Data-Driven Approach for Product Quality/Yield Improvement: How to Specify Target of Qualitative Quality Variables

Manabu Kano, Koichi Fujiwara, Shinji Hasebe, and Hiromu Ohno
Dept. of Chemical Engineering, Kyoto University, Nishikyo-ku, Kyoto 615-8510, JAPAN
E-mail: kano@cheme.kyoto-u.ac.jp

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Abstract

How can we improve product quality and yield? More than ever, the answer to this question is vital as product life cycles are getting shorter and international competition is getting keener. Since this question arises repeatedly when a new product is developed, quality improvement should be achieved faster and in a more systematic way.

In the present work, a data-based methodology for improving product quality/yield is proposed. Referred to as Data-Driven Quality Improvement (DDQI), the proposed method can cope with qualitative as well as quantitative variables, determine the operating conditions that can achieve the desired product quality, optimize operating condition under constraints, and also evaluate the validity of the results.

In DDQI, a space where operating conditions can achieve the desired quality is searched within subspace spanned by principal components. However, desired product quality cannot be specified quantitatively when the quality variable is qualitative, e.g., whether there is any defect on the surface of specialty sheet steel. For such a qualitative quality variable, yield, i.e., the percentage of good products to all products, can be specified instead of the quality itself. In the proposed method, the yield is defined on the basis of histograms for two categories such as good and bad. The histograms can be obtained from operation data, and they can be drawn against the axis defined by a discriminant function. Once the desired yield is specified, operating conditions that can achieve the desired yield can be easily found.

This paper aims to formulate DDQI and demonstrate its usefulness with an illustrative example. In addition, possible extensions and remaining problems are discussed based on the authors' experience of succeeding in improving product quality by applying DDQI to several industrial processes.