RESEARCH COMMUNICATIONS


ACKNOWLEDGEMENTS. We thank Inter University Accelerator Centre, New Delhi for providing beam time facility. We also thank Dr N. C. Mehra, University Science Instrumentation Centre, University of Delhi for his help in carrying out the SEM measurements.

Received 12 May 2009; revised accepted 14 October 2009

Formulation design of cyhalothrin pesticide microemulsion

Feng Zhao1,*, Hong-ying Xia2 and Jing-ling He3

1Jiangxi Key Laboratory of Organic Chemistry, Jiangxi Science and Technology Normal University, Nanchang 330013, China
2School of Chemistry Chemical Engineering, Jiangxi Science and Technology Normal University, Nanchang 330013, China
3Jiangxi Province Torch High Technology Development Corporation, Nanchang 330046, China

Microemulsion is regarded as the most promising pesticide formulation. However, the formulation of pesticide microemulsion is not easy and an efficient, scientific and inexpensive formulation design still remains elusive. Here, we present our formulation method based on the pseudo-ternary phase diagram and orthogonal design. In addition, the preparation of cyhalothrin microemulsion has been described and an explanation of the use of our approach is included.

Keywords: Cyhalothrin microemulsion, formula design, orthogonal design, pesticide formulations, pseudo-ternary phase diagram.

EMULSIFIABLE agricultural chemical formulations have been conveniently and widely used for a very long time1. However, emulsifiable solutions need large amounts of organic solvents such as toluene, dimethyl benzene, etc. which are harmful to man and his environment2. Hence, there is a demand for water-based, granular or control-release new pesticide formulations, which are clean and

*For correspondence. (e-mail: zhf19752003@yahoo.com.cn)
Table 1. A standard $L_3(3^3)$ matrix

<table>
<thead>
<tr>
<th>Experiments</th>
<th>A (w/w)</th>
<th>B (w/w)</th>
<th>C (w/w)</th>
<th>Blank column</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A (30%)</td>
<td>B (1:1)</td>
<td>C (8%)</td>
<td>D_1</td>
</tr>
<tr>
<td>2</td>
<td>A (30%)</td>
<td>B (1:2)</td>
<td>C (6%)</td>
<td>D_2</td>
</tr>
<tr>
<td>3</td>
<td>A (30%)</td>
<td>B (2:1)</td>
<td>C (4%)</td>
<td>D_3</td>
</tr>
<tr>
<td>4</td>
<td>A (25%)</td>
<td>B (1:1)</td>
<td>C (6%)</td>
<td>D_4</td>
</tr>
<tr>
<td>5</td>
<td>A (25%)</td>
<td>B (1:2)</td>
<td>C (4%)</td>
<td>D_5</td>
</tr>
<tr>
<td>6</td>
<td>A (25%)</td>
<td>B (2:1)</td>
<td>C (8%)</td>
<td>D_2</td>
</tr>
<tr>
<td>7</td>
<td>A (20%)</td>
<td>B (1:1)</td>
<td>C (4%)</td>
<td>D_2</td>
</tr>
<tr>
<td>8</td>
<td>A (20%)</td>
<td>B (1:2)</td>
<td>C (8%)</td>
<td>D_3</td>
</tr>
<tr>
<td>9</td>
<td>A (20%)</td>
<td>B (2:1)</td>
<td>C (6%)</td>
<td>D_1</td>
</tr>
</tbody>
</table>

Figure 1. Pseudo-ternary phase diagram defined by $A_1B_2C_1$.

Lathrin pesticide was dissolved in dimethyl benzene as an oil phase, Tween-60 and cosurfactant methanol were mixed at certain weight ratios to obtain the surfactant mixture. Then the mixture of the oil phase and surfactant phase at weight ratios of 1:9, 2:8, 3:7, 4:6, 5:5, 6:4, 7:3, 8:2, and 9:1 were diluted with SDS aqueous solution at various concentrations. Phase diagrams were drawn based on visual inspection at ambient temperature.

A standard orthogonal array matrix ($L_9(3^4)$) was constructed with three factors and three levels (Table 1) to select optimum formulation conditions to obtain a broader region of pesticide microemulsion in the phase diagrams. The characteristic value used in this experimental design was the infinite dilution area with water in the phase diagrams.

Orthogonal experiments were repeated thrice and the average results are presented in Table 2. Additionally, $K_1$, $K_2$, $K_3$, averages of microemulsion existence area in the phase diagrams for three factors under different levels are listed in Table 3. The difference between the highest and the lowest among $K_1$, $K_2$, $K_3$ is defined by the symbol $R$. Higher the $R$, greater the effect on the objective function.

Here, $K_{1A}$ of factor $A$ is calculated by

$$\bar{K}_{1A} = \frac{8.77 + 10.72 + 7.37}{3} = 8.95$$

$R$ of factor $A$ is calculated by

$$R = 8.95 - 7.77 = 1.18.$$  

Table 3 shows that the order of the three factors’ effect on the infinite dilution area with water is $R_C > R_B > R_A$.

According to $R$ analysis from the orthogonal experiments, optimal conditions were found to be $A_1B_3C_1$ with the maximum infinite dilution area with water. To confirm the result of the orthogonal experiments, the pseudo-ternary phase diagram determined by $A_1B_3C_1$ (namely 30% content of pesticide in dimethyl benzene, methanol/
Table 2. Experimental results for a standard L₀ (3^4) matrix

<table>
<thead>
<tr>
<th>Experiment</th>
<th>A (w/w)</th>
<th>B (w/w)</th>
<th>C (w/w)</th>
<th>D</th>
<th>Phase diagrams</th>
<th>Area M%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A₁ (20%)</td>
<td>B₁ (1:1)</td>
<td>C₁ (3:10)</td>
<td>D₁</td>
<td></td>
<td>8.77</td>
</tr>
<tr>
<td>2</td>
<td>A₁ (20%)</td>
<td>B₂ (2:1)</td>
<td>C₂ (5:10)</td>
<td>D₂</td>
<td></td>
<td>10.72</td>
</tr>
<tr>
<td>3</td>
<td>A₁ (20%)</td>
<td>B₂ (3:1)</td>
<td>C₂ (7:10)</td>
<td>D₂</td>
<td></td>
<td>7.37</td>
</tr>
<tr>
<td>4</td>
<td>A₃ (30%)</td>
<td>B₁ (1:1)</td>
<td>C₁ (5:10)</td>
<td>D₃</td>
<td></td>
<td>7.69</td>
</tr>
<tr>
<td>5</td>
<td>A₃ (30%)</td>
<td>B₂ (2:1)</td>
<td>C₂ (7:10)</td>
<td>D₁</td>
<td></td>
<td>7.44</td>
</tr>
</tbody>
</table>

(Contd)
Table 2. (Contd)

<table>
<thead>
<tr>
<th>Experiment</th>
<th>A (w/w)</th>
<th>B (w/w)</th>
<th>C (w/w)</th>
<th>D</th>
<th>Phase diagrams</th>
<th>Area* M%</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>(A_1) (30%)</td>
<td>(B_1) (3 : 1)</td>
<td>(C_1) (3 : 10)</td>
<td>(D_2)</td>
<td><img src="https://via.placeholder.com/150" alt="Phase diagram" /></td>
<td>11.0</td>
</tr>
<tr>
<td>7</td>
<td>(A_2) (40%)</td>
<td>(B_2) (1 : 1)</td>
<td>(C_3) (7 : 10)</td>
<td>(D_2)</td>
<td><img src="https://via.placeholder.com/150" alt="Phase diagram" /></td>
<td>7.12</td>
</tr>
<tr>
<td>8</td>
<td>(A_3) (40%)</td>
<td>(B_2) (2 : 1)</td>
<td>(C_1) (3 : 10)</td>
<td>(D_3)</td>
<td><img src="https://via.placeholder.com/150" alt="Phase diagram" /></td>
<td>7.44</td>
</tr>
<tr>
<td>9</td>
<td>(A_3) (40%)</td>
<td>(B_3) (3 : 1)</td>
<td>(C_5) (5 : 10)</td>
<td>(D_1)</td>
<td><img src="https://via.placeholder.com/150" alt="Phase diagram" /></td>
<td>8.76</td>
</tr>
</tbody>
</table>

*The response value is the infinite dilution area with water.

Table 3. Analysis of experimental data

<table>
<thead>
<tr>
<th></th>
<th>Factor</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>(E_1)</td>
<td></td>
<td>8.95</td>
<td>7.86</td>
<td>9.07</td>
</tr>
<tr>
<td>(E_2)</td>
<td></td>
<td>8.71</td>
<td>8.53</td>
<td>9.06</td>
</tr>
<tr>
<td>(E_3)</td>
<td></td>
<td>7.77</td>
<td>9.043</td>
<td>7.31</td>
</tr>
<tr>
<td>(R)</td>
<td></td>
<td>1.18</td>
<td>1.183</td>
<td>1.76</td>
</tr>
</tbody>
</table>

Tween 60 = 2 : 1 and SDS concentration of 8% w/w) was constructed (Figure 1).

The optimal value obtained from Figure 1 is 11.7%, and Figure 1 confirms the results from orthogonal experiments and the optimization results. The shaded region of microemulsion marked with diagonal lines in Figure 1 is the infinite dilution region, which is the best region for formation of pesticide microemulsion. So the range of
RESEARCH COMMUNICATIONS

pesticide microemulsion components and concentrations were obtained. However, whether the selected region is appropriate for practical applications depends on further evaluations such as heat storage stability, cold storage stability and determination of effective content and efficacy. Studies on these aspects are in progress.

Based on the pseudo-ternary phase diagram and orthogonal design, we can intuitively know the relationship between various components in a microemulsion, thus reducing the number of trials. The most potential formula of cyhalothrin microemulsion can be obtained through our approach. Experimental results show that our method is simple and effective and can be of great theoretical significance in the preparation of other pesticide microemulsions.

References


Received 17 May 2009, revised accepted 10 September 2009

Subtrappean Mesozoic sediments in the Narmada basin based on travel time and amplitude modelling – a revisit to old seismic data

A. R. Sridhar, A. S. S. R. S. Prasad, N. Satyavani and Kalachand Sain*
National Geophysical Research Institute, (Council of Scientific and Industrial Research), Uppal Road, Hyderabad 500 606, India

Of late, the search for hydrocarbons amidst Mesozoic sediments hidden below high-velocity Deccan Traps has gained prominence in the quest for delineating new reserves of energy. The presence of Mesozoics is directly evident in the form of a low velocity layer (LVL) prominently indicated on the refraction records. To delineate such sediments, seismic refraction/wide angle reflection studies were carried out in different parts of India. Seismic data from the Deep Seismic Sound profile in the western part of the Narmada–Son lineament (NSL) that passes through the Narmada and Tapti rivers is used for this study. Since imaging of LVL is not possible from the refraction data alone, we have used travel time skips on the refraction records along with reflections from the top and bottom of the LVL. Data from reciprocal shot points are used for confirmation and precise delineation. The analysis of seismic refraction and wide angle reflection data shows a possible existence of low-velocity Mesozoic sediments of considerable thickness sandwiched between the high velocity thick Deccan Traps and the basement.

Keywords: Deccan traps, low velocity layer, Mesozoics, Narmada–Son lineament.

Deep seismic sounding (DSS) studies have been undertaken by National Geophysical Research Institute (NGRI) in different geological/tectonic provinces of India to explain the tectonics and unravel the evolutionary processes of various regions such as the Himalayas, Delhi–Aravalli fold belt, Central India, Cuddapah basin, Mahanadi basin, Bengal basin, Koyyna region, Saurashtra and Kutch, Dharwar craton and the Southern granulite terrain, etc. All these investigations were remarkably successful and provided the key inputs for understanding the geodynamics of respective regions. The near surface geological patterns are manifestations of deep-seated structural variations and thus the shallow structure is in general, controlled by the deep crustal structure. The irregularities and the distribution of the structural patterns like faults and fractures are associated with mineral deposits. The low velocity layers over lain by hard

*For correspondence. (e-mail: kalachandssain@yahoo.com)