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GROUNDWATER LEVEL MEASUREMENT USING CAPACITIVE SENSOR

Dr. Alok Mishra[1], Dr. P.K.Dwivedi[2] & Pankaj Prajapati[3]

ABSTRACT

In this paper, capacitive sensor for ground water level detection has been fabricated. It has typically, high-impedance sensor, particularly at low frequencies, as clear from the impedance (reactance) expression for a capacitor.[1] Capacitive sensor is a noncontacting device in the common usage. Ground water level sensor based on capacitive principle is created by using two copper plates with height (h), width (w), and distance (d) between two plates. A 5Vpp 3 kHz AC signal is used as input signal for the system. Water level is directly proportional to dielectric constant between two plates. Hence, it can be used to determine water level from electrical characteristic as it inversely proportional to sensor impedance[2]. Linearization, inverting amplifier, and rectifier circuits are used as signal conditioning for the system.

I. INTRODUCTION

The water supply for all types of use in Lucknow is a problem in constant growth; access to drinking water is still very limited for some sectors of the population disregarding the constant increase in groundwater extraction. Some experts conclude that current model of groundwater management in lucknow is not the correct one. Therefore, the water management in Lucknow is here analyzed to propose preliminary solutions[3]. In this regard, an analysis of hydrogeological information , and that obtained from technical and academic forums was prepared. The analysis shows that in Lucknow the so called 630 aquifers have limits established in a conventional way, the hydrogeological monitoring network is inadequate to describe groundwater functioning and has poor coverage, the method of obtaining groundwater availability presents significant errors, among many others[4]. It is concluded that there is a need to establish true aquifer limits based on the particular geological context and the conditions imposed by the prevailing groundwater flow systems.

A basic measurement in ground-water studies is that of water levels in ground. We can monitor ground water level with the help of several equipments. The choice of equipment depends on several factors including the accuracy or ease of measurement required, water quality concerns, type of ground (monitoring or water supply), and pumping activity of ground and (or) nearby ground[5].

For all measurements, a fixed reference point must be established at the ground head. This point usually is the top of the casing or the access port in water-supply ground. The reference point typically surveyed to establish its position above sea level, to an accuracy of 0.01 ft, to ensure the same reference points are used for all measurement, a notch or marking is made on the casing and the location of the point ground documented in the site file. If the ground cap is not vented, remove several minutes before measurement to allow water levels to equilibrate to atmospheric pressure[6].

Infusions and transfusions like procedures require exact amounts of liquid to be monitored, so they need an accurate, easy-to-implement method for sensing liquid level. This article describes the 24-bit capacitive-to-digital converters and level-sensing techniques that enable high-performance capacitive sensing of liquid levels[7].

II. MONITORING OF GROUNDWATER LEVELS

We can obtain data on configuration of water table, depth, ground water movement and discharge and recharge areas location, a network of observation wells and/or piezometers has to be established. The aim of the groundwater level monitoring are to:• Detect impact of groundwater recharge and abstractions.

- Monitor the groundwater level changes
- Assess depth to water level
- Detect long term trends
- Compute the groundwater resource availability
- Assess the stage of development
- Design management strategies at regional level.

The reaction between water table and various discharge and recharge components characterized a ground water systems and is therefore continuously changes. Highest (mean) and lowest (mean)ground water table position give any drainage investigation as well as the mean water table of a hydrological tears. This is the reason that why water level measure should be made as frequent interval for at least one year.

III. PRINCIPLE OF CAPCITANCE SENSOR:

Capacitance is the ability of a body to store electrical charge. The capacitance, *C*, is given by

$$\varepsilon = \varepsilon_O \, \varepsilon_R$$

where *Q* is the charge on the capacitor and *V* is the voltage across the capacitor.

In the capacitor shown in Figure 1, two parallel metal plates with area *A* are separated by distance d. where

C is the capacitance in Farads
A is the area of overlap of the two plates = a × b
d is the distance between the two plates
ε_R is the relative static permittivity
ε_O is the permittivity of free space ($\varepsilon_O \approx 8.854 \times 10^{-12}$ F m^{-1})

IV.CAPACITIVE LEVEL-SENSING TECHNIQUES

We can monitor water level by immersing a parallel plate capacitor in the liquid, as shown in Figure. As the liquid level changes, the amount of dielectric material between the plates changes, which causes the capacitance to change as ground. A second pair of capacitive sensors (shown as C_2) is used as a reference[8].

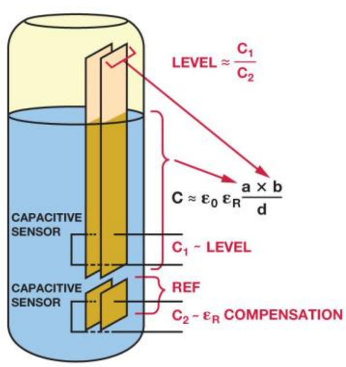

FIGURE 1

Since εR(Air)<<εR(Water),the capacitance of the sensor can be approximated by the capacitance of the submerged section. Thus, the level of the liquid can be calculated as C_1/C_2:

$$C_1 \approx \varepsilon_O\, \varepsilon_R \frac{Level \times b}{d}$$

$$C_2 \approx \varepsilon_O\, \varepsilon_R \frac{Ref \times b}{d}$$

$$Level \approx \frac{C_1}{C_2} \qquad (4.1)$$

where

- *Level* is the length submerged into liquid
- *Ref* is the length of the reference sensor

The sensor board is designed two parallel plates. The dielectric is formed by the, air, and liquid. For two parallel plates the approximate capacitance per length of track is calculated by figure1.ε

From figure1 we can calculate the water level by

C1=ε0εR (4.2)

where

- *d* is the distance between the midpoints of the two parallel tracks
- *l* is the length of the tracks

Water level is calculated by

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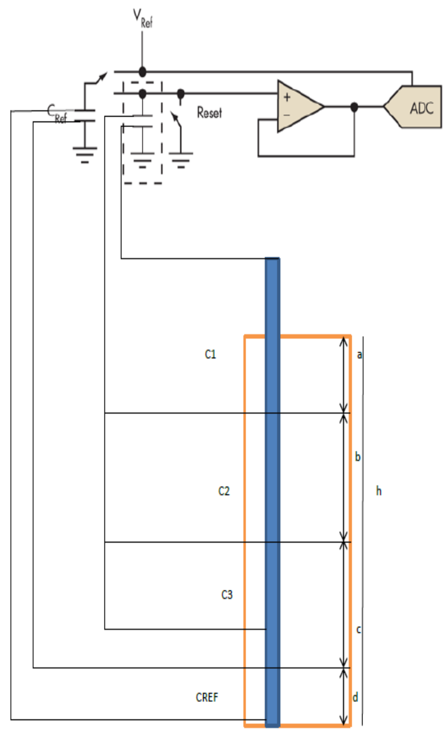

Figure 2

From this equation, the measured capacitive is proportional to the length submerged into water, as the approximate capacitance per length of track for a parallel plates.

The above circuit shows how to calculate water level

The operational amplifier is used as integrator

(4.3)

For the Op-Amp circuit

(4.4)

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From 4.3 and 4.4

Taking integration

The ratio is used to measure the water level from ground level

We see the water level from the following table

Water level	capacitance	ratio	Water level from earth
c	C3	C3/Cref	h-a-b
b	C2	C2/Cref	h-a
a	C1	C1/Cref	h

As the water level reduce the value of capacitance will also be reduce because the dielectric of water will convert in to the air.

V. CONCLUSION

The focus of this paper is to illustrate the importance of systematic, long-term collection of water-level data. Such data are crucial to the investigation and resolution of many complex water resources issues commonly faced by hydrologists, engineers, water-supply managers, regulatory agencies, and the public.

From circuit diagram (figure 2) using capacitive sensor we have calculated the water level of only pure water.

VI. CHALLENGES AND FUTURE OPPORTUNITIES

Water managers and planners need to look widely for ways to improve water management and augment water supplies , as demand for water increases. This is the conclusion of The Committee on Ground Water Recharge that artificial recharge can be one option in an integrated strategy to optimize total water resource management and it believes that with pre-treatment, soil-aquifer treatment, and post treatment as appropriate for the source and site, impaired-quality water can be used as a source for artificial recharge of ground water aquifers.

To ensure that adequate water level data are being collected for present and anticipated future uses, observation-well networks and water-level monitoring programs at the local, State, and Federal level need to be evaluated periodically.

We can improve our circuit for other substances. In ground not only the pure water but it has many materials like soil, saline water etc. we can use a type of DSP processor and optical fibre cable to calculate the dielectric of soil and the mixture of soil, saline water and other material and as the water level down it shows on the LED screen.

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