НАУЧНАЯ СЕКЦИЯ «ИНФОРМАЦИОННЫЕ ТЕХНОЛОГИИ. ПРИБОРОСТРОЕНИЕ. РОБОТЕХНИКА. ИСКУССТВЕННЫЙ ИНТЕЛЛЕКТ»

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ABNORMAL CONDITION IDENTIFICATION MODELING BASED ON FUZZY BAYESIAN NETWORK AND TRANSFER LEARNING

Hui Li
Information Science and Engineering, Northeastern University, Shenyang, China
e-mail: lihui_neu@163.com

***Abstract**: The abnormal condition identification model is established based on the fuzzy Bayesian network and transfer learning for the electro-fused magnesia smelting process in this paper. The data processing problem is analyzed during the process of modeling and reasoning. The proposed method owns the better performance, which lays the better foundation for making effective safe control decisions.*

***Keywords:** Abnormal condition identification, fuzzy Bayesian network, electro-fused magnesium furnace, transfer learning.*

Introduction. The electro-fused magnesia is regarded as an important refractory, which has been applied in many areas. In China, the electro-fused magnesia is produced by the three-phase ac fused magnesium furnace (FMF) because of the low grade and the complex composition of the magnesite. Many related research results have been proposed about the FMF [1-6].

When the abnormal condition appears, it is necessary to take effective measures to identify the abnormity and remove it. The motivation is to decrease the energy consumption and avoid the damage on the equipment and the operators. In the papers [5,6], the abnormal condition identification models of three common abnormities have been established based on Bayesian network (BN) for the electro-fused magnesia smelting process. Moreover, based on the research results in the papers [5,6], the data processing problem during the process of modeling and reasoning will be analyzed in this paper. The abnormal condition identification modeling method based on fuzzy BN and transfer learning is provided.

Process description. The electro-fused magnesia smelting process is depicted in Fig. 1. In general, the smelting process mainly includes the following three operating conditions: heating and melting, feeding, and exhausting [1].

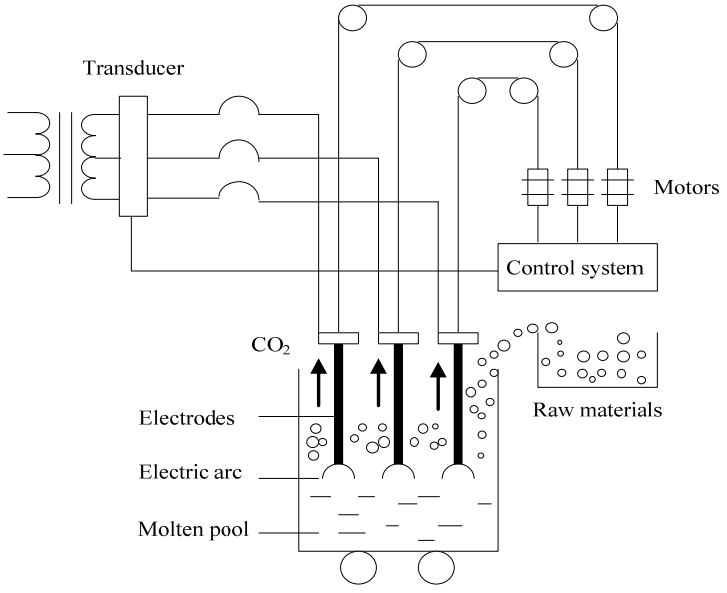

Figure 1 – The electro-fused magnesia smelting process

In this process, there are three types of common abnormal conditions: semimolten condition, overheating condition and abnormal exhausting condition. The specific electro-fused magnesia smelting process and the analysis on the abnormal conditions can refer the papers [1,5,6]. The established abnormal identification BN model can refer to the papers [5,6]. In this paper, we mainly explain the data processing problem during the process of modeling and reasoning.

Proposed method. For the BN modeling, the structure can be obtained by the expert knowledge, and the parameters need to be learned by the offline dataset. When the offline data is not sufficient, the established model will be inaccurate. For the single FMF, the data of the abnormal condition is very limited. Therefore, it is necessary to collect the abnormal condition datasets of the other FMFs in the same or similar factory to learn the BN parameters. By the thought of transfer learning, more abnormal condition datasets are used to establish the identification model, which makes the model more accurate.

For the BN reasoning, the abnormal condition identification result is obtained by the online reasoning. The collected data from the sensors are always continuous. When applying the BN model, the data needs to be discretized. The fuzzy set is the more reasonable way to deal with the online dataset. The abnormal phenomena variables are regarded as soft evidences to obtain the abnormal condition identification result by the fuzzy BN reasoning.

Results analysis. In this paper, the proposed method is verified on the simulation platform. The specific introduction on the simulation platform can refer to the papers [5,6]. Compared with the method in the paper [5], the proposed method in this paper owns the better performance. This method is more consistent with the operator experience, which lays the better foundation for making effective safe control decisions.

Conclusion. This paper develops the abnormal condition identification model based on fuzzy BN and transfer learning. The data processing problem is analyzed during the process of modeling and reasoning. The method provides the better decision support for the abnormal condition identification.

References

1. Zhiwei Wu, Yongjian Wu, Tianyou Chai, Jing Sun. Data-driven abnormal condition identification and self-healing control system for fused magnesium furnace. IEEE Transactions on industrial electronics, 2015, 62(3): 1703-1715.

2. Jie Yang, Tianyou Chai. Data-driven demand forecasting method for fused magnesium furnaces. the 12th World Congress on Intelligent Control and Automation (WCICA), Guilin, China, 2016, pp. 2015-2022.

3. Zhiwei Wu, Tianyou Chai, Yongjian Wu. A hybrid prediction model of energy consumption per ton for fused magnesia. Acta Automatica Sinica, 2013, 39(12): 2002-2011.

4. Zhiwei Wu, Tianyou Chai, Jing Sun. Intelligent operational feedback control for fused magnesium furnace, the 19th World Congress the International Federation of Automatic Control, Cape Town, South Africa, 2014, pp. 8516-8521.

5. Hui Li, Fuli Wang, Hongru Li. Abnormal condition identification for the electro-fused magnesia smelting process. IFAC-Papers OnLine, 2018, 51-18: 720-725.

6. Hui Li, Fuli Wang, Hongru Li. Abnormal condition identification and safe control scheme for the electro-fused magnesia smelting process. ISA transactions, 2018, 76: 178-187