Automatic Valve Operation for Bunkering

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Abstract

Bunkering means refueling of the ships including the fuel filling and distributing the fuel which is being supplied to the shipboard tank. Bunkering is the most difficult procedure of operation on a ship which may lead to several accident and lead to spill of HFO into the sea. Bunkering on a ship can be of fuel oil, sludge, diesel oil, cargo etc. Bunkering of. fuel oil or diesel oil requires most care and alternate to prevent the different kind and type of accidents and oil spill. Current scenario of bunkering system is done manually. This process takes more man power and requires continuous sounding of the tank at particular time interval. So, it is necessary to find out an alternate solution which gives continuous sounding of the bunker tank automatically all the time. The proposed project aims to overcome above problems. A model is fabricated with two tanks, a submersible pump, solenoid valve, microcontroller which controls the operation of valve for bunkering operation and sensors to sense the level of the tanks such that the valves open and close at preset time. The prototype was tested based on time taken in filling a tank and the response of the sensor with respect to time was identified. It is found that the time taken for bunkering is reduced.

Keywords: Bunkering, Risk factors, Automation technology, Building automation system, Marine industry

1 Introduction

Bunkering procedure is the one of the most dangerous operations on ship which leads to the several accidents in a year. Bunkering means refueling of the ship by fuel oil, diesel oil or HFO. “Bunkering” of fuel requires most care and safety to reduce any kind of fire accidents and oil leakage. The word “Bunker” means it is the compartment or storage place especially used on

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the onboard for the storage of the fuel (i.e. Heavy fuel oil, diesel oil etc.). The word “bunker” is derived from a Scottish word “Bunk” which means “reserved seat” or “bench”. In the shipping field, the word “bunker” is the place where we store the fuel and the lube oil in the ship which is used for different operation of the machineries used on ship. If a vessel/ship discharge the marine fuel in another port it is not considered as the “bunker”. The word “bunker” means the vessel or the tanker carrying the fuel to transfer the fuel in to another ship. And this operation of the transportation of fuel is called “Bunkering”. These fuels are stored in a tank called as “Bunker Tanks” from which it is drawn to the ship’s machinery.

2 Literature review

Olgo Aneziris et al., (1): The goal of this work is to thoroughly examine the standards that have already been published for evaluating the hazards that may arise during the bunkering of LNG-fueled ships. It is essential to conduct risk assessment studies for the store installation as well as for the numerous activities that take place even during bunkering of ships due to the potential for significant mishaps involving the usage of LNG that might endanger both people life and the environment. In this regard, several studies that concentrate on the development of risk assessment recommendations for the secure utilizing LNG in port bunkering operations have been created.

Lawrence Henesey et al., (2): This paper evaluates and assesses the potential and challenges associated with automation liquefied natural gas (LNG) bunkering operations. In order to examine the hazards associated with installing automated LNG bunkering technology, BAS is given specific attention in this article. The development of automated LNG technology is argued to provide advantages that are influenced by peripheral technologies developments, such as: low temperature actuators, sensors, Building Automation System (BAS) as well as precision of transfer valves and low temperature pneumatic valves.

3 Components required

Arduino UNO: Arduino Uno is a device which is used to control the circuit with the programming to it. It consisting of 14 output and input pins which are required for connection of different circuit, also it has 6 analog input pins and a USB connection for the laptops for programming, a power jack and a reset button Solenoid valve: A normal valve are used for the flow of liquids, Now all the operation are controlled electrically in these case they use solenoid valves.

Relay: A relay acts as a switching circuit for the function of the circuit. It depends upon the range of the relay required for the prototype.

24 Volt DC Adapter: DC adapter is used for converting the AC to DC supply for the appropriate device. It is designed such a way that it can take a certain amount of input and the output in the form of DC

Submersible Pump: An electric submersible pump (ESP), a submersible pump or sub pump is a machine with a liquid sealed motor that is connected to the body of the pump.

Jump Wire: Simply said, jumper wires are cables having connection pins at each end that can be used to link two places without soldering. With breadboards as well as other prototype tools, jumper wires are frequently used for simple and alter as required.

Ultrasonic Sensors: A sensor is an electronic device that detects input of any kind from the physical world and reacts to it. Light, heat, movement, humidity, pressure, or many of the other environmental factors might be the specific input.

Breed Board: The breadboard is a method of building circuits that enables quick circuit fabrication without the need of solder or the establishment of long-lasting connections.

4 Methodology

Initially, the required components are found out for the prototype. Then required range of components is selected for the setup. Later the Arduino UNO is connected to the laptop for programming. Connection is made according to the circuit diagram. Electricity supplied to the relay is to switch OFF/ON the devices. Submersible pump of 12v is used for the supply of liquid, adapter is connected which converts AC to

DC. Solenoid valves are connected to the relay with a range of 24v to which 24v adapter is connected for working. Experimental setup is done. Painting of hull shape structure is done. Sensors are connected to the microcontroller for sensing the level of tank based on the distance between the liquid surface and the sensor. And it is placed at the top of the tank. The program is done in such a way that when the set is ON the first sensor senses the level and opens the valves for first tank, the level is feed in the microcontroller after reaching its certain level It switch OFF the first valve and opens the second valve and after achieving the certain level it switching OFF the valves and also the system gets turned OFF. Then the time required for filling the tank are noted down and error of the sensor are noted, graphs are plotted according to tabulated values.

5 Implementation and Results:

The prototype is tested based on type of fluid, time taken to bunker the tank and testing of ultrasonic sensor is done. The fluid mainly depends on viscosity of the fluid.

Testing done with water and time taken:

TABLE 1

Testing with Water

Sl.NO	QUANTITY (liters)	TIME TAKEN (min)
1	1.0	0.59
2	2.0	1.58
3	3.0	2.57
4	4.0	3.56
5	5.0	4.55
6	6.0	5.54
7	7.0	6.53
8	8.0	7.52

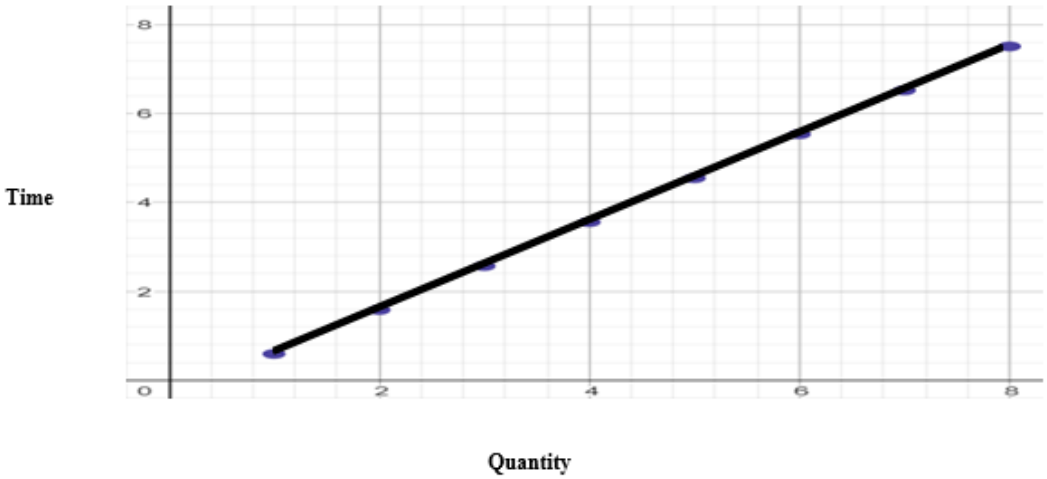

FIGURE 1

Time Taken Verses Quantity

5.1 Testing done with petrol and time taken:

The graph has been plotted according to the data received while testing the time taken to fill the tank with different fluid. It is found that as the viscosity of the fluid increases the time

TABLE 2

Testing with petrol

Sl.NO	QUAN TITY (liters)	TIME TAKEN (min)
1	1.0	0.35
2	2.0	1.10
3	3.0	1.45
4	4.0	2.20
5	5.0	2.55
6	6.0	3.30
7	7.0	4.05
8	8.0	4.40

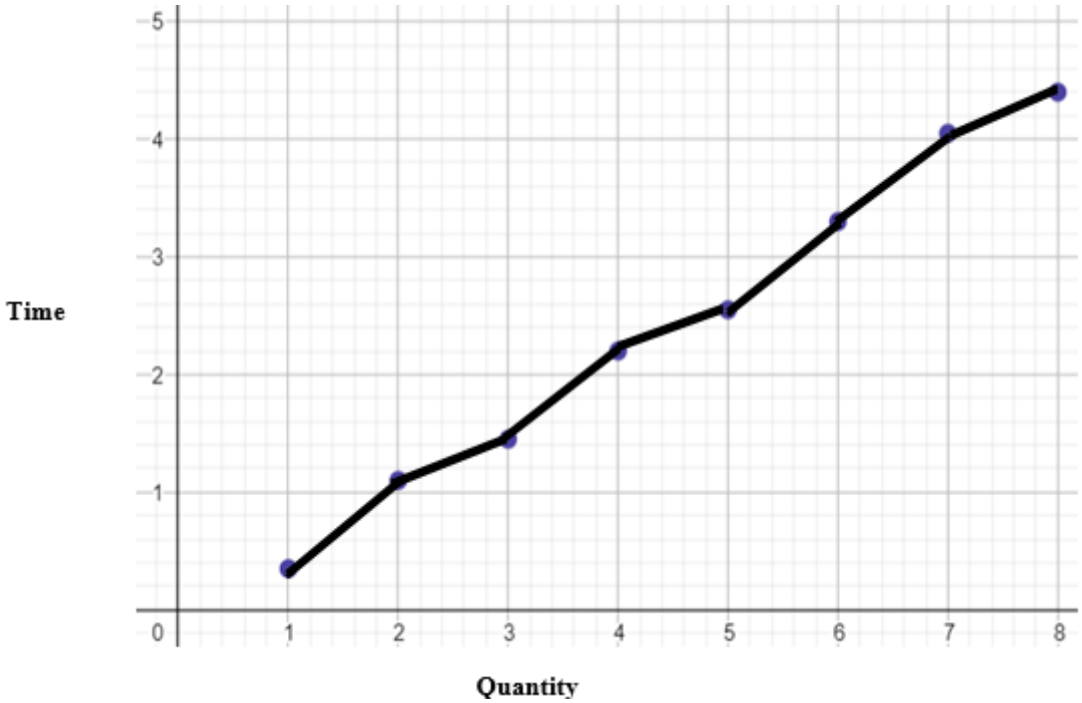

FIGURE 2

Time Taken Verses Quantity

taken to fill the tank also increases because of friction between fluid and lines tend to decrease its flow rate. In above fig 6.4 the oil having larger viscosity and lower density requires larger time for bunkering process.

TABLE 3

Sensor Errors

Distance tested (cm)	Measured distance (cm)	Error (cm)
25	23	2
50	49	1
75	74	1

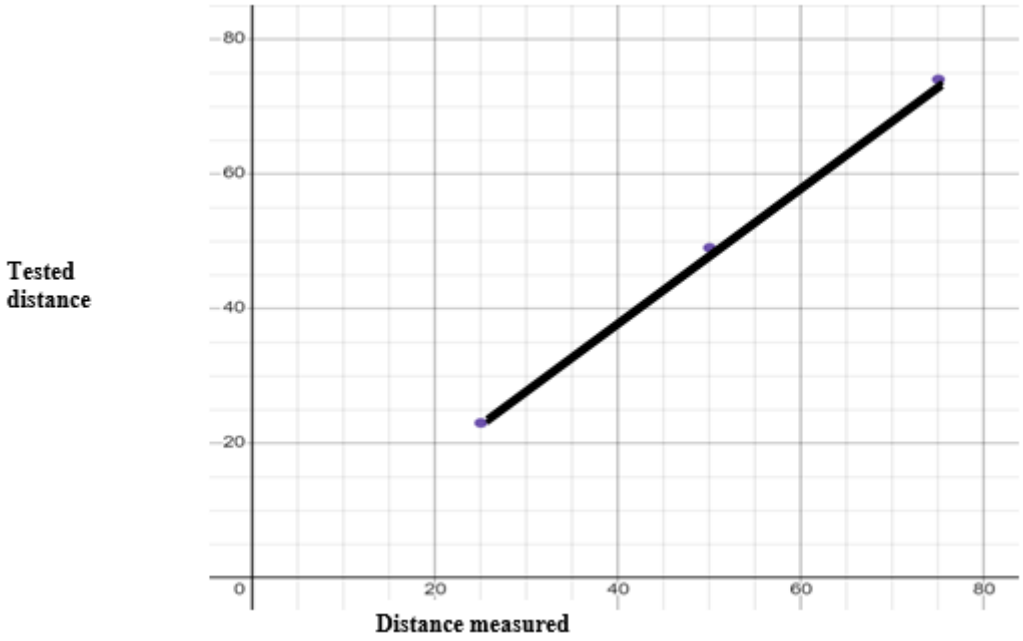

FIGURE 3

Tested Distance V/S Distance Measured

5.2 Ultrasonic Sensor Testing:

This graph has been plotted according to the error occurred while testing the liquid. During the test it is observed that measured distance varies from actual distance. Error obtained is noted down and graph is plotted.

Current scenario of bunkering system is done manually. This process takes more man power and requires continuous sounding of the tank at particular time interval. This proposed project aims to overcome above problems. A model in which microcontroller controls the operation of valve for bunkering operation and sensors to sense the level of the tanks such that the valves open and close at preset time. The prototype was tested based on time taken to fill the tank and the response of the sensor with respect to time was noted. It is found that the time taken for bunkering is reduced with the automatic valve operation. But as the viscosity of the fluid increases the time taken for bunkering also increases.

6 Limitation:

This design has few limitations. It needs a continuous power supply. Connections and programs should be done correctly according to required condition.

7 Future Recommendation :

System can be implemented with high and low-level sensors. Flow rate can be changed according to necessity. Model can be tested using different liquid with some parameters.

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