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A REVIEW STUDY ON THE APPLICATION OF AMMONIA SENSORS

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Abstract

Using multiple sensing concepts, several articles have been published on gas sensors for various sensor applications. Sensors and sensor systems for gaseous ammonia are the subject of this study. There are many sources of ammonia, apart from its natural origin, such as the chemical industry or extreme life-stock. The research we are discussing here discusses numerous fields of operation for ammonia sensors or measuring systems and various techniques available for the manufacture of selective ammonia sensing devices. Solid-state ammonia sensors are not adequately sensitive if very low concentrations are to be measured, such as less than 2 ppb for environmental testing and 50 ppb for diagnostic breath analysis. In comparison, other gases that are frequently available at far higher concentrations lack the necessary selectivity. Optical techniques that enable usage lasers are often broad and costly. Indirect principles of measurement have been identified in literature that appear to be very suitable as tools for ammonia sensing. These devices are ideal for miniaturisation and integration to make them suitable for calculating the small amounts of gas that are typically available in medical applications, such as instruments for diagnostic breath analysis.

Keywords: *Automotive, Ammonia, Environment, Industries, Sensors.*

I. INTRODUCTION

There have been thousands of publications written that deal with some type of gas sensor. This makes it nearly difficult to publish a summary article that explores this topic entirely. Summarizing papers concerned with particular application areas or specific types of gas sensors can be found by reading at the scientific literature. Examples of published studies on gas sensor applications include: high-volume fuel control for the chemical sector, engine exhaust emissions testing sensors for vehicle industries, or supervising of milk products for the

food sector. Articles highlighting a particular category of gas sensor include, for example, solid state gas sensors, polymer gas sensors such as polyaniline, mixed oxide gas sensing, amperometric gas sensors, catalytic field-effect de-vices, and gas sensor arrays used in electronic noses. One particular chemical, ammonia, will be the topic of the analysis discussed here[1].

We accept different artificial sources of ammonia in the atmosphere after a brief introduction of the origins of ammonia in the earth's atmosphere, like intensive life-stock for the decomposition phase of manure, or the chemical industry for the manufacture of fertilisers and for cooling systems. Subsequently, with a description of the ammonia concentrations levels of concern in these various areas, different use areas for gaseous ammonia analyzers are studied. It addresses uses in the fields of agricultural and industrial chemistry, as well as environmental, automotive and medical applications for ammonia sensing equipment. As described in the next section, the description of implementation areas provides us with an example of the required requirements, such as limit of detection and response time, which will be used as a reference for the consideration of various measurement standards and techniques[2][3].

A. **Application areas of ammonia sensors: -**

There are several ways that ammonia can be detected. Since the gas has a very penetrating odour, high levels are easy to identify. The human nose is very susceptible to ammonia as regards to other odorous gases. The human nose struggles in order to obtain the ammonia content or assess lower ammonia concentrations. However, the concentration of ammonia must be identified on several occasions, including at ultra low doses that is less than parts per billion in the atmosphere (ppb). This section reflects on 4 main areas of concern in the calculation of ammonia concentrations: agricultural, industrial, chemical and medical diagnostics, and discusses why the ammonia concentration in these fields needs to be identified. The concentration levels of concern for the multiple implementation areas are defined where appropriate[4].

B. **Environmental gas analysis: -**

This section reflects on 4 main areas of concern in the calculation of ammonia concentrations: agricultural, industrial, chemical and medical diagnostics, and discusses why the ammonia concentration in these fields needs to be identified. The concentration levels of concern for the multiple implementation areas are defined where appropriate.

The development of ammonium salt aerosols is another important point. In the atmosphere, sulphuric acid and nitric acid combine with ammonia in order to form ammonium sulphate and ammonium nitrate. These salts are condensation nuclei, producing airborne particles many nanometers in size. Ammonia thus decreases the volume of acids in the atmosphere. As can also be seen in major cities or manufacturing areas, these ammonia aerosols have a sun-

blocking feature. Such smog clouds have a temperature-reducing effect. Nevertheless, owing to the increasingly extreme global warming triggered by the greenhouse effect, this influence is actually barely visible[5].

The levels of ammonia in the natural atmosphere can be very low, down to levels above the oceans at sub-ppb concentrations. In the Netherlands, the total atmospheric concentration of ammonia is around 1.9 ppb. For calculating these concentration, very precise ammonia detectors with a detection limit of 1 ppb or lower are needed. Ammonia concentrations are much greater, up to more than 10 ppm, near intensive agricultural areas. What degrees of concentrations are of concern depends on the particular application. The time resolution of the appropriate analysis machinery is also calculated by this. Monitoring of atmospheric ammonia levels would not require exceedingly fast detectors for environmental assessment. A shorter response time in the range of a minute is expected when an analyzer is used in a regulated venting system in stables[6].

C. **Automotive industry: -**

For three factors, the car industry is involved in monitoring atmospheric emissions. Next, exhaust emissions are tracked and in urban sites they comprise the main part of gaseous waste. For example, as mentioned earlier, ammonia exhaust is attributed to enhanced airborne particulate matter, such as ammonium nitrate and ammonium sulphate aerosols. Ammonium aerosols are calculated to be less than 2.5 m at up to 17 percent of the concentration of particulate matter. Ammonia emissions of up to 20 mg/s or up to 8 ppm of ammonia in the exhaust gas were measured[7].

D. **Chemical industry: -**

The Haber method is the primary procedure for chemically producing ammonia. In 1904, Fritz Haber, the German physicist, began experimenting on a way to manufacture ammonia. His discovery received the Nobel Prize in Chemistry in 1918. Using a porous metal catalyst, ammonia is synthesised from nitrogen and hydrogen at an elevated temperature of around 500 degree Celsius and a pressure of about 300 kPa. Carl Bosch scaled up the procedure to industrial proportions. Therefore, the mechanism is also referred to as the process of Haber-Bosch[1].

The requirement for an affordable source of nitrogen for the manufacture of nitric acid, a main component of explosives, was initiated by ammonia production. Still, for fertilisers or chemical processing, the bulk of all man-made ammonia is used. This fertilisers include salts of ammonium and are used in agriculture.

E. **Medical applications for ammonia sensors: -**

Large ammonia concentrations are a threat to human health. It is tabulated that the lower limit of the perception of human ammonia by smell is about 50 ppm, equivalent to around 40 g/m3. However, ammonia is irritating to the respiratory system, skin and eyes, well below this limit. Consequently, the long-term permissible concentration at which persons will function is set to

be 20 ppm. Immediate and extreme nose and throat inflammation occurs at 500 ppm. Exposure to high concentrations of ammonia, 1000 ppm or more, will lead to pulmonary oedema; fluid deposition in the lungs. Can can take up to 24 hours before the signs develop: trouble breathing and chest tightness. Short-term exposure to such elevated amounts of ammonia will lead to long-term respiratory system and lung problems that are lethal or severe. Highly high amounts, 5000-10,000 ppm, are indicated to be lethal within 5-10 minutes. Accident reconstructions, however, have shown that the fatal dosage is greater[8].

Longer cycles with low ammonia concentration intake are not considered to cause long-term health issues. Since it is a normal body substance derived from protein and nucleic acid metabolism, there is no buildup in the body. In the form of urea and ammonium salts in urine, ammonia is excreted by the liver. From sweat glands, any ammonia is extracted from the body.

F. **Ammonia sensing principles: -**

There are several concepts that are listed in the literature for calculating ammonia. In the exhaust pipes of vehicles, a separate sensor is used to assess ultra-low atmospheric ammonia concentrations for environmental testing. In this portion, the most commonly used techniques in commercial ammonia detectors are examined. Initially, sensors for metal-oxide gas are listed. Second, catalytic ammonia detectors are treated, followed by polymer ammonia analyzers and techniques for optical ammonia identification. Indirect structures utilizing gas samplers and complex chemical reactions to create a selective ammonia analyzer are discussed in the fifth sub-section, accompanied by a description of the techniques mentioned.

II. CONCLUSION

Now, it is possible to equate the properties of the sensors and sensor systems described with the demands of the potential applications mentioned. It is important to draw the following conclusions:

1. Air surveillance systems for the atmosphere need a detection cap of less than 1 ppb. Few optical gas sensors are acceptable and there is a reasonably small detection limit for the indirect approach. The optical gas sensors, however, are large and pricey, rendering them less suitable. The indirect mechanism is therefore very broad and the specifications for reagent usage and management are challenging. A simpler framework would've been preferable.
2. A lower detection limit of 1 ppm is needed for measuring in stables. It is possible to apply all the mentioned sensor systems for this reason. For growers, sensor equipment that needs a great deal of maintenance is uncomfortable. Conducting polymers, for instance, seems less acceptable because frequent regeneration is needed to avoid sensation loss.
3. The needed detection limits are not very poor for automotive exhaust applications, and the sensor systems mentioned are all sufficiently sensitive. In exhausts, the temperature

increase eliminates fluidic systems and polymer sensor conducting systems. Water can evaporate from the fluidic structures, and it is important to continuously regenerate conducting polymers. Metal-oxide and catalytic field effect gas sensors are the most appropriate sensors. These types of sensors already operate at higher temperatures and have a sensitivity limit that is reasonably small.

4. Automotive air quality management systems need very fast sensor systems that react in a few seconds to elevated concentrations of ammonia. None of the sensors mentioned are fast enough.
5. Chemical warning systems will not need highly sensitive sensors and specificity is not not really much of a concern. The operating temperatures can be elevated, especially in reactors. Overall, the most appropriate type of sensor for these applications tends to be semiconductor and metal oxide gas sensors.
6. There is a very low detection limit of 50 ppb needed for a diagnostic breath analysis device for medical ammonia. For ammonia, the sensor system should be very selective. In addition, the machine can react within a few minutes to a shift in ammonia concentration. Optical devices are the only ammonia sensors that meet with such standards. However, these devices are very wide and costly, rendering them less suitable. The indirect method's sensitivity and selectivity are sufficient, but too much analyte gas is required for the system to analyse in a single breath of air and the system is very sluggish. This issue could be solved by miniaturisation.

III. REFERENCES

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