UNIVERSITI TEKNOLOGI MARA

INTEGRATION OF STATISTICAL PROCESS CONTROL (SPC) AND ENGINEERING PROCESS CONTROL (EPC) IN BATCH PROCESS

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ABSTRACT

Batch process is one of a main type of process in the chemical industry alongside continuous process. It is also called as discontinuous process due to the nature of the batch process. The main industry that utilizes batch process is the kind that produce low volume products and also, industry that produce specialty chemicals. The main principle of a batch process operations is by loading the reactants in a vessel and no material can be added or removed during the process. It is a very difficult encounter to production and process engineers to complete the task of achieving optimal performance of industrial batch processes. Batch processes have many major issues such as they are big batch-to-batch variations, highly non-linear dynamics, and difficulty in real-time measurement. It is significant to control the process in real-time, in order to avoid many issues such as off-spec product. The production of off-spec product is a major problem as the batch has to be eliminated and thus incurring loss. While the study of statistical process control (SPC) and engineering process control (EPC) is garnering attraction in controlling strategy, the implementing of the integration is still rare and few studies and research focus on it compare to continuous process. In this research, first, the real-time monitoring system of the integration of SPC and EPC in batch process is simulated. Secondly, the effectiveness of real- time monitoring systems of the integration of statistical process control and engineering process control in batch process is studied. The research revolves around a simulated case study of penicillin production. The type of control strategy deploy is the integration between SPC and EPC.

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INTRODUCTION

1.1 Research Background

In the chemical industry, there are two main types of process which are continuous process and another one, discontinuous or batch process. The kind of industries that mainly utilizes batch operations are the one that produce low-volume products and also, industries that produce specialty chemicals. The main principle of a batch process operations is by loading the reactants in a vessel and no material can be added or removed during the process. This operation is more flexible than continuous process because it allows the adjustment of the run time and temperature profile. Batch processes are typically produces below 10,000 metric tons per year (D. Bonvin, 2017).

Batch processing is important in producing specialty chemicals. Industries such as bio fermenters in the pharmaceutical sector, and crystallizers in many industries, also utilize batch process. Typically, the development of the operation of batch processes is done in the laboratory. This development involves 2 aspects which are reaction and separation recipes. The order of operations is prespecified. The operations are executed in specialized process equipment, to yield a specific quantity of product. The series of steps to be carried out on the specialized equipment are prespecified. The steps are such as cooling, distillation, heating, reaction, crystallization, and drying (Dominique Bonvin, Srinivasan, & Hunkeler, 2006). The processing sequence is repeated on a prespecified schedule, until the production volume achieved desired amount. In order for the target reactions or process to take place, the limit of temperature, concentrations, and flow rates required is prespecified too. It is a problematic task to adjust pressure, temperature, and feeding profiles by controlling strategies when the development from the laboratories are scaled up to production.

The objective in batch processing is because of its economic nature but the objective also can be expressed in terms of technical goals which include productivity, product quality, and safety. The increment of quantity of final product per unit of time indicates the increasing of productivity. It also can represent the increment of number of batches per shift, as it is beneficial to reduce the time of production. Impurities is