OCCUPATIONAL HEALTH EFFECTS OF EXPOSURE OF LPG AND PROPANE ON HUMAN

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ABSTRACT

To know the effect of released hydrocarbon on the loading operators their medical checkups were done in three different seasons. The result shows that the workers exposed to the LPG and Propane vapours during tanker loading activity for prolonged period (six months) are having higher cholesterol level and it is reversible when they are shifted to the area where there are no vapours of hydrocarbon available in working atmosphere. The study also helped to know the extent of energy loss and revenue loss as well as the method to minimize the loss of hydrocarbon in atmosphere during loading and unloading of tankers thereby limiting the exposure of the operators to hydrocarbon vapours.

INDEX TERMS: Rotogauge, Occupational health, Hydrocarbon, Different seasons, Operators, Tankers

1. INTRODUCTION

Rotogauge is a device which is used to measure the volumetric quantity of liquid level inside the pressurized container. The release of hydrocarbon from the rotogauge cannot be contained and is allowed to disperse in the atmosphere. (Ref #). In India Loading and unloading operation of the Liquefied Petroleum Gas (LPG) and Propane tanker is done with manual intervention to know the liquid level content inside the tank of the tanker lorry. Loading and unloading operation of Liquefied Petroleum Gas (LPG) and Propane tanker is carried out with intermittent checking of liquid level inside the tank with the help of rotogauge (Ref #). Rotogauge is a devise fitted in the tanker which is useful in measuring the liquid level inside the tanker in terms of percentage. In the present scenario the rotogauge helps to determine the liquid level inside the tank and liquid level inside the tank is
ensured. (Maximum allowable liquid level is 95% and Vapour space of 5% is left) (Ref *).

Hydro carbon is released in the atmosphere through rotogauge (Ref photo @) while loading of LPG and Propane in the tankers contributes occupational health problems to the workers, greenhouse gas effect (Ref $) as well as revenue loss though it is insignificant in case of one tanker but it is significant if we consider loading and unloading of tanker at National level per day and Organizational level per year. In order to overcome the problem of releasing of hydrocarbon through rotogauge (for measuring liquid level inside the tanker) it is necessary to study this topic in detail along with the effect of these hydrocarbons on the workers working in that area. The photograph of releasing of LPG / Propane from rotogauge is given below –

2 Steps used in the research

Photograph of Road tanker which is used for loading, unloading and transportation of LPG & Propane is given below

(@) HYDRO CARBON TANKER WITH ROTOGAUGE

(©) HYDRO CARBON TANKER WITH ROTOGAUGE

ROTOGAUGE

The study is designed at every stage keeping in view of the following objective

To study the filling mechanism of LPG as well as Propane tankers - Detail study is carried out regarding loading and unloading operation of LPG and Propane in the tankers at various locations of GAIL (India) Limited as well as other petroleum installations. Standard operating procedures are collected.

To estimate the quantum of hydro carbon released in atmosphere through rotogauge while checking the liquid level of hydrocarbon inside the tankers – Discharge rate of hydrocarbon (i.e. LPG and Propane) through 2 mm diameter size hole of rotogauge is determined theoretically with the help of software available (Ref ©) as well as same is crosschecked practically by collecting the discharge through rotogauge in the sampling balloon. The exact quantity of hydro carbon released through rotogauge is established for one tanker with the help of differential weight of sampling balloon. Data for number of LPG and Propane tankers loaded (at GAIL Vijaipur) during last three years is collected for calculating the quantity of unburnt LPG and Propane released in atmosphere.

To study the occupational health effect of VOC’s (volatile organic compounds) on the loading operators who are involved in loading operations of these tankers over a period of different seasons. Use of mathematical modeling to study the of the release of hydro carbon over a years with respect
to occupational health effect due to exposure to the operator as well as on the organization economy. To suggest the recommendations for overcoming the problem of release of LPG and Propane in atmosphere/application of technology

2. RESEARCH METHODOLOGY ADOPTED

2.1 Theoretical Framework

At present in India there are about 10,400 tankers (LPG + Propane) having valid license to carry/transport compressed hydrocarbon from Petroleum and Safety Organisation (formerly Chief Controller of Explosive). These tankers are being filled and emptied out regularly at different locations in India. All these tankers are having the liquid level measuring device called ROTOGAUGE. While filling as well as emptying out these tankers, the standard practice is to open the Rotogauge screw to check the level of tank in terms of volumetric percentage (Please see photographs of procedure displayed at loading gantry is enclosed). Particularly while filling the tankers, the liquid level content is being monitored at least three times by opening the Rotogauge (approximately hydrocarbon is being released in the atmosphere for total 1 minute through rotogauge). During opening the Rotogauge liquid hydrocarbon is coming out in the form of mist (containing liquid as well as vapours). While loading of these tankers, operator has to ensure that the liquid level of LPG/Propane inside the tanker should not exceed 95% (Ref *). For ensuring the same, operator fixed the rotogauge indicator at 95% mark, so that whenever liquid level reaches that mark, LPG/Propane in the liquid form starts coming out from the 2 mm diameter size orifice of rotogauge. Moreover while doing this measurement the operator is standing very near to the rotogauge device for operating it.

The proposed study is undertaken to see the occupational health effects on the loading workers due to inhalation of hydrocarbon mixed air, estimate the impact on greenhouse gas emission and revenue loss due to release of hydrocarbon in the atmosphere.

3.1 Source of Data

Data for study will be collected from various sources like –

3.1.1 Data collection for standard operating procedure for loading of tankers is taken from ISO manual of GAIL (India) Limited Vijaipur.

3.1.2 Visual inspection with photographs in support of confirming the loading procedure is taken from loading gantry of GAIL (India) Limited Vijaipur.

3.1.3 Quantity of hydrocarbon tankers (i.e. LPG and Propane only) is derived from the official website of Petroleum and Safety Organisation (formerly Chief Controller of Explosives).

3.1.4 Material Safety Data sheets and contribution of unburnt hydrocarbon in greenhouse gas emission through various web sites.

3.1.5 Average price of industrial LPG and Propane is collected from GAIL’s data bank.(through ERP-SAP)

3.1.6 Medical records of the sample loading operators having different years of experience and different age group.

3.1.7 Use of ALOHA software for carrying out the mathematical modeling.
4. SAMPLING

4.1 The data for the study is collected from existing standard operating procedures of loading activities.

4.2 Data pertaining to number of tankers state wise is taken from the official web site of the Petroleum and Safety Organisation (formerly Chief Controller of Explosives).

4.3 Crosschecking of the amount of LPG and Propane release in the atmosphere through 2 mm diameter rotogauge hole is done with the help of collecting the content in the sampling balloon and its differential weightment.

4.4 Survey is carried out for standard tanker loading practices in the other installation so as to determine the impact on health of workers as well as revenue loss at Organizational level on yearly basis.

4.5 Blood sample checking and clinical examination of the fixed workers of different age and different years of exposure.

5. FINDINGS AND CONCLUSION

(A) The occupational health effect after prolonged exposure to Hydro carbons were studied and results are as under -

5.1 Loading operators of different age groups were selected.

5.2 Clinical examination of the operators conducted.

5.3 Total 7 operators each deployed for loading operations in LPG and Propane tanker loading gantry.

5.4 After a period of six months, pathological tests conducted for certain parameters.

5.5 Following precautions taken during study period for the operators –

5.6 Living conditions were monitored.

5.7 Regular food intake of operators.

5.8 Proper scheduling of duties and rest.

5.9 Pathological tests were conducted at the end of first six months.

5.10 Duty locations of all the operators were changed where there is no release of hydro carbon during normal operational activity for next six months.

5.11 Again pathological tests were conducted after the completion of six month at new work location.
Result – The change in lipid profile of almost all the operators were noticed. The total cholesterol level was decreased thereby decreased the risk factor.

5.12 In order to verify the outcome again all the operators were sent back to the loading gantries for next six months and at the end medical tests were conducted.

Result – The change in lipid profile of almost all the operators were noticed. The total cholesterol level was increased thereby increased the risk factor.

5.13 Again duty locations of all the operators were changed where there is no release of hydrocarbon during normal operational activity for next six months.

Result – The change in lipid profile of almost all the operators were noticed. The total cholesterol level was decreased thereby decreased the risk factor.

5.14 When operators were exposed to the hydrocarbon during the winter season, then there is more effect on lipid profile.

5.15 The effect of hydrocarbon on lipid profile (cholesterol) of human being is found to be reversible when exposure duration and quantity is reduces.

The data for exposure of loading operators during three different seasons were measured. Area monitoring were done in three different seasons to know the level of various environment polluting parameters like SPM and Presence of Hydrocarbon traces and for the study total 15 loading operators (three groups of different age range i.e. 21 yrs – 30 yrs; 31 yrs – 40 yrs and 41 yrs – 50 yrs) were monitored for the following parameters –

- Blood cholesterol level.
- Ergonomic postures while doing loading operations.
- Various symptoms like cold, cough, headache, dizziness etc.
- Habits while working.
- Alertness of the operators.

Based on the collected data it is concluded that –

1. For Age group 21 yrs – 30 yrs
   - Cholesterol level was found increased.
   - They were complaining regarding intermittent pain in the right side potion of their body particularly right groin and shoulder.
   - Teeth colour found change from White / off white to Reddish spots due to continuous chewing of tobacco or tobacco product.
   - Mild headache at the end of shift.

2. For Age group 31 yrs – 40 yrs
   - Cholesterol level was found increased including triglycerides.
   - They were complaining regarding pain in the right side potion of their body particularly right groin and shoulder during morning.
   - Teeth colour found change from White / off white to Reddish spots due to continuous chewing of tobacco or tobacco product.
   - Mild headache at the end of shift.
   - No sensation for ethyl mercaptan smell.
3. For Age group 41 yrs – 50 yrs

- Cholesterol level was found increased including triglycerides.
- They were complaining regarding pain in the back and thigh muscles.
- Teeth colour found change from White / off white to Reddish cum blackish spots due to continuous chewing of tobacco or tobacco product.
- Cold during morning.
- These age group operators suffered from fever 4 to 6 times during study may be due to deteriorating immune system.
- No sensation for ethyl mercaptan smell.

<table>
<thead>
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(B) Use of mathematical modeling to study the of the release of hydro carbon over a years with respect to occupational health effect due to exposure to the operator as well as on the organization economy
Mathematical modeling for the release of hydrocarbon (LPG and Propane) is done with the help of ALOHA Software for the following parameters.

<table>
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<tr>
<th>Parameter</th>
<th>LFL (%)</th>
<th>UFL (%)</th>
<th>MFL (%)</th>
<th>LEL (%)</th>
<th>UEL (%)</th>
<th>MEL (%)</th>
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<td>MFL</td>
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<td>UEL</td>
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<td>90.1</td>
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<td>90.1</td>
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<tr>
<td>MEL</td>
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<td>31.3</td>
<td>31.3</td>
<td>31.3</td>
<td>31.3</td>
<td>31.3</td>
<td>31.3</td>
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</table>

- LFL: Lower Flammable Limit
- UFL: Upper Flammable Limit
- MFL: Median Flammable Limit
- LEL: Lower Explosion Limit
- UEL: Upper Explosion Limit
- MEL: Median Explosion Limit
The result of the study with respect to contribution of unburnt LPG and Propane (due to release from rotogauge) in occupational health effects on the workers, in greenhouse gas emission as well as revenue loss over a period of time is calculated and found that –

Sample calculation for the revenue loss & energy loss due to discharge of LPG and Propane in the atmosphere during loading activity at GAIL Vijaipur is summarized below –

- Discharge rate of LPG & Propane from 2 mm diameter hole of rotogauge = 0.085 Kg / Min.
- No of LPG + Propane tankers loaded at GAIL Vijaipur in the year 2012 = 16089.
- Total amount of Hydro carbon discharged through rotogauge in the year 2012 at GAIL Vijaipur = 0.085 x 16089 = 1367.56Kg.
- Average cost of LPG in the year 2012 = Rs. 36,766.9 per MT.
- Revenue loss for GAIL Vijaipur only for LPG for the year 2012 = 1.36x 36,766.9 = Rs. 50281.12
- Calorific Value of LPG / Propane = 11950 KCal/Kg (50032.26 KJ/kg).
- Total amount of Hydro carbon discharged through rotogauge in the year 2012 at GAIL Vijaipur = 1367.56Kg.
- Energy loss for GAIL Vijaipur only for LPG & Propane for the year 2012 = 11950 x 1367.56 = 16342342 Kcal = 68422117 KJ.

6. STUDY OF LITERATURE

As far now with the best of information research in the same / similar field is not undertaken. Same is confirmed from NFSC, NCDC, DIFR, DGFAISLI (Directorate General, Factory Advice Service and Labour Institutes) etc. However following literature is reviewed which is tabulated below with brief summary.

6.1 Greenhouse gas emission by Dr Lawrence Leung. The detail study is done regarding the projection of fugitive greenhouse gas emission to 2020.

6.2 Fuels and combustion by Bureau of energy efficiency. Introduction to fuels, properties of fuel oil, coal and gas, storage handling and preparation of fuels, preparation of fuels, principles of combustion, combustion of oil, coal and gas.


6.4 Meteorological data from meteorological department for temperature, humidity, wind speed and wind direction in different seasons.

6.5 Energy sector overview by the international energy outlook 2005 gave insight about Reserve of hydrocarbon and its consumption pattern.

6.6 OISD GDN 161 regarding LPG tank truck incidents which gives Guidelines for handling emergencies arising out of LPG Tank Truck (TT) incidents.

6.7 Composition of LPG by Indian author gave insight regarding detail properties of LPG and energy need for India.
6.8 Design of LPG and propane tankers by Functional Committee of Oil Industry Safety Directorate gave in-depth design criteria for bullets along with material specifications, fittings, mounting etc for transportation of LPG in bulk by road.

6.9 National Energy Map for India by TERI for estimated energy demand Production of primary sources of conventional energy in India.

6.10 Likely consequences of events on release of LPG by Dr S S Gautam and P K Saxena for Survey of criticality of risk from LPG storage tanks at user sites.

6.11 Loading procedure of LPG road tankers from ISO manuals of GAIL India Limited for studying Detail procedure and operation of rotogauge.

6.12 Loading procedure of LPG rail wagons from ISO manuals of GAIL India Limited for studying detail procedure for measuring the inside content.

6.13 OISD Guideline 144 for design layout of plants wherein details regarding Safety requirements on design, layout, storage, loading / unloading, operation, inspection & maintenance, fire protection, emergency planning and safety audit systems of LPG Installations.

6.14 OISD Guideline 151 for design aspects of tank lorries for Safety in design, fabrication and fittings of propane tank trucks.

6.15 OISD GDN 158 for Handling of bulk petroleum gas gives insight about Operation of equipment and facilities connected with storage and handling of LPG at Gas Processing Plants, Refineries and other Bulk Handling installations. Some basic concepts for design and construction of such facilities.


6.17 Lung Function and Bronchial Reactivity in Asthmatics during Exposure to Volatile Organic Compounds by Institute of Environment and Occupational Medicine, University of Aarhus, Aarhus, Denmark. In this book study was done to investigate whether vapors of organic solvents at low concentrations could exert an adverse effect in the lower airways. Under controlled conditions in a climate chamber.

6.18 Effect of LPG on human being by US Department of health and human services. The details regarding MSDS, monitoring and measurement procedures are studied.

6.19 Hazards of LPG by Major Hazard control by ILO wherein Fire, explosion and BLEVE conditions during release of LPG are studied.

6.20 Chemical process safety by Roy E Sanders. Various case studies are discussed.

6.21 Chemical process safety by Danial A, Crowl, Joseph F, Louvar. Different source models are studied.


6.24 Three cases of sudden death due to butane or propane gas inhalation: analysis of tissues for gas components by Hideaki Sugie, Chizuko Sasaki, Chikako Hashimoto, Hiroshi Takeshita, Tomonori Nagai, Shigei Nakamura, Masataka Furukawa, Takashi Nishikawa, Katsuyoshi Kurihara.

6.25 ATYPICAL COMBINATION-ZOPICLONE AND LPG IN A CASE OF PLANNED COMPLEX SUICIDE by I.C.Prodan, I. Fulga, C.L. Chitecsu, N. Dobrovici-Bacalbasa, C. Georgescu, V. Ardeleanu, D.Perju-Dumbrava. The autopsy findings together with zopiclone and the gas analysis results revealed that the cause of death was anoxic asphyxia following liquefied petroleum gas (LPG) inhaling.


6.29 Exposure of Laboratory Mice to Domestic Cooking Gas: - Implications for Toxicity.


Occupational health is closely linked to public health and health systems development, and WHO is addressing all determinants of workers’ health, including risks for disease and injury in the occupational environment, social and individual factors, and access to health services. WHO is implementing a Global Plan of Action on Workers’ health 2008-2017 endorsed by the World Health Assembly in 2007 with the following objectives:

- devising and implementing policy instruments on workers’ health;
- protecting and promoting health at the workplace;
- improving the performance of and access to occupational health services;
- providing and communicating evidence for action and practice; and
- incorporating workers’ health into other policies.

Further information about the work of WHO in the area of occupational health is available at: http://www.who.int/occupational_health/about/en/index.html.


7. BIBLIOGRAPHY

7.1 @ - Photographs taken during loading operation of LPG and Propane Tanker.

7.2 $ - http://en.wikipedia.org/wiki/Propane

7.3 * - OISD standard 159- LPG tank truck design / fabrication and fitting.

7.4 + - http://www.worldofmolecules.com/fuels/propane.htm

7.5 (¥) – http://www.cypenv.org/world/Files/methane.htm

7.6 (©) – http://www.mechengcalculations.com/index.html

7.7 # - Standard Loading procedure of LPG and Propane Tankers given in ISO:9001 Manual as well as displayed in the loading gantry at GAIL Vijaipur.

8. ABBREVIATIONS

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<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>LPG</td>
<td>Liquefied Petroleum Gas</td>
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<tr>
<td>ISO</td>
<td>International Standardization organization</td>
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<td>GAIL</td>
<td>Gas Authority of India Limited</td>
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<tr>
<td>OISD</td>
<td>Oil Industry Safety Directorate</td>
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<td>PESO</td>
<td>Petroleum Explosive and Safety Organisation</td>
</tr>
<tr>
<td>CCOE</td>
<td>Chief Controller of Explosives</td>
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<tr>
<td>PSV</td>
<td>Pressure Safety Valve</td>
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<td>VOC</td>
<td>Volatile Organic compound</td>
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9. AUTHORS

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