GASOLINE VAPOUR RECOVERY SYSTEM

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Abstract – *Gasoline emissions in service station is one of the biggest issues that people are taking it under consideration , because the rate of the gasoline emissions are very high backs to the high temperature rates. Gasoline emissions should also be taking seriously because the high value of gasoline. These emissions contribute to the formation of smog and the control of these emissions has been applied internationally for some years. Vapor recovery is the preferred control technology after prevention and minimization. Gasoline vapour recovery system is a system to capture the vapours of gasoline so that it does not escape into atmosphere. The vapours are converted into liquid gasoline and again fed to the tank. The system is mainly applied to large storage tanks where there is huge emission of gasoline vapours.*

Key Words: Gasoline Vapour Recovery System, Air pump, Heater, Storage tank, dehydrating agent

1.INTRODUCTION

Gasoline is a transparent, petroleum-derived liquid that is used primarily as a fuel in internal combustion engines. It consists mostly of organic compounds obtained by the fractional distillation of petroleum, enhanced with a variety of additives. A 42-gallon barrel of crude oil yields about 19 gallons of gasoline, when processed in an oil refinery.

Gasoline is a commodity used worldwide. During its use, carbon dioxide, nitrous oxides and hydrocarbons are emitted as a result of combustion processes taking place in a vehicle. Further emissions, consisting of hydrocarbons, take place during the storage and distribution of gasoline due to evaporation.

The hydrocarbons emitted during gasoline storage and distribution can be broadly classified as volatile organic compounds (VOCs). VOCs make up a major class of air pollutants and are a brad collective term for different organic compounds. These include pure hydrocarbons, partially oxidized hydrocarbons and organics containing chlorine, sulfur and nitrogen; with most VOCs being toxic and/or carcinogenic

Gasoline, as used worldwide in the vast number of internal combustion engines used in transport and industry, has a significant impact on the environment, both in local effects (e.g., smog) and in global effects (e.g., effect on the climate). Gasoline may also enter the environment as uncombusted, as liquid and as vapors, from leakage and handling during production, transport and delivery, from storage tanks, from spills, etc.

Volatile organic compounds (VOCs) are among the most common air pollutants emitted by chemical process industries, and include hydrocarbons such as olefins, paraffin and aromatics. VOCs adversely affect air quality as it is one of the precursors of ground level ozone (GLO), the primary component of smog. It can also have a negative impact on human health due to its toxicity. During gasoline storage and distribution, VOCs are emitted due to evaporation, where the rate of evaporation depends on factors such as the vapor pressure of the liquid, temperature and turbulence.

Besides being an environmental hazard, these fugitive VOCs emissions actually cost lot money. So by minimizing the escaped vapors from bulk storage at marketing depot and the storage tank at service station we maximize the profits of the owners of the marketing depot and the service station.

Once released into the atmosphere VOC can react in the presence of sunlight with nitrogen oxides emitted from combustion processes to form ground level ozone and other components of photochemical smog. The potential impacts of ground-level ozone include reduced lung function, increased incidence of respiratory symptoms, respiratory hospital admissions and mortality. Ground-level ozone can also cause damage to many plant species leading to loss of yield and quality of crops, damage to forests and impacts on biodiversity. Benzene is a VOC and a component of petrol. It is also a known human carcinogen and is associated with a heightened risk of illnesses such as leukemia.

2.DESIGN OF THE SYSTEM

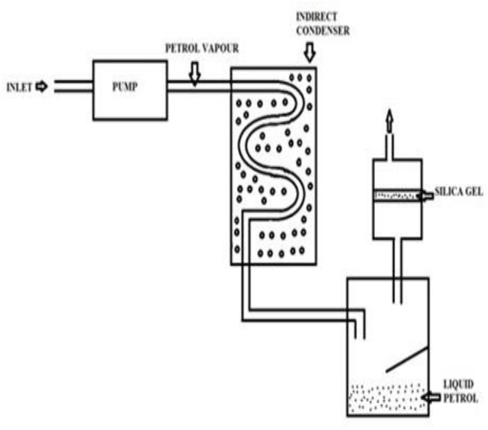

Figure 1. Gasoline Vapour Recovery System

2.1Basic frame

Determining the design for the basic frame for assembling the components and thus make it more portable. The basic frame is made using scrap iron to make it more economical.

Figure 2. Basic Frame

The main components used in our project are a positive displacement pump, a heater and a condenser.

2.2 Positive displacement pump

A positive displacement air pump is used to pump the vapour from the tank to the condenser .A pump of 0.012MPa pressure, 3.5W power and2*3.2L/min output is selected for the same.

Figure 3. Positive Displacement Pump

2.3 Heater

Due to limitation of tank size, sufficient amount of gasoline vapour will not be present for demonstrating our project. So a simple heater is made using PVC pipe to heat the gasoline and form sufficient amount of vapour for demonstration purpose.

2.4 Soldering Iron

A simple Soldering Iron used for soldering is used as the heating element in the heater. Heating up to 623K can be done using this soldering iron.

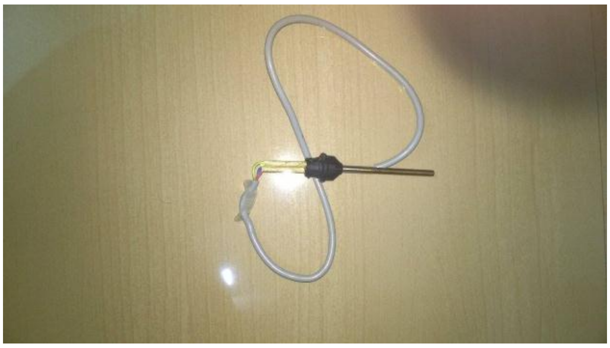

Figure 4. Soldering Iron

Figure 5. PVC Pipe

2.5 Condenser

A simple indirect condenser is used to cool the gasoline vapour. The condenser is made using copper tubes and thermocol box packed with ice.

Figure 6. Themocol Box with Coiled Tube

2.6 Measuring Devices

a) Stopwatch

A stopwatch is used to measure the time taken for the gasoline vapour to get converted to liquid gasoline. The time taken for different quantities of gasoline is taken.

b) Measuring Flask

A 1000 ml measuring flask is used to measure the quantity of liquid gasoline used for experimentation.

3. METHODOLOGY

Gasoline vapours are collected by pump and transferred to indirect condenser. Indirect condenser is an arrangement which contains copper tube with fins and ice cubes inside a box. Vapours are condensed to a low temperature. Vapours changes to liquid state as a result of cold condition inside tube. Finally liquid petrol flows to the tank. Silica gel or calcium chloride is used as dehydrating agents to remove moisture content.

4. FABRICATION OF THE SYSTEM

For the fabrication of the system we need a basic frame, an air pump, a simple heater, condenser and a coiled copper tube. The use of the frame is to assemble the components used in our mini project. The frame is made using scrap iron to make it more economical. A frame is fabricated with provision to hold the condenser, heater, air pump and petrol storage tank in a most effective way and it is fabricated using welding process.

The working principle of our project is simple, ie, collecting the gasoline vapors from the tank and condensing these vapours in a condenser resulting in formation of liquid gasoline. There will be sufficient vapours present in the large storage tanks. But due to limitation of tank size sufficient vapours will not be present for demonstration purpose. This made a problem for demonstrating our project in the college. So we thought of ways to make sufficient vapours for demonstration purpose. We have planned to supply hot air to the gasoline in order to make it vaporize. The next problem encountered is regarding the way to heat the air. We found a solution by designing a simple heater using PVC pipe and soldering iron as heating element. The heat produced by the soldering iron is sufficient for heating the air for our purpose.

The next problem faced was how to supply air to the simple heater. So we used a positive displacement air pump for supplying the amount of air needed for us. A pump of 0.012MPa pressure, 3.5W power and2*3.2L/min output is used for the same.

We need a simple condenser to cool the gasoline vapours coming from the storage tank in a most economical way. A thermocol box used as the condenser which can hold the ice without melting for three to four hours. Coiled copper tubes are used to transfer gasoline vapours through the condenser.

A small tank used in automobile is selected as the gasoline storage tank as it will be strictly sealed so that no vapors can escape out of the tank.

The air from the air pump is transferred to the heater using pipes of small diameters. A hole of size equal to the diameter of the pipe is made to one end of the heater to transfer air from pump to the heater. As the air coming out of the heater is hot, a pipe that has the ability to withstand high temperature is used to transfer hot air from the heater to the condenser. The pipe from the heater is connected to the storage tank containing sufficient amount of gasoline. The gasoline vapours formed are transferred from the tank to the condenser using small diameter pipes and connected to the coiled copper tubes placed in the condenser. The other end of the copper tube is connected to a small vessel to store the liquid gasoline. All the holes and air gaps are tightly sealed using M seal

Figure 7. Experimental Setup 1

Figure 8. Experimental Setup

5. EXPERIMENTATION

Before starting the experiment 50 ml of gasoline is measured and filled into the copper tube inside the condenser. This process is achieved with the help of a syringe of 20 ml capacity. This is done to eliminate the presence of air molecules inside the tube and to create a negative pressure so that gasoline vapours can be initiated with a flow. After a few minutes the power supply was given. The pump starts to supply the air and it passes to the heater setup. The soldering iron fixed in the heater starts to heat the air. To achieve better heating efficiency the valve place at the outlet of the gasoline storage tank is kept closed. So the air starts to circulate inside the heater and heats at a faster rate. After 20-25 minutes the closed outlet is opened and the main delivery valve is being closed. Now the hot air moves into the copper tube inside the condenser where the primed gasoline is present. After a few minutes say 15 minutes the delivery valve is opened. Now carefully collect the primed gasoline and close the delivery valve again. Now the gasoline vapour inside the condenser starts to condense. Wait for few minutes and slowly open the delivery valve. The condensed gasoline starts to flow through the delivery valve.

Figure 9. Condensing System

Fig10. Modified Experimental Setup

6. RESULTS AND DISCUSSION

This experiment was performed with a goal to analyze the rate of condensation of gasoline vapour in the most economical way. Here we converted liquid gasoline into vapour in the initial stage and collected this vapour and condensed to recover the liquid gasoline. Here are the following results:

Amount of gasoline stored in the storage tank = 500ml

Amount of gasoline used for priming the tube = 50ml

Amount of gasoline collected from the primed gasoline = 40-43ml

Amount of gasoline collected at the end of the experiment = 12 ml

Time taken for collecting this recovered gasoline = 227 min

From this experiment we obtained the result that only a negligible amount of gasoline is recovered and the efficiency of the system is too low.

The various reasons for the inefficiency are:

1. Lack of formation of sufficient vapours.
2. Higher pressure developed in the storage tank leading to less evaporation.
3. The valves used were not completely air tight.
4. Leakages were formed as a result of pressure rise in the joints.
5. The Geometry of gasoline storage tank also affected the formation and flow of gasoline vapours.

7.CONCLUSIONS

In this study we analyzed the rate of condensation of gasoline vapour and the obtained results were not satisfactory. The various reasons for the inefficiency of the system is found.

a) Temperature sensors will be installed in the inlet and outlet valve to measure the condensation point of gasoline and the temperature gradient formed in the inlet and outlet of the heating chamber.
b) To install a more efficient gasoline storage tank to create more turbulence inside it.
c) To determine whether to replace the current heating system according to the obtained results from the above steps.
d) To replace the valves which provide much better air tight sealing system

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