

## Density Analysis of Different Percentage of Phosphoric Acid

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### Abstract

Fast development in the industrial application of phosphoric acid has extended a widespread need for trustworthy information on the density of its aqueous solutions. Density is a significant part of measurement and instrumentation. The density measurements are made for two facts like determination of mass, volume and the quality of products. In the present investigation, the density of three concentrations (25, 42, and 50 %) of impure and pure phosphoric acid was determined at different temperatures of 30, 40, 50 and 60 °C using a density meter. The result shows that the density decreases obviously when the temperature rises and it increases when the concentration of phosphoric acid increases. In most acid processing industries, density act as a major role in the control and better management of the production in purest condition.

**Keywords:** Phosphoric acid, Density and Temperature.

### Introduction

Phosphoric acid (PA) is an important industrial chemical used as an intermediate in the fertilizer industry <sup>1</sup>. The industries preparing PA are spread worldwide. Industries in European, Asian and American countries generate PA from phosphate rock (PR) mines, phosphatic fertilizers and phosphate-based products <sup>2</sup>. Acids such as phosphoric, sulphuric, nitric, hydrochloric and acetic acids are broadly applied in many industries: chemical, fertilizers, mineral leaching, water purification, petroleum refining, food and metal production <sup>3</sup>. Specifically, density is one of the more important basic properties in the studies of chemistry, physics and materials science. The density of matter in all its states such as liquid, gas and solid are determined by the ratio of the material's mass to its volume <sup>4</sup>. The current investigation deals with density measurements of different percentages of impure and pure phosphoric acid at varying temperatures

### Materials and Methods

#### 1. Reagents:

15 grams of Bentonite was taken and 100 mL of distilled water was added with stirring. The slurry formed was kept overnight. This freshly prepared 15 % bentonite solution was consumed within four days of preparation. 0.1 gram of flocculent was taken and 100 mL of distilled water was added. It was stirred well continuously for four hours. This freshly prepared 0.1 % flocculent solution was consumed within two days of preparation.

#### 2. Procedure:

To 100 mL of phosphoric acid in a beaker, 3 mL of Bentonite (15 %) was added drop by drop. The solution was kept in the stirrer at high rotation for 30 minutes. After 30 mins, acidic

bentonite solution was stirred slowly. 0.3 mL of flocculant (0.1 %) was added drop by drop stirred slowly for 15 minutes. It was allowed to settle for 8 hours and then filtered.

### 3. Density Analysis:

The density analysis of pure and impure phosphoric acid (25, 42 and 50 %) at different temperatures such as 32, 40, 50 and 60 °C was determined using Anton Paar Density meter DMA 500 at Heavy Water Plant, Thoothukudi, Tamil Nadu.

### 4. Density meter:

The essential components of density meter contain rinse bottle, water bottle, sample cell, interior light source, syringe and recorder. The rinse bottles were filled with sufficient methanol before each analysis. These are used to place the inlet hose of density meter. After pumping, the inlet hose was put into the water bottle. The sample of impure and pure phosphoric acid was injected by syringe. The instrument's interior light was used and checked quickly for bubbles. If bubbles were present, the sample was ejected from the cell. When the instrument display begins flashing, the density was recorded. After recording, the cell was washed with methanol and it was dried with air. The next sample may be analyzed after the air stops blowing.



## Results and Discussion

Phosphoric acid is a triprotic acid. In an aqueous solution, it will dissociate to produce three hydrogen ions. Phosphoric acid is a useful synthesis catalyst since it does not react vigorously with many organic compounds and exhibits catalytic and dehydrating activities. These properties give phosphoric acid an extensive range of industrial applications from metal finishing to food preservatives<sup>5</sup>. Phosphoric acid is produced using various methods. The most commonly used process is the thermal and wet process<sup>6</sup>.

Density (Specific Gravity) versus the concentration of phosphoric acid is given in the following Table and Graph. Specific gravity is an accurate measure of the concentration of phosphoric acid for laboratory analysis<sup>7</sup>. Tables 1 and 2 represent the density measurement of various percentages (25, 42, and 50 %) of impure and pure phosphoric acid at temperatures (30, 40, 50, and 60 °C). When the temperature was increased the density values marginally decreased for impure and pure phosphoric acid.

Density generally decreases with increasing temperature and likewise increases with decreasing temperatures. This is because volume differs according to temperature. Volume increases with increasing temperature due to Van der Waal interactions<sup>8</sup>. The density values range from 1.2639, 1.4262, 1.5411 and 1.2248, 1.3878, 1.5097 for impure and pure phosphoric acid concentrations (25, 42, and 50 %) at 30 °C. Likewise, at 40, 50 and 60 °C increased density values were observed for different concentrations of impure and pure phosphoric acid. 25 % of impure and pure phosphoric acid, the density value is slightly decreased from 1.2639, 1.2412, 1.1853, 1.1731 and 1.2248, 1.2076, 1.1729, 1.1530 at different temperatures (30, 40, 50 and 60 °C). The reduced density values were observed at various temperatures for 42 % of impure and pure phosphoric acid. At 30 to 60 °C, marginally decreased density values were indicated for 50 % of phosphoric acid. The results were noted in Figures 1 to 3.

**Table 1: Density Measurement of Impure Phosphoric Acid**

Percentage of Phosphoric Acid	Temperature (°C)			
	30	40	50	60
25	1.2639±0.15	1.2412±0.26	1.1853±0.28	1.1731±0.11
42	1.4262±0.09	1.4171±0.12	1.4033±0.12	1.3923±0.18
50	1.5411±0.09	1.5320±0.03	1.5308±0.02	1.5300±0.10

**Table 2: Density Measurement of Pure Phosphoric Acid**

Percentage of Phosphoric Acid	Temperature (°C)			
	30	40	50	60
25	1.2248±0.13	1.2076±0.19	1.1729±0.14	1.1530±0.27
42	1.3878±0.16	1.3628±0.20	1.3208±0.15	1.2970±0.30
50	1.5097±0.15	1.4868±0.11	1.4741±0.21	1.4288±0.28

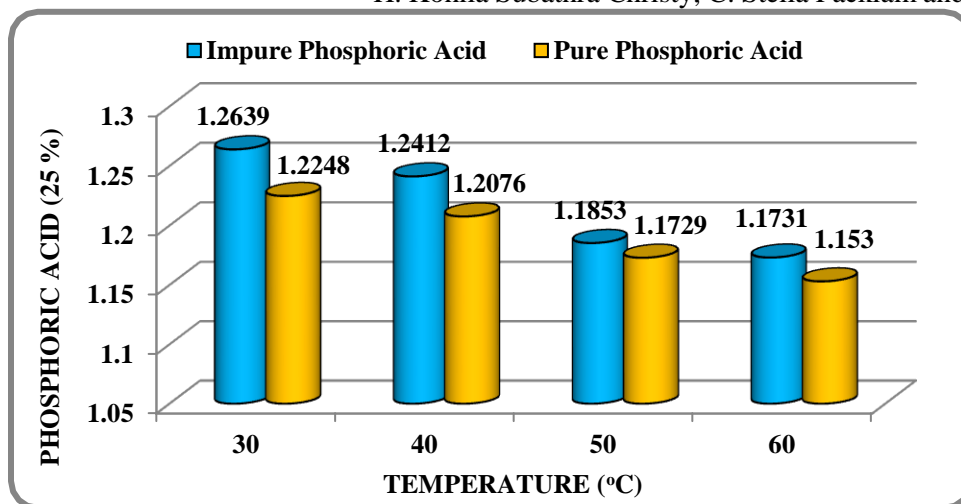


Figure 1: Density Measurement Of 25 % of Impure and Pure Phosphoric Acid

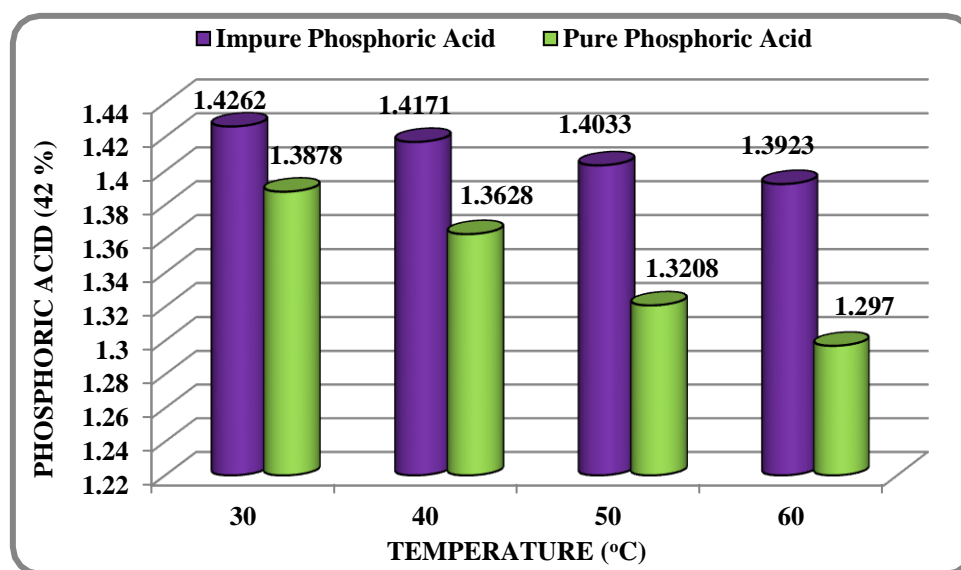
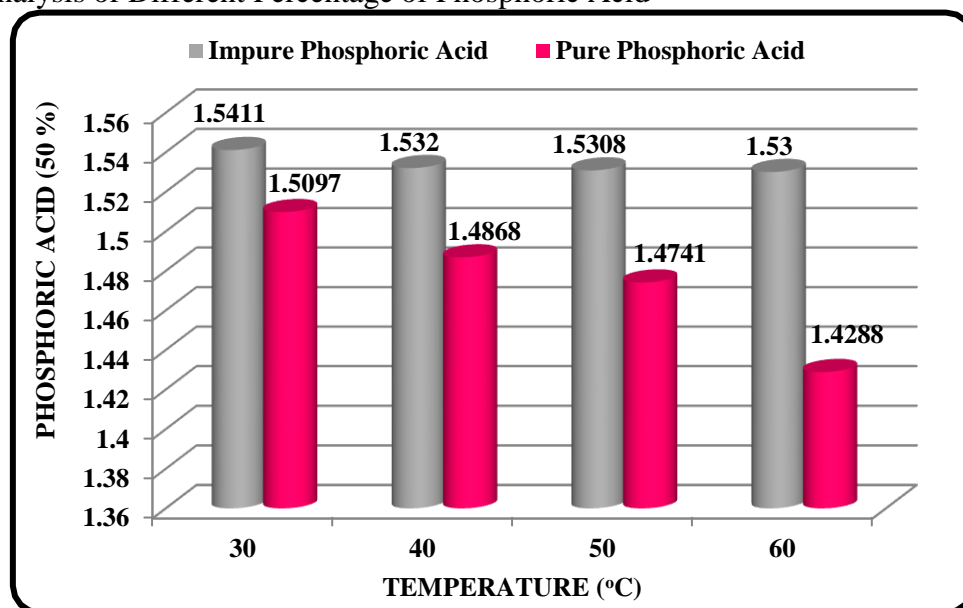


Figure 2: Density Measurement Of 42 % of Impure and Pure Phosphoric Acid



**Figure 3: Density Measurement of 50 % of Impure and Pure Phosphoric Acid**

### Conclusion

In many industrial applications, density measurement ascertains the value of the product. The data for the density and concentration of phosphoric acid has been used to calculate a linear filtration velocity. Density is an important quality control parameter since it is a measure of purity and consistency. It is also used to calculate the concentration of most two-component or binary solutions. Density may be used to determine various concentrations in units of normality, molarity and percent by weight or volume, PPM (Parts Per Million), API (American Petroleum Institute) and many other related density values<sup>9</sup>. This study was set to assess the density of various percentages of phosphoric acid. The density of different concentrations of (25, 42 and 50 %) impure and pure phosphoric acid at temperatures (30, 40, 50, and 60 °C) was found to decrease slightly with increase in temperature. Density is a major key in the control of most industrial processes, better management of the process and also accurate determination of the quantity and quality of phosphoric acid in lot of industries. The presence of impurity in phosphoric acid affect the density and it can be clearly predicted by comparing the parameter of impure and pure form. Phosphoric acid is used in fertilizers, dental cement, in preparing albumin derivatives for textile and food industry. In chemical factories the products are analyzed for purity before marketing.

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