ELSEVIER

Computers and Chemical Engineering 24 (2000) 519–524

Computers & Chemical Engineering

www.elsevier.com/locate/compchemeng

Multi-dimensional object oriented approach for automatic generation of control recipes

Atsushi Aoyama [a,*], Isao Yamadai [b], Rafael Batres [a], Yuji Naka [a]

[a] *Tokyo Institute of Technology, Chemical Resources Laboratory, Nagatsuta Midori-ku, Yokohama 226-8503, Japan*
[b] *Yamatake Corporation, 1-12-2 Fujisawa-shi, Kanagawa 251-8522, Japan*

Abstract

The chemical and biochemical industries face intense pressure to improve efficiency, product quality, and human safety, whilst reducing the environmental impact of their operations. Under these circumstances, batch processing is becoming increasingly important. In the batch process operation, the plant information has to be reconfigured dynamically so that it corresponds to the current operation status. This requires the management of plant information reconfiguration as well as the separate handling of process management and unit management. One of the most important tasks of batch process operation management is a management of recipe that is a set of information that defines the production requirements. The current way of manual configuration of production level recipes is tedious and prone to error. In this research, an automatic generation of production level recipes (control recipes) has been proposed. Once a scheduling is carried out, simple transformation rules can generate the control recipe from the master recipe using the plant structure information. It makes the maintenance of control recipes easy. Because the transformation procedure of the master recipe to the control recipe is completely transparent, it is easy to backtrack the rationale of each operation. © 2000 Elsevier Science Ltd. All rights reserved.

Keywords: Batch process; Operation management; Object oriented model; Simulation

1. Introduction

The chemical and biochemical industries face intense pressure to improve efficiency, product quality, and human safety, whilst reducing the environmental impact of their operations. Under these circumstances, batch processing is becoming increasingly important due to the greater emphasis on low-volume higher added value products and the need for flexibility in the market driven environment. It is well known that the operation management of batch process is much more difficult than of continuous process. In the batch process operation, not only operations carried out in the plant are changing continuously but also relationships between operations and process units are changing dynamically. In order to carry out batch process operations, the plant information has to be reconfigured dynamically so that it corresponds to the current operation status. This requires the management of plant information reconfiguration as well as the separate handling of process management and unit management. One of the most important tasks of batch process operation management is a management of recipe that is a set of information defining the production requirements. The current way of manual configuration of production level recipes (control recipes) is tedious and prone to error. This paper proposes an automatic control recipes generation procedure based on a separate and independent modeling of the plant structure, the operation and the operation management. Based on this new modeling scheme, once a scheduling is carried out, simple transformation rules can generate the control recipe from the master recipe using the plant structure model and at the same tune an operation management structure corresponding to the control recipe is configured automatically.

The next section describes differences between continuous and batch process management and problems of current control recipe generation. Section 3 briefly explains the operation management platform. The au-

* Corresponding author. Tel.: +81-45-9245248; fax: +81-45-9245270.
E-mail address: aoyama@pse.res.titech.ac.jp (A. Aoyama)

0098-1354/00/$ - see front matter © 2000 Elsevier Science Ltd. All rights reserved.
PII: S0098-1354(00)00523-8

tomatic control recipe generator is closely related to the operation management scheme. Section 4 explains the models used by the control recipe generator. Section 5 describes the preconditions of control recipe generation and explains the control recipe generation procedure. Section 6 briefly summarizes the results.

2. Problems of current batch process management

It is generally agreed that the operation management of a batch process is much more difficult than that of a continuous processes. In the continuous process operation, the one-to-one correspondence between operation and process unit is established and their relationship is fixed and does not change over time. For example, if an operation is sequenced as Reaction → Separation → Purification → Pelletize then the corresponding units are also sequenced as Reactor → Distillation Column → Membrane → Pelletizer. On the other hand, in the batch process operation, operations and states of operations carried out in the plant are changing continuously due to scheduling. Therefore, in order to carry out batch process operations, the plant information has to be reconfigured dynamically so that it corresponds to the current operation status. This requires the management of plant information reconfiguration as well as the separate handling of process management and unit management. Those requirements make the batch process operation management complicated and difficult and lead to the necessity of elaborate modeling of operation and operation management.

One of the most important tasks of batch process operation management is a configuration of production level recipes (control recipes) that defines the production requirements including formula, equipment requirements and operation procedures (Fig. 1). Current ways of manual configuration of control recipe are causing a number of problems. For example, the operation is usually expressed as a sequence function chart (SFC) that elaborates the manipulation of individual valves, pumps etc. in which both the process operation information and the plant structure information is implicitly contained. It is often the case that the configuration of SFC from scratch is easier than the modification of it when there is a modification in the physical plant or the operation procedure. A resulting SFC is basically a one-dimensional sequence of manipulation and lacks the ability to hold design rationales used at the operation deign. Therefore it is not possible to use that kind of information at the stage of real-time operation and operation analysis. For example, even though a real goal of specific operation is 'increase the tank level while keeping the temperature steady', the operation written in the SFC is rather like 'open valve 1 for 30 min and turn on the heater after 4 min' and the original meaning of operation is lost when it is executed.

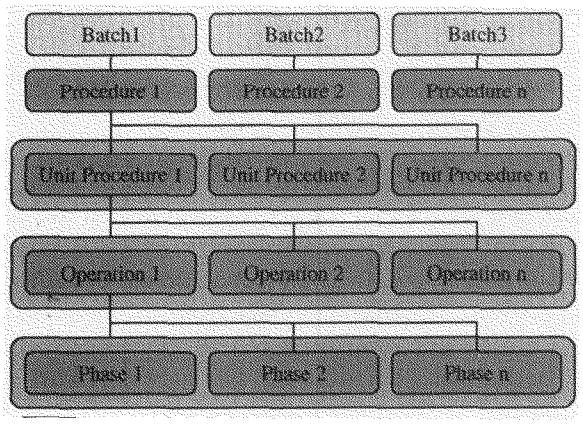

Fig. 1. Operation procedures.

ANSI/ISA-S88 (ANSI/ISA-S88.01, 1995) tried to achieve a better batch process operation management through establishing the standard models, terminology, data structure and guidelines for language used by batch process control. It defines three kinds of recipe (general recipe, master recipe, control recipe) corresponding to their level of abstraction. ANSI/ISA-S88 also defines the layered structure of the operation procedure defined in each recipe; procedure, unit procedure, operation and phase. The management function is also modeled as a multiple layered structure in ANSI/ISA-S88. Viswanathan, Johnsson, Srinivasan, Venkatasubramanian and Arzen (1998) and Johnsson and Arzen (1998) propose a recipe representation and an automatic operation procedure synthesis based on ANSI/ISA-S88. However, in ANSI/ISA-S88 and previous research, the separation of the plant information reconfiguration management, the process management and the unit management is still ambiguous. The contents and expression of operation in each recipe and how to relate the layered structure of operation procedure and the plant structure topology are not clearly defined.

3. Operation management platform

As described in the previous section, one weak point of ANSI/ISA-S88 is that the separation of the plant information reconfiguration management, the process management and the unit management is incomplete. The operation management platform has been proposed in which those three kinds of management are clearly defined (Aoyama, Yamada, Batres & Naka, 2000). The lower part of operation management platform is modeled as a multiple layered structure of process management, unit supervision and phase execution from the upper layer to the lower layer. 'Process management' executes multi-batches through the man-

دریافت فوری ← متن کامل مقاله

ISIArticles
مرجع مقالات تخصصی ایران

✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
✓ امکان دانلود نسخه ترجمه شده مقالات
✓ پذیرش سفارش ترجمه تخصصی
✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
✓ دانلود فوری مقاله پس از پرداخت آنلاین
✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات