Performance Evaluation of Defoamer under Computer Technology

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Abstract. In today's production and life, it is superior to the unavoidable essence of all kinds of materials and produces many bubbles. Moreover, the defoaming efficiency of defoamer is different in different production processes. There are also various factors that affect the efficiency of defoamer, such as the humidity of the environment, the temperature of the foaming system and so on. Different foam producing scenarios should have the most suitable defoamer. Therefore, it is necessary to evaluate the performance of defoamer in different foaming scenarios. With the development and application of computer technology in today's world, all kinds of computer technology are applied in many social production and life. It not only improves the efficiency of production and life, but also reduces people's labor input. In the performance evaluation test of defoamer, we can also combine computer technology, give full play to computer technology, data processing capacity, batch uninterrupted technology, and the ability to run mathematical evaluation model to test and evaluate the performance of defoamer. In this paper, the traditional evaluation method of defoamer performance is used for mathematical, and the corresponding software is generated in the computer for evaluation and analysis. And the computer technology used in the evaluation system of defoamer satisfaction questionnaire survey, trying to the defoamer manufacturers' satisfaction with the application of computer technology, and make corresponding improvements to the shortcomings.

Keywords: Modified Polyether Defoamer, Mathematical Modeling, Performance Evaluation System, Defoaming Principle

1. Introduction
A liquid or solid encapsulates an insoluble gas to form an individual, called a bubble. The bubbles are aggregated together, separated from each other by membrane, called foam. Foam systems are commonly found in gas / liquid, gas / solid, gas / liquid / solid systems. Like any other material, foam can only maintain its structure only when it can not be transformed into a low-energy state. The foam has been in a state of thermodynamical instability. This state is a dynamic equilibrium. When a bubble changes, the bubbles in its adjacent positions will change with [1-2]. Related scholars have divided bubbles into two types by different forms of foam: (1) spherical foam: composed of single,
independent bubbles. Its production can be independent of surfactant, but its stability is generally poor. (2) polyhedral foam: the liquid membrane divides the gas into irregular bubbles. In general, spherical foam will soon deform due to surface tension and accumulate irregular polyhedral foam [3]. The typical aqueous solution foam consists of 95% gas and 5% liquid, of which the liquid itself contains more than 95% water; the rest is composed of surfactants and other substances. In pure liquid and pure gas systems, the foams formed are extremely brittle and unstable. In general, they are less than 1s. Therefore, the foam generation mainly conforms to two conditions: (1) gas-liquid full contact: the gas-liquid two-phase section needs continuous and full contact. (2) bubbles are in dynamic equilibrium. As mentioned above, it is difficult to produce stable foam in pure substances. Only by adding some surfactants to them, bubbles can remain stable. Foam has two groups: hydrophilicity and hydrophobicity. In the process of bubble formation, the two groups are arranged in comb shape, hydrophilic group outward, hydrophobic group inward, wrapping the gas to form bubbles [4].

For the foam produced during the production process, the chemical method is used to eliminate the foam. The chemical method is mainly chemical reaction method and adding defoamer method. The chemical reaction method is mainly to add some substance to the foaming system to react with the foaming material in the system, or to produce some kind of defoaming agent, so that the foam will be broken. However, the main problem of this method is that the product is uncertain, which affects the production process; on the contrary, it is difficult to react due to the influence of other substances, which makes it difficult to achieve the defoaming purpose [5-6]. The method of adding special defoamer is the main application method in various industries, because it has the advantages of fast defoaming, long antifoaming time, easy to use, and does not affect the production process. Defoamer has two main functions. On the one hand, it is "defoaming". As the name suggests, it eliminates the foam that has already been produced. On the other hand, it is "anti-foaming", that is, it has inhibitory effect on foaming system and prevents froth. A defoamer with excellent performance should have the following conditions: (1) good defoaming and antifoaming performance, quick effect and less dosage. (2) Chemical inertness. When it is added to the foaming system, the production process will not be affected and the basic properties of the foaming system will not be changed. (3) The surface tension is low, which is lower than that of the foaming system, so that it can spread and disperse rapidly in the foaming system. (4) Insoluble in foaming system, easy to diffuse and penetrate [7-8].

Bubbles and foam are ubiquitous in people's lives. It is a common physical phenomenon. The existence of bubbles there are both advantages and disadvantages. Foam is needed in the process of fire fighting, dust removal, and making ceramic foam. In the process of desulfurization, fermentation, printing and dyeing, wastewater treatment and so on, the foam needs to be eliminated to reduce the impact on these processes and to harm [9]. At present, different defoamers are used in different industries. Choosing a suitable defoamer has an important impact on a certain industrial production process. Because often choose different defoamer, not only affect the production process, but also can not achieve the defoamer, antifoam effect. Therefore, this paper uses the Internet technology based on computer technology and computer software modeling and calculation ability to explore the evaluation system of defoamer based on the obtained performance evaluation data of different defoamers [10].

2. Data Evaluation Algorithm

2.1. Data Processing

There are m evaluation indexes of defoamer performance evaluation system. Each index uses the data from N original experiments. The performance evaluation system processes these data to obtain the standard matrix

\[
T = (r_{ij})_{m \times n} 
\]  

(1)

Among the m indicators, the i-th indicator is defined as:

\[
E_i = -\frac{1}{\ln n} \ln \left( \ln \left( \ln \left( \frac{1}{r_{ij}} \right) \right) \right), \quad i = 1, 2, ..., m. 
\]  

(2)

2
Among them:

\[ l_{ij} = \frac{r_{ij}}{\sum_{i=1}^{n} r_{ij}} \]  

\[ W_i = \frac{1-E_i}{\sum_{i=1}^{m} E_i}, 0 \leq W_i \leq 1 \]  

For the corresponding information processing indicators, the non-dimensional processing is performed by formula (1) to obtain the non-dimensional value \( x_i \), and the weighted average value is obtained by multiplying the indicator and the corresponding quantized value through weighted sum:

\[ \Delta = \sum_{i=1}^{m} W_i x_i \]  

\[ R(t) = P\{x(t) < [x]\} \quad u(t) \geq [u] \]  

\[ P_{FR}(t) = u(t) \quad P_{RSD}(t) = 1 - \frac{u(t)}{[u]} \]  

\[ t_r - t_1 = \frac{1}{2} (t_2 - t_1) - \frac{1}{2} (t_3 - t_1) \]  

2.2. Statistical Methods

Using statistical methods to deal with the data set obtained by big data technology is conducive to get useful information quickly.

Suppose the overall mean of all response values in sample 1 of the h layer is \( \mu_{1h} \), and the overall mean of all response values in sample 2 is \( \mu_{2h} \). Use \( \mu_h \) to represent the overall mean value of h-layer sensitive issues, and \( \mu_{Bh} \) to represent the overall average value of h-layer non-sensitive issues \( B_h \), defined by the weighted average

Have:

\[ \begin{align*}
\mu_{1h} &= P_1 \times \mu_h + (1 - P_1) \times \mu_{Bh} \\
\mu_{2h} &= P_2 \times \mu_h + (1 - P_2) \times \mu_{Bh}
\end{align*} \]  

Solve the above equations:

\[ \mu_h = \frac{(1-P_2)\times\mu_{1h} - (1-P_1)\times\mu_{2h}}{P_1-P_2} \]  

\[ \mu_{Bh} = \frac{P_2\times\mu_{1h} - P_1\times\mu_{2h}}{P_2-P_1} \]  

Then the sample estimate of \( \mu_h \) and \( \mu_{Bh} \) is:

\[ \begin{align*}
\hat{\mu}_{1h} &= \frac{(1-P_2)\times\bar{r}_{1h} - (1-P_1)\times\bar{r}_{2h}}{P_1-P_2} \\
\hat{\mu}_{2h} &= \frac{P_2\times\bar{r}_{1h} - P_1\times\bar{r}_{2h}}{P_2-P_1}
\end{align*} \]  

Among them:

\[ \bar{r}_{1h} = \frac{\text{The sum of all response values in sample 1 of layer h}}{n_{1h}} \]  

\[ \bar{r}_{2h} = \frac{\text{The sum of all response values in sample 2 of layer h}}{n_{2h}} \]  

2.3. Precautions for Performance Evaluation of Defoamer

The physical and chemical properties of an ideal defoamer must meet the requirements of the applicable system. The following requirements should be considered when selecting defoamers:

1) strong defoaming ability and effective elimination of foam when used in very small quantities.
2) It has lower surface tension than the defoaming system.
3) The basic performance of the original system will not be affected after use.
4) It is insoluble in the defoaming system and not easily solubilized by surfactants in the system.
5) The balance of surface tension is better.
6) The chemical property is stable.
7) It has good high temperature resistance
8) It has good gas solubility and permeability.
9) It is safe, nontoxic and harmless.
10) It has good storage stability.
11) Low cost.

3. Modeling Method

The evaluation and judgment model of defoamer performance is a typical two classification model, and the logist model is the most widely used model. When $x$ is 0, it means the defoamer performance is the best, when $x$ is 1, it means the defoamer performance is one grade worse, and so on. The probability can judge whether the defoamer needs to be remanufactured according to the set threshold.

$$
\rho(X = 1|Y) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x_1 + \ldots + \beta_n x_n)}}
$$

(16)

The fitting effect of the rating model is expressed by the pseudo-t-square statistics, which means the proportion model explained by the self-made quantity of the total variation multiple model of the dependent variable

$$
\text{Cox&Snell} - T^2 = 1 - \left[\frac{\ln(L_0)}{\ln(L)}\right]^2 = 1 - e^{-\frac{2}{n} \ln(L_0) \ln(L)}
$$

(17)

$$
T^2 = \frac{\text{Cox&Snell} - T^2}{1 - (\ln(L_0))^2}
$$

(18)

The coverage rate of the results is in the actual rating samples, and the correct rating proportion model is as follows:

$$
\text{RESF} = \frac{TA}{TA + FN}
$$

(19)

The model describes the regression results between cloud data storage rating and related indicators. First, we use $D_m$ with probability distribution. The basic security model is obtained by learning from the training data set

$$
T_m(x) \rightarrow \{-1, +1\}
$$

(20)

Secondly, the classification error rate on the processor is calculated

$$
e_m = P(T_m(x_i) \neq y_i) = \sum_{i=1}^{N} e^{y_i T_m(x_i)}
$$

(21)

The final data risk treatment is as follows:

$$
T(x) = \text{sign}(f(x)) = \text{sign}\left[\sum_{m=1}^{M} a_m T_m(x)\right]
$$

(22)

4. Evaluation Results and Research

In this paper, the test of common polyether defoamer and modified polyether defoamer, two similar defoamers were tested. The test results of the experiment are input into the computer to generate a visual icon for comparative analysis of the data.
Table 1. Stability test of defoamer

| Stability test         | Time (H) | Stability                                      |
|------------------------|----------|------------------------------------------------|
| Heat stability          | 48       | No delamination and demulsification            |
| Low temperature stability | 48   | No delamination and demulsification            |
| Dilution stability      | 24       | No delamination and floating oil               |

The stability of the improved defoamer was tested, and the results are shown in Table 1. It can be seen from the table that the improved defoamer has good heat resistance, low temperature resistance and dilution stability. After 48 h high temperature, low temperature and 12 h dilution test, the defoamer still does not layer, demulsify and bleach oil. The test items are input into the computer defoamer performance evaluation system, and the defoamer test performance database is established, so as to compare the improved performance of defoamer.

Figure 1. The change of foam volume over time

The defoaming and antifoaming properties of common polyether defoamers and modified polyether defoamers were tested. The defoaming process is shown in Fig. 1. It can be seen from the diagram: (1) when the defoamer is not added, the rate of bubble breaking is very slow. When adding defoamer, the rate of foam breaking is obviously faster. When the foam volume is around 160mL, the slope of defoaming curve decreases, and the defoaming rate decreases. The main reason is that the remaining foam volume becomes smaller, the density becomes higher, the self-healing ability of the bubble film is strengthened, and the stability is improved. (2) the defoaming rate of the improved organic defoamer is faster than that of silicone defoamer. The main reason is that when the two kinds of defoamer are added into the foaming system, the improved silicone defoamer can make the solution have lower surface tension, which can make the defoaming agent disperse and spread faster on the surface of the solution and accelerate the breaking of the foam.

Figure 2. The results show that the solution tension under different defoamers and different mass concentrations

![Defoaming volume over time graph](image1)

![Solution tension graph](image2)
The surface tension of common polyether defoamer and modified polyether defoamer was measured by capillary method, as shown in Fig. 2. It can be seen that the mass concentration of modified defoamer is inversely proportional to the tension indicated by the solution, and the mass concentration increases while the surface tension decreases. When the mass concentration is 0.60/l, the solution surface tension tends to be constant. When the mass concentration is LG / L, the surface tension of the solution is 24.0 Mn / m. When the mass concentration of silicone defoamer is greater than 0.60/l, the increase of mass concentration has little effect on the surface tension. When the mass concentration is 1.00/l, the surface tension is 29.00 Mn / m. Therefore, both defoamers have the characteristics of low surface energy, which can effectively reduce the surface tension of the solution and make them have excellent defoaming and anti-foaming properties. However, under the same conditions, the improved silicone defoamer has lower surface tension, so it has better defoaming and anti-foaming performance than silicone defoamer.

5. Conclusion
In the research and development process of defoamer, not only need to invest a lot of time and money, as well as the energy of researchers, but also need to predict the performance of defoamer, in order to analyze its shortcomings in advance and improve. Effective performance evaluation and prediction can effectively reduce the investment of R & D funds. After the completion of R & D, the performance evaluation can predict the market direction and bring greater benefits to enterprises. This paper mainly proposes the use of computer big data technology to collect the effect evaluation of relevant users; the use of computer data processing visualization technology to visualize the data obtained in the test, which can more clearly analyze its performance and help its improvement. Then, using the database system function of the computer to establish the evaluation model, it is more convenient to evaluate the performance of defoamer.

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