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A REVIEW ON HYDROGEN DETECTION TECHNOLOGY

Ms.Shashikala H.K
Faculty of Engineering and Technology, Jain (Deemed-to-be University), Ramnagar District, Karnataka – 562112
Email Id- hk.shashikala@jainuniversity.ac.in

Abstract:

In relation to other flammable gases and vapours, hydrogen has a variety of peculiar properties, like nitrogen, propane or gasoline vapour. Hydrogen cannot be sensed by human senses as it is a colourless, odourless and tasteless flammable substance, and other ways are thus necessary to detect its presence and to measure its concentration. In conjunction with the production and increased use of hydrogen gas as an energy carrier and as a chemical reactant, hydrogen sensors are of growing interest. Hydrogen detection and concentration measurements have a tradition of over 100 years, starting with hydrogen measurements at airship filling stations. There's an enormous different types of sensors recorded in the hydrogen detector publications and these sensors are grouped into eight different working concepts in this work. These types of sensor characteristic output parameters, like measurement length, sensitivity, selectivity and reaction time, are checked and then grouped into eight groups in order to define the hydrogen sensor criteria for practical applications.

Keywords: *Detection, Hydrogen, Monitoring, Sensors, Technology, Intelligent systems.*

I. INTRODUCTION

Hydrogen has a number of uncommon residences in contrast to other combustible gases and vapours, including methane, propane or fuel vapour. these encompass a totally low density (0.0899 kg/m3) and boiling point (20.39 k) blended with a high diffusion coefficient (0.61 cm2/s in air) and buoyancy. In phrases of its combustion traits, it has a low minimal ignition energy (0.017 mJ), excessive warmness of combustion (142 kJ/g H2) and huge flammable range (4–75percent1), in addition to a excessive burning speed, detonation sensitivity and an ignition temperature of 560 ◦C. Hydrogen also acts as a robust decreasing agent for lots factors and has a excessive permeability through many materials, which demands special precautions in sure packages.

As a colourless, odourless and tasteless flammable gasoline hydrogen can't be detected by means of human senses, and different approach are therefore required to stumble on its presence and quantify the attention. Rapid and accurate hydrogen fuel concentration dimension is critical to alert to the formation of potentially explosive mixtures with air and to assist save you the risk of an explosion [1].

The detection and attention dimension of hydrogen has a records of over 100 years beginning with hydrogen measurements at filling stations for airships. However, there may be a persevered need for faster, greater correct and extra selective detection of hydrogen gasoline in diverse areas of industry for tracking and controlling hydrogen concentration. As an

example hydrogen gas concentration tracking is important in the synthesis of ammonia and methanol, the hydration of hydrocarbons, the desulphurization of petroleum merchandise and the manufacturing of rocket fuels. In metallurgical procedures, the dimension of hydrogen awareness is also required. During the melting of aluminium as an example, the metallic can react with water to shape alumina and hydrogen, which remains dissolved in the melt. Hydrogen awareness have to be monitored all through welding and galvanic plating that allows you to keep away from hydrogen embrittlement and is likewise a applicable parameter within the characterisation of batteries.

Tracking of hydrogen awareness is critical to nuclear reactor safety. In nuclear electricity stations, hydrogen may be fashioned in radioactive waste tanks, during plutonium reprocessing, via the radiolysis of water or through the undesirable reaction of water with excessive temperature reactor core and cladding substances (uranium oxide, zirconium). A hydrogen explosion contributed to the nuclear twist of fate at 3 Mile Island in 1979 and to the Fukushima accident in 2011 [2].

In coal mines hydrogen may be produced within the ppm2 range by methane or coal-dirt explosions or by using the spontaneous heating and coffee-temperature oxidation of coal. The presence of hydrogen can be used to signify a hearth in its early country or to locate coming near transformer failure in electric powered energy plants. Hydrogen gas attention is of relevance in semiconductor production, for which gases such as silanes and nitrogen should be produced with very excessive purity. In the lighting fixtures enterprise additionally, hydrogen is a contaminant that have to be quantified all through the manufacturing of krypton, xenon and neon. Hydrogen leak detection is carried out at gas deliver tubes and in method flora, where its presence can indicate corrosion or wherein hydrogen is used as a coolant for turbine turbines. Liquid hydrogen is used as a fuel in area applications and hydrogen sensors are consequently used for leak detection at some stage in shuttle launches and different aerospace operations. Hydrogen sensing can also play a position in biomedical applications as a hallmark for sure sicknesses and for the detection of environmental pollutants [3].

Hydrogen is an energy provider and can make a contribution to overcoming the issues of dwindling fossil fuel reserves, energy supply protection and international warming. Ongoing research, development and as but small-scale deployment of hydrogen technologies are looking for to realize this capacity. In this emerging hydrogen financial system, the detection of hydrogen leaks and the size of hydrogen concentration are important at some point of production, storage, transportation and use in both stationary and mobile applications. Sensors will consequently be used for protection tracking of hydrogen manufacturing flowers, pipelines, garage tanks, refuelling stations and car cars. Opportunity hydrogen detection techniques rent units such as gas chromatographs, mass spectrometers or unique ionisation gas pressure sensors [4]. Gas chromatographs use columns to split the man or woman fuel components in a mixture and specific varieties of detector to perceive every aspect. Mass spectrometers become aware of gas molecules based totally on their characteristic deflections from a magnetic subject.

Historically, these instruments are notably huge, steeply-priced, high protection and slow in phrases of their sampling and reaction times. But, there was large progress in miniaturisation over the past decade and micro-electro-mechanical systems (MEMS) had been stated [5]. Those contraptions aren't taken into consideration further in this assessment. Hydrogen sensors are transducer gadgets that stumble on hydrogen gas molecules and produce an

electrical signal with a significance proportional to the hydrogen gasoline attention. Hydrogen sensors have several blessings over the traditional hydrogen detection techniques mentioned above, together with their lower cost, smaller length and quicker reaction. These advantages make them extra suitable for transportable and in situ hydrogen detection in a variety of programs [6]. Such sensors are nicely-mounted to be used in industry in which they can be calibrated often and operated with the aid of educated employees. But, the emergence of a hydrogen economy provides the impetus to supply low cost, low renovation, easy to install, smooth to use, correct hydrogen sensors appropriate to be used via untrained people in a variety of programs [6]. There are numerous extraordinary types of hydrogen sensor commercially available or in improvement. Most hydrogen sensing principles have been recognized for decades and hydrogen sensors were commercially to be had for many years.

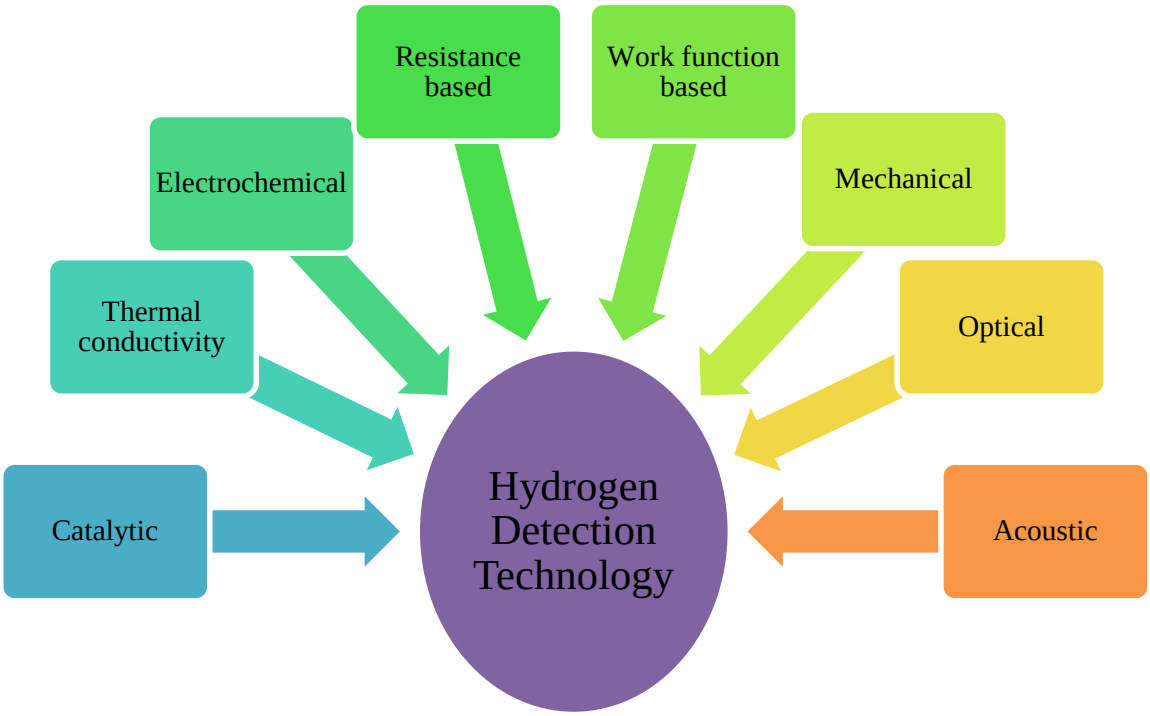

Fig. 1. Eight Types of Hydrogen Detection Technology

On the way to meet the demands of a future hydrogen economic system but, loads of studies is ongoing to constantly improve sensitivity, selectivity, response time and reliability further to reducing sensor length, value and energy consumption [1][7]. These needs on hydrogen sensors can be summarised as follows:

• Indication of hydrogen in concentration range 0.01–10% (safety) or 1–100% (fuel cells)

• Safe performance i.e. explosion proof sensor design and protective Housing

• Reliable results of sufficient accuracy and sensitivity (uncertainty <5–10% of signal)

• Stable signal with low noise

• Robustness including low sensitivity to environmental parameters such as:

◦ Temperature (−30–80 ◦C (safety), 70–150 ◦C (fuel cells))

◦ Pressure (80–110 kPa)

◦ Relative humidity (10–98%)

◦ Gas flow rate

• Fast response and recovery time (<1 s)3

• Low cross sensitivity (e.g. hydrocarbons, CO, H2S)

• Long life time (>5 years)

• Low power consumption (<100 mW)

• Low cost (<100 D per system)

• Small size

• Simple operation and maintenance with long service interval

• Simple system integration and interface [8]

The increase in commercial interest and R&D due to the emergence of new and widespread applications for these devices is reflected in the growing number of relevant publications since the year 2000 in particular [9]. There are eight types of hydrogen detection technology classified in the figure 1.

II. CONCLUSION

There are a range of methods for hydrogen gas detection which have been developed and demonstrated. Any of them are commercially well-established and products have been available for years, manufactured by different producers and with a variety of output capabilities and costs depending on these ideas. Other techniques are less well-developed, but emerging research shows that they show potential for evolving applications for hydrogen detection that introduce new performance criteria, including quicker reaction, lower power consumption or multipoint identification.

Wherever hydrogen is produced, processed, transported or used, hydrogen sensors can play an important role in maintaining the protection of people and property. The evolving hydrogen economy is leading to the production of higher volumes of modern hydrogen sensors, as well as greater range, as various sensor technologies are more suited for different applications. In order to fully satisfy the demands of current and evolving technological applications, more study is needed in terms of fundamental research into new technologies and sensor concepts, as well as advanced research and development. The on-going advancement of hydrogen sensing technology can be facilitated by research and evaluation protocols coupled with applicable standards.

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