ODOUR CONTROL IN PESTICIDE INDUSTRIES

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Received March 02, 2015
Accepted July 05, 2015

ABSTRACT

Air quality is affected not only due to conventional air pollutants but also due to unpleasant odour. Odour has distinctly different characteristics and is undoubtedly the most complex among air pollution problems. Odour or malodour, which refers to unpleasant smells, is now a day’s considered as an important environmental pollution issues. Till date, not much attention has been paid towards odour problems in India. India is the largest producer of pesticides in Asia. Odorous substances from pesticide industries are generally ammonia, chlorine, hydrogen sulphide, ozone, sulphur dioxide and mercaptans etc. This paper discusses the sources of odour in pesticide industries and some controlling methods.

Key Words: Odour pollution, Chemical compounds, Pesticide industries, Control technologies, Health impact

INTRODUCTION

Central pollution control board as well as Ministry of environment and forests, Govt. of India in their guidelines on odour pollution and control defines odour as the perception of smell or in scientific terms as a sensation resulting from the reception of stimulus by the olfactory sensory system. Whether pleasant or unpleasant, odour is induced by inhaling air-borne volatile organics or inorganic. Odour affects human beings in a number of ways. Strong, unpleasant or offensive smells can interfere with a person’s enjoyment of life especially if they are frequent and / or persistent. Major factors relevant to perceived odour nuisance are offensiveness, duration of exposure to odour, frequency of odour occurrence, tolerance and expectation of the receptor etc. Pesticides are defined as the substance or mixture of substances used to prevent, destroy, repel, attract, sterilize, stupefy or mitigate any insects. The word pest comes from the Latin word pasties which includes an animal or plant that occurs in such abundance as to present a distinct threat, economically or medically to man or his interest. A pest may be insect, fungus, weed, rodent, bacteria, virus, nematodes, acrid / mite, parasite and even animal or bird. Pesticides odours are basically toxics and persistence. Undesirable odour contributes to air quality concerns and affect human lifestyles. Odour is undoubtedly the most complex of all the air pollution problems. The study was conducted at pesticide industry in one of the industrial estate area in South Gujarat, India during September 2011 to May 2011.

DISCUSSION

The pesticides industries have grown by 7.6 per cent during last 20 years. Till 1971, the major production of pesticides was used for non-agricultural purposes. In subsequent years, more than 58 per cent of the production was consumed by the agricultural sector. It has also undergone a structural change from low value products to high value products. The major constituents of these industries are technical grade material manufacturers, formulators and dealers. Generally pesticides are used in three sectors viz. agriculture, public health and consumer use. The consumption of pesticide in India is about 600 gm /Hectare, where as that of developed countries is touching 3000 gm /Hectare. There is a wide range of pesticides found used in non agricultural situations such as industries, public health and for a number of purposes in the home.
Pesticide is manufactured as technical grade products and consumable pesticides are then formulated. The installed capacity of technical grade pesticide was 1,45,800 tones during March 2005 and the production in the financial year 2004-05 was 94,000 tones. The actual production during year 2001 to 2005 is presented in Table 1.

Table 1: Actual production of technical grade pesticides

<table>
<thead>
<tr>
<th>S/N</th>
<th>Financial year</th>
<th>Production (Tonnes/year)</th>
<th>Annual growth (%)</th>
<th>Overall annual growth (2004-05)/(2002-01)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2001-02</td>
<td>81,800</td>
<td>-14.9%</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2002-03</td>
<td>69,600</td>
<td>-15.3%</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2003-04</td>
<td>84,800</td>
<td>21.8%</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2004-05</td>
<td>94,000</td>
<td>10.8%</td>
<td>14.9%</td>
</tr>
</tbody>
</table>

Source: Annual Report of Ministry of Chemicals & fertilizers, Department of Chemicals & Petrochemicals

Odorous compounds and their sources
Odorous substances emitted from pesticide industrial processes, includes both inorganic and organic gases and particulate. Many odorous compounds results from biological activities or due to emissions from chemical processes. Most of the odorous substances derived from anaerobic decomposition of organic matter contain sulfur and nitrogen. According to Guidelines given by Central Pollution Control Board (CPCB), odorous substances emitted from any source will be regarded important in the context of odor pollution if they are dispersed in the surrounding area. Odour sources can be classified as follows. Point sources are confined emissions from vents, stacks and exhausts, area sources may be unconfined like sewage treatment plant, waste water treatment plant, solid waste landfill, composting, household manure spreading and settling lagoons etc., building sources of odour like pig sheds and hog confinement chicken and hog of odour, emissions are of fugitive nature like odour emissions from soil bed or bio-filter surface.

Air pollutants from pesticide
In general, process emissions can be classified into channelized and fugitive emissions. The channelized emission is a point source emission from process operations and the fugitive emission is an uncontrolled emission from storage tanks/drums, spills, leaks, overflows etc. In order to identify the various sources of process emissions and their control systems in pesticide industries a questionnaire survey and in-depth study of some pesticide industries should be conducted. The manufacturing process for a product is a combination of various unit operations and unit process. The material balance of the reactants and products gives the characteristics and quantity of emissions. However, their quantity is constrained by the efficiency of conversion of the system. Chances of pure process emissions of only one gaseous pollutant are very less. The process emissions are contaminated by other vapours of raw materials, solvents and also sometimes product of the unit operations. Theoretical emission of pollutants is difficult to compute. Very often during the unit operations wastewater and solid waste are separated, whereas waste gas is directly released from the reactions itself. It is observed that no process or production site is directly comparable to another.

Manufacturing process
Pesticides are produced by chemical reactions of organic materials, which seldom go to completion. The degree of completion of organic reaction is generally very much less than those involving inorganic reactions. The law of mass actions states that in order to transform one reactant fully, the other reactant must be present far in excess in weight than the stoichiometric requirement. As a result, the final mass of an organic reaction is associated with not only the desired product, but also untreated reactants and undesired products of side reactions or partially completed reactions. The manufactures of pesticide is hardly accomplished in one reaction in most cases, it involves various unit processes and unit operations. The important types of unit process (chemical reactions) and the important types of unit operations (physical) are shown in Table 2.
In each reaction state some raw material remain un-reacted, and some unwanted product are formed which remain in the system. Desired products are carefully recovered in each step from the system. Unwanted products are discarded, but not carefully. Some are vented out in the atmosphere. Impurities present in raw materials may also react with one another and in many cases show up as a scum, froth or tar or simply as un-reacted raw material. In order to understand generation of wastewater, solid waste and emission understanding of unit process and operation is required. Table 3 shows major odorous compound from pesticide industry. Table 4 shows odorous compounds, properties, exposure, type of odor and its health impact. Table 5 presents control technologies adopted in India.

### Table 3: Major odorous compound from pesticide industry

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Odorous compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acephate (pungent smell)</td>
<td>HCl</td>
</tr>
<tr>
<td>Dimethoate</td>
<td>H₂S</td>
</tr>
<tr>
<td>Cypermethrin</td>
<td>Cl₂, HCl and SO₂</td>
</tr>
<tr>
<td>Isoproturon</td>
<td>NH₃</td>
</tr>
<tr>
<td>Ethion</td>
<td>H₂S and C₃H₅SH</td>
</tr>
<tr>
<td>Malathion</td>
<td>H₂S</td>
</tr>
<tr>
<td>Phorate (rotteneggs)</td>
<td>H₂S and C₃H₅SH</td>
</tr>
</tbody>
</table>

### Table 4: Odorous compounds, properties, exposure, type of odour and its health impact

<table>
<thead>
<tr>
<th>Compound</th>
<th>Properties</th>
<th>Exposure &amp; odour</th>
<th>Health impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td>Colorless, stable at Room temp</td>
<td>TWA-50ppm, Ammoniacal strong, high corrosive in presence of Cu and its alloys</td>
<td>Exposure can cause Coughing, chest pains Difficulty in breathing</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Greenish Yellow gas, Extremely reactive</td>
<td>TLV-0.5 ppm, pungent suffocating bleach like odour</td>
<td>Can cause itching and burning of the Eyes, nose, throat</td>
</tr>
<tr>
<td>Hydrogen Sulphide</td>
<td>Colorless gas, stable, highly Inflammable</td>
<td>TWA-10 ppm, smell, of Rotten eggs</td>
<td>High toxic may be fatal if inhaled. Skin Contact may cause burns</td>
</tr>
<tr>
<td>Ethyl Mercaptan</td>
<td>Colorless gas, stable under normal storage condition</td>
<td>Odour threshold is 0.001 ppm</td>
<td>Highly toxic, affects The central nervous System</td>
</tr>
<tr>
<td>Sulphur Dioxide</td>
<td>Colorless gas, stable, incompatible with strong reducing or oxidizing agents,</td>
<td>TWA 2ppm, irritating pungent odor</td>
<td>Can cause fatal</td>
</tr>
</tbody>
</table>
Table 5: Control technologies adopted in India

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Control system</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCl (Hydrochloric acid)</td>
<td>Water/Caustic scrubber</td>
</tr>
<tr>
<td>Cl₂ (Chlorine)</td>
<td>Water/Caustic Scrubber</td>
</tr>
<tr>
<td>CH₃Cl (methyl chloride)</td>
<td>Incinerator</td>
</tr>
<tr>
<td>H₂S (Hydrogen sulphide)</td>
<td>Scrubber with NaOH media</td>
</tr>
<tr>
<td>NH₃ (ammonia)</td>
<td>incinerator</td>
</tr>
<tr>
<td>CH₃OH (methyl alcohol)</td>
<td>Adsorption Bed (Charcoal or molecular Sieve)</td>
</tr>
<tr>
<td>HBr</td>
<td>Caustic Scrubber</td>
</tr>
<tr>
<td>Mercaptan</td>
<td>Incinerator</td>
</tr>
</tbody>
</table>

Case study
The study was conducted at Gujarat Industrial Estate (GIDC), Gujarat, India. Survey was conducted during Sep. 2011 to May 2011. To measure the odour pollution different methods like instrumental methods and sensory methods (olfactometry) are famous. For study purpose instrumental method was adopted. By sensing the odour VOC meter was used to record the VOCs present at different locations. Set 1 presents the concentration of VOCs during night hours and set 2 presents the concentration of VOCs during day hours.

The survey was conducted by visiting odorous locations and VOCs were recorded at different locations during day and night hours. Some observations are listed below:

- Incineration system appeared not confirming to the standards laid down in consent of order. The residence time of primary and secondary combustion chambers got tested and was not found sufficient for complete incineration.
- It appeared that the parameters like HC, CO, TOC, HF, mercaptans, pyridine and methyl chloride were not monitored. For treating emission gases, incineration system and wet scrubbers were installed. The systems to control the odour required to be checked for the efficiencies and maintenance.
- During night visits there was profuse leakage of odorous gases giving nauseating and vomiting sensation.
- Raw materials were emitting odour and were stored in sides open sheds.
- Concentrated odour of H₂S was felt at production site.
  - Containers washing area was open, adding strong unpleasant odour in atmosphere.
  - Plantation inside premises as well as near compound walls was very poor.
  - Open belt conveyor was used to feed solid waste in incinerator.
  - Odorous zone was found at ETP, the influent temperature was more than 56°C and cooling tower was not functioning well.

RECOMMENDATIONS
During manufacturing, formulating and packaging processes emissions of Volatile Organic Compounds (VOCs), were responsible for odour nuisance. Some of the measures suggested for the reduction of VOCs are discussed below:

- Consider use of non-halogenated and non-aromatic solvents (viz. ethyl acetate, alcohols and acetone) instead of more toxic solvents (viz. benzene, chloroform and trichloroethylene)
- Use close batch reactors and close feed systems with control operating temperatures.
- Install nitrogen blankets on pumps, storage tanks and during formulation processes.
- Install process condensers after process equipments to support a vapour to liquid phase change and to recover solvents.
- Use close and air tight area for cleaning of reactors, washing of drums and other equipments.
- VOC vapours generated from solvent handling activities and processes should be
controlled by connecting it to air control devices.

- In wet scrubbers or gas scrubbers, with application of water, caustic and acidic scrubbers systems mixing of Hypochlorite solutions was recommended to reduce odour nuisance.
- Activated carbon adsorption was suggested to achieve VOC removal efficiency up to 95-98% even thermal oxidation/ incineration system can was suggested for 99.99% removal of VOCs.

- Nozzles, sprayers and atomizers that spray ultra-fine particles of water or chemicals along the boundary lines and area sources were suggested to suppress odour.
- More stress was emphasised on Green Belt Development. Fig. 1 presents the concentration of VOCs at different locations before and after remedial measures.

**Fig. 1**: Concentration of VOCs at different locations before and after remedial measures

**Green Belt Development**

Green belts are used to form a surface capable of absorbing and forming sinks for odorous gases. Plants which counteract odour are bushes with mild but active fragrance. *Acacia farnesiana* (Mexican plant). It is a type of bush with yellow coloured fragrant flowers. It does not have rich canopy but very effective for counteracting smell. Its limitation is seasonality and thorny nature plants suggested were:

- Melaleuca species: It has sweet fragrance and thin canopy.
- Pine, cedar, junipers for their excellent canopy and protection.
- Eucalyptus is as very good belt and good odour source.
- Hedges, herbs (tulsi, turmeric etc.) for counteracting odour.

- Vetiver: This plant is a king of perfumes for inactivating other odours. It affects the nervous system and relieves fatigue. It is used as key species in aromatherapy was suggested near office and work areas.

**CONCLUSION**

In unpleasant odour situations, it is essential to install air pollution control and odour control systems. These systems often mask the disagreeable smell with a stronger more pleasant scent, though this is a temporary solution. Alternatively, odour controls may neutralize them by absorbing them with specially configured powders, sprays and filters. Odour control systems should be installed in all environments in which unpleasant scents lead to direct or indirect impingement on quality of life and product. Application of sprays, filters or granules with...
different chemical compounds for attack and dissipate Volatile Organic Compounds (VOCs) that produces odour. Granules made of porous materials such as activated carbon to dissolve odour are useful. The latter and more permanent solution is to have very thick and leafy plantation.

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