

# A Simple and Effective Method For the Use of Chemical Accident Cases

Sifeng.Jing<sup>1,2</sup> Xiwei.Liu<sup>1,2</sup>

1. Institute of Smart Education Systems,  
Qingdao Academy of Intelligent Industries  
2. The State Key Laboratory of Management and Control  
for Complex Systems  
Institute of Automation, Chinese Academy of Sciences  
Beijing, China  
[Sifeng.jing@ia.ac.cn](mailto:Sifeng.jing@ia.ac.cn)

Chuanzhong.Xu<sup>3</sup>

3. Refinery No.2  
PetroChina Fushun  
Petrochemical Company  
Fushun, China  
[Xcz-ye@petrochina.com.cn](mailto:Xcz-ye@petrochina.com.cn)

**Abstract**—past chemical industry accident cases include volume valuable information like precursor, equipment involved, relevant causes and experiences of emergence response. In-depth analysis and fully utilization of these information play an important decision-making role in controlling risk and enhancing safety performance in chemical industry. In this work, a survey of use of accident data is conducted around the world and the result shows that the detailed use of these information play an important role in preventing accidents. However, in china there much more needs to be done in the application of accident data. According to the needs of safety management of chemical plants, a simple and effective method of the use of chemical accident cases is proposed based on collecting and analyzing of a large number of chemical accident cases. And finally, a utilization system of chemical industry accident cases is implemented through Microsoft access 2010. The result shows that the system can realize the effective management and use of past chemical accident information.

**Keywords**—chemical accident cases; use of information; database; fuzzy query; chemical safety performance

## I. INTRODUCTION

The top three works described as follow are considered as main contributors to safety performance objectives according to safety managers in chemical process safety management practice. One is to identify the accident precursor information in advance to mitigate the risk and prevent accidents when installations are running. Two is to identify hazard elements and control the risk to prevent accidents before operations at chemical facilities. Three is to control the accidents timely, evacuate the worker to a safe place, reduce the secondary disaster, avoid future accident in the case of accident. This requires that all plant personnel have a great faculty of chemical technologies, operate under the provisions of production and have serious and responsible work attitude. However, it is not enough due to the uncertain and unpredictable behavior of accidents. A brief analysis of notable past process accidents was performed recently and the results show that both accident occurrences and their consequences are non-uniform [1]. Past chemical accidents include valuable information on precursor of accidents, relevant causes, equipment involved and experiences of emergency response.

So effective utilization of past accident information is essential to improve safety performance within an organization.

Adrian L.Sepeda [2] concluded the uses and benefits of process incident database, described the required attributes of database and discussed process safety incident database approach sponsored by the center for chemical process safety. Peter J.M.Sonnemans [3] investigated several accidents to examine the control mechanism inside organizations. The result validated the importance of the use of detailed accident information to prevent accidents through the elimination of disruptions preceding accidents. Dane Lukic [4] built on a conceptual framework for learning from incidents (LFI) by means of empirical data from two multinational corporations in the energy sector. And five important factors for LFI were obtained: participants of learning, type of incidents, learning process, type of knowledge and learning context. Anders Jacobson [5] proposed a method for evaluating the effectiveness of learning. The level of learning is expressed in terms of how broadly the lessons learned are applied geographically, how much organizational learning is involved and how long-lasting the effect of learning is. The method can give insights of aspects that influence the learning from incidents. Lyndsey Fyffe [6] illustrates the usefulness of chemical industry accident cases through the analysis of identified key issues. The themes include: design and engineering, standards, process hazard analysis, emergency planning and response, and hazard recognition. S.M.Tauseef [7] reviewed the limitations of existing past accidents databases to use for past accidents analysis relating to chemical process industry and developed a comprehensive open-source database to assist past accident analysis. Guizhen He [8] found that current chemical accidents-related data system in china is too fragmented and incomplete to support effective policy and decision-making on chemical risk and accident management and china lacks a coordinated and integrated chemical risk and accident information management system through reviewing and assessing the existing data sources and data management. Jinsong.Zhao[9] also reviewed the progress of lessons learned for process safety management in china , pointed out the opportunities for uptake of lessons learned are limited because most of the chemical accidents are not well-known and well-published in china. The research also identified inadequate

process hazard analysis, training and emergency response planning as the top three common causes of chemical accidents in China. And furthermore seven recommendations are proposed to improve the effectiveness of lesson learning for China government agencies and chemical enterprises. In view of this, an investigation of use of chemical industry accident data was made by visiting several Petrochemical enterprises. Conclusions is drawn as follow: 1) In practice, most chemical enterprises pay more attention to analyze and discuss new accidents in the whole organization and then disseminate the experiences and lessons from it to raise faculty personnel awareness of certain types of events with the hope of preventing similar events from occurring in the future. After that, an annual report of these accidents are compiled and stored in the form of documents and then are seldom used. 2) Currently, China National Petroleum Corporation (CNPC) and China Petrochemical Corporation (Sinopec Group) has HSE (Health Safety Environment) management system respectively. Both of the systems have the function of events management. But the system isn't open-source. Small and medium-sized enterprises have few similar event management systems. 3) The China chemical safety association (CCSA) own chemical accident database, in which the information is comprehensive. The database is publicly and freely accessible. But the information of it cannot be easily retrieved because the cases are stored by the PDF documents. So the volume valuable accidents information can't be effectively used in hazard identification, safety training, decision-making, technologies improvement and management innovation.

Therefore, the aim of this paper is to construct a data management system of accident and incident that have occurred in petrochemical industry in China. The system is a supplement to existing chemical accidents management system. The distinguishing features of it include information classification, fuzzy query and data analysis. Section 2 presents the method of utilization of chemical industry accident cases and describes the key work of system development. Section 3 shows the general situation of the above system implementation. Section 4 conclusions are drawn.

## II. METHOD OF THE USE OF CHEMICAL ACCIDENT DATA

In chemical safety management, relevant research has been doing [10-12] in our team based on parallel management theory [13-16]. Management level of chemical plant has been improved as the implementation of parallel management system in Qilu olefin plant of China Petrochemical Corporation.

Query is an essential function of any information systems. It is the fundamental of data analysis and use. This calls for good design of the database. Some work [17] had been done. However, several details need to be improved for efficient and effective utilization of chemical industry accident data. Therefore, an outline of system main function is drawn as Fig.1. System management includes user management, data maintenance and login system. The technology of these is modular. Here, these wouldn't be detailed described. Cases management includes data collection, data classification and data storage. These are the fundamental of the cases use. In this system, accidents were classified into serious accident,

ordinary accident and near-miss. Information Retrieval is the core of cases use. These two part works will be elaborately described in the following. Taking conciseness, compatibility and costs into consideration, the method is implemented in Microsoft access 2010 and several core applications can be achieved by the mean of visual basic for application.

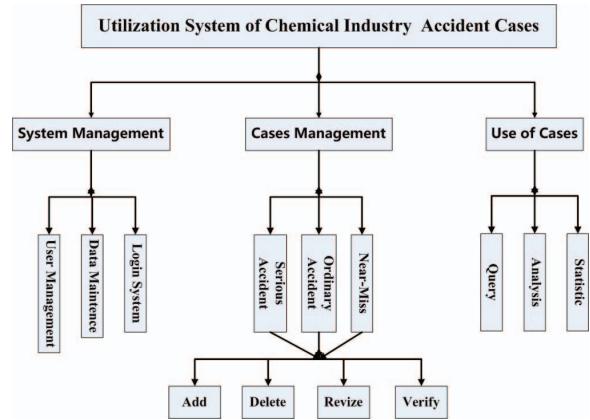


Fig.1 a schematic diagram of main function of system

### A. Fields

In the previous research [17], the entity-relationship (E-R) of the system has been proposed. In this work, several fields are adjusted after communication with workers, engineers, safety managers and production managers in workplaces of petrochemical enterprises. Directors of petrochemical plants pay more attention to the general situation of accidents, which includes economic loss, casualties, the underlying causes and management defects. Chemical engineers focus on risk elements caused accidents like production conditions (season, area, and environment), process technologies and relevant installations. Safety managers used to collect information on hazard factors of similar equipment and experiences of emergency response to similar accidents. Most workers want to obtain past risk factors relative to their unit. To meet these actual needs of plants, fields were selected based on analysis of a large number of accidents occurred in 2006-2015. Fields chosen are showed in table I .

### B. Tables

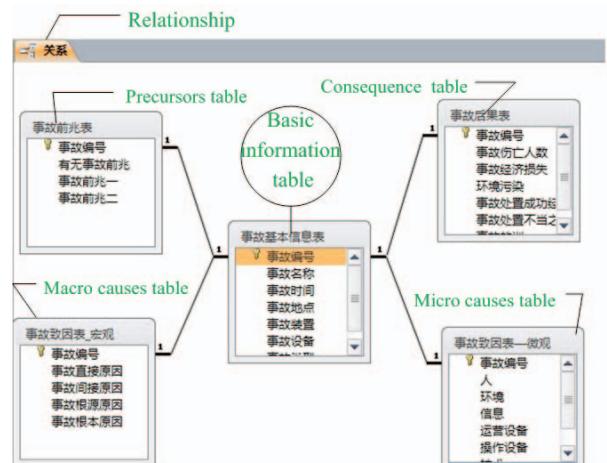


Fig.2 relationships between the 5 tables in the system

TABLE I. BASIC INFORMATION OF TABLES

Table	Name	Fields
1	Basic information table	<u>Serial number</u> , Name, Time, Plant, Address, Equipment, Relevant installation, Type, level of accident.
2	Precursors table	<u>Serial number</u> , Precursors of the accidents.
3	Consequence table	<u>Serial number</u> , Economic loss, Casualty.
4	Macro causes table	<u>Serial numbers</u> , Immediate causes, Indirect causes, Root causes, underlying causes.
5	Micro causes table	<u>Serial numbers</u> , Coordination between workers, Process Technologies, Installations, Management, Human factors, Environment factors.

According to the general design, an accident is classified into five sectors to store. These five sectors include basic information of accidents, precursor information, consequence information, macro causes information and micro causes information. Five tables were constructed as shown in TABLE 1. Serial number is chosen as the primary key. The relationships are formed according to the difference and relevance of the content of each table. In this work, the tables are interrelated as shown in Fig.2.

### C. Retrieval

The core function of the system is that needed information can be easily and quickly extracted. In this work, it is achieved by Microsoft ActiveX Data Objects (ADO), Visual Basic for Application (VBA) and Structured Query Language (SQL).The main framework of the program is described as follow:

```

Private Sub Command68_Click()
Dim rs0 As ADODB.Recordset
Dim cn0 As ADODB.Connection
Dim sql0 As String
Set rs0 = New ADODB.Recordset
Set cn0 = CurrentProject.Connection
Select Case Me.Combo64.Value ' selecting the keyword
Case "type of accident"
If IsNull(Me.Text66) Then
    MsgBox "please input the type, the type cannot be null
! ", vbOKOnly + vbCritical, "indicator"
Else
    Me.Text66.SetFocus
    sql0 = "SELECT basic information table. Serial number,
basic information table. Name, basic information table. Time,
basic information table. Address, basic information table.
Installation, basic information table. Equipment, basic
information table. Type FROM basic information table
WHERE (((basic information table. Type) Like "%" & Text66
& "%'))"
    Text66.Value = ""
    rs0.Open sql0, cn0, adOpenKeyset, adLockOptimistic,
adCmdText
    Debug.Print rs0.RecordCount
End If
End Sub

```

```

Set Me.Recordset = rs0
Me.Requery
rs0.Close
cn0.Close
Set rs0 = Nothing
Set cn0 = Nothing
End If.

```

Under this framework, the user's information needs are easily converted into the operation to databases and information retrieval becomes more flexible.

### III. SYSTEM DEMONSTRATION

After logging in to the system, the main form is presented in Fig.3. Through this interface, data operation of system can be carried out. The other two main function forms are shown in Fig.4 and Fig.5. Basic functions of the system are achieved through several commands like links between different form and Visual Basic Application code (query, add, delete, revise, verify). Take fuzzy query for example, after entering the system, query form in Fig.6. can be opened by "query" button in utilization of cases form in Fig.5. Fire-related accidents are shown in Fig.6 by choosing type of accident as keyword and fire as search item.



Fig.3. Main Form of the System—System Management

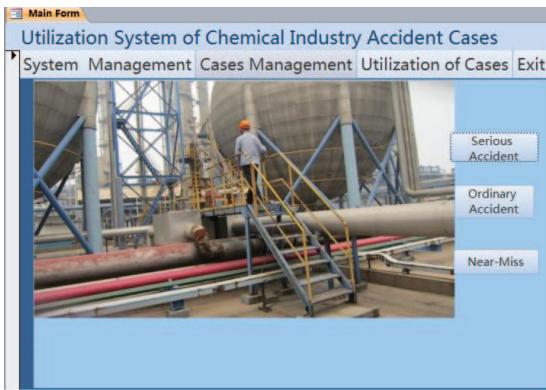


Fig.4. Main Form of the System—Cases Management

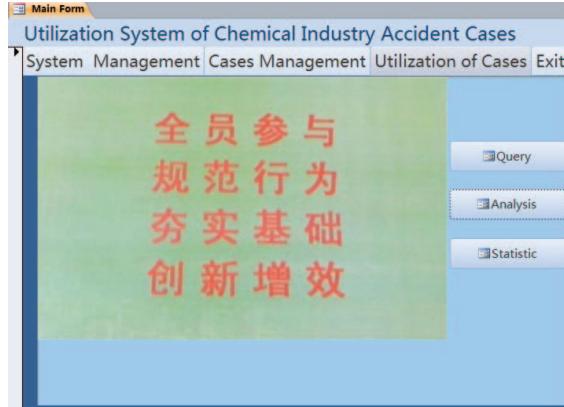


Fig.5. Main Form of the System—Utilization of Cases



Fig.6. Sub form of Query

#### IV. CONCLUSION

A simple and effective method for the use of chemical accident cases is proposed. Take in-depth analysis and fully use of accidents into consideration, serious attention has been given to selection of fields, design of tables and program of fuzzy query.

Based on the method proposed in this paper, an utilization system of chemical industry accident cases has been developed in Microsoft access 2010. A complete register of the latest accident information can be done timely through the system. A flexible query has been achieved by Microsoft ActiveX Data Objects (ADO), Visual Basic for Application (VBA) and Structured Query Language (SQL).

Directors of petrochemical enterprises can grasp the overall accident situation within the whole organization through the system and then they will identify safety problem and adjust management strategies. Process engineers can collect technologies factors triggered accident and analyze all factors in advance to structure preventive measure for similar event. Safety managers can choose the appropriate cases to enhance the emergency response ability of employees according to emergency response plan of the plant. Production monitor can make operation plan of a specific type of work or equipment based on the experiences and lessons from accidents in connection with it.

The implement and application of the system shows that the method for use of past chemical accidents is feasibility. Microsoft access is easy to learn and use for user and is low cost. The method is particularly suitable for small and medium chemical enterprises in improving their safety performances.

#### ACKNOWLEDGMENT

This work is supported by Natural Science Foundation of China Projects (71232006, 61233001 and 61533019). The Early Career Development Award of The State Key Laboratory of Management and Control for Complex Systems.

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