Lab Training in experimental design applied to product engineering: preparation of a cosmetic cream

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As chemical engineering education moves quickly, characterized by competitive global educational market, the role of educators is changing: there is a need to provide modern didactic methods in curriculum delivery. A new Chemical Engineering Master was developed at the University of Barcelona with the objective of approaching the competencies of graduates to the requirements from the chemical industrial sector. Many chemical engineers work in companies, which produce daily use products, and formulated products. By this reason, it is important that students learn by laboratory work the knowledge and the skills involved in product engineering.

A new laboratory work, where students must develop and experimentally study the preparation of a cosmetic cream as a common consumer product, was implemented. To achieve this goal students should know which are the functions and properties that the final product must accomplish, and which composition and preparation variables they could modify in order to obtain the best product.

Students decide the composition and preparation variables to be studied by an experimental design. Results of experimental design could lay down the variables which present a significant influence on the final product properties.

Students studied the influence of the stirring speed (N), addition speed (q) of the dispersed phase (water) and the emulsion dispersed phase ratio. The variables ranges were chosen by them, improving their capabilities of autonomously taking decision with scientific criteria.

The cosmetic cream was obtained as a water-in-oil emulsion composed by an oil phase containing isopropyl miristate, base F-2230 and paraffin. The water phase contained deionized water and glycerin. The oil phase was put into a stirred vessel and homogenized. Dispersed aqueous phase was added by a peristaltic pump.

The properties of the cosmetic cream studied were the stability, droplet size of the emulsion and rheological parameters as yield stress (τ_0) and viscoelastic behavior: viscous modulus (G") and elastic modulus (G'). Response variables were analyzed by an statistical program, so students could observe which composition and preparation variables had a significant importance on the studied parameters.

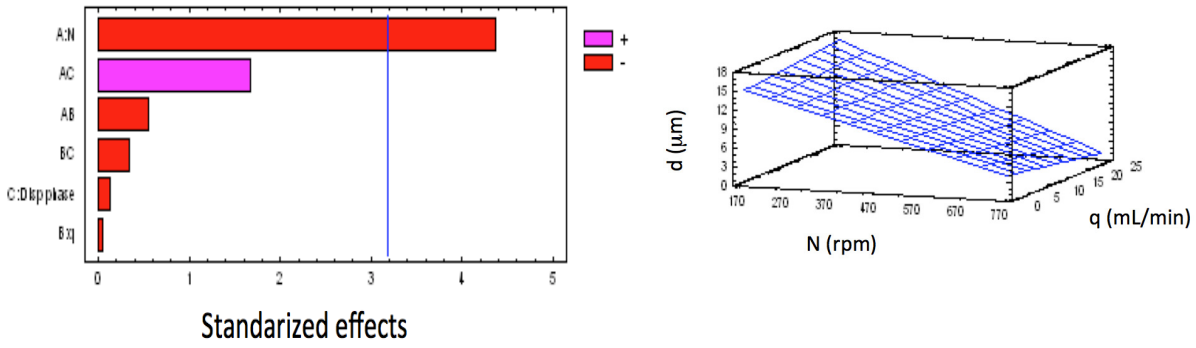


Figure 1. Pareto chart (left) and surface response (right) obtained for droplet diameters.

In the case of the droplet size students obtained the Pareto chart showed in figure 1. The chart indicated that the only variable that had a significant importance in the droplet size was the stirring speed (N). The surface response (Figure 1) showed the droplet size evolution when the stirring speed increases. So, the students conclude that in the studied range the higher stirring speed, the smallest droplet size.

In this laboratory work, students learned to use experimental designs and practiced experimentally the preparation and characterization of common consumer product, acquiring a global view of the parameters to take into account in a process of product engineering. They also worked the three types of transversal skills: (a) instrumental skills (self learning, planning and organization, taking decisions and writing and oral communication skills) (b) social skills (team work, critical reasoning) and (c) systemic skills (creativity, leadership and product care).

Keywords: Product engineering, experimental designs, emulsion, cosmetic cream, lab training.

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