Study of reliability of electrochemical sensor MQ-135 and MQ-137 in concern of ammonia gas in male urinals implemented on IOT based system

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ABSTRACT- **we are living in an era globalisation and technology revolution. Not only Republic of Bharat all over the word witnessing an extreme growth in each and every industry. On the other hand purchasing power and technology dependency on gadgets, internet etc. of a lay man increased since last 10-15 years which make human being more aware about civilisation ethics i.e. health issue etc., this increased sensitisation needs as well. Small cities and town witnessing growth in each and every industry, which gives significant growth in civilization, market, entertainment and infrastructural framework. All this growth creates need of sanitization affairs means need of toilets, urinals and washrooms, but without continuous monitoring these urinals, toilets and washroom becomes unhealthy and stinky. Sanitization is a serious issue so there is a need to build such a flourishing system which can keep continuous eye on sanitization system. Overcome the problem continuous eye on sanitization system, best way is to use the electrochemical sensors with IoT based system. This electrochemical sensors works for particular parameters and substance. Nowadays two main electrochemical sensors MQ-135 and MQ-137 used in urinals and toilets and this sensors sense ammonia gas specifically. Actually urine is the main waste of human body which contains urea which comes from the breakdown of amino acids this occurs by deamination of amino acid result in the production of ammonia (NH3). Ammonia gas is a pungent gas which is lighter than air. Thus ammonia gas is easily traced by the gas sensor device. So that ammonia gas is our main parameter which indicates stink and unhealthy situation of urinals and toilets. The solution also includes the technology Internet of Things (IOT) which is a hook up of computer science and electronics. It can provide means to monitor the condition of urinals and toilets parameters like ammonia. To monitor Sanitisation levels in particular area of interest (urinal or toilet) we use particular sensor so here we compare which sensor is good in terms of sensitivity and life, wireless embedded computing system with the sensor is proposed. The system is using a prototype implementation consists of ammonia sensing devices, microcontroller ATMEGA328, ESP8266 as Wi-Fi module. These sensing devices are interfacing with a wireless embedded computing system to monitor the fluctuations of parameters levels from their normal levels. The aim is to build a powerful system to monitor urinal or toilet environmental parameters i.e. Ammonia.**

Keywords: ***Ammonia, Internet of Things (IOT), Male urinal, Microcontroller ATMEGA328, MQ-135 and MQ- 137 Sensor, Wi-Fi module ESP8266.***

I. INTRODUCTION

As we know growth in an industrial, civilization, market, entertainment, and infrastructural frameworks drastically increasing the need of healthy stink free urinals and toilets so sanitation of urinals and toilets related issues rapidly comes into existence. To fulfil the need of flourishing monitoring system we need good ammonia sensor in term of sensitivity and life, in our project we are establishing a network called the Internet of Things, in which sensing devices are connected with the wireless embedded computing system. Internet of Things is a technology that hooks up the sensors with embedded system and allows the data from these sensors to travel over an Internet. We are implementing a developing model which is able to monitor the inconstancy of parameter better ammonia gas sensitivity and life.

In the proposed model we use microcontroller ATMEGA328. We are using 2 sensors, MQ-137, and MQ-

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135 as a gas sensor. It detects the concentration of ammonia in the air.

For internet connection, we are using flexible Wi-Fi sensor ESP8266. The data from these sensors is stored in the cloud. After processing, through a hotspot web browser will ask about IP address, by putting an IP address web page will create that allows us to monitor the system [4]. We can monitor the parameters on smartphones as well as pc or laptop.

OBJECTIVE OF THE PROJECT

The main objective of the project is to provide an IOT platform that monitors the ammonia parameters by two sensors which are two renowned sensors to sense ammonia gas i.e.MQ-137 and MQ-135 and help to sensor installer for selection of best sensor based on best sensitivity. To create better and healthy stink-free male urinals and toilets for future life.

II. RESEARCH METHODOLOGY

The motive to take ammonia gas for study

WHAT IS AMMONIA GAS:-

Ammonia gas is colourless, flammable, pungent smelled gas. Ammonia is a compound of nitrogen and hydrogen present with molecular formula bearing NH_3. Ammonia is with the following characteristic:-

Formula: NH_3
IUPAC ID: Azane
Molar mass: 17.031 g/mol
Boiling point: -33.34 ^oC
Density: 0.73 kg/m^3
Melting point: -77.73^oC

Ammonia gas is alkaline and it has corrosive properties. Ammonia gas is water soluble gas and easily dissolves in water to form ammonium hydroxide, a caustic solution. Ammonia gas is weak base. Air is heavier than anhydrous ammonia gas and ammonia gas will rise up on air, so that generally it dissipates and does not settle in low-lying areas. But, in the presence of humidity or moisture (i.e. high relative humidity), the liquefied anhydrous ammonia gas produces vapours that are heavier than air. These vapours may spread along the ground or into low altitude (low-lying) areas with poor airflow such as urinal's waste storing shape.

Urea is a cleaned form of ammonia. Urea is non-toxic to mammals, but ammonia, which can be highly toxic to mammals. Urea produced due to reaction between ammonia and carbon dioxide in the liver in a particular cycle and in presence of particular enzymes and reactants.

Bacteria in human gut and cells produce ammonia when our gut break down protein or amino acid. Our liver turns ammonia into urea. Urea is water-soluble chemical.

Urine is the main waste of the human body. Urine encompasses Urine is an aqueous solution of greater than 95% water, with a minimum of following remaining components, in order of concentration:

Urea 9.3gm./L, Chloride 1.87gm/L, Sodium 1.17gm/L, Potassium 0.75gm/L, Creatinine 0.67gm/L, inorganic and organic compounds (proteins, hormones, metabolites) in limited range cells and micro-organism, other dissolved ions.

THE PURPOSE OF TAKING AMMONIA GAS FOR STUDY

Ammonia is the main gas which is produced in urinal or toilet. Thus the presence of ammonia in urinal or toilet can tell the hygienic and health condition of urinal or toilet.

Ammonia in urinals comes from various sources following may be the solid reason:-

- Breakdown of urine:-
  Actually, ammonia generates due to hydrolysis of urea in presence of the enzyme urease and breakdowns into ammonia and carbamate, and highly unstable carbamate spontaneously divide into carbonic acid and another one ammonia molecule. And this aforesaid process is always run into urinals. Sometimes even fresh water flush in urinal does not make urinal stink-free.
- Design of urinals where residual urine store or collect.
- Shape or design of Urinal or Toilet sheet and pipe and plumbing design
- Poor ventilated or ventilation free toilet and poor exhaust system.
- Ingested foods, drugs, chemical-like nicotine, alcohol, etc.
- Bacteria, fungi, or another microorganism present on the toilet or urinal sheet or environment of urinal or toilet.
- Cleaning chemical which is used for urinal or toilet cleaning.
- Water which is use flushing.

Air is heavier than anhydrous ammonia gas and ammonia gas will rise up on air so that generally it dissipates and does not settle in low-lying areas. But, in the presence of humidity or moisture (i.e. high relative humidity), the liquefied anhydrous ammonia gas produces vapours that are heavier than air. These vapours may spread along the ground or into low altitude (low-lying) areas with poor airflow such as urinal's waste storing shape. Where people may access and exposed themselves.

III. METHOD OF DETECTION

Ammonia detection can be done by various methods like human senses, mechanical, electrical or chemical, etc. instrument.

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Ammonia detection using sensor electrochemical gas sensor using IOT is the best way to continuously detect and monitor ammonia collect data and alarm the management for cleaning the urinal or toilet. So we have two main ammonia sensors one is MQ-135 and another is MQ-137 which can detect ammonia in toilets.

IV. TEST EQUIPMENT LIST WITH DESCRIPTIONS

Proposed system specifications include hardware requirements and software requirements.

Instrument description

HARDWARE REQUIREMENTS

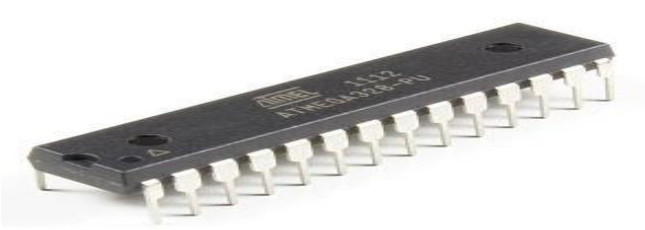

Fig -1: ATmega328 microcontroller

ATmega328 microcontroller can be programmed with Arduino software Arduino IDE (Integrated Development Environment). ATmega328 is AVRISC based 8-bit microcontroller that contains 1 kB EEPROM, 2 kB SRAM, 23 general purpose I/O lines, 32 kB ISP Flash memory, 32 general purpose working registers, 3 flexible timer/counters, internal and external interrupts, serial programmable USART on a single chip.

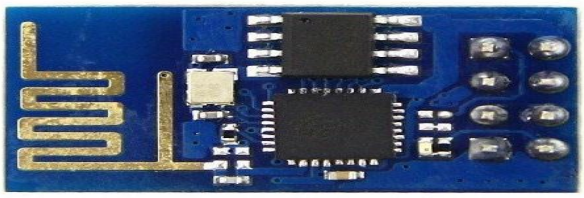

Fig -2: ESP8266 Wi-Fi module

ESP8266 is a UART to Wi-Fi module, a really cheap and easy way to connect any small microcontroller platform having network connectivity is good for any computing system. And connect to a system utility we can get any data from www. We can push data to cloud for storage, computation or monitoring. We need external hardware that converts Wi-Fi data into a data format that understood by a common microcontroller like UAT, SPI, and I2C

SOFTWARE REQUIREMENTS

The microcontrollers are typically programmed using features from the programming languages C and C++. To install the Arduino software on windows following steps are useful.

Step 1- Download the Arduino software from Google.

Step 2-Install the software. Connect the board with the computer and let Windows open its driver installation process.

Step 3- Open the control panel and open the system device manager.

DESCRIPTION OF SENSOR MQ-135 AND MQ-137

MQ-137: MQ-137 is highly sensitive, selective to ammonia and quick to respond with the output [Analog output voltage: 0V to 5V Digital output voltage: 0V or 5V (TTL Logic)] on LED indication with two-way signal output on 5V DC operating voltage. MQ-137 can read and measure ammonia gas and vapour between a range of 10 to 300 ppm as per design of the sensor. And the standard temperature is 20^{o}c +-5^{o}c and humidity is 65%+-5% for better result. Oxygen concentration (standard condition 21%) is also a factor that affects the reading of the sensor. Actually, MQ-137 is also less sensitive for ethanol (C_2H_6O) and even carbon mono-oxide (CO).

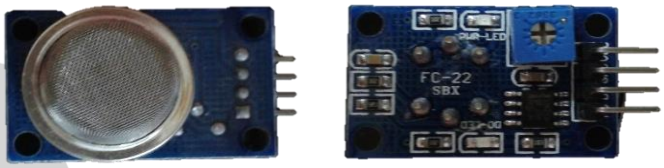

Fig -3: MQ-137 Sensor

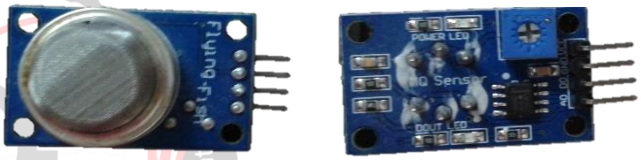

Fig -3: MQ-137 Sensor

MQ-135: MQ-135 is highly sensitive to NH3, alcohol, Benzene, smoke, CO2, etc. and quick to respond with the output [Analog output voltage: 0V to 5V Digital output voltage: 0V or 5V (TTL Logic)] on LED indication with two-way signal output on 5V DC operating voltage. MQ-135 can read and measure air quality or can say aforesaid gases and their vapour between the range of 10 to 300 ppm as per design of the sensor. And the standard temperature is 20^{o}c +-5^{o}c and humidity is 65%+-5% for better result. Oxygen concentration (standard condition 21%) is also a factor that affects the reading of the sensor.

Step 4- Connect Arduino Uno board to the system through USB cable. After connecting the select board and COM port in Arduino IDE.

Step 5- Develop an Arduino Code for sensors to cloud system in Arduino IDE, compile and upload the code in Arduino Uno board.

V. SAMPLING PLAN

Take urinals which are used by mass like public toilet or urinal which are situated in malls, court college et cetera. For sampling, male urinals are the first choice because due to some hormones and body structure male's urine is more

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stinky and more with ammonia than female male urinals becomes our first choice to collect the sample. So that two different sensor MQ-135 and MQ-137 with Instrument based on IOT were installed in public male urinal at two different locations which are the following:-

Public toilet (male urinal) near district court, Indore (Madhya Pradesh) India.

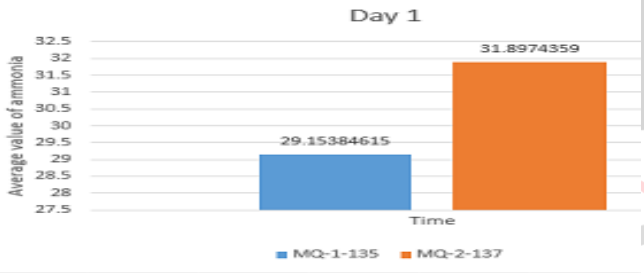
Public toilet (male urinal) near rajwada market, Indore (Madhya Pradesh) India.

Size and dimensions of urinals:-irrespective size and dimensions of the urinals sensor system are installed just above the urinal.

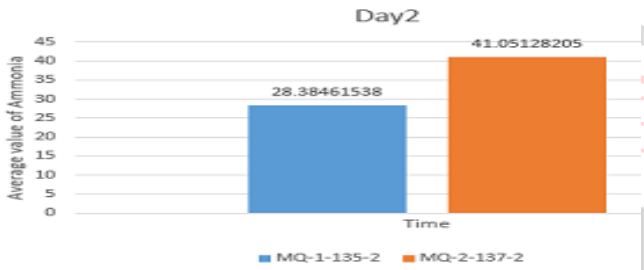
VI. RESULT OF RESEARCH

Study of data shows the following trends:-

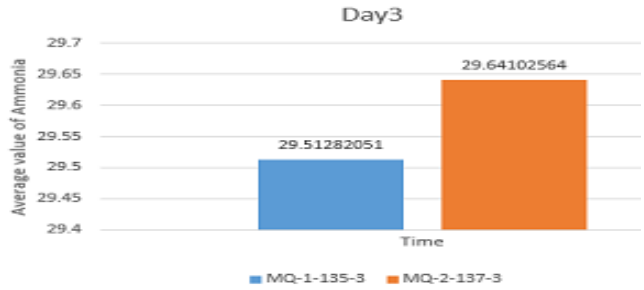
The data collected from male urinals on Microsoft Excel 2013 and graphical presentation prepared and using the analysis of variance and the results are shown in charts is concluded in graph figure.



Graph No. 1



Graph No. 2



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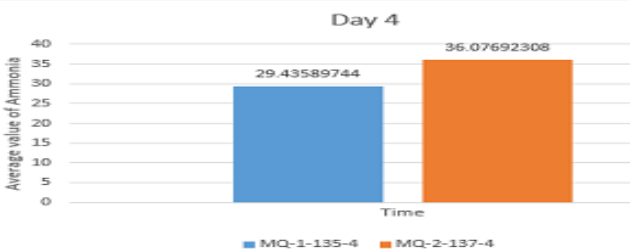

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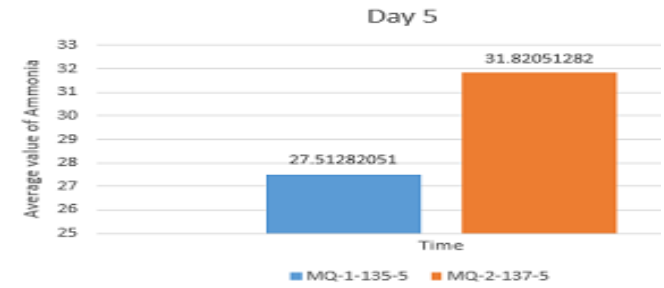

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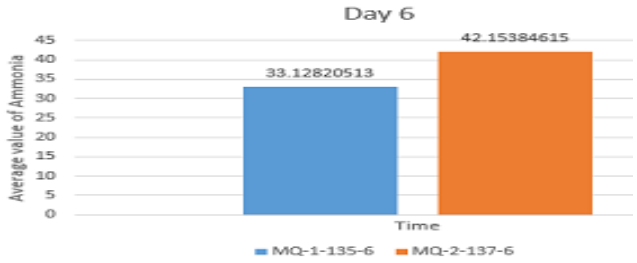

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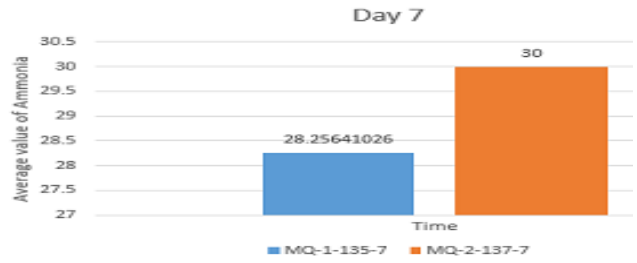
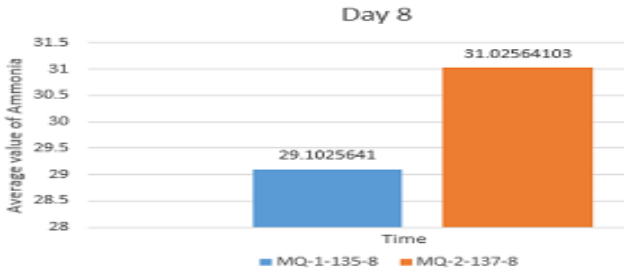
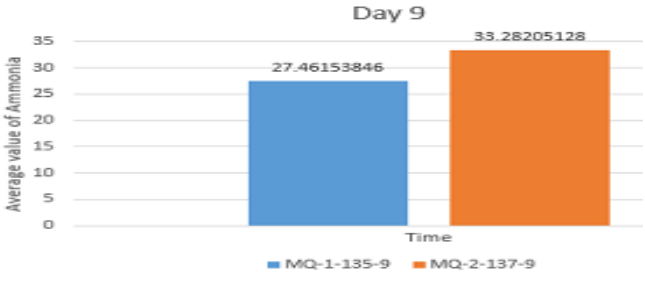


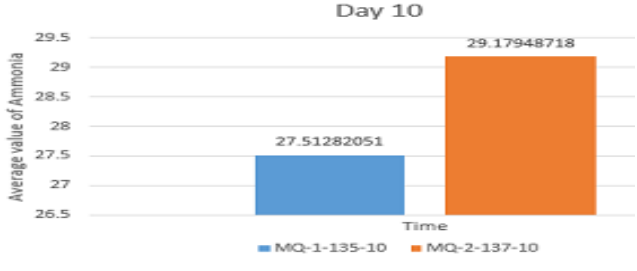
Graph No. 7



Graph No. 8



Graph No. 9



Graph No. 10

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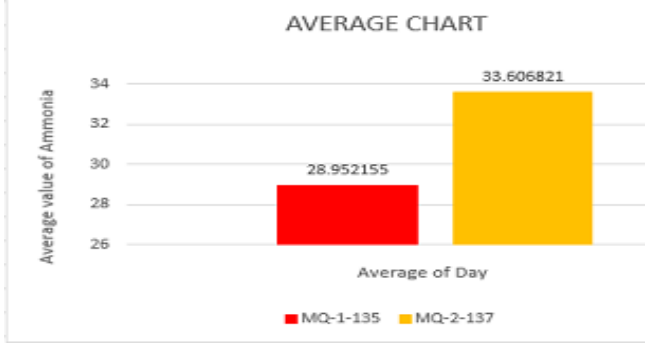
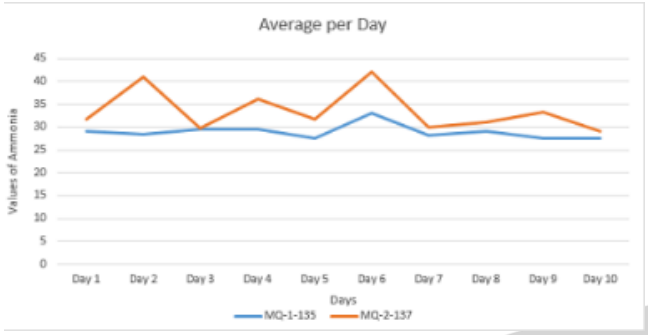


Graph No. 11



Graph No. 12

VII. DISCUSSION

For the reliability test of sensor MQ-135 and MQ-137 data collected from male urinal on Microsoft Excel 2013 and graphical presentation prepared and using the analysis of variance and the results are shown in charts is concluded in graph figure shows:-

The analysis of data shows that MQ-135 is less efficient to detect ammonia then MQ-137. Some-time sensor MQ-135 shows more high reading than MQ-137 but it is due to the presence of other gases like CO_2 etc. is not the only presence of ammonia. Comparison of graph number 1to 10 which are each processed by 40 values per day clearly indicates that MQ-137 is more specific to sense ammonia.

Graph no. 1 shows that average of 40 values of the day is 29.1538 for sensor MQ-135 and 31.89 for sensor MQ-137 most of time MQ-135 sense ammonia value less than 35ppm whereas MQ-137 sense ammonia value at the same time more than 40 ppm.

Graph no.2 shows that average of 40 values of the day is 28.38 for sensor MQ-135 and 41.051 for sensor MQ-137 most of time MQ-135 sense ammonia value less than 30ppm whereas MQ-137 sense ammonia value at the same time more than 40 ppm.

Graph no.3 shows that average of 40 values of the day is 29.5128 for sensor MQ-135 and 29.65 for sensor MQ-137 most of time MQ-135 sense ammonia value less than 30ppm whereas MQ-137 sense ammonia value at the same time more than 30 ppm .

Graph no.4 shows that average of 40 values of the day is 29.435 for sensor MQ-135 and 36.07 for sensor MQ-137 most of time MQ-135 sense ammonia value less than 30ppm whereas MQ-137 sense ammonia value at the same time more than 35 ppm .

Graph no.5 shows that average of 40 values of the day is 27.5 for sensor MQ-135 and 31.8 for sensor MQ-137 most of time MQ-135 sense ammonia value less than 30ppm whereas MQ-137 sense ammonia value at the same time more than 40 ppm.

Graph no.6 shows that average of 40 values of the day is 33.128 for sensor MQ-135 and 42.15 for sensor MQ-137 most of time MQ-135 sense ammonia value less than 35ppm whereas MQ-137 sense ammonia value at the same time more than 50 ppm.

Graph no.7 shows that average of 40 values of the day is 28.25 for sensor MQ-135 and 30 for sensor MQ-137 most of time MQ-135 sense ammonia value less than 30ppm whereas MQ-137 sense ammonia value at the same time more than 30 ppm.

Graph no.8 shows that average of 40 values of the day is 29.1025 for sensor MQ-135 and 31.025 for sensor MQ-137 most of time MQ-135 sense ammonia value less than 34ppm whereas MQ-137 sense ammonia value at the same time more than 32 ppm.

Graph no.9 shows that average of 40 values of the day is 27.46 for sensor MQ-135 and 33.28 for sensor MQ-137 most of time MQ-135 sense ammonia value less than 35ppm whereas MQ-137 sense ammonia value at the same time more than 40 ppm.

Graph no.10 shows that average of 40 values of the day is 27.5 for sensor MQ-135 and 29.17 for sensor MQ-137 most of time MQ-135 sense ammonia value less than 30ppm whereas MQ-137 sense ammonia value at the same time more than 30 ppm.

Means at the same time in the same concentration of ammonia gas MQ-135 show value less, whereas MQ-137 shows more value means at one point (let's imagine only 5 ppm ammonia gas is present than MQ-135 cannot sense the same, but MQ-137 can sense that ammonia gas in some value) MQ-135 cannot detect ammonia but MQ-137 can detect easily.

Graph number 11 average per day MQ-135 average per day for 10 days are subsequently present here 29.15, 28.38, 29.57, 29.435, 27.5, 33.128, 28.25, 29.1025, 27.46, 27.5, 28.9 and MQ-137 average per day for 10 days are subsequently present here 31.8,41.05, 29.6,36.07,31.8, 42.15, 30, 31.025, 33.28, 29.17, 33.6 indicates that clearly only one time MQ-135 and MQ-137 closely meet at the point, but at this point, MQ-137 proves itself more reliable than MQ-135. Graph number 12 Average Chart Graph number 12 shows average of 10 days, for MQ-135 average of 10 days is 28.9 and for MQ-137 average of 10 days is

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33.6 clearly indicates a comparison between MQ-135 and MQ-13, MQ-137 is far-far better than MQ-135.

Actually MQ-135 is suitable for detecting or estimating of NH_3, smoke, CO_2, benzene, alcohol, NO_2, etc. and all these gases or chemical can be increased due to human activities like consumption nicotine product like cigarette, chewing tobacco, or alcohol and other food product or drug so in general conditions such type of chemical cannot be present in urinals so that MQ-137 is more efficient otherwise MQ-135 gives more considerable values but these values are not come from such urinal which is full with urine and massy urinal sheets. Temperature, humidity, catalysers, age, cleaning and fly or insects killing chemicals and other environmental conditions such as smoke, etc. also effects MQ-135 reading and MQ-137 also. But in general conditions of urinals which are full of urine, only MQ-137 works more efficiently which is showing in graphs. Actually, MQ-137 is also less sensitive for ethanol (C_2H_6O) and even carbon mono-oxide (CO) so that sometimes it is also affected by environmental conditions other than urine only but in less measures.

VIII. CONCLUSION

Here male urinals are sampling base for measuring the reliability of gas sensor MQ-135 and MQ-137 and reading comparison is direct shown on LCD which is not counting on PPM. Although MQ-137 is more reliable than MQ-135 as sampling and reading took and it is a well-known fact that MQ-137 is ammonia-specific, graph study and point Discussion makes clear, what is the factor (gas, chemicals, food, drinks etc.) which can affect the detecting and measuring ammonia capability. Another fact is the design of urinals, plumbing and pipe system of urinals, ventilation, sanitising chemicals, the gender of human being, food, drugs, external environment, etc. also affects the reading and measurements of sensors. Oxygen concentration (standard condition 21%) is also a factor that affects the reading of the sensor. In future first of all sampling and reading would be taken on standard room temperature, humidity, chemical-free condition. And compare with the sampling and reading in general condition like aforesaid sampling for the better result which can help to decide which sensor is more appropriate and reliable in all urinals in all conditions.

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