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# Drift Effect of Ultrasonic Penetration in the Aqueous Alkaline NaOH Solution With Respect To Constant Temperature and Pressure

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**Abstract:** In chemical biological and food industries, one of the greatest challenges is to control $p^H$ value over the bulk scale during the batch operations. It is one of the crucial significant parameter which defines product yield. Traditional and bench mark $p^H$ control process can be implemented to control the required $p^H$ value over bulk scale but it requires greater cost and lengthy sequence. Hence in the present innovative study the measurement and change in the $p^H$ value ($\Delta p^H$) of various electrolyte solutions (NaOH) *via* using ultrasonic waves of specific wavelength (has been carried out by using single prototype.

The penetration of ultrasonic waves found to be affect on $p^H$ value at constant temperature and pressure along with total recovery of the sample. The same protocol has been scrutinized for different electrolytes at different concentration studies and it is found to be extremely efficient with high integrity with respect to cost effectiveness in the present industrial scenario.

**Index Terms:** Ultrasonic waves, $P^H$, electrolyte solution.

## 1. INTRODUCTION

At present many techniques are used in chemical, biological and food industry to preserve and increase the shelf life of respective products, prior to subsequent processing.

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Sodium hydroxide (NaOH) is also known as caustic soda, and is used in the chemical industry as well as soap industries. It is a strong base and used in all fields to control the $p^H$ value. It is a white solid salt and highly caustic metallic base and alkaline in the nature.

By weight, Sodium hydroxide forms an approximately 50% saturated solution with water. Sodium hydroxide is soluble in water, ethanol and methanol. One of the most common uses of Sodium Hydroxide is its use in unclogging drains. It also comes in the form of lye soap which can be used to wash practically anything from the dishes. Sodium Hydroxide is also used quite a bit in food processing. The compound is often used in steps for peeling fruits and vegetables, processing cocoa and chocolate, thickening of ice cream, poultry scalding and soda processing. Olives are soaked in Sodium Hydroxide along with other substances to make them black, and soft pretzels are also coated with the compound to give them a chewy texture. Other uses include:

- Used in processes to make products including plastics, soaps rayon and textiles.
- Revitalizing acids in petroleum refining.
- Removal paint.
- Etching aluminium.
- Dehorning of cattle.
- During two steps of the paper making process.

- Used in relaxers to help straighten hair however this is becoming less popular because of the possibility of chemical burns.

We know that when ultrasonic waves can be penetrated through aqueous solution then that solution is irradiated with ultrasonic waves and pH value changes. Traditional processes for the pre-treatment of substances involves thermal processing, however the non thermal process provides the possibilities of producing processed materials or substances. The change in pH value is observed when ultrasonic waves are penetrated through alkaline NaOH solution for different molarities. When an ultrasonic transducer is placed in liquid, bubbles of very short life time formed collapse immediately so that implosion takes place. During this process temperature and pressure increases because of which small pits are formed on the surface of transducer. The bubbles also hinder the propagation of ultrasonic waves; this process is known as cavitation. Ultrasonically cavitation can be defined as the formation, growth and collapse of gases or vaporous bubbles under the influence of ultrasound. Cavitation is used in ultrasonic cleaning process, medical and optical instruments. The tiny bubbles which form near the surface of the specimen exert a strong pull on the surface of liquid due to this dust particles are pulled off. This cavitation process is also useful for immiscible liquid which is useful to increase the rate of chemical reactions. Current research includes the chemical processing as well as sonochemistry. When ultrasonic waves are penetrating through alkaline solution more aggressive effect was observed on the surface due to which change in pH value was observed.

The aim of this work was to use ultrasound as a pre – treatment method to observe the drift action penetration of ultrasonic waves found to be affect pH value even pressure and temperature remains constant. The use of ultrasound is actually a non-thermal process which is used for better products. The effect of ultrasonic waves on the sample of different molarities was also studied.

## 2. MATERIALS AND METHODS

### 2.1. Raw material

Volume of alkaline NaOH solution for penetration used was 500ml. 0.5N NaOH solution was prepared by adding 20gm NaOH in 1000ml water (0.5N). Another sample (0.1 N) has been prepared by dilution to get further analysis.

### 2.2. Ultrasound treatment

**0.1 N NaOH solution** was sonicated for ( how many ????hrs) with ultrasonic waves of frequency, 20 KHz by using ultrasonic probe interferometer (model F-80, 220V mains voltage) attached to a transducer with measuring capacity 2MHz and fuse 500 mA. Maximum displacement of the reflector was 20mm and required quality of the liquid is 12c.c. Length of the connecting cable between the generator and the cell is 50cm approximately. The liquid was irradiated with an ultrasonic wave directly from the horn tip. Since the ultrasonic waves irradiated in a liquid produces heat which records the temperature as a function of time leads to the acoustic power by the following equation;

$$P = mC_p\,(dT/dt)$$

Where; m = mass of the sonicated liquid

$C_p$ = specific heat at a constant pressure

$dT/dt$ = slope at the origin of the curve. $W/cm^3$ volume of the sonicated solution

For the ultrasound treatment when ultrasonic waves were penetrating through alkaline solution of NaOH solution (500ml) were sonicated for corresponding 1 hr. The samples were treated with 20 KHz probe (interferometer model F-80). Compressibility and ultrasonic velocity is temperature dependent, so suitable water bath may be provided. The measuring call is specifically designed double walled cell for maintaining the temperature of the liquid constant during the experiment.

### 2.3. $P^H$ determination

$P^H$ of the alkaline solution before and after ultrasound were determined by pH mater. The measurements were carried out by placing ph electrode in the aqueous alkaline NaOH solution.

#### 2.3.1. Statistical analysis

The whole study was repeated and after each one hour $P^H$ was measured when ultrasonic waves are passed. The effect of the ultrasound treatment on the properties investigated and determined. pH values for different periods were noted when ultrasonic waves are passed through the solution.

## 3. EXPERIMENTAL PROCEDURE

In the present study, the pH value is calculated without change in temperature and pressure for different molarities of alkaline solution of 500ml

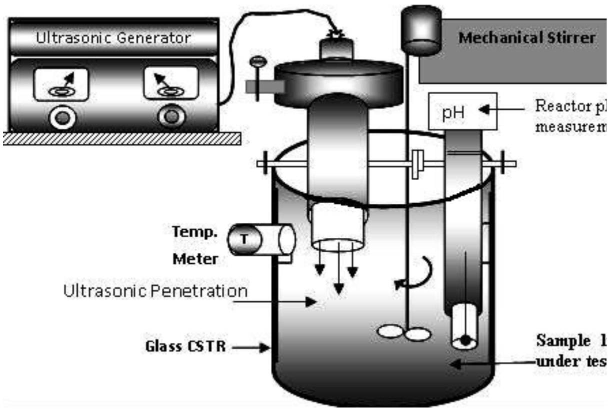
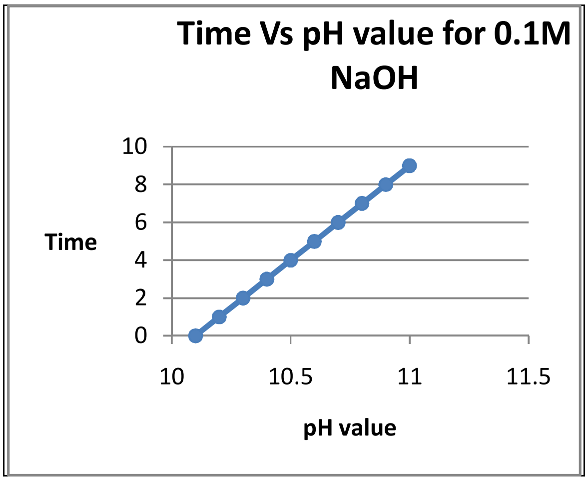
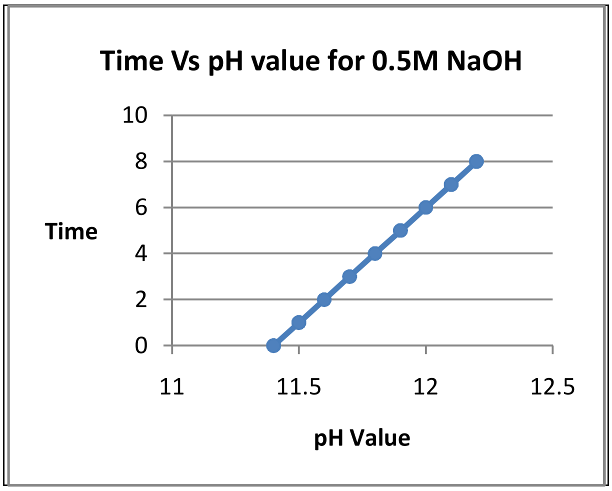



**Fig (1.1): Prototype laboratory Equipment for penetration of ultrasonic waves in the electrolyte solution**

| Analysis of pH change study at | | |
|---|---|---|
| **0.5 M NaOH** | **0.1 M NaOH** | **Time** |
| **pH** | **pH** | **Time in Hrs.** |
| 11.4 | 10.1 | 0 |
| 11.5 | 10.2 | 1 |
| 11.6 | 10.3 | 2 |
| 11.7 | 10.4 | 3 |
| 11.8 | 10.5 | 4 |
| 11.9 | 10.6 | 5 |
| 12 | 10.7 | 6 |
| 12.1 | 10.8 | 7 |
| **12.2** | 10.9 | 8 |
| | 11 | 9 |




**Graph. (1.3) Variation of pH value with time (t)**

## 4. RESULTS AND DISCUSSION

From the graph 1.2 and 1.3 it is clear that there is linear increase in the $P^H$ of an electrolyte at different concentration 0.1 N and 0.5 N (solution turns towards base) with respect to greater penetration of ultrasonic waves in the solution.

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