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Development of a new chemical process-industry accident database to assist in past accident analysis

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ABSTRACT

Past accident analysis (PAA) is one of the most potent and oft-used exercises for gaining insights into the reasons why accidents occur in chemical process industry (CPI) and the damage they cause. PAA provides invaluable 'wisdom of hindsight' with which strategies to prevent accidents or cushion the impact of inevitable accidents can be developed.

A number of databases maintain record of past accidents in CPI. The most comprehensive of the existing databases include Major Hazard Incident Data Service (MHIDAS), Major Accident Reporting System (MARS), and Failure and Accidents Technical Information Systems (FACTS). But each of these databases have some limitations. For example MHIDAS can be accessed only after paying a substantial fee. Moreover, as detailed in the paper, it is not infallible and has some inaccuracies. Other databases, besides having similar problems, are seldom confined to accidents in chemical process industries but also cover accidents from other domains such as nuclear power plants, construction industry, and natural disasters. This makes them difficult to use for PAA relating to CPI. Operational injuries not related to loss of containment, are also often included. Moreover, the detailing of events doesn't follow a consistent pattern or classification; a good deal of relevant information is either missing or is misclassified.

The present work is an attempt to develop a comprehensive open-source database to assist PAA. To this end, information on about 8000 accidents, available in different open-source clearing houses has been brought into a new database named by us PUPAD (Pondicherry University Process-industry Accident Database). Multiple and overlapping accident records have been carefully eliminated and a search engine has been developed for retrieval of the records on the basis of appropriate classification. PUPAD doesn't aim to replace or substitute the well established databases such as MHIDAS and MARS but, rather, aims to compliment them.

1. Introduction

One of the two pillars on which the edifice of process safety research and development stands is past accident analysis (PAA) – the other pillar being experimentation (Abdolhamidzadeh, Abbasi, Rashtchian, & Abbasi, 2010; Lees, 2005). But in contrast to most other branches of science and technology, wherein reproducible experiments provide the foundation for building, testing, and refining theoretical frameworks, there is very limited scope of conducting such experiments in the domain of accident forecasting and prevention.

This situation bestows great importance to PAA in chemical process industries (CPI). By careful reconstruction of events, and identifying their triggers, sequence, and their consequences, valuable wisdom of hindsight can be acquired with which pointers for developing accident prevention strategies can be drawn (Khan & Abbasi, 1998, 1999).

PAA also provides crucial insights with which findings of small-scale experiments can be extrapolated to real-life possibilities.

But PAA is easier said than done and there are several daunting problems associated with the task of obtaining records of past accidents (Abdolhamidzadeh et al., 2010). The more serious among them include;

a) lack of a proper mechanism of accident reporting and maintenance of records existing in many countries, especially so in the previous century;
b) intentional under-reporting of accidents by industries/governments to reduce or escape liability;
c) contradictory versions of what actually happened and the inability of post-mortems to resolve the uncertainty due to lack of unassailable evidence;

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d) inherent imprecision of a great deal of available records – for example fire and explosions are often recorded in generic sense and in many situations it is not possible to figure out the specific event type, and
e) unclear documentation of sequence of accidents in an episode.

Even in the case of accidents occurring in present times and in developed countries, doubts exist on the precise sequence and nature of events.

For example two major explosions occurred due to the derailment of a train carrying tank cars filled with LPG (liquefied petroleum gas) at Viareggio, Italy, on June 29, 2009 (Brambilla & Manca, 2010; Manca & Brambilla, 2010). But whether both explosions were independent of each other, or whether one explosion led to the other, is not known because both explosions occurred very close to each other in time and space.

Likewise it is uncertain as to exactly how many explosions accompanied the major fire that had occurred in the refinery of Indian Oil Corporation (IOC) at Jaipur on October 29, 2009 (Wikipedia, 2009). Interestingly the Jaipur event was telecast live from the point the fire began to rage to the point it subsided several days later. Yet the exact cause of the accident and its initial sequence remains a matter of some conjecture. Whether the worst-ever process-industry disaster – the Bhopal gas tragedy – was the result of a sabotage or an inadvertent mistake is still mired in controversy (Abbasi & Abbasi, 2005; Lees, 2005).

Even in the case of the Flixborough disaster – which is one of the most extensively post-mortemed of all process safety accidents – opinions differ to this day as to what had exactly happened. A Court of Inquiry, which had gone into great details on the basis of all available evidence, had given its report some years back. But process safety experts continue to question its conclusions. For example Venart (2007) has rebutted nearly all of the widely accepted findings of the Court.

Notwithstanding these problems associated with PAA, PAA remains the biggest source of wisdom for process safety professionals. It is, therefore, very important that in future efforts should be made by all concerned to ensure proper and complete documentation of accidents which occur in process industries. But, whereas it may be possible to achieve this objective in the developed countries and in the relatively better-off developing countries like India and China, it is unlikely to be achieved by several other countries besieged with economic and political crises. So, at global level, uncertainties are likely to remain in the foreseeable future.

For the past, especially, we have to make do with whatever has been documented and learn to minimize the uncertainty associated with the past records by seeking corroborative evidence from multiple sources.

2. The PUPAD database

In an attempt at improving the situation the authors have developed an open-access database named Pondicherry University Process-industry Accident Database (PUPAD). To put PUPAD in perspective it may be pertinent to look at the strengths and weaknesses of existing databases.

Among the most well-known among paid databases is MHIDAS. Most researchers doing PAA rely on MHIDAS (Carol, Vilchez, & Casal, 2002; Clini, Darbra, & Casal, 2010; Gerboni & Salvador, 2009; Gomez-Mares, Zarate, & Casal, 2008; Guo, 2002; Montiel, Vílchez, Arnaldos, & Casal, 1996; Planas-Cuchi, Montiel, & Casal, 1997; Renni, Krausmann, & Cozzani, 2010). But despite being quite extensive MHIDAS is far from totally authentic, comprehensive, or accurate. In the course of developing inventories of BLEVE accidents and dust explosions (Abbasi & Abbasi, 2007a, 2007b, 2007c, 2008) we had found that several incidents were either not picked up by MHIDAS or had been misclassified. For example Hauptmann (2010) reports BLEVE events which are not covered by MHIDAS (Table 1).

MHIDAS has also misclassified the train accident in Cairo which had begun with an LPG cylinder undergoing BLEVE (Wikipedia, 2010). It was an explosion which set off a fire but MHIDAS has put it under 'fire'.

Likewise the LPG tanker BLEVE that had occurred at Treviso, Italy, in 1996 (Zenier, Antonello, Dattilo, & Rosa, 2001) has been recorded as 'release and explosion' which leaves the nature of the explosion unspecified.

Elsewhere the same BLEVE event that had occurred at Clymers, USA on 18/02/1999 (NTSB, 2001) has been recorded twice in MHIDAS!

For an estimated one third of all accidents included in MHIDAS, the cause of accident has not been given.

Hence we decided to look beyond established databases such as MHIDAS, to tap the various open-access databases that exist. The objective is not to find an alternative to established databases such as MHIDAS but, rather, develop a compendium which can be used along with the established databases to minimize the errors that occur if we depend solely on the pre-existing databases.

To feed PUPAD, data has been acquired from numerous open sources (Fig. 1). Most of these sources do not contain records of only process safety accidents but also cover various other types of accidents like kitchen fires, occupational injuries not related to loss of confinement, accidents in locations other than process industries, etc. The mass of data has been carefully sifted to pick up accidents relevant to CPI. This has led to over 8000 items of information now enshrined in PUPAD.

After carefully eliminating multiple counting, the data has been fed into the PUPAD software developed by us with which to retrieve and use the information and to also continuously update it. The distinguishing features of the software are:

1. The database has three main branches: mainland accidents, accidents in offshore fixed facilities, and accidents in offshore floating facilities.
2. The search engine (retrieval program) reads the data into the program and allows the user to interactively do the search using different filters or search criteria.
3. The user can customize the output by selecting the fields to be displayed and saved for further analysis.

The information contained in PUPAD covers the following aspects:

2.1. Type of accident

- Fire
- Explosion

Table 1
Major BLEVE events not covered in MHIDAS.

Date of accident	Location	Material involved	Casualties	Source
July 30th, 2004	Ghislenghien, Belgium	LNG	23 Died, 200 injured	Hauptmann (2010)
May 7th, 2007	L'Ain (France)	LPG	Nil but widespread destruction	Hauptmann (2010)