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A Comprehensive Study on Petrol Vapours based Gas Sensors

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Abstract: ***There are different semiconducting metal oxide sensors (SMOs) have employed to detect parts per million concentration of inflammable gases like liquefied petroleum gas (L.P.G), Ethanol (C_2H_5OH), Methanol (CH_3OH), ammonia and Petrol vapours. Among all Petrol vapours are dangerous and Hazardous. Therefore a lot of attention has needful and necessary to build a proper type of sensors for Petrol vapours. This article is an effort in contribution of bringing attention and focus in the direction of what type of gas sensors are available for petrol vapours. It summarizes operating temperature, selectivity, response time and sensitivity of sensor materials for Petrol vapours***.

Keywords: Petrol vapours, gas sensors, inflammable gases, response time etc.

I. INTRODUCTION

Nature is surrounded different types of gases with major to minor concentrations, as nitrogen present in atmosphere 97% to different gases like inert gases are in ppm level. But some gases are produced due to secondary reactions or result from primary source. In Earth crust, petroleum is present with its reservoir containing petrol, diesel and kerosene with higher number of saturated and unsaturated hydrocarbons. Generally reservoirs are composed of natural gas, crude oil and coal tar products. Petroleum is formed when large quantities of dead organisms especially zooplankton and algae are buried under sedimentary rock and subjected to intense high pressure and heat. When Colonel Edwin Drake drilled the first oil well in Titusville, Pennsylvania in 1859 discovered petrol first. In India the first petroleum dug was discovered in Digboi Assam state. Assam provides about 63% of the total contribution in India. Rajasthan and Gujarat contributes to 18% petroleum and oil ores. Quick Starting for cars, highly combustible and fast acceleration makes its use in vehicles for internal combustion engines. It is also used as solvent for oils and fats. The use of petroleum products causes global warming and ocean acidification. Petroleum engineering is a field of engineering concerned with the activities related to the production of hydrocarbons which can be crude oil or natural gas, its exploration and production. . Crude petroleum is a mixture of aliphatic, aromatic hydrocarbons and a variety of branched hydrocarbons of saturated and unsaturated linkages. Petrol is distilled from crude petroleum. A vapours obtained from evaporation of petrol is considered as petrol vapours [1]. Petrol vapours mainly contains the aliphatic chain of alkanes n-butane, n-pentane, n-hexane and n-octane with decreasing quantity with some negligible percentage of aromatic hydrocarbons [2-3]. Petrol vapours are regarded as reducing gases since it is mixture of carbon and hydrogen or hydrocarbons.

Table-1 Petroleum constituents in crude oil

Sr. No.	Name of the elements	Percentage
1	Carbon	93-97
2	Hydrogen	10-14
3	Nitrogen	0.1-2
4	Oxygen	01-0.5
5	Sulphur	0.5-0.6

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II. LITERATURE SURVEY AND NEED OF PETROL VAPOUR GAS SENSOR

It is interestingly to know the purpose behind to manufacture petrol vapour gas sensor. As petrol is highly volatile liquid. It has high vapour pressure. Petrol is flammable liquid as well as its vapours is also highly flammable. It exerts a partial vapour pressure producing vapours in large quantities. The petrol vapours are lighter than air. Therefore in air petrol vapour spread vastly. Petrol vapours concentration in atmosphere or affected area must be detected and monitor in certain limit around parts per million level concentrations. Leakage due to petrol vapours are difficult to overcome therefore proper sensor need to be constructed from metal oxides. In this world there were different calamities aroused from leakage of different chemical, industrial and polluting gases. On 7th May 2020, A current issue of this month is leakage of styrene gas in L.G Polymer Company India private limited (Hindustan Polymer) located at Venkatpuram near Vishakhapatnam in India. In this bad event total 11 peoples were died from suffocation of Styrene gas. Styrene gas was used in manufacture of synthetic rubber and resins. Methyl Isocynate (MIC) was a dangerous gas exploded at Bhopal Union Carbide Company. Six lacs peoples were injured and many people were killed. These are two events of experience of gas leakage which teach us to search possible remedy for other inflammable gases like petrol vapours and construct sensors from desired materials. There is too much need to develop safety in petroleum industry and tanks of petroleum products. In the decade of eighty, Japanese researchers in 1983 have made attempts to manufacture ceramics based sensors α-Fe_2O_3 [4] and γ-Fe_2O_3 [5-6] as a sensitive material for reducing gases like petrol vapours, LPG and hydrocarbon gases. Petrol sensor transmitters constructed from poly-carbonate material, cast-aluminium and stainless steel with response time less than 10 seconds are used in automotive industries, oil and gas refinery, petrochemical refinery, Hotels generator rooms, cracking plants, hydrogenation plants, chemicals, cold stores, Pharmaceutical and medical formulations with warm up signal or warning alarm less than 5 minutes[7].

III. MATERIALS EMPLOYED AS PETROL VAPOUR GAS SENSOR

Investigation and design of sensor in gas sensing technology has been much paying a lot of attention and scope to material science researchers in all across the countries. Many semiconducting metal oxides are employed as gas sensors for different pollutant, reducing, oxidizing, inflammable and explosive gases like Nitrogen Oxide (NO_2), Carbon dioxide (CO_2), Carbon Monoxide (CO), Ethanol (C_2H_5OH) vapours, Liquefied petroleum gases (LPG), Ammonia (NH_3), Chlorine gas (Cl_2), Hydrocarbon gases like Methane (CH_4), Ethane (C_2H_6), Propane (C_3H_8), ethers and gasoline or natural gas. Gas sensing mechanism is based on adsorption or surface phenomenon [6, 7-8]. Petrol vapours nowadays attracting a full of attention in gas sensing field since petrol vapours has high vapour pressure and its associated high instability in air or open atmosphere. Petrol vapours can be calibrated in terms of heptane or octane as it is considered to be mixtures [8]. Doping in some percentage of base material can improve 4S parameters. It enhances speed, selectivity, sensitivity and stability. Very few studies are concerned and focussed on base material to be employed for petrol vapours like iron oxide (Fe_2O_3) especially alpha phase (α) since having more stability than remaining four phases like β, γ, δ and ε [9]. In 1993 Poghossian et al., concluded that Fe_2O_3 deposited by electron beam evaporation method with thickness 0.3μm possess a good selectivity for petrol vapours over ethanol vapours and natural gas in the temperature range 270^{0}C-300^{0}C [10]. The magnitude of selectivity for petrol vapours was found to be greater than 20 times more than ethanol vapours and natural gas. In 2019, the attempt has been made in the direction of additives incorporated into base material. Indium oxide has added into ferric oxide for petrol vapours as an additive with different percentage ranging from 1%, 3%, 5%, 7% etc.[11]. Deshmane et al., suggested that doping of 7% In_2O_3 into Fe_2O_3 has pronounced effect on response (56%) to petrol vapours at 300^{0}C operating temperature. Similarly 3% In_2O_3 into Fe_2O_3 exhibit response (50%) to petrol vapours at 250^{0}C [11]. They noted that at 250^{0}C, 3% In_2O_3 films were found to be more selective to petrol vapours from 200 ppm to 1000 ppm concentration as compare to gases such as NO_2, NH_3, Ethanol (C_2H_5OH) and LPG. The increased sensitivity for petrol vapours to modified hetero-junction indium oxide incorporated in ferric oxide is obtained because of decomposition of hydrogen in longer chain of aliphatic hydrocarbons [10-11].

IV. CONCLUSION

Gas sensing field has been changing drastically, but some of the gases like petrol vapours are not keep in touch with research and development for various applications. Petrol is highly inflammable liquid. Petrol vapours are also dangerous capable of causing fired event if proper global and universal alarm is not available. The above work is related to topic which is weakly focussed by material science researcher's community and possibly demands of more work on hazardous reducing gases like Petrol vapours. In this paper reported work has been summarized. α-Fe_2O_3 is better sensor material designed for petrol vapours. As compared to base material the incorporation of metal oxide as an additive into base material gives significant role for 4S parameters such as sensitivity selectivity speed and stability. Study revealed that indium oxide implemented into base material ferric oxide would have been proven to be reliable sensor for petrol vapours.

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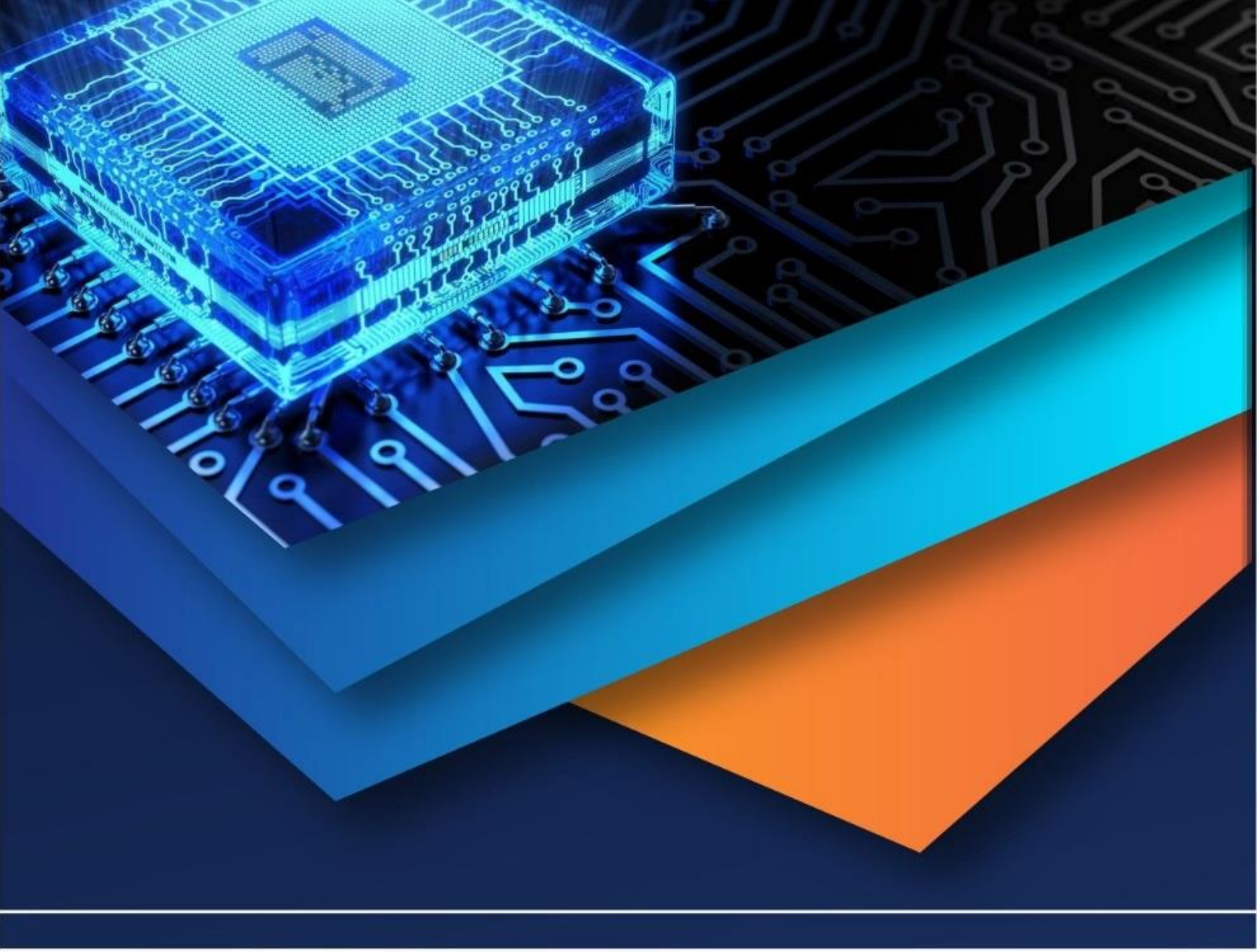

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