**The Quality Monitoring of Vinyl Chloride Polymerization by Soft Sensor and OPC Technology.**

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***Highlights***

* A multi-model fusion modeling method
* A soft sensor application scheme by OPC technology
* The operation load of the entire monitoring system is light and stable

**1. Introduction**

In the vinyl chloride polymerization process, it is essential to monitor the polymerization rate and the conversion rate online for the sake of product quality, process optimization and safety [1]. Traditional off-line measurement methods cannot meet the real-time control requirements. A soft sensor method with multi-model is used for the polymerization process monitoring by OLE for Process Control (OPC) technology.

**2. Methods**

The development of modern control theory and artificial intelligence enriches the soft sensor technology [2,3]. According to the characteristics of vinyl chloride polymerization, a multi-model fusion modeling method, based on an improved Kalman filter algorithm, is proposed, as shown in Figure 1.



**Figure 1.** Multi-model fusion modeling structure

where，*X*1, *Y*d, *X*2, *Y*m are inputs and outputs. The update equations are as follows:

*Yt*=*Yt-*1+(*Yd*,t-*Yd,t*-1)+*wt-*1  (1)

*Zt*=*Ym,t*=*HYt*+*vt* (2)

where *t* is the time, *Y* is the state variable, *Z* is the observation variable, *H* is the gain of state variable to observation value, *w*, *v* are the process noise and the measurement noise respectively, and the corresponding variances are *W* and *V*. In the recursive framework of the Kalman filtering algorithm, the combined weights are automatically adjusted online. The predictive value of combination model *Yh* is obtained. Moreover, a linear sliding smoothing filter is applied to stabilize *Yh* and the final prediction value *Yf* is obtained. However, the application of the method takes much computing resource if this program is run in the control system. Thus, a soft sensor application scheme by OPC technology is proposed, the structure is shown in Figure 2. The server station and the operation station constitute the communication network through the industrial Ethernet. The real-time process parameters of DCS control system are sent by OPC server. The server computer runs soft sensor module program. The target variables are sent back to the control system. The monitoring software obtains the data by the OPC client.

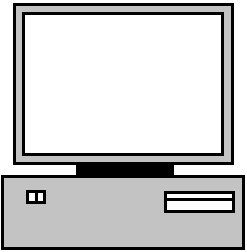
OPC

client端器

Ethernet

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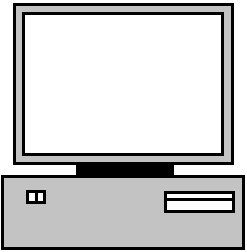
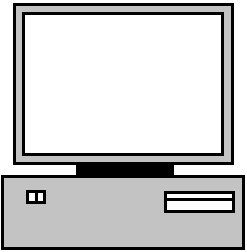


Operate

Computer



Switch



OPC

client端器

OPC

client端器

Operation Station

Server Station

Server

Computer

Operate

Computer

computer



**soft-sensor**

**model software**

OPC

server

**Figure 2.** Structure of a soft sensor application scheme by OPC technology

**3. Results and discussion**

The multi-model fusion modeling method and OPC technology are applied to the soft-sensing of the polymerization rate in vinyl chloride polymerization. First, a data-driven modeling method is used by combining mixtures of Kernels Principal Component Analysis (K2PCA) with Artificial Neural Network (ANN). The input variables are polymerization time *t*, polymerization temperature *Tr*, inlet and outlet temperature of jacket cooling water *TJi* and *TJo*, flow rate of jacket cooling water *FJ.* The output variable is polymerization rate. Second, a mechanism model based on the heat balance model of the reactor is proposed by calculating the thermal equilibrium parameters. The thermodynamic mechanism model is as follows:

 (3)

The final value *of* polymerization rate *Yf* is obtained through a series of mentioned techniques. Then, the polymerization conversion *X* can be obtained by integral.

 (4)

**4. Conclusions**

The OPC application result is satisfactory.The soft sensor technology solves the problem of online monitoring of the polymerization quality. The OPC technology solves the data switching problem between different software and hardware. The application in the vinyl chloride polymerization process proves the stability and reliability of the method.

**References**

1. J. Zeaiter, V. G. Gomes, J. A. Romagnoli, et al. Chemical Engineering Journal,2002,89 (1-3) 37-45.
2. F. S. Mjalli, A. S. Lbrehem. Chemical Engineering Research and Design, 2011, 89 (7) 1078-1087.
3. G. Zahedi, A. Lohi, K. A. Mahdi. Fuel Processing Technology,2011, 92 (9) 1725-1732.