LIQUID MIXTURE CONTROL SYSTEM USING PLC

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ABSTRACT

The principle of the Liquids Mixture Control System By using PLC is to mix two or more types of liquids with different PH values, in order to acquire new PH value with correct composition, which to maintain product quality .These processes exist in beverage, drinkingwater, food, pharmaceuticals, chemistry, refinery indutries, also important for fish hatcheries, water conditioning and aquaculture, etc, moreover correct composition of PH value in our diet is important for our health,therefore for this project, volumetric of one type of liquid,can be determined its quantity of volume before entering into the Mixture tank and then, another liquid is entered automatically into this Mixture Tank,after that the mixing process will be done,which this system determined PH value automatically that macthing the PH value requirement as a complete product.Programmable Logic Controller (PLC) with analogue input signal is used to control this Liquids Mixture Control system.This system consist of six tanks, with one mixturer motor and also five pumps are used to control the system via PLC. PH sensor is used to detect PH value of the mixture, which this signal is fed to analogue input PLC teminal, that to be used for comparing PH value required as a product. The user can select volume one type of liquid to be entered into Mixture Tank, by pressing select buttons on the control panel board.This project can be used for manufacturing industries base on liquids and also for fish hatcheries, water conditioning and aquaculture ,which have been proved by project analyzing and testing results.

ABSTRAK

Sistem kawalan campuran cecair ini digunakan untuk mengawal dua atau lebih cecair yang mempunyai nilai PH berbeza, untuk menghasilkan satu campuran baharu dengan campuran yang tepat sebagai satu produk ,serta dapat mengekalkan kualiti produk tersebut. Proses ini berguna untuk industri minuman , makanan , perubatan , kimia dan juga penting untuk penternakan hidupan air dan kawalan PH air. Tambahan lagi nilai PH yang tepat dalam tubuh hidupan adalah penting bagi mengekalkan kesihatan. Untuk sistem ini isipadu salah satu cecair dapat dipastikan terlebih dahulu sebelum dialirkan kedalam tangki campuran, sistem ini kemudiannya dapat memastikan campuran yang tepat secara automatik bagi satu lagi cecair yang lain supaya menghasilkan nilai PH yang dikehendaki dalam campuran berkenaan, sebagai produk yang mahu dihasilkan.Sistem ini menggunakan PLC sebagai kawalan.Sistem ini mengadungi enam tangki , lima pump serta satu motor pengaduk campuran. Pengesan PH digunakan bagi mengesan nilai PH dalam campuran.Pengesan nilai PH ini disambungkan ke terminal analog PLC untuk dibandingkan dengan nilai PH rujukan mengikut program PLC, apabila nilai PH ini setara dengan nilai PH rujukan ,sistem akan menghentikan campuran serta mengalirkan campuran ini sebagai satu produk.Sistem ini telah terbukti berkesan apabila merujuk kepada analis dan keputusan ujian yang telah dilakukan terhadap sistem tersebut, sehubung itu sistem ini boleh digunakan untuk perindustrian pengeluaran berasaskan cecair dan juga untuk penternakan hidupan air.

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CHAPTER I

INTRODUCTION

1.1 Project Background:

Watching our diet are important. To stay healthy, human need the right balance of carbohydrates, proteins and fats. Recently, however, people have also begun to consider the amount of acid in their food. The acid-alkaline balance diet is promoted as having different health benefits.

According to Dr. Ben Kim the central tenet of the acid-alkaline balance diet is that many people consume too much acid. This chronic overconsumption of acid-producing foods can cause chronically low blood PH. This theoretically can result in a number of health problems, including osteoporosis and poor kidney function, promoters of the acid-alkaline balance diet claim. Some claim that the right balance of acidic and alkaline foods and drink can help fight cancer [Dr.T.Baroody and Yao,2001].

Referring to Robert O. Young -"A cold is the body removing excess dietary and/or metabolic acids through the orifices of the body to maintain its delicate alkaline PH. Colds are NOT caused by viruses but are caused by eating too much acidic GARBAGE. I won't get YOUR cold if MY body is properly alkaline. Excess acids can also be caused by your thoughts or negative emotions which can also give rise to the elimination of these acids through various orifices, such as your eyes, ears, mouth or nose."

Inside pure water, a decrease in pH value of about 0.45 occurs as the temperature is raised by 25 °C. In water with a buffering capacity imparted by bicarbonate, carbonate, and hydroxyl ions, this temperature effect is modified .The PH values of most raw water lies within the range 6.5–8.5 [Yao and Robert Baldo,2001].

Also according to Acidic or alkaline - the importance of the PH value of food editted by Ingrid Kunze 25.02.2008 Health and Nutrition, human body consume both alkalis and acids with food. The proportion should be around 70-80% alkalis and 20-30% acids. Unfortunately this ratio has slipped to the opposite today. The organism is particularly careful to maintain the PH level of blood so that it is a slightly alkaline environment of 7.365. Because of this considerable variation of the acid/alkali equilibrium the PH level in our bodies is influenced negatively, and as a result a good breeding ground for many illnesses is provided. A permanently acidic PH value destroys body tissue, causes restlessness and sleep deprivation, headaches, a state of exhaustion, a weak immune system, fungal infections of the finger and toenails, raised blood pressure or high cholesterol, which the body forms around the blood vessels as a protective measure against damage.

If we referring to Alkaline-Acid Food Theory for Healthy Living by Dhyana Tribe, N.D. From *"Healthy Options" No 42*, said that, all foods leave an ash residue after metabolism, which is either alkaline or acidic, depending on the mineral composition of the food and the way in which an individual digests them. Individual stress patterns, the ability to process life's ups and downs and emotional stability all influence the action of the digestive juices. A happy person in a satisfying job, who takes the time to chew their food well in a peaceful environment, will digest their food and experiences more easily than a stressed, overworked person who has to eat on the run. However a busy, well-organized person with strong digestive juices and a calm disposition may be able to digest better than the person who does everything right according to the health book but worries and frets over little things [Micheal and Adam Cloe, 2001].

Beside foods and drinking water, others products such as Soap based products; (bars, liquids and shower and bath gels) are often very drying and can cause irritation to the skin. Because soap based products are high in alkaline value they will alter the natural PH balance of your skin. Normal healthy skin is slightly acidic with a PH of 5.0 to 6.0 and this provides a protective acid mantle, which helps to protect the skin from environmental damage and dryness. Good quality Soap Substitutes or "non-soap" products will have a slightly acidic or lower PH value. As a result they are much gentler and less likely to cause irritation [Micheal and Adam Cloe, 2001].

PH Values of Shampoo: To understand pH values, understanding the PH levels of our skin and solutions we use on an everyday basis is essential. Human Skin’s PH value is approximately 5.5. Ordinary bar soap that we use has an approximate PH value between 9 and 11. When this soap comes into contact with our skin, the soaps’ alkaline PH reverses the acidic qualities of the hydrolipidic layer, rendering the skin defenseless against the onset of infection. The skin then needs about 2 hours to recuperate from the negative chemical effects of soap. Sensitive skin needs as long as 26 hours to re-establish a normal PH of 5.5. [Micheal and Adam Cloe, 2001].

Marine lives, either in freshwater or sea creatures also need correct PH value of water, then this important to determine correct PH value in aquariums so that these marine creatures can live with healthy and safety, this also important for fish hatcheries, water conditioning and aquaculture.

The pH of a solution indicates how acidic or basic (alkaline) it is. The PH term translates the values of the hydrogen ion concentration- which ordinarily ranges between about 1 and 10 x -14gram-equivalents per liter - into numbers between 0 and 14.On the PH scale a very acidic solution has a low PH value such as 0, 1, or 2 (which corresponds to a large concentration of hydrogen ions; 10 x 0, 10 x -1, or 10 x -2 gram-equivalents per liter) while a very basic solution has a high PH value, such as12, 13, or 14 which corresponds to a small number of hydrogen ions (10 x -12, 10 x -13, or 10 x -14 gram-equivalents per liter).A neutral solution such as water has a PH of approximately 7.

Substances are classified as acidic, alkaline or neutral. We can determine these substance properties using manual method such as litmus paper (but for project digital meter equipped with PH electrode is used) as shown on chart 1. Which if a substance change the colour of a blue litmus paper to red, it is acidic, if a substance change the colour of a red litmus paper to blue, it is alkaline, but if both litmus papers do not change colour, the substance is neutral. Litmus papers are chemical indicator, there are blue and red litmus papers, they change colour when come into contact with acidic or alkaline substance (liquids), as shown on figure 1.1.

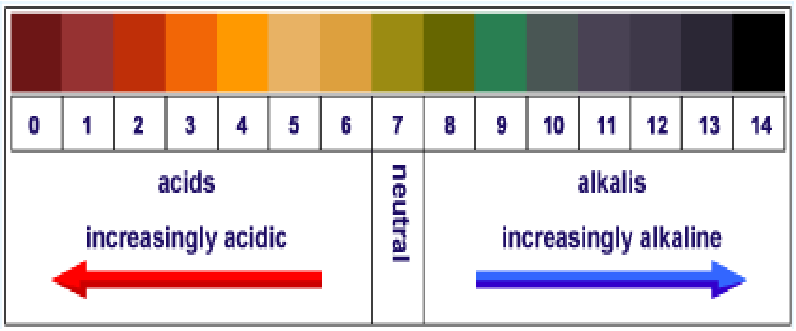

Figure 1.1 PH Chart

For ease of understanding we can view the PH scale as a range of 0 to 14.

1) a PH of 7 is neutral
2) a PH less than 7 is acidic
3) a PH greater than 7 is alkaline or basic.

There are many food and foodstuff found in our daily life; on tables 1.1 and 1.2 show pH values of some common food and foodstuff products can be found.

Table 1.1 Acid/Alkaline values of Some Common Liquids

Some common pH values

Substances	**pH**
Acid Mine Runoff	-3.6 – 1.0
Battery Acid	< 1.0
Lemon Juice	2.4
Cola	2.5
Vinegar	2.9
Orange or Apple Juice	3.05
Beer	4.5
Coffee	5.0
Tea	5.5
Acid Rain	< 5.6
Milk	6.52
Pure Water	7.0
Human Saliva	6.5 – 7.4
Sea Water	8.0
Hand Soap	9.0 – 10.0
Household Ammonia	11.5
Bleach	12.5
Household Lye	13.5

Table 1.2 PH values of some common food and foodstuff products can be found

Product	Approximate pH
Abalone	6.1 - 6.5
Aloe Vera	6.1
Apples	3.03 - 3.9
Apricots	3.3 - 4.8
Apricots, canned	3.4 - 3.8
Apricots, nectar	3.8
Artichokes	5.5 - 6.0
Asparagus	6.0 - 6.7
Avocados	6.3 - 6.6
Bananas	4.5 - 5.2
Bass, sea, broiled	6.6 - 6.8
Beans	5.6 - 6.5
Blackberries	3.9 - 4.5
Blueberries	3.1 - 3.4
Bread, white	5.0 - 6.2
Beets	4.9 - 5.5
Broccoli, cooked	5.3
Butter	6.1 - 6.4
Buttermilk	4.4 - 4.8
Cabbage	5.2 - 5.4
Cactus	4.7
Calamari (squid)	5.8
Capers	6.0
Carp	6.0
Carrots	5.9 - 6.3
Celery	5.7 - 6.0

For this project PH sensor is used instead of litmus papers, which this pH sensor will determine either substance is more acidic or alkaline (for more detail please refer to pH sensor or electrode on pages 19, 20 and 21).The liquid mixing control system is the mechanism to control the composition of liquid to be mixed in the mixture process, used in the Process Industry, in sectors such as beverage,drinking water, food,pharmaceuticals,chemistry,refinery and etc. This system consist of six tanks, with one mixturer motor and five pumps are used and PLC is used to control the system.

Programmable Logic Controller (PLC) is used to control this Liquids Mixture Control system.The users are indipendently can select the volume of liquid from one of two separate tanks by selecting either one of two select buttons which locate on control panel, then the mixing process will be done, which the correct composition is determined by PH sensor of the mixture matching the PH value requirement as a product.After completing the mixing process ,this mixured liguids are transfered into the finishing tank as a complete product.

For this project PLC is chosen because of, PLCs are well-adapted to a range of automation tasks. These are typically industrial processes in manufacturing where the cost of developing and maintaining the automation system is high relative to the total cost of the automation, and where changes to the system would be expected during its operational life. PLCs contain input and output devices compatible with industrial pilot devices and controls, little electrical design is required, and the design problem centers on expressing the desired sequence of operations. PLC applications are typically highly customized systems so the cost of a packaged PLC is low compared to the cost of a specific custom-built controller design. On the other hand, in the case of mass-produced goods, customized control systems are economic due to the lower cost of the components, which can be optimally chosen instead of a "generic" solution, and where the non-recurring engineering charges are spread over thousands or millions of units [Omron Industrial Automation, Malaysia, 2010].

Figure 1.2 an example of PLC uses for industry of automation

Figure 1.2 is an example of PLC uses for industry of automation, which control panel with PLC (grey elements in the center). The unit consists of separate, elements, from left to right; power supply, controller, relay units for in- and output [R.Blisener and F.Ebel, 2002]

1.2 Problem Statements

Liquid Mixture System model IPC 201 from SMC actuating by corresponding pneumatic solenoid valve, this method need air compressor to supply air ,this system also unable to determine correct pH value of the product. Moreover air compressor need high maitainance and compressor's room need large space and clean room.

Furhermore IPC 201 also need electrical supply to supply stirrer actuated by a motor , then for this project I would be used pump which only electrial supply is needed, instead of using two type of supply.In addition this sytem do not need large space to locate air compressor.This system consist of four tanks, with one mixture motor and also three pumps are used to control the system. Programmable Logic Controller (PLC) is used to control this Liquids Mixture Control system and pH sensor is used to determine correct pH value of product to be produce.The user are indipendently can select the volume of liquid from one of two separate tanks by pressing either one of these two buttons.After completing the mixing process this liguids are transfered to the finishing tank as a complete product.

1.3 Project Objectives:

This project is to achieve new pH value of combination of two different liquids that have different pH values as a product and then maintain this pH value although the volume of one of two liquids is vary

The main objectives of this project are:

a) To acquire new pH value of mixture composition in mixture process tank as a product.
b) To maintain quality of the product to be produced.
c) To develop PLC as a controller to control Liquid Mixture system
e) To apply the Liquid Mixture Control system that can be used to obtain product in the main tank.

1.5 Project Scopes:

This project is primarily concerned to get new pH value of combination of two different liquids that have different pH values as a product and then maintain this pH value although the volume of one of two liquids is. The scopes of this project are:

a) Develop a system that can produce new product during mixing process of two liquids that have different pH values.
b) Buid up the system that can maintain pH value of mixture composition in mixture process tank as a product

c) Employ PLC as a controller to control the system.

d) Use pumps as output for taking in and taking out liquids from tanks.

e) Obtain mixture as a product in main tank from two separate liquids tanks.

CHAPTER II

LITERATURE REVIEW

2.1 Technology Developments:

Liquids Mixture Control system is used in many applications in engineering and also in industry fields such as food, pharmaceuticals, chemistry, and refinery.IPC-201 as showing on figure 2.1, which developed by SMC is an example of a liquids mixture control system for production, that control and regulation,used in the Continous Process Industry. This IPC-201 has three tanks,two at the side which store the raw material (liquids) and another in middle where the mixing takes place.Which by actuating the corresponding pneumatic solenoid valve, these two at the side can be pressurized, allowing the liquid to be transferred towards the middle the middle tank via a special valve for fluids with a non-return valve device.Then the liquid from the side tanks is mixed in the middle tank.A stirrer actuated by a motor reducer homogenizes the mixture. The tank has an analogue pressure sensor located on the bottom of the tank [Commercial Catalogue-Perusahaan Majuco Sdn Bhd, 2008].

Figure 2.1 The IPC 20

But this method need air compressor to supply air ,this system also unable to determine correct PH value of the product. Moreover air compressor need high maitainance and compressor’s room need large space and clean room. Furhermore IPC 201 also need electrical supply to supply stirrer actuated by a motor , then for this project I would be used pump which only electrial supply is needed, instead of using two type of supply.In addition this sytem do not need large space to locate air compressor.

This system consist of four tanks, with one mixture motor and also three pumps are used to control the system. Programmable Logic Controller (PLC) is used to control this Liquids Mixture Control system and PH sensor is used to determine correct PH value of product to be produce.The user are indipendently can select the volume of liquid from one of two separate tanks by pressing either one of these two buttons.After completing the mixing process this liguids are transfered to the finishing tank as a complete product.

2.2 Theories

2.2.1 Why pH Values important:

One of the primary goals of WHO (World Health Organization) and its member states is that “all people, whatever their stage of development and their social and economic conditions, have the right to have access to an adequate supply of safe drinking water.” A major WHO function to achieve such goals is the responsibility “to propose regulations, and to make recommendations with respect to international health matters ....” The first WHO document dealing specifically with public drinking-water quality was published in 1958 as International Standards for Drinking-Water.

It was subsequently revised in 1963 and in 1971 under the same title. In 1984–1985, the first edition of the WHO Guidelines for drinking-water quality (GDWQ) was published in three volumes: Volume 1, Recommendations; Volume 2, Health criteria and other supporting information; and Volume 3, Surveillance and control of community supplies. Second editions of these volumes were published in 1993, 1996 and 1997, respectively. Addenda to Volumes 1 and 2 of the second edition were published in 1998, addressing selected chemicals.

An addendum on microbiological aspects reviewing selected microorganisms was published in 2002.Recently, people have begun to consider the amount of acid in their food. The acid-alkaline balance diet is promoted as having different health benefits. For example, the pH value of water is a measure of the acid–base equilibrium and, in most natural waters, is controlled by the carbon dioxide–bicarbonate–carbonate equilibrium system. An increased carbon dioxide concentration will therefore lower pH, whereas a decrease will cause it to rise. Temperature will also affect the equilibrium and the pH value. In pure water, a decrease in pH value of about 0.45 occurs as the temperature is raised by 25 °C. In water with a buffering capacity imparted by bicarbonate, carbonate, and hydroxyl ions, this temperature effect is modified (*1*). The pH values of most raw water lies within the range 6.5–8.5 (*1*) [Byrne and Wensheng, 2001].

That why this project is done, which this system is to mix two different liquids with different pH values. Substances are classified as acidic, alkaline or neutral.The pH of a solution indicates how acidic or basic (alkaline) it is. The pH term translates the values of the hydrogen ion concentration - which ordinarily ranges between about 1 and 10 x -14gram-equivalents per liter - into numbers between 0 and 14. On the pH scale a very acidic solution has a low pH value such as 0, 1, or 2 (which corresponds to a large concentration of hydrogen ions; 10 x 0, 10 x -1, or 10 x -2 gram-equivalents per liter) while a very basic (alkaline) solution has a high pH value, such as 12, 13, or 14 which corresponds to a small number of hydrogen ions (10 x -12, 10 x -13, or 10 x -14 gram-equivalents per liter).

This project is to achieve new pH value of combination of two different liquids that have different pH values as a product and then to maintain this pH value although the volume of one of two liquids is vary. For more detail how this system can be applied please refer to chapter 3 – Methodology starting on page 39.

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2.2.2 Theory of System operation:

When START push button is pressed, system is ready for operation, user can choose either to operate in Level 1 or Level 2 for liquid 1 (tank 1) modes by pressing Level 1 pushbutton or Level pushbutton respectively on the control panel board , after flowing of liquid 1 (tank 1) into Mixture tank is finished, system will automatically flowing out Liquid 2 (tank 2) into Mixture tank and will stop to flow if pH sensor which locating in Mixture tank detect that mixture is reached pH value requirement. Then this mixture is transferred into Finish product tank as a complete product, after that cleaning liquid is flowed into Mixture tank and Mixture motor is rotated for cleaning purpose before next processed, finally this cleaning liquid is drained out into Cleaning liquid removal tank, and system is ready for the next processed by pressing Reset pushbutton and then Level modes requirement. During operation we can stop the system for safety purpose by pressing STOP push button. Then by pressing RESET push button and then START push button , the system is ready for operation.

2.2.2.1 pH Sensors and Principles of Operation

How They Work:

Understanding pH measurement in the process world, pH is an important parameter to be measured and controlled. The pH of a solution indicates how acidic or basic (alkaline) it is. The pH term translates the values of the hydrogen ion concentration - which ordinarily ranges between about 1 and 10 x -14gram-equivalents per liter - into numbers between 0 and 14. On the pH scale a very acidic solution has a low pH value such as 0, 1, or 2 (which corresponds to a large concentration of hydrogen ions; 10 x 0, 10 x -1, or 10 x -2 gram-equivalents per liter) while a very basic (alkaline) solution has a high pH value, such as 12, 13, or 14 which corresponds to a small number of hydrogen ions (10 x -12, 10 x -13, or 10 x -14 gram-equivalents per liter).

A neutral solution such as water has a pH of approximately 7. A pH measurement loop is made up of three components, the pH sensor, which includes a measuring electrode, a reference electrode, and a temperature sensor; a preamplifier. A pH measurement loop is essentially a battery where the positive terminal is the measuring electrode and the negative terminal is the reference electrode. The measuring electrode, which is sensitive to the hydrogen ion, develops a potential (voltage) directly related to the hydrogen ion concentration of the solution. The reference electrode provides a stable potential against which the measuring electrode can be compared. Figure 2.2 shows a typical pH sensor.

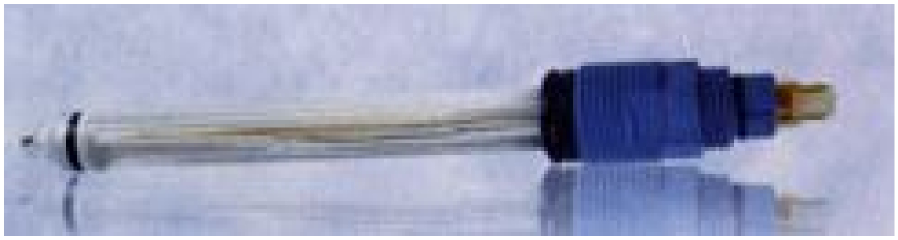

Figure 2.2 typical pH sensors

PH is a measure of acidity or alkalinity. The amount of hydrogen ions (H+) causes a liquid to be acidic (high concentration of hydrogen ions) or alkaline (low concentration of hydrogen ions). The pH range is measured from 0 to 14. Values below 0 or above 14 are possible but rare and cannot be measured with our electrodes. Table 2.1 shows hydrogen ion concentration in Moles /Liter at 25ºC.

Table 2.1 shows hydrogen ion concentration in Moles /Liter at 25ºC

pH	H+ conc.	OH - conc.
0	1.0	0.00000000000001
1	0.1	0.0000000000001
2	0.01	0.000000000001
3	0.001	0.00000000001
4	0.0001	0.0000000001
5	0.00001	0.000000001
6	0.000001	0.00000001
7	0.0000001	0.0000001
8	0.00000001	0.0000001
9	0.000000001	0.00001
10	0.0000000001	0.0001
11	0.00000000001	0.001
12	0.000000000001	0.01
13	0.0000000000001	0.1
14	0.00000000000001	1.0

2.2.3 How does a reference electrode work?

Figure 2.4 shows an example of pH electrode and a reference electrode work as follow:

1) A porous reference junction separates the filling solution in the electrode from the solution whose pH is to be measured.
2) The filling solution's constant chloride ion concentration generates a milli voltage at a pure silver wire with silver chloride on it.
3) The silver wire passes the signal from the solution being measured to the electrode's cable or connector.

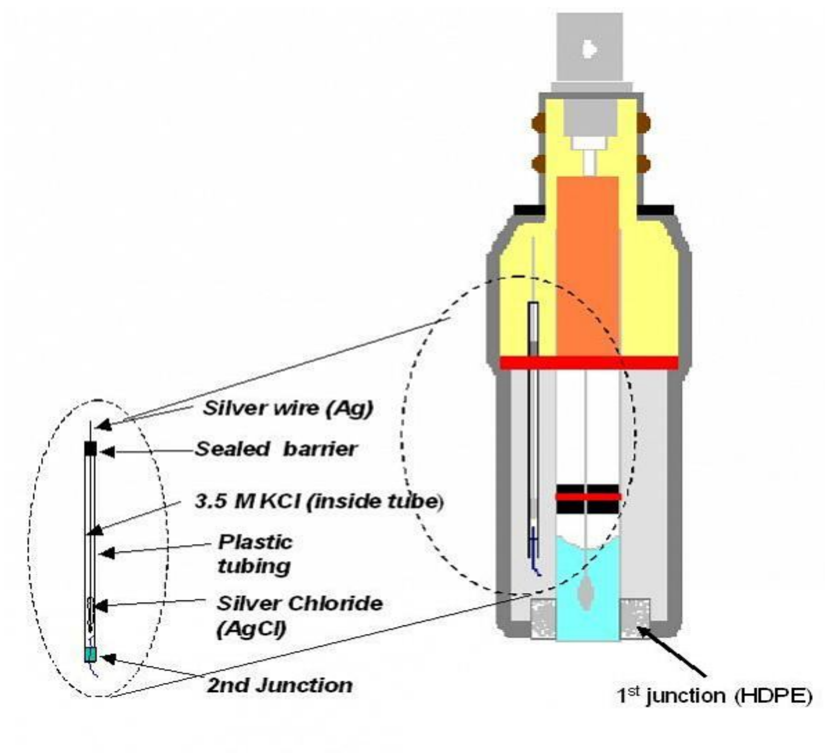

Figure 2.3 an example of pH electrode and a reference electrode.

2.2.5 The ideal pH electrode:

1) Zero volts output at neutral PH (=7.0)
2) Positive voltage in acids, PH<7
3) Negative voltages in bases, PH>7
4) Total realistic PH range is 0 to 14.
5) Generates -59.16 mill volts per PH unit at room temperature (="Nernst potential"). Note that this is a negative slope--higher PH, lower voltage.
6) the full scale range is +/-0.414 volts. (+/-0.05916*7), at 25Cº.
7) Temperature coefficient of the Nerst potential is -0.001984 mV per °C. That makes the slope -54.2 mill volts per PH unit at 0 degrees Celsius, and -74.04 mill volts per PH unit at 100 degrees Celsius.

2.2.5.1 But the electrode is practically never ideal:

The above values depend somewhat on the construction of the individual electrode, and its aging. That is why it is necessary to calibrate and standardize the PH monitoring and recording instrument from time to time, depending on the conditions it is subjected to. "Standardize" means to adjust the offset so that the instrument reads zero in neutral (PH 7) solution. "Calibrate" means to trim the slope of the PH/mV response to the correct value for the electrode at that point in time. The instrument should probably have automatic temperature compensation, to adjust the slope in response to different calibration and working temperatures.

The kicker from the electronic standpoint is that the output impedance of the pH electrode is extremely high. The electrode acts like voltage source, however, there is a 10 to 50 mega ohm resistor in series with the voltage. Any voltmeter that measures the output of a PH electrode has to have extremely high input impedance, 1 tera ohm or more. Even many digital multi meters, which have 10 or 20 mega ohms of input resistance, will load down a PH electrode and give a reading that is much lower than it should be:

1) It is the glass membrane of the probe that is responsible for the high resistance. It a special glass with tiny "pores" that cannot support much electrical current.
2) The usual approach to PH electrodes is to amplify and buffer the signal, with an MOS or CMOS input operational amplifier. When properly constructed with attention to the input circuit layout, it can easily achieve the necessary high input resistance.

2.2.5.2 The circuit of a pH amplifier:

Figure 2.4 shows amplifier circuit that be used for this project this amplifier produces 1 volt output in neutral, PH=7, buffer. Adjust RT1 to set this offset. This adjustment could also be used to set the output to 1.0 volts when the PH probe at the input is placed in neutral PH buffer. The resistor R6 sets the gain. With 221k½ installed at R6, the overall gain will be x2, and the full scale output will be nominally 0.16 to 1.84 volts to cover the 0 to 14 PH range.

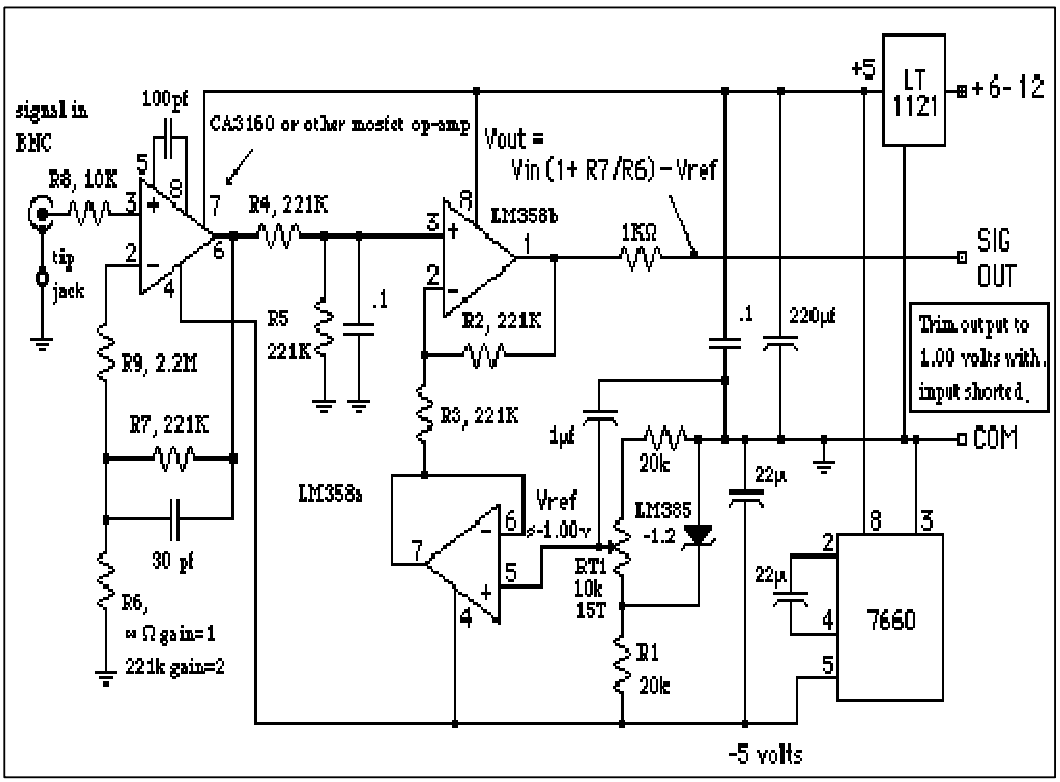

Figure 2.4 an example of a pH amplifier

2.2.5.3 The Digital PH Meter

PH meter is used to measure pH value of the liquids as showing on figure 2.5.

Figure 2.5 PH meter

This pH meter already calibrated by signal that simulated from the ideal pH electrode output (base on 25ºC environment). However due to:

1) Most electrodes are slightly off.
2) The measuring environment temperature may not 25ºC , it is necessary to make following calibration procedure that keep instrument combine electrode within high accuracy.

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