

Full Length Research Paper

Safety analysis on hazardous chemicals transportation by Indian roads

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In engineering industries, necessary safety measures during manufacturing, storage and loading of the chemicals which are dangerous in nature, also known as hazardous chemicals are generally taken. There are means to monitor and control the same, but once the product vehicle is loaded and leaves the plant premises, there is hardly any control over it. The safety of it largely depends on the condition of vehicles and the quality of driver. In this paper, the possible situations creating accidents are discussed and the safety prevention methods are explained.

Key words: Accidents, hazardous chemicals, protection, safety, transportation.

INTRODUCTION

Safety during chemicals transportation is extremely important as it involves the risk of injury or loss to public and/or crew, Environmental pollution, Economic loss and of company image loss, etc. In India, the risk from hazardous chemicals transport is even greater due to ignorance in general, lack of education and training of crew, poor condition of roads and vehicles, lack of amenities to crew and is further compounded due to inadequate concern by the consigner, the consignee, the transport contractor and the transport department authorities. In this study, details of various accidents that had happened due to hazardous chemicals in south India have been studied. Action taken for improving safety in transportation of chemicals, safety rules for transportation of hazardous substances and other relevant legislations in India are mentioned for maintaining safe transportation

of hazardous chemicals in the Indian engineering industries. In India the products are mostly transported by road, hence this study is restricted to the transportation of hazardous chemicals by road.

ACCIDENT ANALYSIS

The major types of accidents during the handling of the hazardous substances are process and storage plant accidents, accidents in waste storage area, accident due to transportation and improper handling of hazardous materials during loading or unloading. The eight causes for accidents are mechanical failure, impact, human factors, instrument failure, service failure, violent reaction, external events and upset process conditions. Scientific

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Table 1. Number of Accidents due to hazardous chemicals during the period of April 2011 to March 2012.

| Month | Accidents due to solid chemicals | Accidents due to oil usage | Accidents due to gaseous substances |
|----------------|----------------------------------|----------------------------|-------------------------------------|
| April 2011 | 7 | Nil | Nil |
| May 2011 | 7 | 2 | Nil |
| June 2011 | 2 | Nil | Nil |
| July 2011 | Nil | 1 | Nil |
| August 2011 | 16 | 1 | Nil |
| September 2011 | Nil | Nil | 1 |
| October 2011 | 2 | Nil | Nil |
| November 2011 | 1 | Nil | Nil |
| December 2011 | 7 | Nil | Nil |
| January 2012 | Nil | 6 | Nil |
| February 2012 | Nil | Nil | Nil |
| March 2012 | 11 | Nil | Nil |

handling methods of chemicals are always practiced in large industrial units, but the information on such aspects is not readily available and accessible to people working in medium and small scale chemical industries. Unless the workmen know the properties of the chemical and take adequate precaution while handling them, they will be affected by the ill effect of chemicals. So knowledge of hazards to prevent occupational illness is thus of great importance.

Major accidents in South India

Wanda et al. (2004) mentioned in their paper that, 21% of chemical accidents are happening during transportation and the other accident causes involving 39% for equipment failure and 33% for human error. Fabiano et al. (2005) indicated the main areas where the accidents can occur during the road transportation. They are; tunnels bend radii, height gradient, slope, traffic frequency of tank truck, dangerous good truck and other critical areas. Weili et al. (2011) discussed in their paper about the causes and environmental issues of various hazardous chemical accidents in China between 2000 and 2006. During that period most of the accidents had happened by the petroleum and chemical explosives. The details of various accidents that have happened due to hazardous chemicals in south India has been shown in Table 1.

In view of large potential for accidents involving vehicles carrying hazardous chemicals there is lot of scope for improving the quality of vehicles used for transporting chemicals and drivers and also the quality of roads, highways and amenities for the crew members. Chunyang et al. (2004) stated that most of the accidents occur by human error and equipment failure. In the daily life many explosive flammable and toxic substance goods are more dangers hazards when they release improperly. The intimation must be sent to the rescue persons from environmental protection agencies, police and fire

departments, poison control centers, hospitals, local media, and other rescue officials immediately in the accident happens.

Safety rules for transportation of hazardous materials

Chee Beng and Chi Bun (1995) explained the safety methods for transport the liquid petroleum gases in the Singapore road ways. In India motor vehicle act is a central act applicable throughout the country. Motor vehicles department in India (<http://morth.nic.in/> accessed on 10.08.2013) has prescribed the various Central Motor Vehicle (CMV) rules for hazardous chemical transportation throughout India as mentioned thus.

Safety rules for display labels

CMV rule 137 contains the description of class labels according to the nature of dangerous goods. It further describes the indicative criteria for toxic inflammable chemicals and explosives along with a list of hazardous and toxic chemicals. The CMV rule 129 stipulates the display of distinct mark of the class label to the type of dangerous or hazardous goods as specified in CMV rule 137, and makes it mandatory for every hazardous material carrier to be fitted with appropriate safety devices, including techograph. The CMV rule 129A makes it essential for every hazardous material carrier to be fitted with a spark arrestor as specified by the Bureau of Indian Standards. The CMV rule 130 delineates the manner of display of appropriate class labels on hazardous material carriers. It also specifies the size of letter and placement of class labels on such carrier.

Safety rules for human responsibilities

Jie et al. (2010) noted that, high speeding in the road traffic and the presence of heavily populated residential

areas near the road are the dangerous environments may cause the accidents during hazardous chemical transportation. The CMV rule 131 indicated that, the responsibility of the consigner is to have appropriate permit to transport such hazardous goods and to ensure that the owner or transporter and driver one supplied with full and adequate information about the hazardous material being transported and the CMV rule 132 mentioned that, it should be the responsibility of the owner or transporters to ensure that, besides valid registration and permit; the vehicle is safe to transport such hazardous goods and is provided with adequate safety equipments and devices. He should also ensure that the driver being deputed for transportation is trained to handle and transport such hazardous materials and has been provided adequate and correct information, so as to enable him in comply with various safety rules and regulations, as prescribed.

Quarantelli (1991) has mentioned the importance of the emergency response and the problems in planning to the safe transportation of the hazardous chemicals. Tremcard (Transport Emergency Card) is an important document containing details to the driver to transporting hazardous goods in Indian roads. The CMV rule 133 explained that, the major responsibility of the driver is to keep of information provided to him in Tremcard and that to be kept in the drivers cabin also is available at all times while hazardous material related to it is being transported. It is essential for every hazardous material carrier to display correctly the Engineering Information Panel in the format and at places specified under the CMV rule 134, and that it is kept free and clean from obstructions at all times. The owner or transporter of hazardous goods carrier will ensure, to the satisfaction of the consigner that the driver has been provided adequate instructions and training for safe transportation of hazardous material being carried by him as mentioned in CMV rule 135. CMV rule 136 indicates that, it should be the duty of the driver to report to the nearest police station and also to the owner, about the occurrence of accident during transportation of hazardous goods (Figure 1).

Steps to be taken for improving safety in transportation of chemicals

Juan et al. (1995) indicated the seven different classifications of hazardous chemical accidents are; process plant, storage plant, transportation, loading and unloading, waste storage, domestic or commercial and warehouse accidents. Planas et al. (2008) mentioned in their paper about the responsibilities of the owner and driver of the vehicles transporting the hazardous chemicals. As per his statement, the vehicle owner is the one responsible for providing all of the systems for transporting the hazardous chemicals safely. System

administrator has to maintain the system properly. The driver is the one to drive the vehicle from the origin to the destination of the goods according to the pre-planned route. The vehicle must carry all of the safety systems like sensors to find out the position of the vehicle. Tremcards in different languages are to be published for all products, by-products and even for the imported raw materials, which are required to be transported by road, similarly, the instructions to drivers and cleaners in different languages are to be published. The appropriate emergency information is displayed on all the vehicles transporting chemicals. Self adhesive stickers are to be kept ready for correcting, if necessary, the emergency information panels on the customer's vehicles when they arrive for loading. A painter should be available to paint the emergency information panels on the customers vehicles is required.

Fitness of vehicle and crew members

In order to ensure the good condition of vehicle and the safety of crew members, the following points need to be checked each time a vehicle reports for loading, which include valid driving licence, condition of the vehicle, fire extinguishers, statutory documents like licence from the inspector of explosives and insurance, instruments and fittings like pressure gauge, rota gauge, temperature indicator and relief valve, protection of fittings against accidental damage, proper emergency information panels, tallying of gross and tare weights painted on the vehicles with the corresponding figures in the permit, availability of appropriate printed instructions to drivers and cleaners and the Tremcard, availability of wheel checks, any source of ignition like lighted agarbatti, cigarette etc., random breath analysis of drivers to check alcohol consumption and availability of tool box, emergency light or battery torch, personal protective equipment, eye-wash bottle and first aid box. Though some regular contractors provide the necessary personal protective equipments like polyvinyl chloride gloves, safety goggles, etc. most of the customers hired vehicles do not have these personal protective equipments. In each case the required personal protective equipments are to be provided at the loading station. For certain products like benzene, the breathing apparatus should also be provided.

Qualification of crew and special training

Kevin et al. (2003) noted in their paper that, many explosive flammables are dangerous when they release improperly and they create great challenge to the environmental pollution. Crew members engaged in transportation of hazardous chemicals must have a certain minimum level of education. Arrangements should

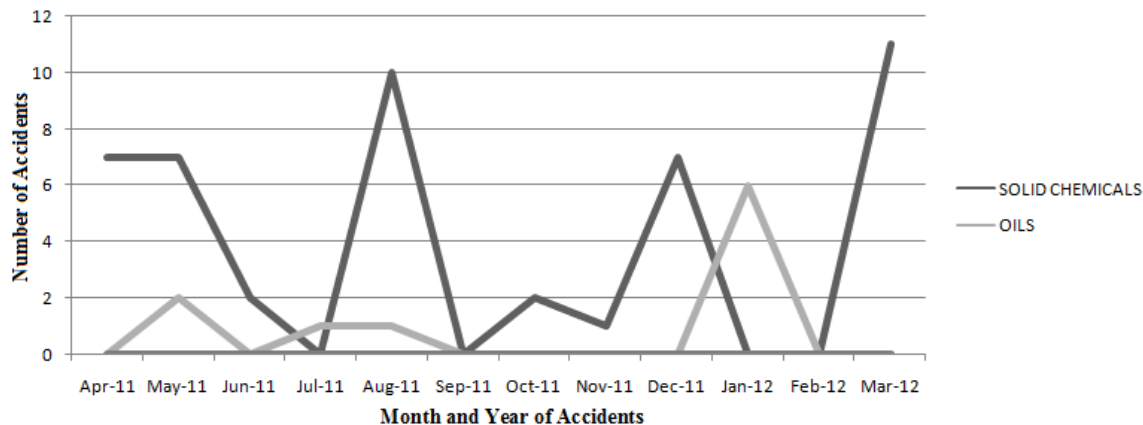


Figure 1. Hazardous chemical accidents level during the period of April 2011 to May 2012.

be made for imparting special training in transportation of hazardous chemicals by road and it should be endorsed in their driving licence or a special licence or certificate should be issued to the trained drivers. Also, the motor vehicles rules should be complied with so as to permit only specially trained drivers, who possess valid special licence or certificates to drive the vehicles carrying hazardous chemicals. These drivers should also be given a periodic refresher course.

The transport contractors should collect the drivers and cleaners who are literate and physically fit. The training programmes are to be conducted for all the product drivers once in every six month, including defensive driving techniques, prescribed routes and prohibited routes, emergency procedures, emergency communication, hazards associated with various chemicals, emergency action code, use of fire extinguishers, loading and unloading procedures, general knowledge of the customers facilities, general inspection of the vehicles, minor repairs of the vehicle, maintaining proper logs, and preparing accident report. Tom et al. (2000) indicated that in common road way the accident can initiate by the major reasons like high volume or road traffic and the presence of populous residential areas. The bypass ways have to be used for chemical transportation by the hazardous chemical transporters.

Safety actions

Ren et al. (2012) mentioned that, hazardous chemical accidents in roads are main issues for public safety. Samuel et al. (2009) also noted the same in their paper and they indicated that, the quick response from the accident area to the rescue personals is very important to solve the problem easily and to reduce human death. For every 3 to 5 km, telephone facility should be made available along all the national highways to enable one to contact the nearest emergency control centre to obtain

help promptly or to contact the local police, fire brigade or consigner in the event of an emergency. Prompt penal action should be taken against offending drivers. There should be a deterrent fine for driving without proper licence, driving without lights or with only one headlight at night, using worn out or damaged tyres, overloading or improper loading, carrying passengers on vehicles transporting chemicals and breakdown of vehicles on road because of poor maintenance. Automatic speed monitors (doppler readers) with the television camera, video monitor and recorder should be installed on highways to deter drivers from over-speeding. Also, installation of techograph should be made compulsory on all vehicles carrying hazardous chemicals; this will monitor the driver's performance.

Conclusion

Most of the chemical accidents that happened in south India is because of the careless mistakes and improper handling of materials. The transport contractors are required to check their vehicles thoroughly and issue a 'certificate of fitness' for each vehicle once a month to prevent the accident during hazardous chemical transportation. A sincere joint effort by the industry, the transport contractors and the concerned authorities can surely contribute to bring substantial improvements in all the aspects of road safety and drastically reduce the number of road accidents involving vehicles carrying hazardous chemicals, thereby reducing human suffering and economic loss. Finally, the crew members themselves can contribute a lot by increasing their awareness of the hazards and training.

Conflict of Interest

The authors have not declared any conflict of interest.

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