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Process plant risk analysis and modelling

Jelenka Savkovic-Stevanovic

Department of Chemical Engineering , Faculty of Technology and Metallurgy, The University of Belgrade, Karnegijeva 4,11000 Belgrade, Serbia, E-mail: savkovic @tmf. bg.ac.yu

Abstract

A framework of fault troubleshooting system which including qualitative and quantitative reasoning was investigated. For accident detection the qualitative model is forecasted the future behavior of the system and then compared with actual measured data. A systematic cause event analysis was given the results which are summarized in the form of a diagnostic decision support model. As a case study the process separation of the prolyl-tRNK sintetase from Soya bean, Phaseolus aureus was used. It purpose is to discover and locate the disturbance or faults which could lead to accidental situations. The fault diagnosis model was derived. The obtained results indicate the influence of a single disturbance to registered symptoms, as well as to the safety of the whole plant.

Keywords: Prevention of accidental situation, correct hazard, model fault tree, faults diagnosis system

1. Introduction

Method for analyzing system safety and the synthesis methods for the construction of fault tolerant system are of elementary importance for the chemical and food industry. Process operation makes history database of manipulated and object variables, detect process disturbance before they cause significant disruption[1].
Risk system analysis including hazard identification, frequencies analysis, consequence analysis and hazard cost was investigated in papers [2-6].
In this paper process safety analysis of the plant for prolyl - tRNK sintetase

separation from Soya bean was derived. The obtained results demonstrated successful application dispersion network modelling in process risk analysis.

2. Process risk analysis

Despite increased concern and safety standards, accidental situations throughout the industry occur, influencing very often large environmental damage. Regardless weather the reason for accidents is human error or technical failure, it is necessary to take an action in order to prevent them.
Hazard identification methods can be used in different ways to model part of the incident scenario leading to a possible accident [3,4]. A systematic cause event analysis gives the results which are summarized in the form of the fault three model. It follows the structure of a generic fault tree point to the release of materials, chemicals and of an event tree from this point to the release on people, the plant and the environment.

3. Process safety model

Hazard identification method was used to model the incident scenario of a possible accident. Frequency and probability analysis involves frequency values of hazards, magnitude identification of each hazard and develop of sound criteria for quantification of logic tree by probability model [5,6].
So many accidents have been caused by operator's miss judgments or miss operation. There is a need to model a system which can also suggest appropriate action to taken when a hazard occurs. Process safety analysis begin with system definition. Definition includes system components, topology, input and output attributes, state variables, behavior rules and initial scenarios. Process safety analysis includes hazard identification, frequencies and probability analysis, consequence analysis and hazard cost analysis.

3.1. Fault diagnostic system modelling

Starting with the basic variables and their interrelations, the qualitative event model of the system can be formulated successively in the form of Boolean functions. The fault event of a system are generally in the first instance formulated in an IF …THEN form. This can be immediately reformulated using the operators AND, OR and NOT in Boolean form if one can assume that primary event have only two states: existence and non-existence.
The system can diagnose for causes of faults associated with state variables pressure, flow rate and temperature The qualitative variables are described in three discrete values (low, medium, high). For diminishing the losses, a systematic cause – event analysis was made and the results of this was summarized in the form of fault tree. The attributes of the model are chosen

to be pressure, supply, flow and resistance. Supply is described in two discrete values (present, absent).

Equipment state are described in qualitative term such as closed, open, failed, blocked and leak. The following blocks are considered: blockage (B), leakage (L), malfunction, or miss operation (M). The study of fault detection and diagnostic is concerned with designing system that can assist the human operator detecting and diagnosing equipment faults in order to present accidents.

Original model generates various scenarios. In the aim of the completion of the simulation runs, a resultant symptom scenario matrix is formed. The interpretation and presentation means monitoring system symptoms. In the symptom decomposition phase, the relational symptom/scenario matrix is decomposed by using a projection operation to produce elementary relations. This projection operation delineates which scenarios were found to have the same symptom values in their final state. Various scenarios of the process are considered. The implementing software for the studied case includes 70 scenarios and approximately 950 rules.

3.2. Case study

As a case study the Soya bean plant was examined. In order to study qualitative model building the process separation of the prolyl-tRNK sintetase from Soya bean, Phaseolus aureus was investigated. The process separation line for the enzyme prolyl-tRNK sintetase separation from Soya bean consists of a container for Soya bean, mill, exchanger, pumps, extraction tanks, tanks for acid, vessels and transporters as shown in Figure 1.

The study of fault detection and diagnostics of the Soya bean plant is concerned with designing a system that can assist a human operator in detecting and diagnosing equipment faults in order to prevent accidents.

3.3. Results & discussions

Model for risk analysis and prevention of accidental situation for investigated bean plant is realized through development of a logical frame and interface frame system equations (1). Its knowledge base is composed of information streams, and database of occurred symptoms and faults at a single unit.

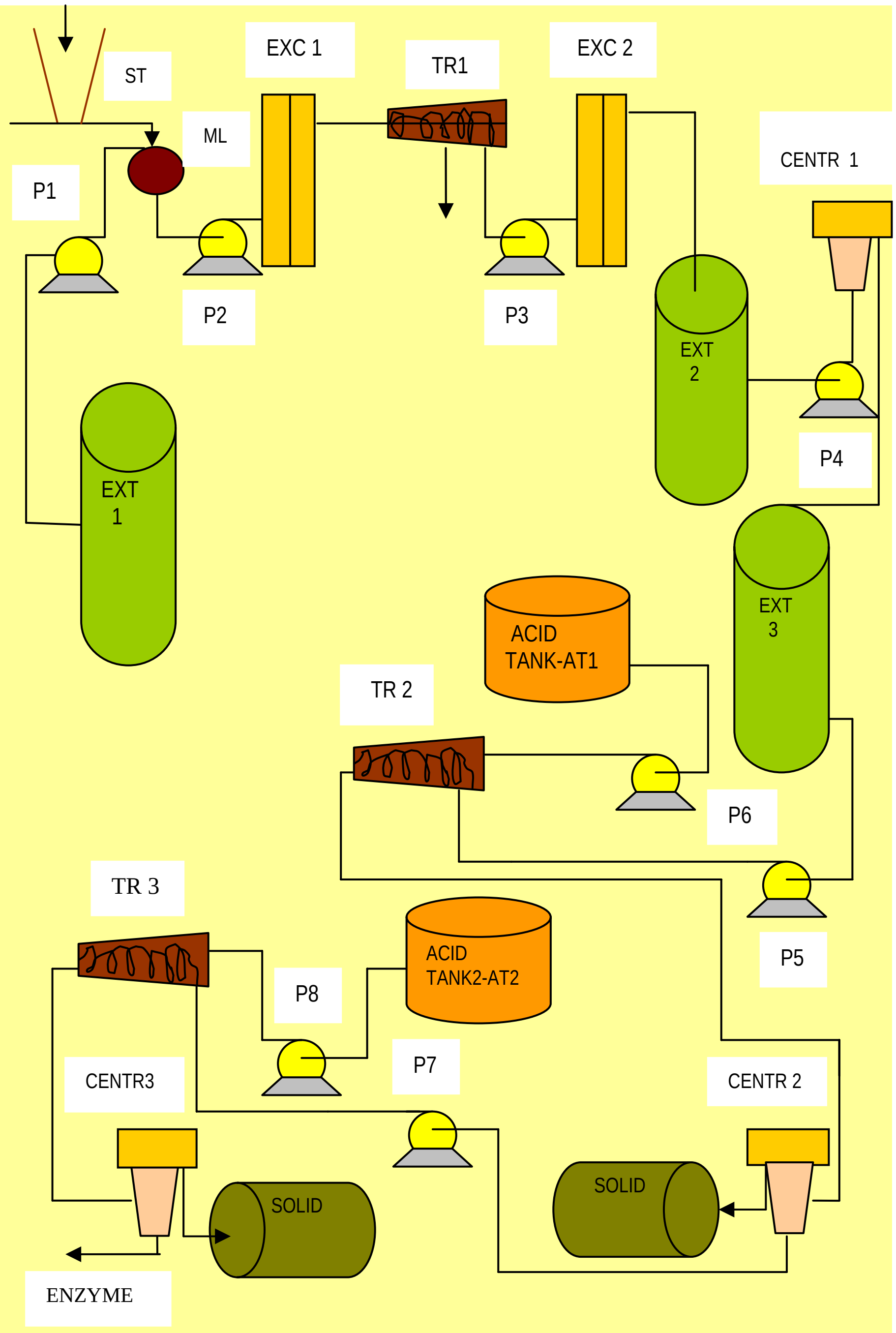

Figure 1. The enzyme extraction from Soya bean plant

HEAD=ENZYME
$ENZYME=B(CENTR3)\cup L(CENTR3)\cup CENTR3\cup TR3$
$CENTR3=B(CENTR3)\cup L(CENTR3)\cup M(CENTR3)$
$TR3=B(TR3)\cup L(TR3)\cup M(TR3)\cup P7\cup P8$
$P8=B(P8)\cup L(P8)\cup M(P8)\cup AT2$
$P7=B(P7)\cup L(P7)\cup M(P7)\cup CENTR2$
$AT2=B(AT2)\cup L(AT2)$
$CENTR2=B(CENTR2)\cup L(CENTR2)\cup M(CENTR2)\cup TR2$
$TR2=B(TR2)\cup L(TR2)\cup M(TR2)\cup P6\cup P5$
$P6=B(P6)\cup L(P(6)\cup M(P6)\cup AT1$
$AT1=B(AT1)\cup L(AT1)$
$P5=B(P5)\cup L(P5)\cup M(P5)\cup EXT3$
$EXT3=B(EXT3)\cup L(EXT3)\cup M(EXT3)\cup CENT1$
$CENTR1=B(CENTR1)\cup L(CENTR1)\cup M(CENTR1)\cup P4$
$P4=B(P4)\cup L(P4)\cup M(P4)\cup EXT2$
$EXT2=B(EXT2)\cup L(EXT2)\cup M(EXT2)\cup EXC2$
$EXC2= B(EXC2)\cup L(EXC2)\cup M(EXC2)\cup P3$
$P3=B(P3)\cup L(P3)\cup M(P3)\cup TR1$
$TR1=B(TR1)\cup L(TR1)\cup M(TR1)\cup EXC1$
$EXC1=B(EXC1)\cup L(EXC1)\cup M(EXC1)\cup P2$
$P2=B(P2)\cup L(P2)\cup M(P2)\cup ML$
$ML=B(ML)\cup L(ML)\cup M(ML)\cup ST\cup P1$
$ST=B(ST)\cup ABSENT\_Soya\_bean$
$P1=B(P1)\cup L(P1)\cup M(P1)\cup EXT1$
$EXT1=B(EXT1)\cup L(EXT1)\cup M(EXT1)$ (1)

PROLOG programming language was used for the development computer simulation model. Algorithm of the model execution is shown in Figure 2.

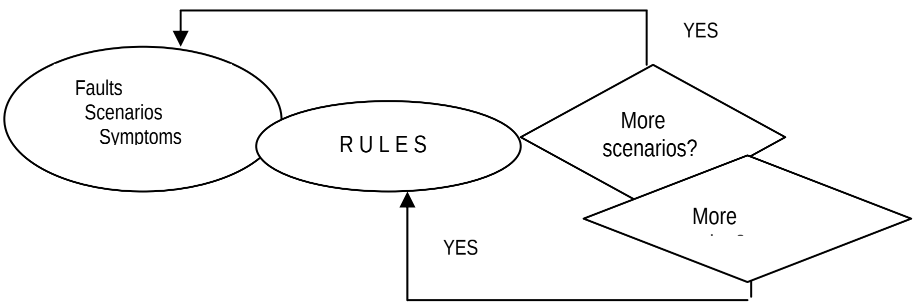

Figure 2. The fault diagnostic model executing

The cost fault assessment was obtained by substituting the Boolean variables with the appropriate event frequencies linking faults with costs. Fault occurring frequencies were estimated according to equation (2) and costs according to equations (3) and (4).

Middle frequency = Number of faults/ 10E04 hours (2)

Cost = (middle frequency) x (cost unit) (3)

and remediation cost R_C

$$R_C = a P^b x C^c \quad (4)$$

where *P* is middle frequency of the fault and *C* is cost the fault occuring, and *a*,*b* and *c* are parameters.

4. Conclusions

The obtained results indicate risk estimation for the Soya bean plant operation and design. This investigation show advantages for waste minimization.

In this paper dispersion modelling for troubleshooting system and formalizing hazard report as a learning tool were developed. Model for risk reduction analysis and prevention of accidental situation for the Soya bean plant is realized through development of a logical frame and acquisition frame. Its knowledge base is composed of information streams and databases of occurred symptoms and faults at a single units. It allows results can be used in concurrent systems in the other domain.

Acknowledgements

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