Safe Transportation of Intermediate Chemicals in Chemical Industry

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Abstract— Transportation plays vital role in supply chain management system or logistic. Logistic is one of the strongest pillar of any country in view of its economy and rapid industrialization. Transportation of hazardous chemical is one of the burning subject for many researchers. Many researchers have studied on transportation and vehicle routing problems. Causalities due to the accidents caused by trucks carrying hazardous materials will be intolerable. There are many strict compliance regulation for transportation of hazardous chemical are monitored by authorized government agency. Transportation of intermediate chemical is one of the upcoming rapid issue evolving from the various chemical industries. A Intermediate compound or chemical is one of any chemical family that has never been tested in animals; or is in preliminary stages of animal testing. Intermediate chemical status affects the evaluation of a compound for potential for adverse side effects and the animal monitoring intensity level. This research paper enable us to develop safe work practices regarding safe transportation of intermediate chemical. In this article one of intermediate chemical which is derivative of additive material has been taken into the account and all the preventive measures for transportation through the road have been explained after incorporating all the applicable rules and regulations.

Keywords: Transportation of Hazardous Chemical, Intermediate Chemical, Chemical Industry

I. INTRODUCTION

Hazardous chemicals are substances, mixtures and articles that can pose a significant risk to health and safety if not managed correctly. They may have health hazards, physical hazards or both. Transportation of hazardous chemicals are well defined in structured manner for example if chemical is to be transported through the road then the international or local rules like central motor vehicle will be applicable, if chemicals is to be transported through the marine or ship then International Maritime Dangerous Goods Code will be applicable and if hazardous material is to be transported through the air way then International Air Transport Association where as there is no specific unique guideline for intermediate drug or chemicals has been published for transportation of intermediate chemicals. As per the united nation directive all the chemical have been categorized into the 9 categories based on their hazardous chemical properties as follows.

1) Explosive substances
2) Compressed Gases
3) Flammable liquid
4) Flammable solids
5) Oxidizer substances
6) Toxic substances
7) Radioactive substances
8) Corrosive substances
9) Miscellaneous substances.

II. METHODOLOGY

A qualitative approach has been adopted for formulation of complete journey starts from the dispatch of material from the warehouse to the receiving destination. This methodology has been formulated in view of transportation of intermediate chemical through "Road" only, rest of other median like air and marine can be assessed later. Following below steps have taken into the account for formulation of safe journey of intermediate chemical via road.

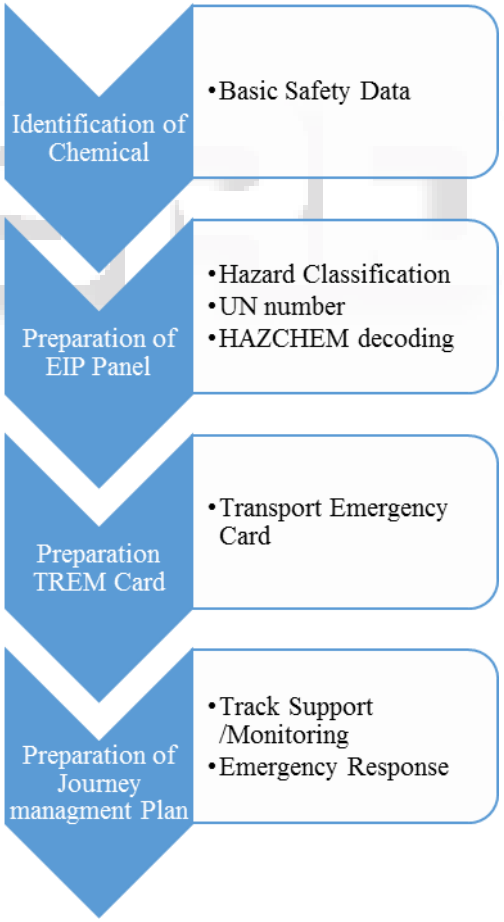

Fig. 2.1: Process for Safe Transportation of Hazardous Chemicals

A. Step-1- Identification of chemical

Identification of chemicals means the basic safety data of particular chemical must be available with the warehouse designee or consignor. This basic safety data must include or

either safety data sheet or material safety data sheet can also be referred.

1) Identification of chemical
2) Hazard identification
3) Composition
4) First Aid measures
5) Firefighting measures
6) Accidental release measures
7) Handling & Storage
8) Exposure control/PPE
9) Physical & Chemical Properties.
10) Stability & Reactivity
11) Toxicological Information (If available)

B. Step-2- Preparation of EIP panel

EIP panel means emergency information panel which must be displayed at all the three sides which is mandatory requirement of central motor vehicle act. For preparation of EIP panel following information needs to be furnished.

1) Hazard Classification- Classification of hazardous material will be based on the section "b & i" of step no. 1 of relevant MSDS.

Fig. 2.2: Example of Hazardous Chemicals

2) UN Number- A UN number (United Nations number) is a four-digit number that identifies hazardous materials, and articles (such as explosives, flammable liquids, oxidizers, toxic liquids, etc.) in the framework of international transport. Some hazardous substances have their own UN numbers (e.g. acrylamide has UN 2074), while sometimes groups of chemicals or products with similar properties receive a common UN number (e.g. flammable liquids, not otherwise specified, have UN 1993). A guideline called ADR represent UN number for all the commercial and identified chemicals. ADR means ADR is the European agreement concerning the international transport of Dangerous Goods by Road (ADR) e.g.

UN Number	Name & Description	Hazard Class
1993	Flammable	3
3286	Flammable, Toxic & Corrosive	3, 6, 8
1992	Flammable & Toxic	3, 6
3290	Toxic & Corrosive	6, 8
3288	Toxic	6
1760	Corrosive	8
2920	Flammable & Corrosive	3, 8
NA	Non Hazardous	9

Table 2.1: UN Number and Hazard Class

3) HAZCHEM decoding- The HAZCHEM code (also called Emergency Action Code) gives vital information to fire brigade and other emergency services on the action to be taken to combat spillage, leakage or fire in an emergency involving a hazardous substance.

The number in the first part of the code indicates the equipment suitable for fire fighting and, where appropriate, for dispersing spillages of dangerous goods as follows:

1- Water Jets	2- Fog	3- Foam	4- Dry Agent
Category	Violence	Protection	Substance Control
P	V	Full	Dilute
R			
S	V	BA	
S		BA for Fire Only	
T		BA	
T		BA for Fire Only	
W	V	Full	Contain
X			
Y	V	BA	
Y		BA for Fire Only	
Z		BA	
Z		BA for Fire Only	
E	Consider Evacuation		

Table 2.2: HAZCHEM Decoding

HAZCHEM code consists of a number i.e. 1 to 4 followed by an alphabet from the chart. Sometimes these code is of three characters and the 3rd one is E

a) Numbers:
   1) Water jets
   2) Fog
   3) Foam
   4) Dry Agent

b) Alphabets:
   1) P R S T – Material needs to be Diluted
   2) W X Y Z – Material needs to be Contained
   3) V – Can be violently or can be explosively reactive
   4) E – Consider evacuation as first priority

c) Substance Control:
   1) Dilute – Dilute means, spilled chemical can be wash and reduce the concentration of chemical
   2) Contained – It should be prevented to get into the drain pipes or water channels. The alphabet shown in black background with white font represents there is a danger of violent reaction or explosion. See the below-attached photo for details.

S	Possibility of Violent reaction + BA for fire + Spillage to be Dilute
T	No Possibility of Violent reaction + BA for fire + Spillage to be Dilute
Y	Possibility of Violent reaction + BA for fire + Spillage to be Contain
Z	No Possibility of Violent reaction + BA for fire + Spillage to be Contain

Table 2.3: HAZCHEM Decoding Details

1) Full – Full represents full-body protection is required along with breathing apparatus
2) BA – BA stands for breathing apparatus
3) BA for fire only – It represent that breathing apparatus is required in case of fire only.

Example

Hazchem code of sulphuric acid is 2P Here, 2P represent; 2 i.e. we need to use Fog as a fire fighting mode and P represent that it can be violently reactive hence Full body protection along with breathing apparatus is required. Spillage can be diluted and washed with water.

C. Step-3- Preparation of Transport Emergency Card

Transport Emergency Cards (TREM Cards) are cards that workers carry at all times when their work involves transporting hazardous wastes. These cards are provided by the occupier or operator of a facility and must be kept in the cab of any vehicle transporting dangerous goods, unless they are in sufficiently low quantities.

TREM Cards carry information about the particular goods being transported and provide instructions to the driver or emergency responders in the event of an incident.

TREM CARD
Name of Chemical
4-methyl-2(2,2,2-trifluoro-1,1,1-dimethyl-ethyl)-pyridine
Hazardous Information

First Aid Measures
General advice Consult a physician. **If inhaled** If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician. In case of skin contact Wash off with soap and plenty of water. Consult a physician. In case of eye contact Flush eyes with water as a precaution. If swallowed Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.
Fire Fighting Measures
Suitable extinguishing media Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
Accident Release Measures
Use personal protective equipment. Avoid dust formation. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Avoid breathing dust.
Contact In case of emergency
BARELOCHER LIMITED., DEWAS-455001, MADHYA PRADESH POLICE-100, FIRE BRIGADE-101

Fig. 2.3: TREM Card

D. Step-4- Preparation of Journey Management Plan

The journey management plan shall be prepared. The plan contains up to date details of internal contact details for plant key personnel, journey route from where material is dispatch to till arrival of material, national highway aid service like fire brigade, hospitals etc. Journey management plan also consist of emergency organogram who has to act in case of emergency occurs at highway or road and how to tackle the emergency within minimum time of response.

III. PLANT DESCRIPTION

All the transportation regulations code have similar categorization of hazardous chemical but safety precaution while transportation will be different based on the circumstances of event. The Baerlocher Group is a leading manufacturer of additives for the plastics industry. Its portfolio includes a broad range of stabilizers and other additives suitable for all polymer applications. Baerlocher has a strong focus on customer and employee needs and is highly committed to innovation and sustainability. Its pioneering and proactive role is underlined by the support provided to the PVC industry during the transition from lead- to calcium-based stabilizers and by its innovative lubricant systems for wood plastic composites. Baerlocher started its operation in India with the acquisition of a running polymer additive unit of National Peroxide Limited located at Dewas in Madhya Pradesh. After take-over of the unit, it has implemented modernization-cum-expansion programs from time to time. As a result, the production capacity has increased from 4,000 MTPA in the year 2000 to the present level of 30,000 MTPA.

Baerlocher India has been growing consistently over the years by earning the confidence of customers in its products and services. Dewas plant of Barlocher ltd. consumed various types of chemicals which are in hazardous nature. Most of the raw material are identified and commercially available in the market and adequate safety information is available for safe handling of those chemicals. Barelocher has their own R&D centre and having more than 12 intermediate patented adhesive chemical which they again used as raw material to get the final adhesive material. However basic safety data for theses intermediate chemicals are available with the Barelocher team. The main objective of this literature is to provide adequate information and process flow for transportation of intermediate chemical. Contribution of this literature is not limited up to the adhesive manufacturer company it can be utilized for chemical company, agro chemical, pharmaceutical, polymer and petrochemicals where all the intermediates and in process chemicals still are unaware about their actual hazardous properties. This study has been performed on dewas plant of barelocher ltd.

IV. SAFE TRANSPORTATION OF INTERMEDIATE CHEMICALS

There are various intermediate chemicals are used at barelocher at dewas plant to make the adhesive material. In this sturdy one of intermediate has been taken for the assessment & rest of other chemicals can also be assessed similarly.

A. Step-1- Identification of chemical

4-methyl-2(2,2,2-trifluoro-1,1,1-dimethyl-ethyl)-pyridine) is one of the novel chemical or intermediate chemicals are dispatched from the dewas plant to Europe for one of their client. Following below properties have been derived during safety study of 4-methyl-2(2,2,2-trifluoro-1,1,1-dimethyl-ethyl)-pyridine)

1) Identification of chemical- 4-methyl-2(2,2,2-trifluoro-1,1,1-dimethyl-ethyl)-pyridine)

a) Hazard identification- Flammable liquid & Toxic
b) Composition- 100%
c) First Aid measures- General advice Consult a physician. If inhaled If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician. In case of skin contact Wash off with soap and plenty of water. Consult a physician. In case of eye contact Flush eyes with water as a precaution. If swallowed Never

give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

d) Fire fighting measures- Suitable extinguishing media Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
e) Accidental release measures-Use personal protective equipment. Avoid dust formation. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Avoid breathing dust.
f) Handling & Storage-Avoid contact with skin and eyes. Avoid formation of dust and aerosols. Provide appropriate exhaust ventilation at places where dust is formed. Store in cool place. Keep container tightly closed in a dry and well-ventilated place.
g) Exposure control/PPE-
h) Eye/face protection Safety glasses with side-shields conforming to EN166 Use equipment for eye protection tested and approved under appropriate government standards.
i) Skin protection Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.
j) Body Protection Complete suit protecting against chemicals, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace. Respiratory protection For nuisance exposures use type P95 (US) or type P1 (EU EN 143) particle respirator.For higher level protection use type OV/AG/P99 (US) or type ABEK-P2 (EU EN 143) respirator cartridges. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).
k) Physical & Chemical Properties. Liquid & No data available
l) Stability & Reactivity-Hazardous decomposition products formed under fire conditions. - Nature of decomposition products not known.
m) Toxicological Information (If available)-p Not Available

B. Step-2- Preparation of EIP panel

ETIP Panel for 4-methyl-2(2,2,2-trifluoro-1,1,1-dimethyl-ethyl)-pyridine) shown below.

1) Hazard Classification- 4-methyl-2(2,2,2-trifluoro-1,1,1-dimethyl-ethyl)-pyridine) is flammable and toxic .

Fig. 4.1: GHS Label

2) UN Number- Un number can be derived from ADR book which is UN- 1992 for flammable liquid and toxic material.

UN Number	Name & Description	Hazard Class
1992	Flammable & Toxic	3, 6

Table No. 4.1 – UN Number and Hazard Class

3) HAZCHEM decoding-The HAZCHEM code of - 4-methyl-2(2,2,2-trifluoro-1,1,1-dimethyl-ethyl)-pyridine) as follows:

Fig. 4.2: EIP Panel

C. Step-3- Preparation of Transport Emergency Card for for 4-methyl-2(2,2,2-trifluoro-1,1,1-dimethyl-ethyl)-pyridine)

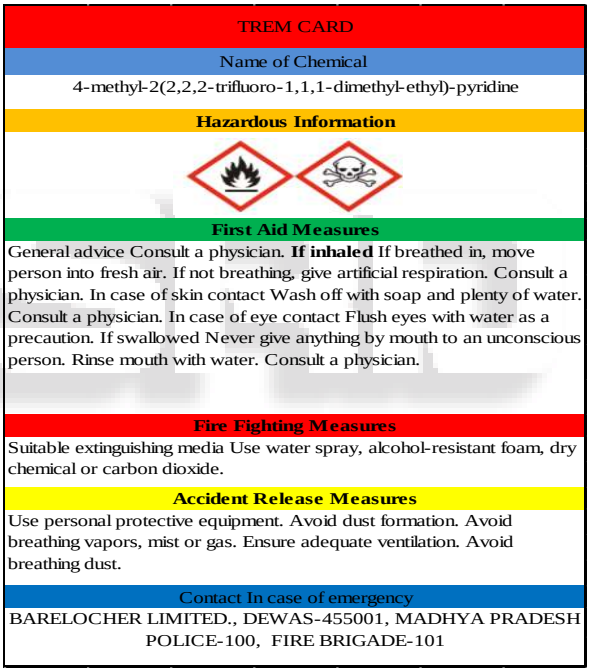

Fig. 4.3: TREM Card

D. Step-4- Preparation of Journey Management Plan

Journey management plan is most important part of the total journey which includes below following major elements.

Selection of journey route- A dedicated route is preferred for transportation of hazardous chemicals. Where regular speed, break, halt, movement of route are tracked on periodic interval on the basis of GPS tracker system if any mishap happen automatic alert is received to the sender at barelocher plant to activate the emergency response team.

Fig. 4.4: Selection of Journey Route

Emergency aid service like fire brigade and ambulance are evaluated on time to time and all the information is share to the driver in case of emergency occurs.

Fig. 4.5: Emergency Aid Services during Transit

Emergency response team is formed to tackle the emergency including plant personnel and external support bodies like fire brigade.

Compliance of legal regulation like- Valid licences of vehicle, valid driving licence to the driver, TREM card availability , Emergency kit availability , proper insurance copy, training certificate on carrying hazardous goods, etc. to avoid any misconduct.

V. CONCLUSION

This dissertation has been performed for Bare ocher India Ltd. for its Dewas manufacturing facility which is engaged in manufacturing of adhesive chemicals. The concept safe transportation of journey has been derived from the one of the code of Responsible Care which is developed and maintained by Indian chemical council. Before implementation of this concept the Transportation safety is most grey area of Barelocher ltd. which they have overcome and now following the best practices and set the benchmark. With reference to below performance (Accident/Deviation Statistics) table which show the actual analytical result after before and after implanting the transportation safety protocol at site.

Sr. No.	Deviation/ Accident/ Incident	Accident/ Deviation Statistics(Before implementation of safe transportation practices - Before April-2020)	Accident/ Deviation Statistics(After implementation of safe transportation practices - After April-2020)
1	No Valid licences for Vehicle	14	0
2	NO TREM Card	50	0
3	NO EIP Panel	48	0
4	NO Driver Training	50	0
5	Over speeding	280	12
6	Overtake- Rash Driving	250	10
7	Changing Route- Deviation	34	1
8	Vehicle malfunctioning - Deviation	30	5
9	NO Emergency Equipment	300	0
10	Vehicle Collapse	2	0
11	Vehicle Collision	1	0
12	Vehicle toppled-up	3	0

Table 5.1: Analytical Result for Implementation of Safe Transportation Practices

This dissertation has been carried out for barelocher india limited which is biggest manufacturer of adhesive material and consume lot of intermediate material which are not only high expensive they are extremely hazardous and novel category. Handling of novel chemical or intermediate chemicals are very risk job where as all the generic chemical have their own CAS number and safety information to predict in such as specific manner. However the stability and reactivity data is not easily available on public domain. In order to cater this problem and having unique solution this study has contributed many small pillar of safety can utilize for safe transportation of any type of novel chemical or intermediate chemicals.

There are many safety aspects with respect to safe transportation of hazardous chemicals have been studied systematically to avoid any noncompliance of any statutory requirement or local regulation. This dissertation not only applicable for intermediate chemical or novel chemical engaged company or industry it will be utilized for other hazardous combustibles material which are harmful to human, property or our environment.

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