Preface

Forty years ago, I worked for Max Factor's research and development division in Hollywood as head of the emulsion laboratory. One day, I dictated a report on an emulsion product to a new typist, but when I read the transcription, I discovered an interesting typo. Instead of "emulsion stability deteriorated" as I had dictated, the report read, "***emotional*** stability deteriorated." I thought at that time it was merely a funny coincidence. Later, after I became a consultant specializing in trouble-shooting of problems related to emulsion manufacturing, I discovered that there is often a significant correlation between the emulsion stability of the product and "emotional stability" of the people involved. This correlation is particularly strong when the product failure caused by unexpected emulsion instability threatens large financial losses for the business.

Emulsion-based cosmetics are very popular. By nature, however, most of them, including many cosmetic creams, lotions, sunscreens, hair conditioners and foundation make-ups, have a limited shelf life. Generally, the expected minimum shelf life of personal care products is about three years. However, depending not only on the raw materials used, but also on how the emulsion is processed, the shelf life of a freshly manufactured formulation can vary from batch-to-batch, and could be three years or three days. In the latter case, the person who made the batch or who was responsible for quality control (QC) would most likely notice something unusual about the appearance or physical properties of the emulsion and the batch would (hopefully) be rejected before it was filled and shipped to the trade. In such cases, the damage would be limited to the cost of the raw materials and labor. Paradoxically, if the shelf life of this defective batch turned out to be three months instead of three days, the injury could be much more serious, with a much greater financial loss, due to what I call a "***time-bomb effect***."

This is an unexpected, late onset stability problem that occurs when an emulsion initially looks perfectly good, passes all QC tests and specifications, and is filled and shipped to stores without any alarm. Then three months later, customers purchasing this cream at upscale department stores become upset as oil phase separation caused by emulsion instability makes the cream, which was smooth and beautiful when filled in the factory, look coarse and ugly. This kind of emulsion stability problem would naturally affect the emotional stability of customers, and cause them to lose trust in the brand. As the number of unhappy customers seeking refunds grows, the emotional stability of executives at the cosmetic company and those involved in marketing, manufacturing and formulating this product would likely be in serious jeopardy.

Forty years ago, the number of available raw materials was quite limited, and formulating chemists did not have personal computers or access to the Internet to

search for information on a dizzying number of surfactants, emulsifiers and other functional ingredients available. Today, we know more about the science of emulsification, and we have more powerful, better-designed equipment with which to process emulsions. It would seem that we ought to have fewer problems manufacturing cosmetic emulsions than we did in the past, but the reality is not so. We continue to struggle with serious production problems, still have great difficulty predicting product stability and still find it hard to control the qualities of emulsion products. Many cosmetic chemists and engineers have said to me that the problems they face are getting worse, not better.

Two key reasons for this, I believe, are increased competition and globalization of our industry. Many US cosmetic manufacturers are expanding their business to Latin America, Europe and Asia. They are doing well in newly developed markets like China. Globalization has increased business opportunity, but has also promoted competition and introduced additional complexity in manufacturing. To survive in this increasingly competitive market, streamlining of production is essential. Many cosmetic companies are now able to buy raw materials and package components from abroad to reduce their product costs, but few have outsourced production of emulsion products overseas, due at least in part to the difficulty of controlling product quality.

One way to reduce the overhead and labor costs of production is to increase batch sizes. Forty years ago, a 500-gallon batch was considered quite large for making cosmetic emulsion; today, 5000-gallon processing tanks are common. The production cost of making one 5000-gallon batch is certainly much lower than making ten 500-gallon batches. However, in this age of globalized economies, the financial loss and emotional toll of dealing with a failed 5000-gallon batch can be much greater than those associated with a 500-gallon batch gone bad.

A 5000-gallon batch or 20 tons of a cream equates to about one million pieces of an anti-age cream when filled in 20-gram jars. Should this batch of product start to separate and deteriorate three months after manufacturing, the cost of a recall can be huge, particularly if the product has already been shipped not only to hundreds of stores in the United States, but also to various cities in Europe and Asia. The CEO of a cosmetic manufacturing operation who is presented with this kind of bad news would surely want to know the reason for the failure, and staff would be called upon to explain. The process of seeking and identifying the true causes of product failure is often not easy to initiate because so many ***possible*** reasons exist, including variations in quality of raw materials, weighing mistakes and processing errors. Many emulsions are sensitive to process variables and sometimes the use of new equipment, a different batch size or even a slight alteration in manufacturing procedure—like a change in the order of adding ingredients to a batch—can cause unexpected product failure. Although identifying the true cause (or causes) of the problem is most important in preventing similar problems in future, in an emotionally unstable atmosphere, finding the facts and collecting important data needed to determine the problem source can be extremely challenging.

I recall from my Max Factor days a company typist specialized in typing formulations, who was able to identify with great accuracy the creator of a given formula, because, as she would explain to me, most chemists have their favorite combinations of ingredients which they would tend to use in their emulsion formulations. I thought this observation was an interesting one and I found—and still find—nothing wrong with this formulation approach. In fact, I believe it is prudent practice to "go with what you know" when formulating emulsions because doing so can help to avoid problems arising from their often unpredictable stability. By using a variation of their tried-and-true combinations, chemists can minimize the risk of product failure. I used to advise formulation chemists to keep their formulas as simple as possible so that in case of unexpected problems caused by chemical or physical interactions, it would be easier to isolate and identify the causes with a limited number of ingredients. This advice is still valid today, though I acknowledge that it is often difficult to follow because chemists are now often forced to incorporate many unfamiliar ingredients into formulations with increased risk of stability problems.

Most cosmetic products are designed to promote the health of the skin and attractiveness of the user. In marketing cosmetics, however, it is important not only to make sure that the products perform the required functions, but also that they look attractive, feel good and smell nice. In addition, their packaging must also be attractive and present a good impression to the consumer. As the market has become ever more competitive, every little detail, including the names of the ingredients and their impression on consumers, is being scrutinized by manufacturers and their marketing teams.

Forty years ago, selection of cosmetic ingredients used in formulation was largely left to the decision of individual chemists. Management cared only about the cost and the marketing department cared mostly about product performance and appearance. Since the US Food and Drug Administration (FDA) started requiring labeling of ingredients in 1976, the formulation rules have changed and the ingredient lists of skin care products have become longer and, to some, more "impressive." It is quite common today to find high-priced creams containing more than 60 ingredients. More ingredients mean more complexity and greater possibility for unexpected interactions, which can cause discoloration, phase separation or other forms of product degradation.

Even more worrisome is a new trend by some marketers to remove certain useful functional ingredients, not necessarily because they are unsafe, but often simply because their INCI names are too long, "too chemical" and deemed unattractive to consumers, or erroneously perceived as unsafe. Many formulation chemists working for manufacturers of organic cosmetics are having difficulty removing their "tried and true" functional chemicals and substituting for them with unfamiliar "natural" ingredients with sometimes questionable performance history.

Unfortunately, this trend for "greener" consumer products is not likely to reverse any time soon as serious environmental problems including air and water pollution, the greenhouse effect, and depletion of energy sources continue to frighten the public,

and organic foods continue to gain popularity and market share. In many ways, the cosmetic industry will be deeply affected by these environmental concerns in the coming years and we must be prepared.

I believe that we are consuming a far greater amount of energy than is necessary in manufacturing most cosmetic emulsions. Most cosmetic emulsions contain waxy substances like fatty acids or fatty alcohols and heating is required to melt them down so they can be combined with other materials. Since the bulk product generally must be cooled before packaging, thermal energy must be removed, and this step is usually accomplished by circulating refrigerated water in the jacket of the processing tank. It will be shown in Chapter 14 that the amount of thermal energy used in making commercial emulsions far exceeds the theoretical minimum required. Thus, most of the thermal energy applied in heating the batch is removed or discarded during the cooling process. As the batch size increases, the cooling efficiency in a jacketed kettle decreases significantly, requiring additional time and energy for cooling, compounding the waste.

I have published a number of papers on Low-Energy Emulsification (LEE) in which I argue that in many cases, 50% or more of the thermal energy used in processing typical cosmetic emulsions could be saved through carefully planned, selective application of energy, and without compromising product quality. This energy-saving technique can also significantly increase the productivity of manufacturing operations by substantially shortening cooling time, which for large batches can consume many hours. The use of less energy to improve productivity may seem contrary to conventional wisdom. However, LEE is not mere theory, but rather a proven useful tool which has been utilized by many companies to process various types of emulsions with substantial savings of energy and processing time. In most cases, no new equipment is required to implement this process. However, understanding of its basic principles and carefully planned experiments are needed to determine optimum processing conditions.

The "Less Is More" principle demonstrated here can be applied to other areas, including the reduced use of surfactants in formulating emulsion products, a technique discussed in Chapter 16, "Low Surfactant Emulsification." Surfactants are needed to reduce interfacial tension to prepare stable emulsions. It does not follow, however, that more surfactant will result in a more stable emulsion or better product, because the stability of emulsion is often dependent on the balance of the hydrophilic/lipophilic nature of the surfactant blend, and not necessarily on the total quantity used. Addition of more surfactant can sometimes cause instability if the wrong one is used. In addition, adding surfactants may cause an increase in the irritation potential of the product, or cause undesirable interactions with other ingredients.

The main purpose of this book is to present a new strategy for coping with the complex problems that arise today in formulating and manufacturing cosmetic emulsions, encouraging application of science and creativity to find solutions, manage complexities and prevent recurring of problems. These days, managers in

cosmetic companies are under great pressure to deliver quality products in a very short time. Manufacturing errors can cause huge losses for a company. In attempting to reduce the likelihood of these errors occurring and improve quality, management will often issue rules and call more meetings. More rules, more meetings and more inspections and audits do not always reduce production problems and errors. In fact, sometimes the technical staff can become too busy attending meetings and dealing with auditors that they simply neglect to do the necessary research that would lead them to discover the true cause or causes of the problem. More is not always better.

This principle of "Less Is More" is based on the common sense observation that too much of anything, even something good, is usually not good, and that moderation can be key. Over 2000 years ago, Aristotle taught in Nicomachean Ethics:

Anyone can become angry, that is easy. But to be angry with the right person, to the right degree, at the right time, for the right purpose, and in the right way, that is not easy.

Even anger can be productive if directed correctly and used at the right degree. The secret of this "Less Is More" principle is this balance and specific targeting. It is a principle that can be applied not only in emulsion manufacturing but also in many other situations we in the cosmetics business face daily, often reducing costs and improving productivity.

In December 2006 after I spoke at a Manufacturing and Scale Up Session of the SCC Annual Scientific Meeting in New York City, my friend, Nancy Allured, suggested that I seriously consider writing a book on emulsion technology. She heard my presentation, "Strategies and Techniques for Trouble-Free Manufacturing of Cosmetic Emulsions," that day and told me that a book on this topic would be useful to many. I was flattered and after a good amount of thought decided to accept the challenge. Writing this book has been stressful at times, but also a lot of fun. I am grateful to Nancy for suggesting the project.

Fortunately, I have a very supportive family and many great friends who encouraged me to continue writing. I need to thank especially my wife Cathy and my three sons, Edward, Theodore and Richard and their wives for their support. Particularly, Edward has spent many hours reviewing my manuscripts, discussing with me the contents and contributing many ideas. I am also grateful to many of my good friends, including Dr. Hiromichi Sagitani of Pola Chemical Industries, Dr. Samuel Lin of Applechem, Jennifer Chang and Gregory Pum of Levlad Laboratories and Alice Han of Cosmowiki.com for their valuable comments, suggestions and encouragement. I also wish to thank Angela Kozlowski, my book editor, and all the other fine folks at Allured Publishing for their help in making this book possible.

Less is a Gain, More is Confusion

-Lao-tse, Chinese Philosopher