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Design of Control System for Measurement of Ph and EC of Fertilizer Solution

Prof Ajay V . Raipure[1], Dr. Ashwinikumar P. Dhande[2]

Professor, Dept. of ECE, PCP College, Pune, Maharashtra, India [1]

Professor, Dept. of ECE, Pune Institute of Computer Technology, Pune, Maharashtra, India [2]

ABSTRACT: Preserving environment in farming is now becoming main concern since use of inputs like fertilizers & pesticides has been widely employed. Site–specific application of agricultural chemicals is an effective way of resource saving and environmental protection. Precise farming implementation is now gaining popularity and widely accepted as one of smart solutions to sustain agriculture production without ignoring environment.

In appropriate nutrient inputs has affected environment and human's health. Indiscriminate use of nitrogen and phosphorus fertilizers has led to ground water pollution. So the farmers has to pay attention to nutrient control into their farming techniques. The balanced nutrition level to plant is provided by managing pH and Electrical conductivity level of fertilizer solution according to soil pH and electrical conductivity. Design consist of two sensors to measure pH and EC of the fertilizer solution and soil. The output signals from the pH and EC electrode sensors are conditioned with the help signal conditioning and then interfaced to microcontroller through inbuilt ADC. Microcontroller will turn ON and OFF particular solenoid valve to pore the fertilizers into the mixing tank according to the pH and EC level in the mixing tank solution.

KEYWORDS*:* pH, EC, Microcontroller, Electrical conductivity, fertilizer.

I. INTRODUCTION

The pH and EC (electrical conductivity) are the two important indices of fertilization[1]. They represent the whole quality and characteristics of fertilizers and water. It varies for different plants and soils. (a) *pH* - pH give the information of acidity or alkalinity of solution. . A pH reading of 7 is neutral because there are equal concentrations of (H+) and (OH-) is ideal for many plants and spray materials.

pH = - log [H+] (neg. log of the H+ conc.)

pH level gives the availability of nutrients in the soil or fertilizer solution [2], [3]. pH range of fertilizers solution delivered in soil effects the soil properties. Calcium, Phosphorus, potassium and magnesium are unavailable to plants in acidic soil. Plants have difficulty in absorbing micronutrients like copper, zinc, boron, manganese and iron in basic soils; however their presence in soil can also be excessive and become toxic to plants. A higher quantity of bicarbonate ions are contained inbasic soil which affects the optimum growth in plants by interfering with the normal uptake of other ions [4], [5]. (b) *Electrical Conductivity* - Salinity of solution is measured by common way using electrical conductivity (EC) sensor. This sensor measures the electricity moves through a saltier solution, the electricity moves through it is directly proportional to the conductivity readings. EC is measured in dS/cm (deciSiemens per centimeter) [6], [7], [8]. In all soils salts are naturally present additional salts build up in the soil by higher concentration of fertilizers applied .

II. FERTILIZERS CONTROL SYSTEM

Fertilizer tanks to deliver fertilizers and mixing tanks to mix fertilizers are used in this system as shown in figure 1. The control units like solenoid flow valves operated by relays circuits are available that allow fertilizer tanks to be turned open at pre-set times to deliver fertilizer in mixing tank. Solenoid valve to be turned ON and OFF according to a pre-determined program that controls the valve according to the pH and EC signal of solution.

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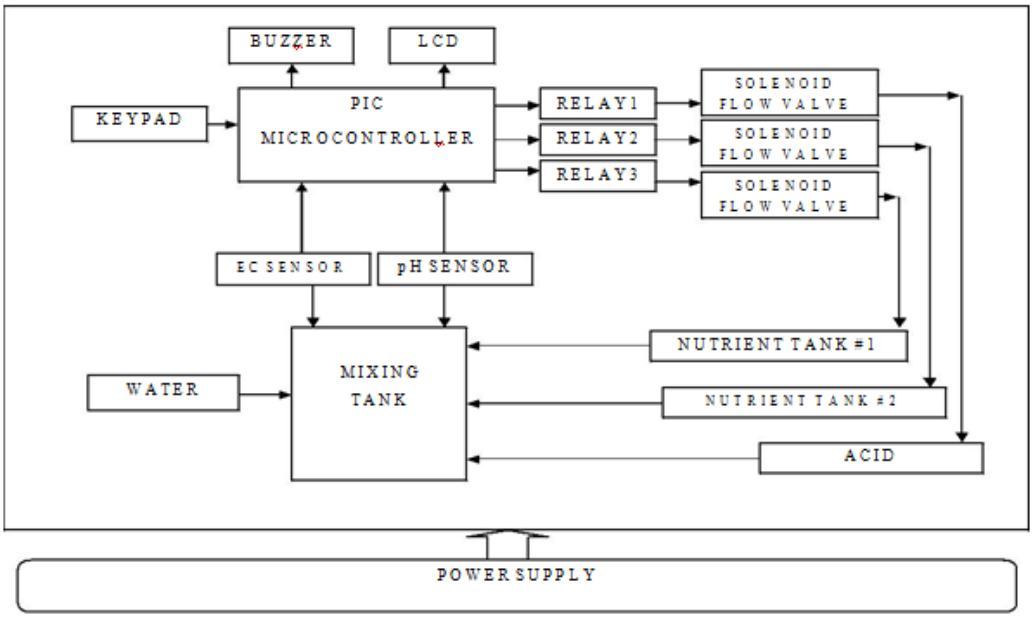

Figure. 1 Fertigation Control System

There is an equipment to monitor and modify the pH and electrical conductivity (EC) of the nutrient solution. pH readings are used to control availability of nutrients in the fertilizer solution. The EC values are used to give information about the quantity of fertilizer being injected into the fertilizer solution when the EC readings of the solution are higher than required amount that means high amounts of fertilizer has been injected in the fertilizer solution.

III. GENERAL DESCRIPTION OF SYSTEM

A Microcontroller

The system is based on PIC16F877A programmable controller used to measure and maintained the pH and EC according to the required values entered through keypad. The PIC controller has inbuilt ADC to measure the analog signal received from pH and EC sensor.

B Relay

Relay switch is electrically operated and used to operate the solenoid flow valve. The Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts.

C Relay Driver

For relay's interfacing with microcontrollers or other low current digital ICs, a power or current amplifier circuit is required known as relay driver circuits. Diodes and optocouplers are used to operate relay using microcontroller.

D Solenoid valve

A solenoid valve is an electromechanically operated valve which is most frequently used to control fluids flow. Their tasks are to shut off, release, dose, distribute or mix liquid form solutions.

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E Mixing Tank

A mixing tank contain the fertilizer solution mixed with water dropped through solenoid valves from other fertilizers tanks.

F Nutrient Tanks

Fertilizer tanks contain the different types of fertilizer to make solution acidic or alkaline.

G Buzzer

A buzzer is an audio signal producing output device. In this system buzzer is used for the indication of completed process.

H Liquid Crystal Display (LCD)

The LCD is used to display the computing results. The main features of Hitachi 44780 LCD are: 16 X 2 displays used for alphanumeric characters & based on ASCII codes.

IV. FERTILIZERS SELECTION

The main factors affecting fertilizers composition are the plant characteristics, soil characteristics, irrigation water quality and growing place. Major nutrients nitrogen (N), phosphorus (P) and potassium (K) are supplied to plant through fertigation process. However calcium (Ca) and magnesium (Mg) are sometimes supplied in the field. When potassium sulphate and magnesium sulphate are used to supply K and Mg respectively, soil also gets Sulphur (S) in addition. The micronutrients such as boron (B), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu) and molybdenum (Mo) are generally applied as foliar sprays because they are required in small amounts.

Fertilizers to manage pH and EC- Soil pH is altered by the application of fertilizers solution. Ammonium forming fertilizers make solution acidic while nitrate forming fertilizers contains basic ions and are less acid forming make solution alkaline. Ammonium and ammonium forming fertilizers (ex. urea) are used to decrease pH level. Elemental sulphur, ammonium sulphate, and compounds such as iron or aluminium sulphates can reduce the soil pH. Acidic soils are neutralized with the application of lime addition in soil. The requirement of lime dependent upon the buffering capacity of the soil. The Saline soils are also termed as alkaline soil [8]. Gypsum is the most common amendment used to remove excessive amounts of sodium ions (Na+) from soil profile and improve saline soil. Gypsum is used to improve saline and alkaline soil having pH range up to 9.0. Sulphur, iron sulphate , iron pyrite used for soil having pH level 8.0-9.0, lime stone is used having pH less than 8.0. *Mixing Of Fertilizer*-The mixing container with 50 - 75% of the required water should be used in the mixture if mixing dry soluble fertilizers. Always put acid into water rather than water into acid.When chlorinating water with chlorine always add chlorine to water and not vice versa. aAcid or acidified fertilizers can not be mixed with chlorine.

V. WORKING OF pH AND EC SENSOR

A Measuring pH

Fertigation solution pH is measured using pH electrode. The output signal of pH electrode is in milli-volts (mV). The working of pH electrode is based on the principle that a potential is developed when two solutions of different pH comes in contact through a thin glass membrane. The pH electrode is consists of glass electrode and reference electrode the potential between these two electrodes.

Temperature changes the chemical activity. The pH electrode transfer function at the temperatures 100 deg C, 25 deg C and 0 deg C are shown in figure 3, generally most measurements of pH include a temperature correction to a standard temperature of 25 degrees C. The signal generated by the pH sensor has a linear relationship with the pH of the aqueous solutions.

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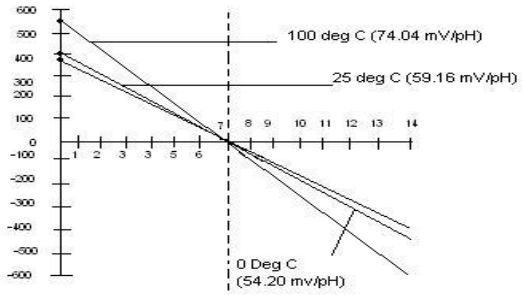
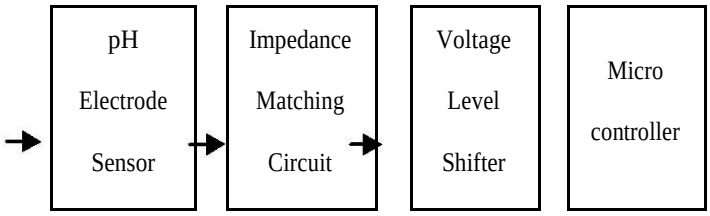


Figure 3. pH electrode transfer function

pH sensor is interfaced to microcontroller through unity gain differential amplifier for impedance matching.



B Measuring EC

The electrical conductivity of a solution is measured by determining the resistance of the solution between two flat or cylindrical electrode separated by a fixed distance. The resistance is measured by a conductivity cell. An alternating voltage is used in to avoid electrolysis.The parameter cell constant of conductivity cell is used to convert the conductance measured by conductivity cell and is defined by

K= d/A
K = Cell constant or Cell factor.

d = Distance between the electrodes A = Area of the electrodes

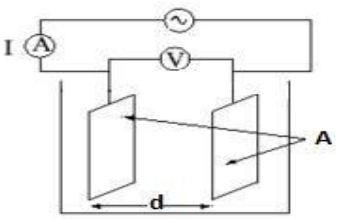


Figure56. Parameters of conductivity cell

Measurement of conductivity is done by measuring the conductance of fertilizer solution or soil extract. The conductance so measured is multiplied by the cell constant to get conductivity of soil and is given by

C = G x K

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C = Conductivity
G = Measured Conductance

K = Cell Constant Conductivity of solutions cannot be measured by applying a DC signal to conductivity cell, because if the DC signal is passed through the conductivity cell and dipped in the aqueous solution, it will rip the ions apart and a constant changing reading will be obtained.

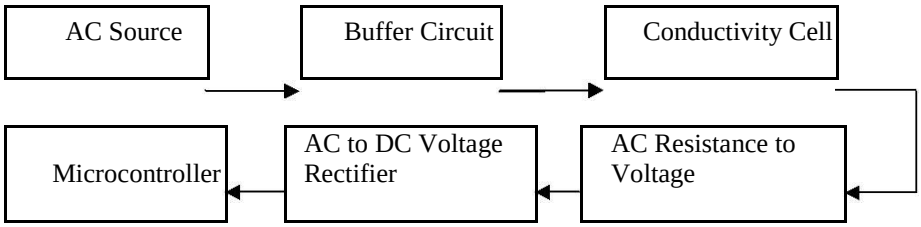

Figure 6. working of conductivity meter

Figure 6. shows the working of conductivity meter.

VI. PROGRAMMING STEPS -

The main steps are given as following.

1) Enter the soil parameters pH and EC either manually through keypad or the soil parameters determined by the system from soil sample with the help of sensors.

2) Enter the desired parameters of crop manually or select the predefined crop mentioned in the system.

3) Comparison of the desired parameters of crop with actual parameters of soil is done using microcontroller.

4) Fertilizer control system will monitor and modify the pH and EC of mixing tank solution by taking fertilizers from selected fertilizer tanks.

5) Select the parameter which is to be modified pH or EC.
6) As per the selected parameter microcontroller will get the signal from sensor.

7) Again comparison of the actual value of fertilizer solution with desired value of fertilizer solution is done using microcontroller.

8) On the basis of the comparison done in step7 microcontroller will turn the particular solenoid valve either on or off and corresponding fertilizer from the fertilizer tank will be poured in the mixing tank for certain time.

9) If desired parameters achieved the system will stop with the indication of buzzer else the system will go back to the step 7 and step 8 in continuous manner until the desired value is achieved.

VII. RESULTS

The developed system was tested using urea and nitric acid. The control unit present satisfactory operation of all the valves as per the programming.

A pH characterstics

Adition of urea to water did not have significant effect on acidic or alkaline behavior of water but nitric acid reduce the pH level make the solution acidic as shown in figure 8.

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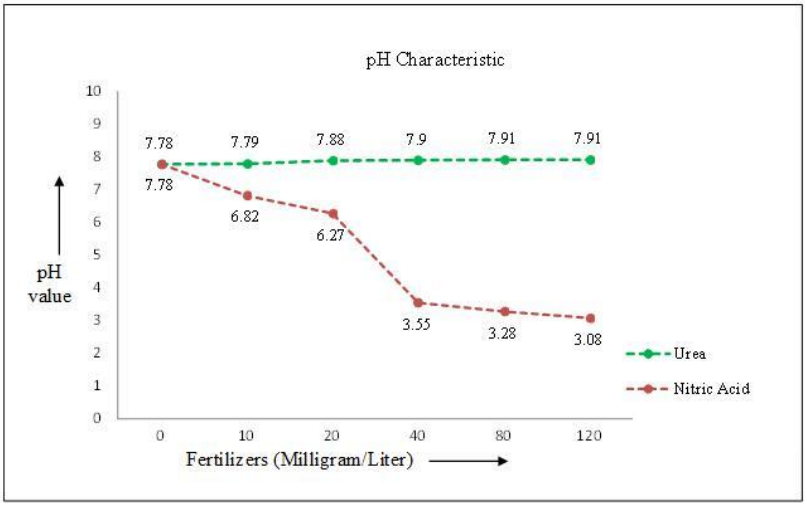

Figure.8 pH characteristics according to the addition of urea and nitric acid fertilizers

B Electrical conductivity characterstics

Addition of urea and nitiric acid rise the electrical conductivity level of solution as shown in figure 9.

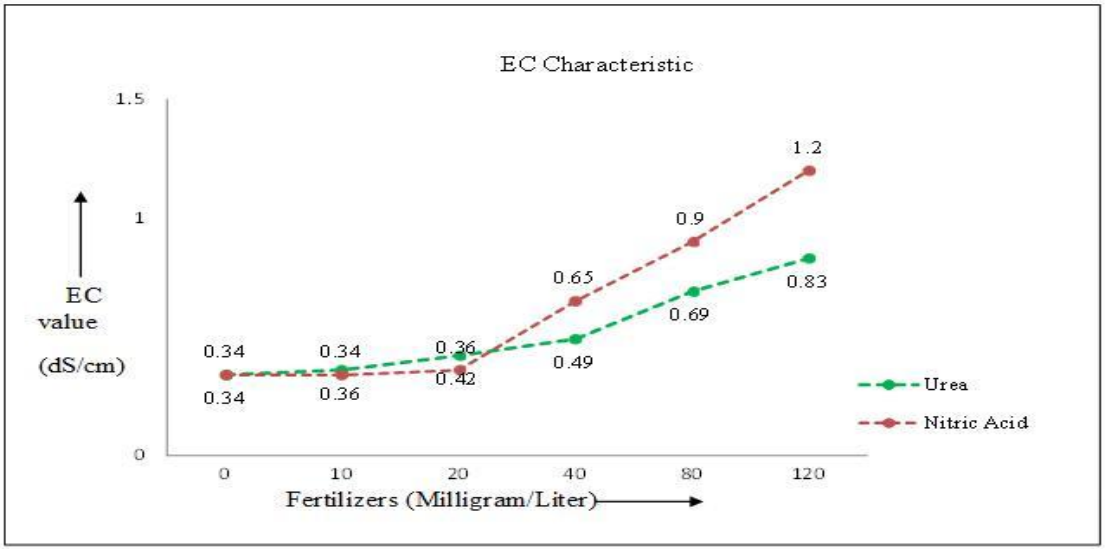

Figure**.9** EC characterstics according to the addition of urea and nitric acid fertilizers

VIII. CONCLUSIONS

. The result of solution's pH measurement gives the information about availability of nutrients in solution and EC readings are indicative of amounts of fertilizers being injected into the fertigation system. This work aims to develop a system that can measure these parameters (pH and EC) with the help of electrical sensor and maintained their level using required amount of fertilizers. The fertilizer quantity is limited according to the crop requirement..

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REFERENCES

[1] de Caritat, Patrice, Michelle Cooper, and John Wilford, (2011) "The pH of Australian soils: field results from a national survey." Soil Research 49, no. 2 173-182.
[2] National Instruments, (2006) "pH measurement tutorial", Available: http://zone.ni.com/devzone/cda/tut/p/ id / 2870.
[3] Agronomy Fact Sheet Series,(2005) "Soil pH for Field Crops", Nutrient Management Spear Program, Department of Crop and Soil Science, Cornell University Corporative Extension, Fact Sheet Number 5.
[4] G.E. Cardon, J.G. Davis, T.A. Bauder, and R.M. Waskom,(2003) "Managing Saline Soils", Colorado State University Cooperative Extension. www.ext.colostate.edu
[5] Tony Provin and J.L. Pitt, (2001) "Managing Soil Salinity", The Texas A&M University System Extension publications E-60. Web at: http://texaserc.tamu.edu,.
[6] David H. Hardy,(2008) "Effect of fertilizer salts on soil pH", NCDA&CS Agronomic Division. Robert Flynn,(2010) " Introduction to Soil Salinity", New Mexico State University Gardening