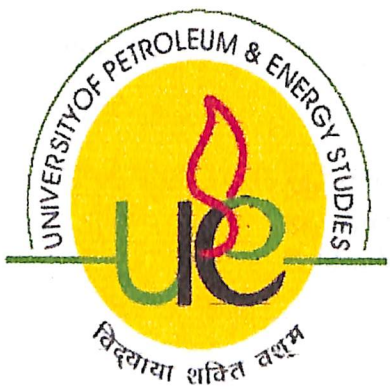
CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH IN ACRYLONITRILE PLANT, R.I.L.,VADODARA.

By
(Desh Deepak)



College of Engineering
University of Petroleum & Energy Studies
Dehradun
May, 2008

CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH IN ACRYLONITRILE PLANT, R.I.L.,VADODARA.

A thesis submitted in partial fulfillment of the requirements for the Degree of
Master of Technology
(Health, Safety &Environment Engineering)

By
(Desh Deepak)

Under the guidance of

Mr. G. Sanjay Kumar,
Course Co-coordinator,
M.Tech. (HSE),
UPES, Dehradun.

Mr. K.N. Sharma,
Sr. Safety Manager,
R.I.L., Vadodara, Gujrat.

Approved

.....
Dean

College of Engineering
University of Petroleum & Energy Studies
Dehradun
May, 2008

RELIANCE INDUSTRIES Ltd Vadodara Manufacturing Division
Petrochemicals, Dist.Vadodara-391 346, Gujarat,02656696658

CERTIFICATE

Dated 23.04. 2009

We are pleased to inform that Mr. DESH DEEPAK of IV-Sem, M.Tech (HSE),University of Petroleum & Energy Studies, Dehradun had successfully completed his project under my guidance and has submitted a project report on COSHH(Control of Substances Hazardous to Health) in ACN Acrylonitrile) Plant. During his training he has been placed in the Safety Center at Reliance Industries Limited, Vadodara Manufacturing Division, Vadodara, Gujarat, for the period of Six weeks from 13-March 2009 to 23-April-2009

K. N SHARMA
Senior Manager (Safety)
Reliance Industries Ltd.
Vadodara Manufacturing Division
PO: Petrochemicals-391346, Dist. Vadodara

Mr. K. N. SHARMA

(Sr. Safety Manager)

Abstract/ Synopsis

COSHH is a useful tool of good management which sets eight basic measures that employers, and sometimes employees, must take. Using chemicals or other hazardous substances at work can put people's health at risk, so the law requires employers to control exposure to hazardous substances to prevent ill health. They have to protect both employees and others who may be exposed by complying with the Control of Substances Hazardous to Health Regulations 2002 (COSHH) (as amended).

After the implementation of COSHH project at ACN Plant following observations were made:

(1) Elimination of ACN vapours exposure during tanker loading.
(2) Elimination of Hydrocarbon exposure to working personnel's.
(3) Environmental improvement.
(4) Elimination of fire hazard.
(5) Health improvement.
(6) Recovery of hold up material.
(7) Elimination of ACN vapours exposure during maintenance work.
(8) Safe working condition.

Hence the implementation of this project saved the worker's from being exposed to harmful chemicals and various hazards. It alsc lead to improvement of health of workers and in the environment improvement as well as provided safe working condition.

Acknowledgement

The fate of any Project is decided by the efforts put by every single person involved in the pursuance of Project. Success can not be achieved with a single hand. It is the team effort same as the ship, sails to the coast. So, I would like to express my deep gratitude towards everyone who helped me in completing my training.

I would also like to thank **Mr. K. N. Sharma** (Sr. Manager-Safety) who guided me during the project work.

I would like to thank **Mr. G. Sanjay Kumar** (Course Coordinator, M.Tech - HSE) for the co-operation which he bestowed on me during the project work.

I would also like to thank **Mr. Shri Hari (Dean, College of Engineering)** for his co-operation during my project work.

I am extremely thankful to M/S RIL-VMD who gave me the opportunity to gain the subject knowledge and to prepare this valuable report by providing all sorts of infrastructure.

I wish to warmly thank **Mr. D.A. Sharma** (HSEF-Chief), **Mr. R. K. Desai** (GM-Safety).

I would also like to thank **Miss. Karuna Purohit** (Sr. Librarian) for helping me to the fullest and in providing the study materials during the training period.

Last but not the least, I am extremely thankful to my family members & my all friends for the moral support, they provided without which I would have been unable to successfully complete my project work.

Desh Deepak

DESH DEEPAK

M.Tech (HSE)

List of Contents

LIST OF FIGURES

Figures **Page No.**

LIST OF TABLES

TABLE **PAGE NO.**

Abbreviations

1. ACN = Acrylonitrile
2. HCN = Hydrogen Cyanide
3. COD = Chemical Oxygen Demand
4. BOD = Biological Oxygen Demand
5. COSHH= Control of Substances Hazardous to Health
6. WEL's=Workplace Exposure Limits
7. ALARP =As Low As Reasonably Practicable
8. LD_{50} = Lethal Dose 50
9. CEF= Combined Exposure Factor
10. THF = Toxic Hazard Factor
11. RF = Risk Factor
12. CR = Control Regime
13. PPE= Personal Protective Equipment
14. HSE = Health Safety & Environment
15. COSHH= Control of Substances Hazardous to Health

(1)INTRODUCTION OF IPCL

INTRODUCTION OF IPCL

- Indian Petrochemical Corporation Limited is pioneering Petrochemical Company in India.
- It was established on March 22, 1969.
- The construction of first Petrochemical Complex in year 1973.
- IPCL is second Petrochemical Complex was commissioned in year 1992 at Nagothane in Maharastra.
- The third was commissioned in year 1997 at Gandhar in Gujarat.
- In June 2002, Government disinvested 26% of its shares to Reliance Petrochemical Limited, a Member of Reliance Group, following a competition bidding process.
- On June 4th '02, RPIL and the Government executed a shares purchase Agreement & share holder Agreement pursuant to which RPIL acquired 26% of IPCL's outstanding equity shares from the Government at a price of Rs. 231 per equity share, for an aggregate cash payment of Rs. 14908 million.
- IPCL is ranked as 29th largest company in terms of sales with net sales of Rs 50290 million.
- Today IPCL is one of best leading Petrochemical Company.
- Its business comprise of:
  - Synthetic Fiber
  - Polymer
  - Fiber Intermediate
  - Solvents
  - Surfactant
  - Industrial Chemical
  - Catalysts
  - Absorbents
- It having also Research Centre, Technology management Centre and Customer Relation Centre. The Company produces over 1 million tones of product and has turnover also US$ 2 million.

(2) ACN PLANT

ABOUT ACN PLANT:

The plant consists of four sections-

(1) Acrylo reactor section
(2) Acrylo recovery section
(3) Acrylo purification section
(4) HCN purification unit –
    (a) HCN purification unit
    (b) Aceto purification section
    (c) Waste water treatment

The ACN process block diagram is shown on the next page-

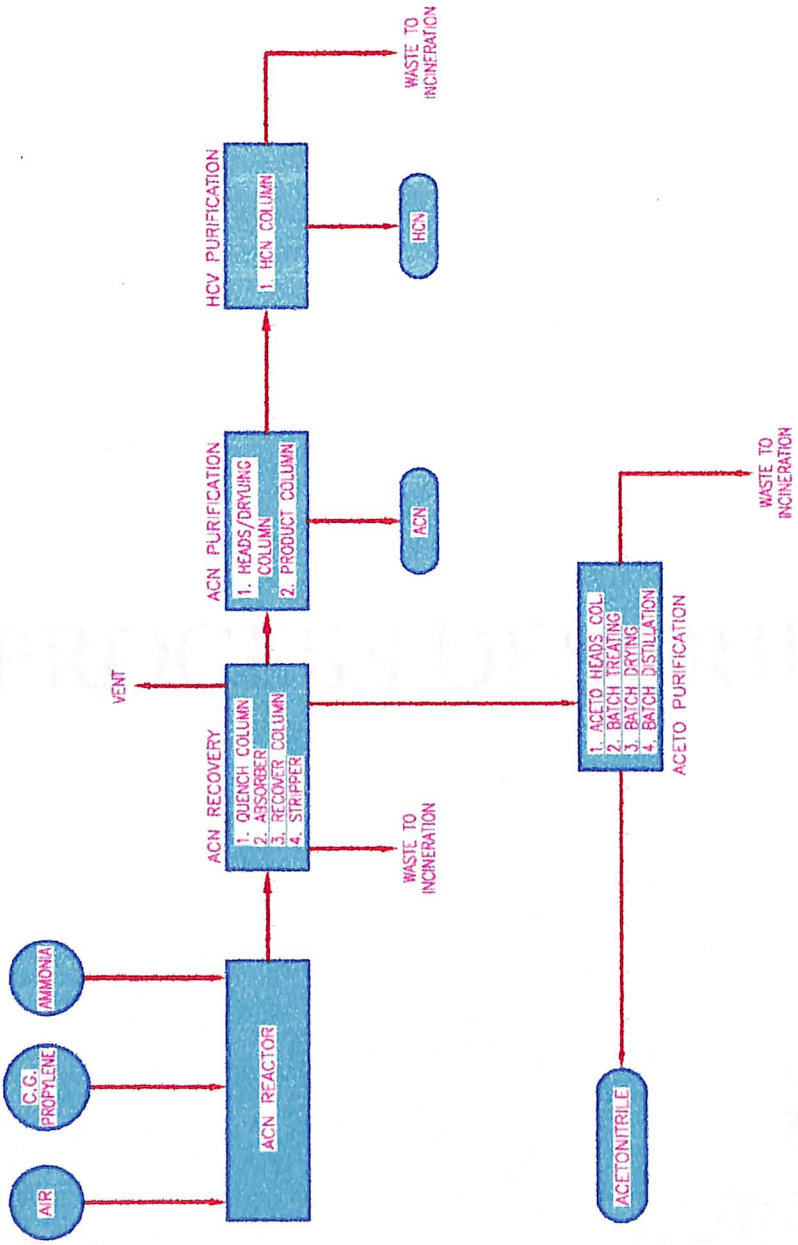


Fig1: ACN PROCESS BLOCK DIAGRAM

(3) PROCESS DESCRIPTION

BRIEF PROCESS DESCRIPTION

The plant consists of four sections-

(1) Acrylo reactor section
(2) Acrylo recovery section
(3) Acrylo purification section
(4) HCN purification unit –

(a) HCN purification unit
(b) Aceto purification section
(c) Waste water treatment

(3.1)Acrylo reactor section:

Acrylonitrile production involves the chemical catalytic reaction of propylene and among vapours with oxygen. The chemistry of this reaction step may be presented by the following equation:

$$C_3H_6 + NH_3 + 3/2\ 0_2 \text{ ------> } C_3H_6NI + 3\ H_2O$$

Propylene + Ammonia + Oxygen -------> Acrylonitrile + Water

Oxygen for the reaction is supplied by air. The resultant heat of reaction is removed from the system by utilizing the heat to produce stem. The design production of acrylonitrile is achieved in one reactor.

Liquid propylene and liquid ammonia are vapourised in the recovery section of the unit for their refrigeration value. Both vapour feed streams are then superheated and sent to the reactor section.

The propylene is combined with ammonia vapour and introduced near the bottom of the reactor through distributor. Reaction air is supplied by a large air compressor to the reactor. The air enters

the bottom of the reactor through a distributor plate located below the propylene ammonia distributor.

Propylene, ammonia and air are intimately mixed as they flow upward through the fluidized catalyst bed. Here the exothermic reaction to produce acrylonitrile occurs. In the disengaging zone above the fluidized bed, the hot reaction gases are partially separated from entrained catalyst. Removal of the bulk of catalyst particles from the product gas is accomplished by three-stage cyclones located in the upper portion of the reactor. The product gases leaving the top of the reactor are partially cooled by heat exchanger with the air feed to the reactor and then with boiler feed water before flowing to the recovery
section of the unit.
High pressure stem is generated in cooling coils located in the reactor beds. This steam is superheated, used for drives and export. A fired heater is provided to preheat the air at start up.

(3.2)**Acrylo recovery section:**

The reactor effluent gases are further cooled and partially quenched in the quench column by stripper column bottoms stream. The unreacted ammonia is neutralized with Sulphuric acid in quench column upper section and the resultant 20% ammonium sulphate aqueous solution is fed to the waste water column where organics are stripped out and returned to the quench column. The bottoms consisting cyanides, heavy organics and ammonium sulphate are sent for incineration. The net quench lower (blow down) stream is sent to catalyst setting pit to remove catalyst particles and then sent to incineration.

The gases from the quench column pass to the absorber where lean water stream scrubs out the soluble products. The non-absorbed gas consisting of unreacted hydrocarbons, nitrogen, excess oxygen, carbon monoxide, carbon dioxide, water and a small amount of acrylonitrile leaves the top of the absorber and is vented to atmosphere via a vent stack. The dilute aqueous solution of acrylonitrile, acetonitrile and hydrogen cyanides etc., is fed from the absorber to the recovery column after passing through a heat exchanger system. Extractive distillation, using water as a solvent, separates acrylonitrile from acetonitrile using vapour from the stripper as a source of heat. Acrylonitrile and hydrogen cyanide go overhead as an azeotrop with water.

The overhead product is condensed, cooled and goes to the decanter where two liquid layers form. The organic rich upper layer is pumped to the purification section. The water-rich lower layer is returned to the recovery column feed.

The recovery column bottoms containing the acetonitrile, is fed to the stripper. There acetonitrile, hydrogen cyanide, traces of other organics and some water are condensed as the overhead product. This crude acetonitrile product is sent to the acetonitrile purification unit.

Lean water fed to absorber is withdrawn from 10th tray of stripper column. Solvent water used in recovery column is withdrawn from 3rd tray of stripper column. Part of solvent water is sent to circular pond as waste water-II, before sending to Biotreatment. Stripper bottom stream is sent to quench column lower section for quenching reactor effluent gases.

(3.3)Acrylo purification section:

The crude acrylonitrile stream from the recovery column decanter is charged to the heads section of the heads drying column where essentially all of the hydrogen cyanide present in the feed is taken overhead as a high purity hydrogen cyanide product and flows under gravity to the HCN purification unit.

A liquid side stream of acrylonitrile and water is withdrawn from the bottom of the heads section of the column. This stream is cooled and separated into organic and water layers in the side stream decanter. The water phase is recycled to the quench column and the organic phase is returned to the column as reflux to the drying section.

The drying section in this column has dual functions: water removal and acetone concentration and removal. To remove water from acrylonitrile the column has a sufficiently high boll up rate to drive all of the water and acetone in the feed to the upper part of the section where they may be withdrawn with the side stream of acrylonitrile.

Dried crude acrylonitrile from the drying column bottoms is charged to the product column. Acrylonitrile product is withdrawn as a side cut from this column and sent to the rundown tanks. A

pasteurizing section is provided in the top of the product column for removal of any volatile organic compounds, which may remain in the feed or form in the column as decomposition by-product.

This top cut is recycled to the recovery column decanter for rerunning. The product column bottoms which consist of acrylonitrile and higher boiling organic compounds are charged to the quench column. The product column operates under vacuum to minimize the formation of polymers.

As acetic acid injection system is provided to prevent the polymerization of hydrogen cyanide in the overhead system of the heads column. So vapours are introduced into the HCN vapour product line to minimize polymerization of the hydrogen cyanide in this piping.

Hydroquinone polymerization inhibitor is injected into the heads drying column and just below the product draw off try on the product column. Water injection via pump seals on the drying column and product column bottoms pumps also provides protection against polymerization in these system.

(3.4)HCN purification unit:

(3.4.1)HCN purification unit:

The crude HCN from the heads column is distilled in HCN distillation column to a highly pure product. This is drawn off the column and fed after stabilization and cooling to the rundown tank and from this to battery limits.

Stabilization in affected by H_2SO_4 addition. The column bottoms mainly cyanide with acrylonitrile and water are sent to the waste organic tank or to the heads column. Vapour phase cyanide is stabilized with SO2. For the distillation column liquid phase acetic acid and SO2 is used.

(3.4.2)Aceto purification section:

Crude acetonitrile coming from stripper top having around 1-2% HCN is taken in topped crude tank and HCN is killed by digestion with formaldehyde and caustic in treating kettle. The overhead material is chemically dried by anhydrous calcium chloride and for final purification batch distillation is operated.

(3.4.3)Waste water treatment:

The plant effluents are incinerated partly and partly sent to biopond. While the incinerator handles highly toxic waste (W. W. I. high COD/BOD). The toxic waste (W.W.II) is destroyed by biological degradation.

The process flow diagram of ACN plant is given on next page:

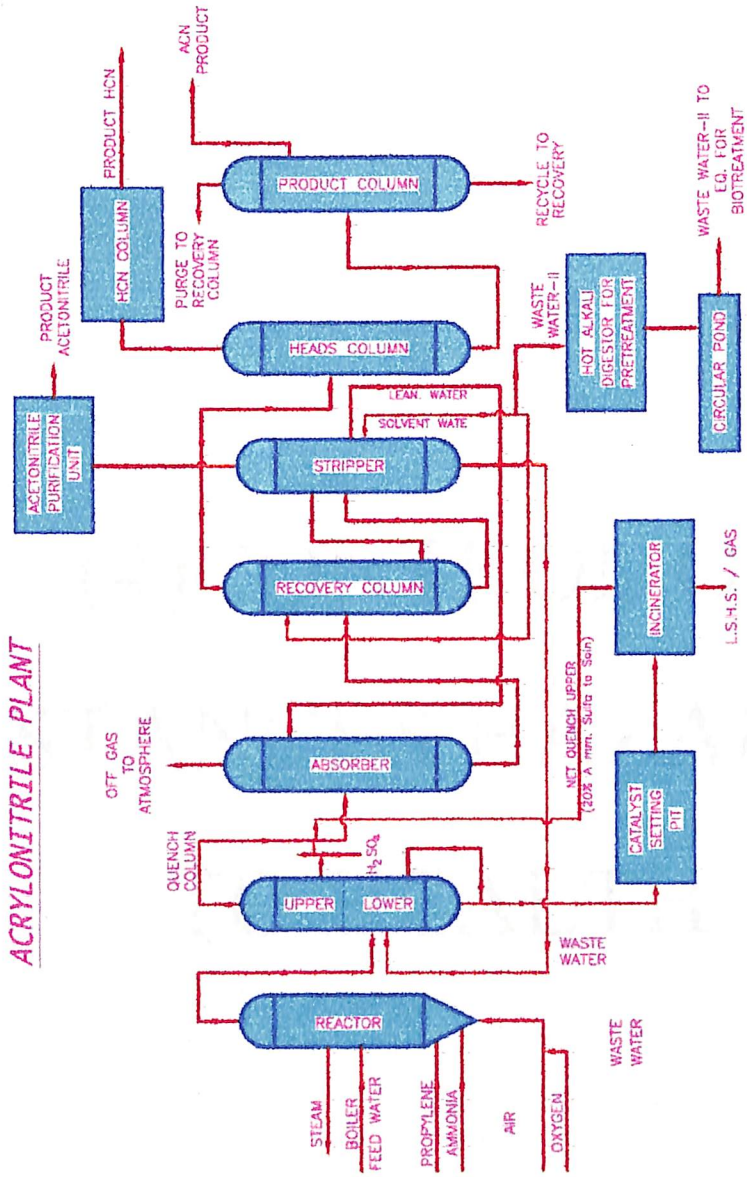


Fig2: PROCESS FLOW DIAGRAM OF ACN PLANT

(4)CONTROL OF SUBSTANCES HAZARDOUS TO HEALTH

(4.1) INTRODUCTION-

Using chemicals or other hazardous substances at work can put people's health at risk, so the law requires employers to control exposure to hazardous substances to prevent ill health. They have to protect both employees and others who may be exposed by complying with the Control of Substances Hazardous to Health Regulations 2002 (COSHH) (as amended).

COSHH is a useful tool of good management which sets eight basic measures that employers, and sometimes employees, must take. These are set out in this leaflet with a simple step-by-step approach which will help to assess risks, implement any measures needed to control exposure and establish good working practices.

If you as an employer fail to adequately control hazardous substances, your employees or others may become ill. Effects from hazardous substances range from mild eye irritation to chronic lung disease or, on occasions, death. This may:

(1) Result in lost productivity to your business;

(2) Leave you liable to enforcement action, including prosecution under the COSHH regulations;

(3) Result in civil claims from your employees.

There can be positive benefits to your business from carefully following through the requirements of COSHH:

(1) Improved productivity as a result of using more effective controls (E.g.: Less use of raw material);

(2) Improved employee morale;

(3) Better employee understanding and compliance with health and safety requirements.

A SUBSTANCE HAZARDOUS TO HEALTH (SHH) is defined as a substance that is-

- Listed with the Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 (CHIP3/CHIP 2002) as very toxic, toxic, harmful, corrosive or irritant.
- Subject to an HSC Workplace Exposure Limits (WEL's)
- A harmful organism, a substantial concentration of any dust, or any substance which because of its chemical or toxicological properties and the way it is used or is present creates a risk to health

While the COSHH Regulations are concerned with all health risks, a major concern is with inhalation of gases, vapours, fumes and dust of SHH, and the following occupational exposure limits (WELs) have been imposed on the use of some substances.

- Workplace exposure limit (WEL) is the maximum concentration of an airborne substance, averaged over a reference period, to which employees may be exposed by inhalation, this must not be exceeded. This limit works on the basis that 99% of the population would not suffer at or below the WEL.
- Special cases such as carcinogens must have their concentrations reduced as low as is reasonably practicable ALARP in addition to:

A comprehensive list of occupational exposure limits WEL's is published annually by HSE in guidance note EH40.

The duties of employers under these regulations (except for the requirements to provide monitoring, health surveillance, information and training and dealing with accidents etc (r10-13)) extend to persons who are not employees but who are on the premises, i.e. contractors (r3).

Substances for which COSHH assessment should be done-

(1) Carcinogens
(2) Explosive risks
(3) Highly corrosive materials
(4) Materials which present special risks in handling (such as a violent reaction with water or air)
(5) Systemic poisons, particularly hydrofluoric acid and phenol.
(6) Those whose lethal dose 50 (LD50 - rat) is less than 1mg/kg body weight.
(7) Those with a maximum exposure limit of less than 5 ppm.
(8) Those with an occupational exposure standard of less than 5 ppm.
(9) Pyrophoric material.
(10) Teratogen or Mutagen
(11) Substances for which special first aid provision is required.(E.g. HF Acid)
(12) Dusts of any kind where its concentration is:
    (a) More than 10 mg/m^3 of inhalable dust
    (b) Or 4 mg/m^3 of respirable dust.

Hazardous substances may cause:

(1) Skin irritation or dermatitis as a result of skin contact.

(2) Asthma as a result of developing allergy to substances used at work.

(3) Losing consciousness as a result of being overcome by toxic fumes.

(4) Cancer which may appear long after the exposure to the chemical that caused it.

(5) Infection from bacteria and other micro- organisms (biological agents).

(4.2)What COSHH requires-

To comply with COSHH you need to follow these eight steps:

Step 1	Assess the risks	Assess the risks to health from hazardous substances used in or created by your workplace activities.
Step 2	Decide what precautions are needed	You must not carry out work which could expose your employees to hazardous substances without first considering the risks and the necessary precautions. and what what else you need to do to comply with COSHH.
Step 3	Prevent or adequately control exposure	You must prevent your employees being exposed to hazardous substances. Where preventing exposure is not reasonably practicable, then you must adequately control it. The advice in this leaflet, and in the other guidance it refers to, will help you to make correct assessments and to put the appropriate controls into place.
Step 4	Ensure that control measures are used and maintained	Ensure that control measures are used and maintained properly and that safety procedures are followed.
Step 5	Monitor the exposure	Monitor the exposure of employees to hazardous substances, if necessary.
Step 6	Carry out appropriate health surveillance	Carry out appropriate health surveillance where your assessment has shown this is necessary or where COSHH sets specific requirements.
Step 7	Prepare plans and procedures to deal with with accidents, incidents and emergencies	Prepare plans and procedures to deal with accidents, incidents and emergencies involving hazardous substances, where necessary.
Step 8	Ensure employees are properly informed, trained and supervised	You should provide your employees with suitable and sufficient information, instruction and training.

Table: 1 - COSHH Procedures

(4.2.1)

Step 1: Assess the risks

The first step is to decide whether there is a problem with the substance(s) the company is using, or those to which your employees are incidentally exposed. This is called a risk assessment.

Identify the hazardous substances present in your workplace.

Remember to think about substances which have been supplied to you; those produced by your work activity, e.g. fumes, vapours, aerosols, final products and waste materials; and those naturally or incidentally present in your workplace, e.g. infectious agents carried by farm animals.

You must:

- identify the hazardous substances present in your workplace;
- consider the risks these substances present to people's health.

Consider the risks these substances present to people's health:

Assessing the risk involves making a judgment on how likely it is that a hazardous substance will affect someone's health. You need to ask yourself:

- How much of the substance is in use or produced by the work activity and how could people be exposed to it?

- Who could be exposed to the substance and how often? It should include all groups of people who could come into contact with the substance, i.e. contractors, visitors and members of the public, as well as the employees. Persons involved in cleaning and maintenance tasks – high exposures can occur during this type of work hence should be included. Also, certain groups of people could suffer more from exposure than others, e.g. pregnant women, individuals with a suppressed immune system.

- The possibility of substances being absorbed through the skin or swallowed (e.g. as a result of a substance getting into the mouth from contaminated hands during eating or smoking)? Are there risks to your employees at other locations if they work away from your main workplace? While assessing the risks such questions should be kept in mind.

Who should do the assessment?

The legal responsibility for the assessment is of the employer, but others can do some or even most of the work of preparing it on his behalf. Except in very simple cases, whoever carries out the assessment will need to:

- have access to and understand the Regulations and relevant Approved Codes of Practice or to someone else who does;
- be able to get all the necessary information and have the knowledge and experience to make correct decisions about the risks and the actions needed.

Person doing the assessment and his employees have the most knowledge of what really happens in the workplace. Use this knowledge before deciding whether you need outside help. If there is no expertise available in the company to assess the more complex risks, you will need to get competent help, for example from a professionally qualified occupational hygienist, health and safety specialist or a trade association.

The employees or their safety representatives or safety committee should be involved in assessments. They have valuable contributions to make. They must also be informed of the results of the assessment.

(4.2.2)

Step 2: Decide what precautions are needed

- If you identify significant risks, decide on the action you need to take to remove or reduce them to acceptable levels.

- check that your control systems work and are effective;
- consider whether the substance could be absorbed through the skin. Where this could occur, a biological monitoring programme may be used to assess the risks.

What further action should be taken?

If there are risks to health, action must be taken to protect the employees (and others) health.

Even if it is judged that the control measures being used fully control the risks, still it's recommended to go through the remaining steps to ensure full compliance with COSHH(NI). This will also help to ensure that controls stay effective.

Recording and reviewing the assessment

If five or more employees work then a record should be kept of the main findings of the assessment. The record should be made as soon as practicable after the assessment and should contain enough information to explain the decisions that have been taken about whether risks are significant and the need for any control measures. Also suggestions from employees and others need to be taken to ensure hazardous substances are adequately controlled. If there is no risk from the hazard to health or the risk is trivial, then a record should be made having the identity of the substance, the control measures taken, and the fact that it poses little or no risk.

The assessment should be a 'living' document, which can be revisited if circumstances change. It should definitely be reviewed when:

- there is reason to suspect the assessment is no longer valid;
- there has been a significant change in the work;
- the results of monitoring employees exposure shows it to be necessary.

The assessment should state when the next review is planned. The records mainly form part of the system to protect health, but others may want to see them, e.g. safety representatives, safety committees, health and safety inspectors.

(4.2.3)

Step 3: Prevent or adequately control exposure

Prevent exposure

COSHH (NI) requires you to prevent exposure to substances hazardous to health, if it is reasonably practicable to do so. Thus one can:

- change the process or activity so that the hazardous substance is not needed or generated;
- replace it with a safer alternative;
- use it in a safer form, e.g. pellets instead of powder.

Adequately control exposure

If prevention is not reasonably practicable, one must adequately control exposure. One should consider and put in place measures appropriate to the activity and consistent with the risk assessment, including, in order of priority, one or more of the following:

- Use appropriate work processes, systems and engineering controls, and provide suitable work equipment and materials e.g. use processes which minimize the amount of material used or produced, or equipment which totally encloses the process;

• Control exposure at source (e.g. local exhaust ventilation), and reduce the number of employees exposed to a minimum, the level and duration of their exposure, and the quantity of hazardous substances used or produced in the workplace;

• Provide personal protective equipment (e.g. face masks, respirators, protective clothing), but only as a last resort and never as a replacement for other control measures which are required.

Meaning of 'adequate control'

Under COSHH, adequate control of exposure to a substance hazardous to health means:

- applying the eight principles of good practice set out in Schedule 2A to COSHH;
- not exceeding the workplace exposure limit (WEL) for the substance (if there is one) and
- if the substance causes cancer, heritable genetic damage or asthma, reducing exposure to as low a level as is reasonably practicable.

Adequate control of carcinogens, mutagens and asthmagens:

COSHH acknowledges the particular hazards of substances which cause cancer, heritable genetic damage or asthma by requiring that exposure to these is reduced to as low a level as is reasonably practicable.

For carcinogens (substances which may cause cancer) or mutagens (substances which may cause heritable genetic damage) special requirements apply. These are in regulation 7(5) of COSHH.

Skin absorption

Some substances can damage the skin itself while others can readily penetrate it, become absorbed into the body and cause harm, so you must consider the need to protect skin when deciding on control measures.

(4.2.4)

Step 4: Ensure that control measures are used and maintained

Using the controls

COSHH requires employees to make proper use of control measures and to report defects. It is the responsibility of owner of the company to take all reasonable steps to ensure that the employees do so. This is why employees must be given suitable training, information and appropriate supervision.

Maintain controls

COSHH places specific duties on you to ensure that exposure controls are maintained. The objective being to ensure that every element of the control measure continues to perform as originally intended. This applies to items of equipment such as local exhaust ventilation and to systems of work, which will have to be regularly checked to make sure that they are still effective. Respiratory protective equipment should also be examined and, where appropriate, tested at suitable intervals. COSHH sets specific intervals between examinations for local exhaust ventilation equipment, and you must retain records of examinations and tests carried out (or a summary of them) for at least five years.

(4.2.5)

Step 5: Monitor exposure

Under COSHH, you have to measure the concentration of hazardous substances in the air breathed in by workers where your assessment concludes that:

- there could be serious risks to health if control measures failed or deteriorated;
- exposure limits might be exceeded; or
- control measures might not be working properly.

However, you do not need to do this if you can show by another method of evaluation that you are preventing or adequately controlling employees exposure to hazardous substances, e.g. a system which automatically sounds an alarm if it detects hazardous substances.

Air monitoring must be carried out when employees are exposed to certain substances and processes specified in Schedule 5 to the COSHH Regulations. Where it is appropriate to carry out

personal air monitoring, the air to be sampled is the space around the worker's face from where the breath is taken, i.e. the breathing zone.

You should keep and maintain a record of any exposure monitoring you carry out for at least five years. Where an employee has a health record (required where they are under health surveillance), any monitoring results relevant to them as an individual must be kept with their health record. They should be allowed access to their personal monitoring record.

(4.2.6)

Step 6: Carry out appropriate health surveillance

COSHH requires you to carry out health surveillance in the following circumstances:

- Where an employee is exposed to one of the substances listed in Schedule 6 to COSHH and is working in one of the related processes, e.g. manufacture of certain compounds of benzene, and there is a reasonable likelihood that an identifiable disease or adverse health effect will result from that exposure;
- Where employees are exposed to a substance linked to a particular disease or adverse health effect and there is a reasonable likelihood, under the conditions of the work, of that disease or effect occurring and it is possible to detect the disease or health effect.

You must keep a simple record (a 'health record') of any health surveillance carried out. COSHH requires you to keep health records for at least 40 years.

(4.2.7)

Step 7: Prepare plans and procedures to deal with accidents, incidents and emergencies

This will apply where the work activity gives rise to a risk of an accident, incident or emergency involving exposure to a hazardous substance, which goes well beyond the risks associated with normal day-to-day work. In such circumstances, you must plan your response to emergency involving hazardous substances before it happens.

That means preparing procedures and setting up warning and communication systems to enable an appropriate response immediately any incident occurs, and ensuring that information on your

emergency arrangements is available to those who need to see it, including the emergency services. It also requires these 'safety drills' to be practiced at regular intervals.

If any accident, incident or emergency occurs you must ensure that immediate steps are taken to minimize the harmful effects, restore the situation to normal and inform employees who may be affected. Only those staff necessary to deal with the incident may remain in the area and they must be provided with appropriate safety equipment.

However, you do not have to introduce these emergency procedures if:

- The quantities of substances hazardous to health present in your workplace are such that they present only a slight risk to your employees health; and
- The measures you have put in place under Step 3 are sufficient to control that risk.

However, the requirements described in Step 7 must be complied with in full where carcinogens, mutagens or biological agents are used.

(4.2.8)

Step 8: Ensure that employees are properly informed, trained and supervised

COSHH requires you to provide your employees with suitable and sufficient information, instruction and training which should include:

- The names of the substances they work with or could be exposed to and the risks created by such exposure, and access to any safety data sheets that apply to those substances;
- The main findings of your risk assessment;
- The precautions they should take to protect themselves and other employees;
- How to use personal protective equipment and clothing provided;
- Results of any exposure monitoring and health surveillance (without giving individual employees' names);
- Emergency procedures which need to be followed.

You should update and adapt the information, instruction and training to take account of significant changes in the type of work carried out or work methods used. You should also ensure that you

provide information etc that is appropriate to the level of risk identified by the assessment and in a manner and form in which it will be understood by employees.

These requirements are vital. You must ensure your employees understand the risks from the hazardous substances they could be exposed to. Your control measures will not be fully effective if your employees do not know their purpose, how to use them properly, or the importance of reporting faults.

(4.2.9) COSHH Risk Assessment Procedure-

COSHH Risk Assessment:

(4.2.9.1) Check list for applicability of COSHH assessment.

1. Is the chemical carcinogen? YES/NO.
2. Is the chemical having explosive risk? YES/NO.
3. Is it highly corrosive? YES/NO.
4. Does it have special hazards like reaction with water or air? YES/NO.
5. Is it a systemic poison? Ex. Hydrofluoric acid, phenol etc.? YES/NO.
6. Is the LD50 less than 1 mg/kg body weight? YES/NO.
7. Is the TLV of chemical less than 5 ppm? YES/NO.
8. Is it a pyrophoric material? YES/NO.
9. Is it a teratogen or mutagen? YES/NO.
10. Is it a substance for which a first aid provision required? YES/NO.
11. Is dust concentration higher than 15 mg/m3 or more??

B.RISK ASSESSMENT FOR COSHH

- **Date:**
- **Operation:**
- **Plant:**
- **Chemical name:**
- **Location:**
- **Assessed by :**

(4.2.9.2)

SECTION: I HAZARD IDENTIFICATION

Activity and Chemical Information where manual handling is done or chances are :

Brief description of the activity:

Ingredients/Chemicals/Substances involved	Exposure Limit (ppm, Mg/M^3)	Exposure Assessment if any	Exposure Limit exceeded?	Physical Form	How much used?	How frequently used?	How long used?

Hazards:

Chemicals: (Review MSDSs and answer the following)

Substance Adversely affects: Lungs.....☐ Kidney.....☐

Liver.....☐

Nervous system .....☐ Other body parts.....

Irritant .....☐

Carcinogen/Teratogen/Tumerigen/Reproductive hazards

Respiratory exposure to fumes/ toxic gas/ vapor/ dust...☐

Contact with eyes.....☐

Contact with face.....☐

Contact with Skin.....☐

Pressure other than ambient (High/Low)..... ☐

Elevated temperature.....☐

Other Hazards:. .....

.....

.....

Describe specific activity where the above hazards are present (e.g., Loading, unloading, cleaning of the area)

Seal area, process activity, maintenance work, sampling walk through, laboratory analysis,

(4.2.9.3)

SECTION: II CONTROLS MEASURES :

Controls provided or recommended (if not provided):

Prevention and Control	**In place**	**Not in place (Recommended)**	**Not applicable**
Elimination or substitution of the hazardous chemicals/substance if possible			
Reduce volume of hazardous chemical/substance in use			
Storage of Chemicals: • According to their incompatibility • In special/controlled environment (if required) • Inventory maintained • Labeling of the containers •			
Ventilation: • General ventilation in the area. • Fume hood/LEV used • Fume hood sash/LEV hood at the recommended height • Air is not recirculated/if circulated filtered • Periodic measurement and maintenance of ventilation mechanism			

Engineering Control for Exposure: • Enclosed System • Cooling coils • Any other engineering control in place. Information Sources: • Safe Operating Procedure (SOP) available • Safe Operating Procedures (SOP) updated • Material Safety Data Sheet are available • Material Safety Data Sheets are updated • Other sources of information Training: • Potential hazards and safe work practices • Spill Control • Emergency Response • First aid			
Personal Protective Equipment: • Selected based on hazards • Ear protection • Eye glasses/face shields used • Gloves used • Overalls/ apron • Inspected Respirators: • Selected based on hazards • Inspected • Medical examination provided • Fit tested • Training fit checking Air line respirators/SCBA provision:			
Other controls (explain):			

(4.2.9.4)

SECTION: III RISKS

Quantitative Risk Assessment:

Calculation of the Exposure Factor (CEF)

The combined exposure factor takes into account the following:

Q the weight or volume of the substance being used;

P the physical properties of the substance;

M the operational procedure and/or how it is handled.

	Weight	*Volume**	*Score*
Q *Quantity*	<1 kg	<1 Lit	1
	1-200 kg	1-200 Lit	2
	201-500 kg	201-500 Lit	3
	>500 kg	>500 Lit	4

P Physical Properties	Dense solid; Dilute solution; Non-volatile liquid (Flash Point > 93°C); No skin absorption likely;	1
	Dusty solid; Concentrated solution; Volatile liquid (Flash Point 65-93 °C); Low skin absorption possible;	2
	Volatile liquid (Flash point 23-65 °C); skin absorption likely	3
	Allergens; Gas; Aerosol; Very volatile liquid (Flash Point < 23 °C); Skin absorption more likely; Skin absorption promoter;	4

M Operating Procedure	Fully Automatic	1
	Semi Automatic	2
	Manual Handling	3
	Welding Grinding Soldering Spraying	2

	COMBINED EXPOSURE FACTOR CEF = Q x P x M	

The Calculation of the Toxic Hazard [TH]		
Category	***Typical Characteristics***	TH Score
HH High Hazard	Allergens Proven Carcinogens Respiratory irritants Substances with an TLV <0.1 ppm Substances classified as either toxic; very toxic; or corrosive	4
MH Medium Hazard	Substances with an TLV of 0.1 – 5 ppm Skin irritants (including substances that might cause dermatitis, but excluding allergens), Potential carcinogen	3
LH Low Hazard	Substances classified as harmful irritants Substances with an TLV in the range 6 – 500 ppm	2
NH No Hazard	Substances not matching criteria classification as dangerous. Substances with an of >500 ppm.	1

Calculating the Risk Factor [RF] and selecting the Control Regime [CR]

The numerical value for the risk factor acts as a guide to the Control Regime (CR).
As far as is reasonably practicable, the final choice of Control Regime must allow the maintenance of a ***healthy and safe working environment.***

Combined Exposure Factor *CEF = Q x P x M*	***Toxic Hazard Factor*** ***TH*** *= Toxic Hazard Score*	*Risk Factor* ***RF*** *= CEF x TH*

Risk Factor Score	*Control Level*	***Control Regime***
Up to 25	*1*	*Good working practice, with or without simple extra precautions.*

25-50	*2*	*Needs Improvement. engineering controls should be monitored continuously .PPEs religiously to be used.*
>50	*3*	*Improve the measures by COSHH techniques. Provide additional measures or reduce the quantity of chemical.*

Risk	**High (>50)**	**Medium(25-50)**	**Low(<25)**	**None**
Health				

Recommend controls based on the above assessment:

1. Hazard assessment for PPE_____
   _____Activity specific safe operating procedure
   _____
   _____

2. _Addition measures:_____
   _____
   _____
   _____

(4.2.9.5)

What is not a substance hazardous to health under COSHH?

COSHH applies to virtually all substances hazardous to health except:

(1) Asbestos and lead, which have their own regulations;

(2) Substances which are hazardous only because they are:

- Radioactive;
- At high pressure;
- At extreme temperatures; or
- Have explosive or flammable properties (other regulations apply to these risks);

(3) Biological agents that are outside the employer's control, e.g. catching an infection from a workmate. (If in doubt, please contact HSE for advice.)

For the vast majority of commercial chemicals, the presence (or not) of a warning label will indicate whether COSHH is relevant. For example, there is no warning label on ordinary household washing-up liquid, so if it's used at work you do not have to worry about COSHH; but there is a warning label on bleach, and so COSHH does apply to its use in the workplace.

(5)ACRYLONITRILE PLANT

COSHH PROJECT

COSHH PROJECT IN ACN:

Sr. No.	PROJECT(COSHH)	Aspect
(1)	Elimination of ACN vapours exposure during tanker loading.	Health & Safety
(2)	Reboiler draining with Nitrogen & Demineralized Water flushing. (TT-5002/5003 & TT-1016).	Safety, Health & Environment.
(3)	Organic pump Filter water flushing.	Safety, Health & Environment.
(4)	PP 9001 A/S Pump casing drain valve provision.	Safety.

Table-2 (Projects under COSHH implementation)

Project approach- The focus of my project approach is based on:

Identifying and preventing the hazards related to Safety, Health & Environment during production and maintenance activities in the plant.

(5.1) Elimination of ACN vapour exposure during tanker loading-

Hazard- ACN Exposure

Aspect- Health, Safety & Environment

Previously tanker filling was done through a simple metallic hose. Hose was tightened with tanker valve. This caused release of ACN vapour from side of the hose. There was also a chance of release of hose and causing an accident.

Fig3: Tanker loading before implementation of COSHH project

Action taken: Metallic hose replaced with loading arm.

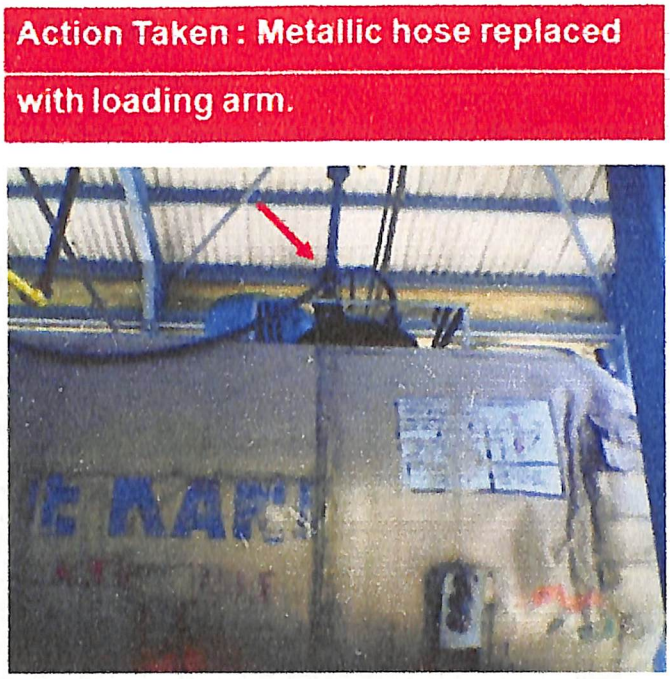


Fig4: Tanker loading after the implementation of COSHH project.

Results Achieved: Traditional loading hose system replaced with loading arm which can be fixed with bolting. This eliminates ACN vapour release and also eliminates the chance of hose release from the tanker.

(5.2) Reboiler draining with Nitrogen & Demineralized water flushing (TT-5002/TT-5003 & TT-1016)

Hazard- Hydrocarbon Exposure.

Aspect- Health, Safety & Environment.

Flushing system was not there, resulting in hold up material during opening of reboiler. This caused hydrocarbon exposure to working persons, increase in fire hazard potential, loss of hydrocarbon.

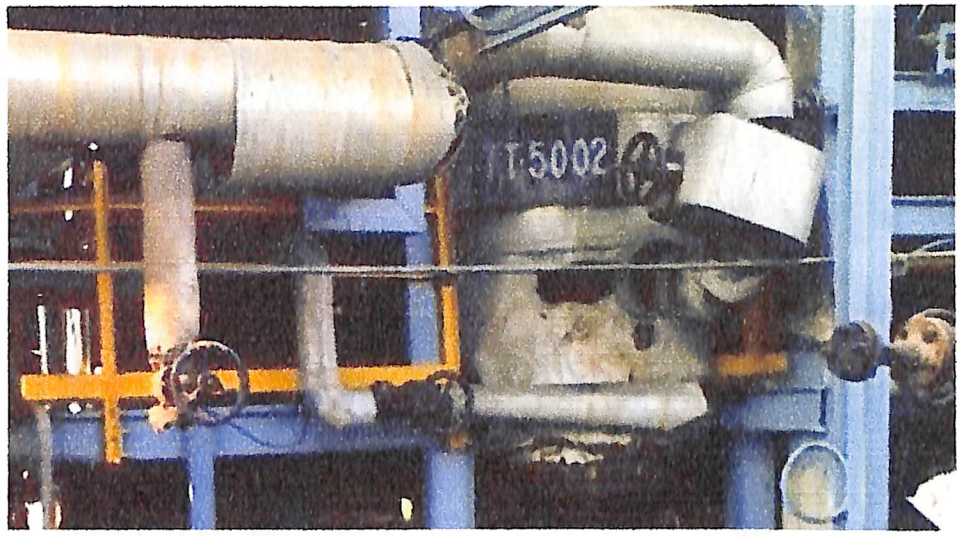


Fig5: Reboiler (TT- 5002/TT-5003 & TT-1016) before implementation of the COSHH project.

Action taken: Close loop draining system with Nitrogen and Demineralized water flushing.

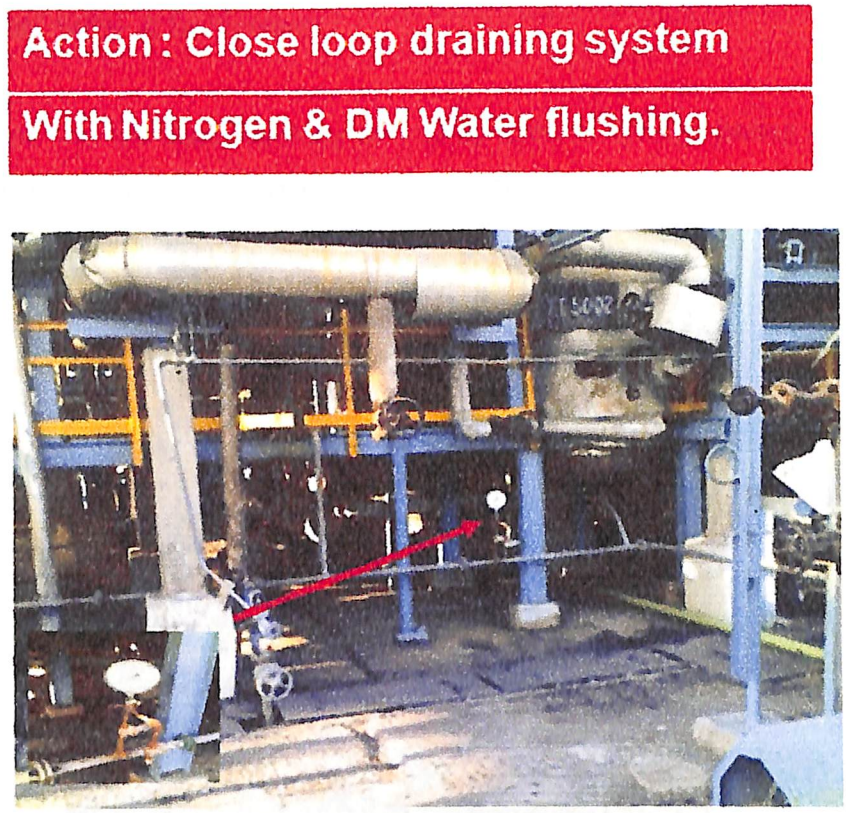


Fig6: Reboiler draining with Nitrogen & Demineralized water flushing (TT- 5002/TT-5003 & TT-1016) after implementation of the COSHH project.

Results Achieved:

(1) Elimination of hydrocarbon exposure to working personnel.

(2) Elimination of fire hazard.

(3) Recovery of hold up material.

(4) Health improvement.

(5) Environment improvement.

(5.3)Organic pump filter water flushing-

Hazard- Hydrocarbon exposure.

Aspect - Health, Safety & Environment.

Flushing system was not there, resulting in hold up material during opening of filter. It caused hydrocarbon exposure to working persons, increase in fire hazard potential, loss of hydrocarbon.

Fig7: Organic pump filter before the implementation of the COSHH project

Action taken: Close loop draining system with water flushing facility to TS.

Fig8: Organic pump filter water flushing after the implementation of the COSHH project.

Results Achieved:

(1) Elimination of hydrocarbon exposure to working personnel.

(2) Elimination of fire hazard.

(3) Recovery of hold up material.

(4) Health improvement.

(5) Environment improvement.

(5.4)PP 9001 A/S pump casing drain valve provision:

Hazard- Acrylonitrile exposure.

Aspect - Health, Safety & Environment.

There was hydrocarbon exposure to working personnel during maintenance of pump. It was an unsafe working condition. Chances of fire hazard also present. There was a loss of valuable product. It also had an impact on environment.

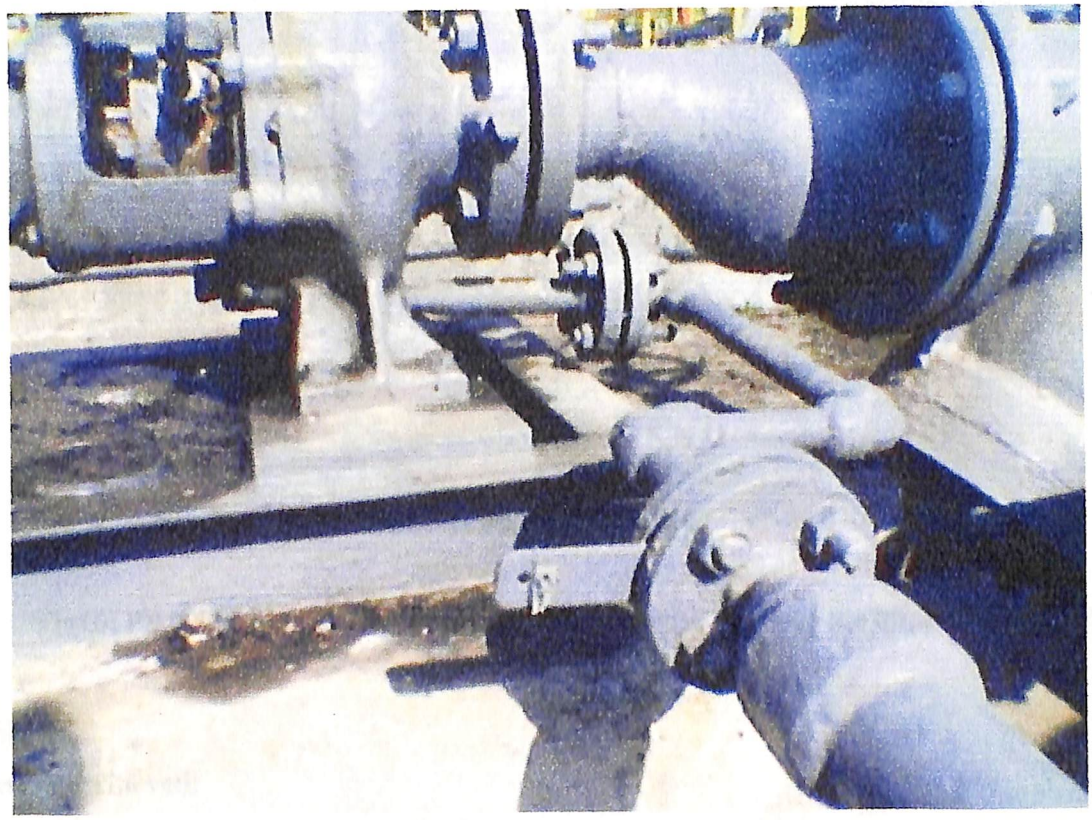


Fig 9: PP 9001 A/S pump casing before the implementation of COSHH project

Action taken: Isolation valve provided on pump casing drain line.

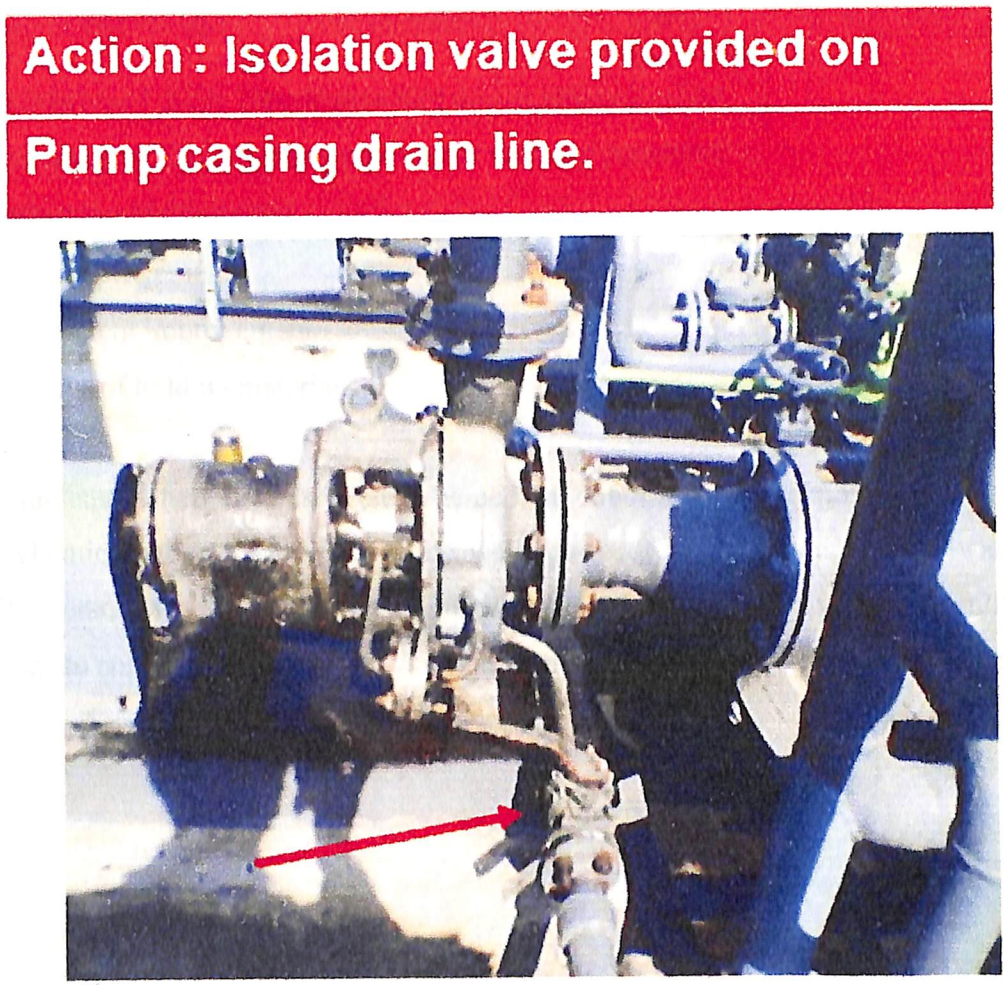


Fig10: PP 9001 A/S pump casing drain valve provision before the implementation of COSHH project

Results Achieved:

(1) Elimination of ACN exposure.

(2) Safe working condition.

(3) Product saved.

(4) Environment protection.

(5) Enhanced safety

(6)RESULTS AND DISCUSSIONS

The implementations of COSHH project at ACN Plant lead to:

- Elimination of ACN vapour exposure during tanker loading.
- Elimination of Hydrocarbon exposure to working personnel's.
- Elimination of fire hazard.
- Health improvement.
- Environment improvement.
- Recovery of hold up material.

Thus the implementation of this project helped in controlling the exposure of employees to hazardous chemicals that are handled at the work place. It also resulted in improved employee productivity. Persons working there had an improved morale, and worked with more enthusiasm. Overall it lead to enhanced safety at the workplace, and providing the workers a safe place to work.

(7)CONCLUSIONS AND RECOMMENDATIONS

Considering the ACN plant, a large number of toxic chemicals are released during production, loading and unloading, storage, maintenance etc. hence it becomes necessary to safeguard the personnel working from the toxic releases, fire hazards and various types of other hazards.

Various emissions lead to pollution of the environment, hence control measures are required to curb it.

The recovery of the hold up material is also necessary.

Thus it is concluded that COSHH project lead to the improvement in safety standards of the organization. It helped in increasing the confidence of personnel's working there towards the organization. Its implementation also increased the morale of the workers. It also lead to the improvement of the surrounding environment.

(8)REFERENCES

1. Industrial safety and pollution control hand book by NSC.

2. MSDS IPCL safety hand book and GE BETZ MSDS manual.

3. Occupational health and safety handbook by ILO.

4. Safety Manual IPCL Baroda Complex.

5. ACN Plant manual.

6. COSHH (NI): A brief guide to the Regulations. What you need to know about the Control of Substances Hazardous to Health Regulations (Northern Ireland) 2003 (COSHH (NI)).