Expert System

Kesler Isoko
Department of Chemical and Biological Engineering
Universtiy of Sheffield
October 2021

Abstract

A semi-quantitative framework employed to examine risk within chemical process industries (CPI) was initially developed over 60 years ago and then formalised as HAZOP by Kletz (1983). Nevertheless, the need for automation was soon evident as Parmer and Lees (1987) explored HAZOP automation, pioneering a rule-based, qualitative reasoning approach to identify hazards. The tool was developed to address the strong dependence on experienced personnel to conduct adequate HAZOP studies, by facilitating the passage of key risk assessment information. Nowadays the advent of big data allows us to make more rigorous quantitative models, as such, a data driven approach to HAZOP Automation was developed to make use of the technology and allow the addition of new information to the study tool to fully augment the operations of the staff. The Expert System achieves the aforementioned objectives by connecting an Object Relational Model Database to a dynamic user interface through a RESTful API, allowing the user to perform statistical analysis such as regression and classification in order to make more site-specific models, guiding the user throughout the data collection stage and safeguard selection by suggesting relevant tests, providing functions to evaluate back of the envelope design calculations and suggest best practices for powder handling and powder explosion mitigation required to meet industry standards. Nonetheless, the software provides an algorithm to estimate risk quantitatively using Fault and Event Tree Analysis, of which architecture can be fully developed by the user, who can also manually describe each leaf of the tree to also model the process qualitatively. However, the tool provides an Expert System feature to perform a more traditional HAZOP automation as the user will be provided with a complete HAZOP study table once relevant information about the process are typed into an excel file allowing for a fast implementation of the framework or a first iteration of a more robust investigation aiding the user in all the aspects of the HAZOP study.

Key words: HAZOP, API, Fault tree, Event tree

I. Introduction

THE automated Hazop that are more commonly used measure disturbances in operation parameters by uising the data directly from the PID or a digraph version of the PID of the process in order to automatically generate an Hazop table that can then be manually managed and can enable automation of a LOPA accordingly. Nevertheless, for this project a new approach to Hazop automatioin was implemented as data was extracted from a fault or an event tree that was manually initialised by the user to generate an Hazop table containing the compiled information. This data-driven apporach is relatively less automated then the automated Hazop packages used in industry however it provides a wider range of tools to help the uer throught the Hazop study and more degrees of freedom for the process architecture as such helping the user to make the quantitative judgements that need to be made to compile a rigorous Hazop table.

II. Methods

To make the static webpage that was the previous iteration dynamic a flask application was developed using python.This provides all the funcitonality required to run a fully functioning web application as both the RESTful API and the SQL Database could both be developed uising flask.
Additionally, to integrate the previous backend to the new backend the built in os python package was implemented in order to launch comand line command from the script. As such the application will launch the backend when the sign EXpert System is clicked on the website.
Afterwards the different hubs such as:

- Explosions
- Console
- Tests

were compiled using the same base html file and added to the existing file in order to make the frontend. Once each moving part of the system was tested and fully functioning a logging python file was developed in order to provide the user information that can be used to make further customisations of the software and future improvements.

III. Results

In conclusion the current version of the Expert System is far from complete. Nevertheless, it could be a good minimum viable product as a proof of concept for this new aproach to hazop automation or it could used as the backbone of a more traditional Hazop automation software application that has the previous verion's functionality, a backend connected to a front end using an API and a unique database for equipment powder explosions and other scenarios that the user can visualise and update.