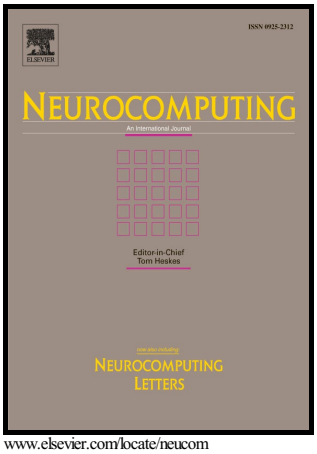

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Quality-related process monitoring for dynamic non-Gaussian batch process with multi-phase using a new data-driven method

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Abstract

In this paper, a quality-related monitoring scheme of batch process using multi-phase dynamic non-Gaussian model is presented. Product quality of a batch process is difficult to be effectively guaranteed because of its frequent start-stop operation, variable operating conditions, strong dynamic and non-Gaussian character of process data, etc. A direct dynamic PLS (DDPLS), in which weighted time-lagged matrix is used to extract dynamic components, is introduced to the dynamic problem. Meanwhile, independent component analysis(ICA) is proposed to deal with non-Gaussianity of dynamic components in DDPLS. Considering most batch processes are multi-phase in nature, in order to well describle the characteristics of every phase and set up sub-models, GMM algorithm is adopted for phase division and fuzzy membership method for transition identification. TE benchmark is used to verify the validity and superiority of our new method over traditional PLS, DPLS. Then the new method is applied to a real hot strip mill production plant.

Keywords: batch process; quality-related; multi-phase; process monitoring; hot strip mill process

1. Introduction

Nowadays, modern industrial production has a trend of batch process with characteristics of small scale, multi-target and high-value added products. Batch process has been widely applied to steel manufacturing, chemical, semiconductor manufacturing, polymer reactions, etc. To keep high enterprise profit, quality-related process monitoring and fault diagnosis tools play a very important role. During the past few decades, process monitoring techniques have achieved tremendous developments both in research and practice, and are becoming key elements of modern process control system and often prescribed by authorities[1].

Due to the nonlinearity, dynamic, time-varying, multi-phase, large-scale and other factors of batch process, it is difficult to build precise process models based on priori knowledge[2–9]. In contrast to the model-based approaches where priori knowledge is needed, data-driven methods which only require a large

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