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Detection of Abnormal Process Behavior in Copper Solvent Extraction by Principal Component Analysis

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Abstract : Frequent measurements of product steam quality create a data overload that becomes more and more difficult to handle. In the current study, plant history data with multiple variables was successfully treated by principal component analysis to detect abnormal process behavior, particularly, in copper solvent extraction. The multivariate model is based on the concentration levels of main process metals recorded by the industrial on-stream x-ray fluorescence analyzer. After mean-centering and normalization of concentration data set, two-dimensional multivariate model under principal component analysis algorithm was constructed. Normal operating conditions were defined through control limits that were assigned to squared score values on x-axis and to residual values on y-axis. 80 percent of the data set were taken as the training set and the multivariate model was tested with the remaining 20 percent of data. Model testing showed successful application of control limits to detect abnormal behavior of copper solvent extraction process as early warnings. Compared to the conventional techniques of analyzing one variable at a time, the proposed model allows to detect on-line a process failure using information from all process variables simultaneously. Complex industrial equipment combined with advanced mathematical tools may be used for on-line monitoring both of process streams' composition and final product quality. Defining normal operating conditions of the process supports reliable decision making in a process control room. Thus, industrial x-ray fluorescence analyzers equipped with integrated data processing toolbox allows more flexibility in copper plant operation. The additional multivariate process control and monitoring procedures are recommended to apply separately for the major components and for the impurities. Principal component analysis may be utilized not only in control of major elements' content in process streams, but also for continuous monitoring of plant feed. The proposed approach has a potential in on-line instrumentation providing fast, robust and cheap application with automation abilities.

Keywords : abnormal process behavior, failure detection, principal component analysis, solvent extraction
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