the analysis of emulsions, it is necessary to differentiate the phases of the emulsion. The phase that is in the form of droplets is called the dispersed phase or the internal phase. The phase that forms the matrix in which these droplets are suspended is called the continuous phase or the external phase. The internal phase is also called the discontinuous phase while the external phase is also called the non-dispersed phase.

Classically, there are two types of emulsions based on the known case of water and oil emulsions:

- a- if the dispersed phase is the oil (then the emulsion is of the oil-in-water type and is symbolized U/A);
- b - when the water is in the dispersed phase, the emulsion is of the water in oil type and is symbolized A/U.

This terminology is conveniently applied even in the case of emulsions where the phases are not oil or water.

2. a. Surface tension

The separating surfaces between a liquid and a gas, or between two immiscible liquids, behave like an elastic, stretched membrane. It deforms under the action of an external force and returns to its original shape when the force ceases to act. The tangential forces on the surface of liquids cause their surface area to become minimal. The surface tension of a liquid is the result of tangential forces relative to the unit of length: in (N / m)

(1) The surface tension can also be expressed as a function of the surface free energy (E) and the surface of the liquid (S):

(2) and represents the force acting tangential to the surface of the liquid. The surface tension of most liquids decreases with increasing temperature. When the temperature approaches a critical value, the surface tension approaches zero.

2. b. Interfacial tension

Very important in emulsion theory are the stresses in the boundary layer between two immiscible liquids. The voltage in the boundary layer is called the interfacial voltage. When two immiscible liquids are brought into

contact, an interface results. The net attractive forces acting on the interface molecules are slightly different from those acting on a simple liquid surface, so that the value of the interfacial tension of two immiscible liquids in contact is between the value of the surface tension of the two liquids, without it is a general rule. Interfacial tension has the same sense of action as superficial tension. If an emulsion is unstable the system spontaneously tends to the minimum energy. This tendency is achieved by reducing the contact surface, so by merging the drops of the dispersed phase (coalescence). It has been found that a certain type of interface occurs between immiscible liquids when a small amount of a water-insoluble material is allowed to diffuse on the surface of the water.

3. Stability of emulsions

The study shows the stability of emulsions as a mathematically treatable kinetic phenomenon in order to remove water from naval fuel. For an emulsion consisting of liquids of approximately equal density, in the absence of an emulsifying agent, the separation rate is determined by the frequency of interglobular collisions. This depends on the intensity of the Brownian motion of the droplets of the dispersed phase and on the momentary degree of separation which in turn depends on the initial concentration of the dispersed phase. The Brownian motion equation is:

$$\frac{\zeta^2}{t} = \frac{R \cdot T}{3 \cdot \pi \cdot N \cdot \eta \cdot r}, \quad (1)$$

where:

- r - is the radius of the drop (m);
- R - perfect gas constant (J kmol °K);
- N - Avogadro's number;
- T - temperature (°K).

4. Demulsification of marine fuel-water emulsions

The complete destruction of the emulsion stability represents the complete dissolution of the phases also called demulsification. Demulsification is often accompanied by inversion and skimming. Skimming is the process of dissolving the emulsion into two emulsions of different concentrations of the dispersed phase. The coagulation of the dispersed phase at demulsification takes place in two stages.

In the first stage, the dispersed phase particles flourish. In the second stage, called coalescence, the flower aggregates combine to form a single larger drop, a process that accelerates until the emulsion is completely dissolved. The total number of dispersed phase particles, flowered or not, in the coagulating emulsions is given by the relation: in which:

$$n = \frac{n_o}{1 + a \cdot n_o \cdot t} + \frac{a \cdot n_o^2 \cdot t}{(1 + a \cdot n_o \cdot t)^2} \cdot \left[\frac{a \cdot n_o}{k} + \left(1 - \frac{a \cdot n_o}{k} \right) \cdot e^{-kT} \right], \quad (2)$$

where:

- n_o - is the number of particles at time $t = 0$;
- a - constant of the processing speed;
- k - the measure of the coalescence of the process.

When k is infinite (in the case of instantaneous coalescence) the above equation is reduced to:

$$n = \frac{n_o}{1 + a \cdot n_o \cdot t}, \quad (3)$$

When $k = 0$ (no coalescence occurs) then $n = n_o$ for all values of t. For values of k belonging between 0 and infinity the effect of changing the value of the emulsion concentration on the coagulation rate is given by the relation (3).

5. Checking the mathematical model

To test the adequacy of the mathematical model assumed for the quantitative characterization of the ultrasonic emulsification process, the regression analysis, in this case, was used, the least-squares method. For this purpose, the average degree of dispersion of the particles was determined analytically and compared with the experimental one. The analytical expression of the system by which the model coefficients are calculated is as follows:

$$n \cdot b_0 + b_1 \cdot \sum x = \sum y \quad , \quad (5)$$

$$b_0 \cdot \sum x + b_1 \cdot \sum x^2 = \sum xy$$

Where:

- b_0 and b_1 are the coefficients of the proposed model.

The mathematical model of emulsification is:

$$\Phi = \Phi_0 \cdot e^{-k \cdot \tau} \quad , \quad (6)$$

By logarithm the equation can be linearized:

$$\ln \Phi = \ln \Phi_0 - k \tau \quad , \quad (7)$$

The coefficients are identified and,

$$\ln \Phi = b_0 \quad , \quad (8)$$

$$b_1 = k \quad , \quad (9)$$

These, result from solving the system, so:

$$b_1 = \frac{n \cdot \sum xy - \sum x \cdot \sum y}{n \cdot \sum x^2 - (\sum x)^2} \quad , \quad (10)$$

$$b_0 = \left(\frac{\sum y - b_1 \cdot \sum x}{n} \right)$$

Conclusion

The emulsion is a heterogeneous system, consisting of at least one immiscible liquid, intimately dispersed in another in the form of droplets, whose diameter exceeds 0.1 microns. These systems have a minimum stability that can be increased by the addition of additives such as surfactants, finely ground solid particles, etc. Emulsions are considered heterogeneous systems that belong to the category of pseudo-acids. Knowledge of the physical phenomena that accompany the emulsification and demulsification processes can create the predictive premise of the two phenomena mentioned above.

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