INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

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SPECIAL ISSUE FOR
NATIONAL LEVEL CONFERENCE
"RENEWABLE ENERGY
RESOURCES & IT'S APPLICATION"

MEASUREMENT OF SOIL MOISTURE USING LED LIGHT SENSOR

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Accepted Date: 12/03/2016; Published Date: 02/04/2016

Abstract: Sodium atoms have atomic number = 11and K atoms have atomic no. = 19 then its orbital length is more than Na atom, so the reflection of light occur due to K atom is greater than Na atom. Here K atom s are present only on its surface and not in its inner side ,hence when we put cover slip vertically then light rays emerging from LED directly transmits from cover slip and it absorbs by photo-detector, then there is no variation in intensity. But when we put cover slip horizontally then light rays emerging from LED are reflects from cover slip and it absorbs by photo-detector, then there is variation in intensity.

Keywords: Soil, LED Light Sensor, Moisture

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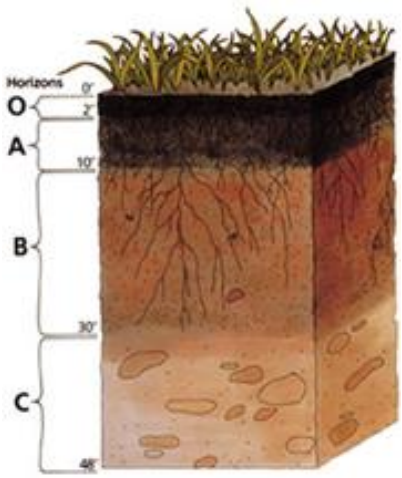
How to Cite This Article:

Sagar Shriram Jane, IJPRET, 2016; Volume 4 (8): 72-85

PAPER-QR CODE

INTRODUCTION

Soil is the naturally occurring, unconsolidated or loose covering on the Earth's surface. Soil is composed of particles of broken rock that have been altered by chemical and environmental processes including weathering and erosion. Soil is different from its parent rock(s) source(s), altered by interactions between the lithosphere, hydrosphere, atmosphere, and the biosphere. It is a mixture of mineral and organic constituents that are in solid, gaseous and aqueous states. Soil particles pack loosely, forming a soil structure filled with pore spaces. These pores contain sol solution (liquid) and air (gas). Accordingly, soils are often treated as a three state system. Most soils have a density between 1.0 kg/m³ and 2.0 kg/m³ (60 and 120 pounds per cubic foot). Soil is also known as earth: it is the substance from which our planet takes its name. Little of the soil composition of the earth is older than Tertiary and most no older than Pleistocene. Darkened topsoil and reddish subsoil layers are typical in some regions.



Soil forming factors:-

Soil formation, or pedogenesis, is the combined effect of physical, chemical, biological, and anthropogenic processes on soil parent material. Soil genesis involves processes that develop layers or horizons in the soil profile. These processes involve additions, losses, transformations and translocations of material that compose the soil. Minerals derived from weathered rocks undergo changes that cause the formation of secondary minerals and other compounds that are variably soluble in water, these constitutes are moved (translocated) from one area of the soil to other areas by water and animal activity. The alteration and movement of materials within soil causes the formation of distinctive soil horizons. The weathering of bedrock produces the parent material that soils form from. An example of soil development from bare rock occurs on recent lava flows in warm regions under heavy and very frequent rainfall. In such climates plants become established very quickly on basaltic lava, even though there is very little organic material. The plants are supported by the porous rock becoming filled with nutrient bearing water, for example carrying dissolved bird droppings or guano. The developing plant roots themselves gradually break up the porous lava and organic matter soon accumulates. But even before it does, the predominantly porous broken lava in which the plant roots grow can

be considered a soil. How the soil "life" cycle proceeds is influenced by at least five classic soil forming factors that are dynamically intertwined in shaping the way soil is developed, they include: parent material, regional climate, topography, biotic potential and the passage of time.The term soil has different connotations for scientist's belonging to different disciplines. The definition given to a soil by an agriculturist is different from the one used by the civil Engineer .To an agriculturist, soil merely means the top layer of the earth which is responsible for supporting for plant life .Even to a Geologist, soil is the thin outer layer of loose sediments within which plant roots are present. A geologist refers to the rest of the earth crust as rock, irrespective of how strong or weak the bonding forces of the sediments are. Soil is also the abundantly available construction material Form ancient times, man has used soil for the construction of tombs, monuments, dwelling and barrages for storing water. In modern times, the use of earth for building dams and for constructing pavements for highways and airfields is an important aspect of Civil engineer.

SOIL FORMATION AND SOIL TYPES:-

On the basis of the geological origin of their constituents sediments , soil can be divided into two main groups – those which owe their origin to the physical and weathering of the parent rocks, and those which are chiefly of organic origin . The latter types are extremely compressible and their use as foundation material is best avoided. Of the former group, soil which are a product of physical weathering or mechanical weathering or mechanical disintegration, retain the minerals that were present in the parent rocks and are coarse grained. Gravels and sands fall in to this category. If the products of rock weathering are still located at the place where they originated, are called residual soils. Any soil that has been transported form its place of origin by wind, water, ice or any other agency and has been redeposited, is called a transported soil. Residual soils are not as common as transported soils. Transported soils are further classified according to the transporting agency and method of deposition:

Alluvial deposit- soils that have been deposited from suspension in running water.

Lacustrine deposit- soils that have been deposited from suspension in still, fresh water of lakes Marine deposit- soils that have been deposited from suspension in sea water.

Aeolian deposit- soils that have been transported by wind. Glacial deposit- deposits that have been transported by ice.

REGIONAL SOIL DEPOSITS OF INDIA-

The soils of India can be broadly divided into the following groups, based on climatic conditions, topography and geology of their formation:

A) Marine deposits B) Laterites and lateritic soil C) Black cotton soils D) Alluvial soils E) Desert soils F) Boulder soils

A) Marine deposits-These deposits are found all along the coast in narrow tidal plains. The marine clays are very soft and may contain organic matter. They possess low shear strength and high compressibility and hence pose problems as a foundation material or as a material of construction.

B) Laterites and lateritic soils:-Laterites soils are cover an area of about 100,000 sq.km and extend over Kerala, Karnataka, Maharashtra, Orissa and West Bengal. Laterites are formed by the decomposition of rock removal of the bases and silica and formation of oxides of iron and aluminum at the top of the soil profile. In Kerala the laterites are soft when wet but harden with age. There are two types of laterites, namely, the primary and the secondary .primary laterites is found in situ. The original rock structure, joints and quartz material are intact and the laterite deposit overlies the bedrock. Primary lateriet is found at high altitudes near hills. Secondary laterites are found in the coastal belt. These are formed from sedimentary deposits such as gravels and pebbles by sesquioxide impregnation and cementation. They are pellet type and are quite different from the underlying soil or bed rock.

C) Black cotton soil:-

This is the Indian name given to the expansive deposits in the central part of the country. They cover an area of approximately 3, 00,000 sq km .these soils have been formed from basalt or trap and contain the clay mineral montmorillonite.

D) Alluvial soils:-

The thickness of these soil deposits is sometimes over 100 m. The deposits have alternating layers of sand, silt and clay. There is a great deal of variation in the thickness of these layers and there horizontal development. The alluvial deposits extend from Assam in the East to Punjab in the west.

E) Desert soils: They formed under highly arid conditions. Dune sand is nonplastic uniformly graded, fine sand. Some of the problem associated with this soil is of soil establishment for roads and runways.

F) Boulder soils:- Rivers flowing in hilly terrains and near foot-hills carry large boulders downstream. The deposits that such flows make may contain large quantities of boulders. Such deposits are often found in the su8bhimalaya regions of Himachal Pradesh and Uttar Pradesh .the properties of these deposits depends on the relative proportions of the boulders and the soil matrices .the boulder to boulder contacts may results in large friction resulting in higher angles of shearing resistance .

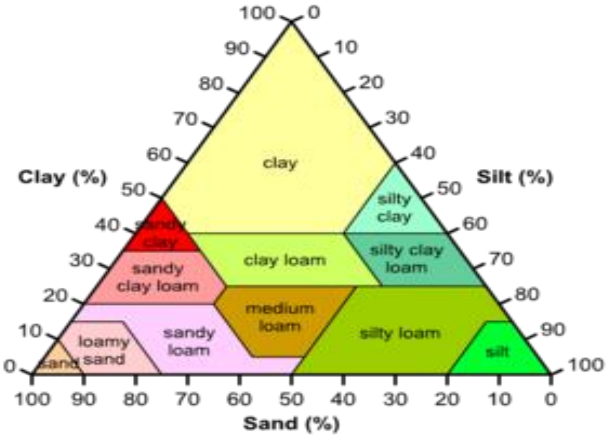
SOIL SCIENCE:-

For soil resources, experience has shown that a natural system approach to classification, i.e. grouping soils by their intrinsic property (soil morphology), behavior, or genesis, results in classes that can be interpreted for many diverse uses. Differing concepts of pedogenesis, and differences in the significance of morphological features to various land uses can affect the classification approach. Despite these differences, in a well-constructed system, classification criteria group similar concepts so that interpretations do not vary widely. This is in contrast to a technical system approach to soil classification, where soils are grouped according to their fitness for a specific use and their edaphic characteristics.Natural system approaches to soil classification, such as the French Soil Reference System (Référentiel pédologique français) are based on presumed soil genesis. Systems have developed, such as USDA soil taxonomy and the World Reference Base for Soil Resources, which use taxonomic criteria involving soil morphology and laboratory tests to inform and refine hierarchical classes.

Another approach is numerical classification, also called ordination, where soil individuals are grouped by multivariate statistical methods such as cluster analysis. This produces natural groupings without requiring any inference about soil genesis.

In soil survey, as practiced in the United States, soil classification usually means criteria based on soil morphology in addition to characteristics developed during soil formation. Criteria are designed to guide choices in land use and soil management. As indicated, this is a hierarchical system that is a hybrid of both natural and objective criteria. USDA soil taxonomy provides the core criteria for differentiating soil map units. This is a substantial revision of the 1938 USDA soil taxonomy which was a strictly natural system. Soil taxonomy based soil map units are additionally sorted into classes based on technical classification systems. Land Capability Classes, hydric soil, and prime farmland are some examples.

CHARACTERISTICS



Soil types by clay, silt and sand composition.

Soil color is often the first impression one has when viewing soil. Striking colors and contrasting patterns are especially memorable. The Red River (Mississippi watershed) carries sediment eroded from extensive reddish soils like Port Silt Loam in Oklahoma. The Yellow River in China carries yellow sediment from eroding loessal soils. Mollisols in the Great Plains are darkened and enriched by organic matter. Podsols in boreal forests have highly contrasting layers due to acidity and leaching. Soil color is primarily influenced by soil mineralogy. The extensive and various iron minerals in soils are responsible for many soil colors. The development and distribution of color within a soil profile result from chemical weathering, especially redox reactions. As the primary minerals in soil parent material weather, the elements combine into new and colorful compounds. Iron forms secondary minerals with a yellow or red color, organic matter decomposes into black and brown compounds, and manganese forms black mineral deposits. These pigments produce various color patterns as a result of the affects by the environment during soil formation: aerobic conditions produce uniform or gradual color changes, while reducing environments result in disrupted color flow with complex, mottled patterns and points of color concentration. Soil color results from chemical and biological weathering. As the primary minerals in parent material weather, the elements combine into new and colorful compounds. Iron forms secondary minerals with a yellow or red color; organic matter decomposes into brown compounds; and manganese, sulfur and nitrogen can form black mineral deposits. Soil structure is the arrangement of soil particles into aggregates. These may have various shapes, sizes and degrees of development or expression. Soil structure affects aeration, water movement, resistance to erosion, and plant root growth. Structure often gives

clues to texture, organic matter content, biological activity, past soil evolution and human use, and chemical and mineralogical conditions under which the soil formed.

Soil texture refers to sand, silt and clay composition. Sand and silt are the product of physical weathering while soil is the product of chemical weathering. Soil content is influential on soil behavior, affecting the retention capacity for nutrients and water. Sand and silt are the products of physical weathering, while clay is the product of chemical weathering. Clay content is influential on soil behavior because it has retention capacity for nutrients and water. Clay soils resist wind and water erosion better than silty and sandy soils, because the particals are more tightly joined to each other. In medium textured soils, clay often is often translocated downward through the soil profile and accumulates in the subsoil. The electrical resistivity of soil can affect the rate of galvanic corrosion of metallic structures in contact with it. Higher moister content or increased electrolyte concentration can lower the resistivity and thereby increase the rate of corrosion.[18] Soil resistivity values typically range from about 2 to 1000 Ω·m, but more extreme values are not unusual. A homeowner tests soil to apply only thenutrientsneeded. Due to their thermal mass, rammed earth walls fit in with environmental sustainability aspirations. A homeowner sifts soil made from his compost bin in background. Composting is an excellent way to recycle household and yard wastes

Uses: Soil is used in agriculture, where it serves as the primary nutrient base for the plants. The types of soil used in agriculture (among other things, such as the purported level of moisture in the soil) vary with respect to the species of plants that are cultivated. Soil material is a critical component in the mining and construction industries. Soil serves as a foundation for most construction projects. Massive volumes of soil can be involved in surface mining, road building, and dam construction. Earth sheltering is the architectural practice of using soil for external thermal mass against building walls.

Soil resources are critical to the environment, as well as to food and fiber production. Soil provides minerals and water to plants. Soil absorbs rainwater and releases it later thus preventing floods and drought. Soil cleans the water as it percolates. Soil is the habitat for many organisms. Waste management often has a soil component. Septic drain fields treat septic tank effluent using aerobic soil processes. Landfills use soil for daily cover.

DEFINITION OF MOISTURE SENSOR:-

Moisture sensor is device element, which converts polarized moisture in (one form of energy) into other electrical energy one. The output is defined as an electrical quantity and measured as a ”physical quantity”, property or condition, which is measured “.This definition can be

generalized by extending, ”electrical quantity” to any type of signal such as mechanical and optical and extending physical quantity, property of condition being measured to those of natural. Chemical, biochemical and so on.

An element that senses a variation in input energy to produce a variation in another or same form of energy is called a sensor. A properly cut piezoelectric crystal can called a sensor. The sensing principals are physical or chemical in nature. The sensing principals can be grouped according to the form of energy in which the signals are received and generated .A matrix like arrangement can thus be obtained for elaborating the principals .signals can be divided into six categories on the basis of energies generated or received.

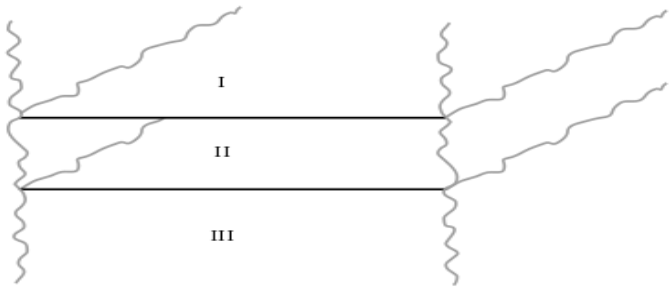
DIFFERENT DOMAINS OF SENSORS:-

The sensors are generally categorized on the basis of six different forms of energies as Radiant, Mechanical, Thermal Magnetic, Chemical etc. The photoconductivity and p-n junction photovoltaic effects are the working phenomenon for radiant sensors .The current e.m.f., inductor, resistance, are the measurements for electrical sensors. The change in the displacement, Velocity, Pressure, acceleration etc. acts as an input signals for mechanical sensors. The thermocouple, positive temperature coefficient (PTC) dependent sensors, thermister etc. are the examples of thermal energy sensors. The temperature dependent resistant is the basic characteristic for this type of sensors. The Hall Effect is the basis for magnetic sensors. In the case of chemical sensors the different species: atmospheric gases, water pollutants, humidity etc. are the measurements.

WAVEGUIDE (OPTICS):-

An optical waveguide is a physical structure that guides electromagnetic waves in the optical spectrum. Common types of optical waveguides include optical fiber and rectangular waveguides. Optical waveguides are used as components in integrated optical circuits or as the transmission medium in local and long haul optical communication systems. Optical waveguides can be classified according to their geometry (planar, strip, or fiber waveguides), mode structure (single-mode, multi-mode), refractive index distribution (step or gradient index) and

material(glass,polymer,semiconductor).



A dielectric slab waveguide consists of three dielectric layers with different refractive indices. Practical rectangular-geometry optical waveguides are most easily understood as variants of the simple dielectric slab waveguide, also called planar waveguide. The slab waveguide consists of three layers of materials with different dielectric constants, extending infinitely in the directions parallel to their interfaces.

Light may be confined in the middle layer by total internal reflection. This occurs only if the dielectric index of the middle layer is larger than that of the surrounding layers. In practice slab waveguides are not infinite in the direction parallel to the interface, but if the typical size of the interfaces is much much larger than the depth of the layer, the slab waveguide model will be an excellent approximation. It should be noted that guided modes of a slab waveguide can not be excited by light incident from the top or bottom interfaces. Light must be injected with a lens from the side into the middle layer. Alternatively a coupling element may be used to couple light into the waveguide, such as a grating coupler or prism coupler.One model of guided modes is that of a plane wave reflected back and forth between the two interfaces of the middle layer, at an angle of incidence between the propagation direction of the light and the normal or perpendicular direction, to the material interface is greater than the critical angle. The critical angle depends on the index of refraction of the materials, which may vary depending on the wavelength of the light. Such propagation will result in a guided mode only at a discrete set of angles where the reflected plane wave does not destructively interfere with itself. This structure confines electromagnetic waves only in one direction, and therefore it has little practical application. Structures that may be approximated as slab waveguides do, however, sometimes occur as incidental structures in other devices.

EXPERIMENTATION

Heat the KNO3 powder in a silica crucible and when it becomes start to melt pour NaCl cover slips into it. After some times the powder becomes completely melt. The k+ ions are deposited on the cover slips. The time required to complete this procedure is about two hrs. Then take out the cover slips from the crucible and allow it sometime for cooling and then washed it with water. Make such type of 3 sample and label it as a, b, c. The reaction takes place in a following way

$$KNO3 + NaCl \rightarrow KCl + NaNO3$$

After formation of transmitter and receiver circuit in such a way that LED and photo-detector both are placed infront of each other at a distance of 2 to3 cm. Then take 2 glass slides and washed it. Make an assembly of glass slides, photo detector and LED such that visible light pass through the sample a which is mounted on a glass slide in a horizontal manner and fall on photo detector. Then measure the velocity across photo detector by using multimeter. Similarly, measure the velocity for sample b and c. Then pour Black soil on sample a and measure velocity and pour drops of water on sample a. Then pour no. drops up to no.15 on sample a and take readings for each drop. Repeat same procedure for sample b and c and take readings. Now pour White soil on sample a and measure velocity and pour drops of water on sample a. Then pour no. drops up to no.15 on sample a and take readings for each drop. Repeat same procedure for sample b and c and take readings. While doing this procedure the room temperature is about 30°c.

Light Emitting Diode:-

As its name implies it is a forward biased P-N junction which emits visible light when energized. As discussed earlier, charge carrier recombination takes place when electrons from N-side cross the junction and recombine with the holes on P-side. Now, electrons are in the higher conduction band on the N-side where as holes are in the lower valance band on the P-side. During recombination some of this energy difference is given up in the form of heat and light (i.e. photons). For Si and Ge junction greater percentage of this energy is given up in the form of heat so that the amount of emitted light is insignificant. But in the case of other semiconductor materials like GaAs, GaP and GaAsP. A greater percentage of energy released during recombination given out in the form of light. If the semiconductor material is translucent, light is emitted and the junction becomes a light source i.e. a light emitting diode (LED). The colour of the emitted light depends upon the type of material used as given below: 1) GaAs – infrared radiation (invisible) 2) GaP - Red or Green 3) GaAsP – Red or yellow.

Printed Circuit board (PCB):-

Making of printed circuit board (PCB) is as much an art as a technique particularly so when they are to be fabricated in very small numbers. There are several ways of drawing PCB pattern, making the final boards, but the method most likely to interest people in need of just a few PCBs has to be simple and economical.

The making of a PCB essentially involves two steps 1) preparing the PCB drawing. 2) Fabricating the PCB itself from the drawing.

The traditional method of making a PCB drawing with complete placement of parts taking a photographic negative of the drawing and developing the image of the negative formed on photosensitive copper plate and dissolving the excess copper by etching is a standard practice being followed in large scale operations. However for small scale operations, where large numbers of copies are not required the cost saving procedure presented here may be adopted.

Making PCB drawing involves some preliminary considerations such as placement of components on piece of paper locations of holes, deciding the diameters of various holes, the optimum area each component should occupy, the shape and location of island for connecting two or more components at a place, full space utilization and prevention of overcrowding of components at a particular place.

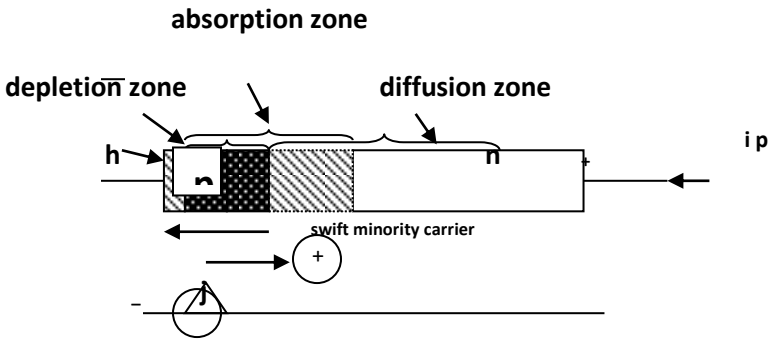
PHOTO DETECTOR:-

Several type of photosensitive device has been tried as a detector for use with fiber optic. These include silicon photo diodes, phototransistors and photo resistor. Most of them however do not have the fast response and extreme sensitivity needed to useful for communication purpose. The once that do include the P-I-N diodes and avalanche diode.

The P-N photodiode:

An ordinary P-N diode may be use as a photo detector, but it tends to have extremely low sensitivity, even though its speed is satisfactory. Fig. A shoes the structure of PN photodiode. It has a thin P layer deposited on an substrate, the light enter through the P layer. This diode has relatively thin depletion zone around the junction when it is reverse biased. Photons of light entering the depletion zone ionized the hole- electron pair when they encountered atoms within the crystal structure within the depletion zone. The hole – electron pair are drawn across the junction by electric field established by reverse biased and contribute to leakage current, so that leakage current is proportional in magnitude to the incident line intensity.

Unfortunately in this type of diodes many of photons entering the thin depletion zone near the junction passed through and on into the W-region, where the hole-electron pair generated are not affected by the junction field and do not contribute to leakage or photocurrent. Thus the responsibility or conversion efficiency of the diode is quite low. However since the hole-electron pair will recombine on moving through the thin depletion zone, their life time is quite short and the diode will respond very rapidly to change the light intensity.



Soil moisture sensor consists of two circuits i.e. Transmitter and Receiver. They continuously in contact with each other through visible light. Transmitter circuit consists of many active and passive components QBC557C and the LED are main components of Transmitter circuit. The external power supply of 5V is given to this circuit for transmitting the visible light signals. Receiver circuit also consists of many components like IC LM324, resisters, capacitors, photo-detector etc. Photo-detector is use to sense the visible light and generates electrical signals in the form output voltage. The construction of the circuit for the detection of soil moisture is as shown in following circuit diagram. The circuit contains two parts-

Transmitter B) Receiver

Chapter III: - Statistical data of result

For Black soil Sample I (a)

Const. voltage = 0.68 volt, Soil weight = 0.237 gram

Cover slip weight=0.229 gram, Total weight=0.466 gram

After water drop, weight=0.590 gram

For Black soil: Sample I (b)

Const. voltage = 0.68 volt, Soil weight = 0.219 gram

Cover slip weight=0.229 gram

Total weight=0.448 gram, after water drop, weight=0.572 gram

For White soil

Sample II (a) .Const. voltage = 0.68 volt

Soil weight = 0.120 gram, Cover slip weight=0.229 gram

Total weight=0.349 gram, after water drop, weight=0.467 gram

For White soil

Sample II (b)

Const. voltage = 0.68 volt, Soil weight =0.208 gram

Cover slip weight=0.229 gram

Total weight=0.437 gram, after water drop, weight=0.576 gra

RESULT AND DISCUSSION

Sodium atoms have atomic number = 11and K atoms have atomic no. = 19 then its orbital length is more than Na atom, so the reflection of light occur due to K atom is greater than Na atom. Here K atom s are present only on its surface and not in its inner side ,hence when we put cover slip vertically then light rays emerging from LED directly transmits from cover slip and it absorbs by photo-detector, then there is no variation in intensity. But when we put cover slip horizontally then light rays emerging from LED are reflects from cover slip and it absorbs by photo-detector, then there is variation in intensity.

From graph, for black soil as no. of water drop increases voltages decreases. For white soil sample as no. of water drop increases voltages increases. Hence it is clear that black soil contains more moisture than white soil

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