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Analysis of various sensors to measure the physical parameters of the oil stored in Oil Tank for Oil and gas Industries in Oman

Dr.Vimalakeerthy Devadoss[1], Dr.Sivakumar Muthusamy[2], Dr.Muthukumar Selvakannu[3] Dr.Suresh Kumar Arumugam[4], Mr.Nanathakumar Chokkalingam[5]

[1]*Lecturer, Electrical Engineering University of Technology and Applied Sciences, Nizwa, Sultanate of Oman*
[2] *Lecturer, Electrical Engineering University of Technology and Applied Sciences, Nizwa, Sultanate of Oman*
[3] *Lecturer, Electrical Engineering University of Technology and Applied Sciences, Nizwa, Sultanate of Oman*
[4] *Technician, Electrical Engineering University of Technology and Applied Sciences, Nizwa, Sultanate of Oman*
[5] *Technician, Electrical Engineering University of Technology and Applied Sciences, Nizwa, Sultanate of Oman*

Abstract - *Oil and gas industries play a vital role in improving the economy of Oman. Oman government pays major attention in improving the production and safety measures in oil and gas industries. As oil is flammable, it is important to measure various internal and external parameters of oil when it is stored in a tank. Having a smart monitoring system with suitable sensors will have safe environment and enhanced production. In this paper various sensors that can be used for oil and gas industries is discussed and the proposed sensor technology that is efficient than the existing models is suggested.*

Key Words: Sensors, Oil and gas Industries

1. INTRODUCTION

Oil is the main source of resource in Oman. Oman has large number of oil fields and is a well-known country in term of exporting oil to various neighbouring countries. Oil and gas industries are normally located outside the residential areas considering safety and also depends on the location where the oil is explored. There are so many internal process associated with oil when it comes to domestic usage. Each process is significantly should be handled with utmost safety as oil is hazardous in nature[1].

It is very important to measure various factors of oil and the storage tank when it is stored for processing or delivering for domestic usage. Modern technology has immense research interest in developing smart sensors with safety measure to enable parameter measurement at optimal cost and safety.

Various sensors that are currently under usage is discussed in this paper and an efficient sensor that can be used for oil and gas industries with cost, simplicity and efficiency is suggested in this paper.

2. SENSOR TECHNOLOGIES

As oil is highly hazardous it is a difficult tast to choose the sensors with high efficiency and optimal performance. In this paper improves sensor models are discussed.

Sensors needed for the oil storage tanks

2.1. Pressure sensor

It is a Submersible pressure sensor ranging from 0 – 0.2 bar for measuring the level of a 2 meter oil storage tank. This type of the pressure sensor can be installed directly into a storage tank containing fuel oil. It issues a outpt signal of 4-20mA with 0.1% accuracy[2].

Figure 1. Pressure Sensor

2.2 Multi-spot thermometer

The average temperature of the oil can be measured using these multi spot thermometers. The standard measuring elements are according to EN 60751. Min. 150 mm from foot of the sensor to the head spot[3].

Figure 2. Multi Spot Thermometer

2.3. Flowmeter

In oil and gas industries accurate and reliable oil flow measurement is required for estimating the cost of distribution and generation.. The mostly used type of flow meters are Positive displacement flow meters. In recent days differential pressure flow meters are widely used to measure the oil flow[4].

Figure 3. Flow Sensor

2.4. Gas analyser

Gas sensors are essential for personal safety and environmental protection. These sensors are mainly used to detect and measure actual levels of methane, hydrogen sulphide, carbon monoxide, oxygen along with 50 other gases. This sensor has auto-calibration function that allows for precious calibration of the gas levels. This sensor can store the values and could transfer data to a computer[5].

Figure 4. Gas Analyser

2.5 Densitometer

It is important to measure the level of flowing oil stream. A densitometer is can measure continuously in on-line the measure the density of a flowing stream. In the oil and gas industry, a densitometer is normally used to measure the density of liquid hydrocarbon finished products like propane and gasoline and liquid mixtures like Y-grade natural gas liquids (NGL), but can also be used to measure the density of crude oil. The typical installation is in a single-phase liquid stream, but densitometers can be used to measure single-phase gas or vapor. This paper addresses only continuous, on-line liquid density measurement[6].

Figure 5. Density Meter

2.6. Interfacial Tension

Surface tension is the major property of any liquid in contact with the gas. Interfacial tension stands of the property that exists between various forms of liquid to solid, solid to solid or solid to air.

The cohesive energy is measured with respect to the Interfacial Tension. By using this measurement the practical imbalance of forces that exist between molecules at any type of interface can be estimated.

The imbalance of force is created due to the contact of two different phases of substances. As a result accumulation of free energy at the interface takes place. This accumulated energy is called surface free energy and can be calculated to increase the surface area of the interface[7].

Excess energy exists at any type of interface. If one of the phases is the gas phase of a liquid being tested, the measurement is normally referred to as Surface Tension (ST). If the surface investigated is the interface of two immiscible liquids, the measurement is normally referred to as interfacial tension (IFT).

2.7 Oil Viscosity

Oil Viscosity is one of the important parameters measured because of its importance to analyze the condition of the oil and lubrication. There are two ways to measure the oil's viscosity. One measurement technique is based on its kinematic viscosity or its absolute viscosity[8].

Figure 6. Gas Analyser

Oil viscosity is measured easily using the capillary tube viscometer. It consists of a metal rod that is inserted into the two beakers that are similar to each other. The actual force required for stirring the gear oil will be much more greater than the actual force required to stir the turbine oil.

Based on this observation, it might be tempting to say that the gear oil requires more force to stir because it has a higher viscosity than the turbine oil. However, it is the oil's resistance to flow and shear due to internal friction that is being measured in this example, so it is more correct to say that the gear oil has a higher absolute viscosity than the turbine oil because more force is required to stir the gear oil.

2.9. PH

Acidity or basicity of a liquid is measured with Ph values. Ph value of the oil plays a significant role to know the quality of oil with respect to chemical reactivity and its effect on environment [9].

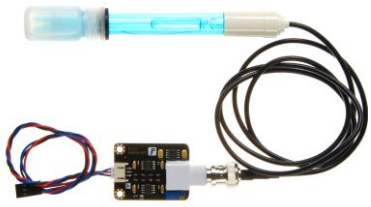

Figure 7. Ph Analyser

Arduino compatible PhSensors as indicated in the figure above can able to measure the Ph Value of the oil accurately and sends the value to the Arduino for further computations.

2.10. TANK LEVEL SENSOR

As the oil present inside the storage tanks are not capable of viewed from outside a level sensor is in need to measure the amount of oil inside the tank. The measurement could help the motor to drive from one tank to another tank when the level of oil falls below some safe values.

Also it is possible to estimate the amount of oil transferred for billing purpose and to know the supply quantity[10].

Figure 8. Ultrasonic Sensor

Since oil is highly flammable it is essential to have a non-contactable sensor to avoid fire accidents. Ultrasonic sensors can able to measure the level without having any contact with the oil.

2.11 Environmental sensor

The BME680 is the one of the type of gas sensor that measures high-linearity and high-accuracy gas, pressure, humidity and temperature sensors. This sensor is made for usage in mobile applications due to its small size and low power consumption. The BME680 has various advantages - depending on the various operating mode under optimized consumption, longer-term stability and higher EMC robustness. MBE680 can measure the air quality for personal measurement and the gas sensor within the BME680 can detect a large range of gases like volatile organic compounds (VOC).

The following are the Possible use cases that can be measured using this sensor:

- Personal air quality tracker
- Air quality mapping
- Air quality inside cars & public transport
- Enhanced context awareness
- Accurate step & calorie tracker
- Quick GPS-fix & improved navigation
- Indicator of too high / low humidity
- Air quality & well-being indicator
- Sleep / recovery tracker

- Weather trend
- Stair counter
- Floor level detection

Figure 9. BME Environmental sensor

2.12 CO2 Sensor

It is a well know fact that Greenhouse Effec is melting the Earth ice core every day there by creating dangerous icebergs. By measuring the exact concentration of CO2(Carbon Dioxide), it is possible t to reduce the CO2 and to protect our Earth.

In oil and gas filed it is very important to measure the CO2 level that comes out of the gas tank to avoid any fire accidents. Oil and gas when stored in a closed tanks are subjected to emission of gases due to changes in environmental temperature and gas pressure of the storage tank.

It is obvious and compulsory to measure the CO2 level coming out of this storage tank to safe guard the plant from any excess emissions that can cause smokes or burns.

This is the first CO2 sensor that are made for compatible with the Arduino market. The output voltage of this sensor decreases as the concentration of the CO2 increases. There is a potentiometer designed along with this sensor board to set the threshold of voltage. The measurement works ss long as the CO2 concentration is high enough (the voltage is lower than the threshold), a digital signal (ON/OFF) will be sent to the Arduino sensor pin.

Figure 9. BME Environmental sensor

The CO2 sensor is basically a MG-811 sensor module which is highly sensitive to CO2 emissions. This sensor is made with less sensitive to alcohol and CO, low humidity & temperature dependency.

Onboard heating circuit brings the best temperature for the sensor to function. Internal power boosting to 6V for heating sensor best performance.

This sensor has an onboard conditioning circuit for amplifying output signal.

To ease the difficulty of using this CO2 sensor, a Gravity Interface is adapted to allow plug play. The Arduino IO expansion shield is the best match for this CO2 senor connecting to your Arduino microcontroller.

This is an electrochemical Arduino-based CO2 sensor, it is suitable for qualitative analysis. There are other Infrared CO2 sensors, which could make a quantitative analysis.

3. CONCLUSIONS

In this paper various sensors that are required to be used in oil and gas industries are discussed. It is very important to measure the internal and external oil quality parameters. As oil is highly flammable liquid utmost attention is required in selecting proper sensor to operate safe and to give accurate results. The sensors discussed here are made with latest technologies and can able to operate safely as per the climatic condition in Oil and gas industries in Oman.

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REFERENCES

[1] Pan Yi, Xiao Lizhi and Zhang Yuanzhong, "Remote real-time Monitoring System for Oil and Gas Well Based on Wireless Sensor Networks", 2010

[2] Stig Petersen, Paula Doyle, Svein Vatland, Christian Salbu Aasland, Trond Michael Andersen and Dag Sjong Requirements. Drivers and Analysis of Wireless Sensor Network Solutions for the Oil & Gas Industry, 2007, IEEE

[3] Kazem Sohraby, Daniel Minoli and Taieb Znati. Wireless sensor networks: technology, protocols, and applications. Published by John Wiley & Sons, Inc., Hoboken, New Jersey, 2007 ISBN: 978-0-471-74300-2

[4] Summarized Version published in Ozean Journal of Applied Sciences 6(2), 2013. ISSN 1943-2429, Pages 39 – 43. Ozean publication REFEREN CES Alex Talevski, Simon Carlsen and Stig Petersen. Research Challenges in Applying Intelligent Wireless Sensors in the Oil, Gas and Resources Industries, 7th IEEE International Conference on Industrial Informatics (INDIN 2009)

[5] He, J.; Yang, S.; Gan, C.; He, J.; Yang, S.; Gan, C. Unsupervised Fault Diagnosis of a Gear Transmission Chain

[6] Using a Deep Belief Network. Sensors 2017, 17, 1564.

[7] Gkerekos, C.; Lazakis, I.; Theotokatos, G. Ship Machinery Condition Monitoring Using Performance Data

[8] through Supervised Learning; University of Strathclyde Publishing: Glasgow, Scotland, 2017; pp. 105–111.

[9] ISBN 9781909522169

[10] Marichal, G.N.; Hernández, A.; Acosta, L.; González, E.J. A Neuro-Fuzzy System for Extracting Environment

BIOGRAPHY

Dr.D.Vimalakeerthy is working as Lecturer at University of Technology and Applied Sciences Nizwa. He has 22 years of teaching experience and involved in real time research activities.