An ecologically innocuous method of replacement of phenolphthalein indicator with Calotropis procera, Nerium oleander and Begonia crenata and applying it on a Batch and a Semi-Batch process

Praveenkumar.V[1], Muthu Aravind.M[2], Muthukumar.K[3]

[1,2,3]*Department of Chemical Engineering, St. Joseph's College of Engineering*

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Abstract - We use Phenolphthalein solution as indicators in laboratory experiments. Basically, indicators are used to determine the pH of the particular titration solution. Here in this paper, we are going to use an alternative in form of environmentally friendly Calotropis procera, Nerium oleander and Begonia crenata petals. This method is cheap and eco-friendly. The procedure to extract the petal solution is detailly discussed. The practical applying of the natural extract indicator is used in kinetic studying of a batch reactor and a Semi-Batch reactor. The results are compared and graphically determined with the usage of MATLAB software. The variations in using the synthetic and Calotropis procera, Nerium oleander and Begonia crenata petals extract indicator is discussed here.

***Key Words*:** Natural indicators, Synthetic indicators, Batch process, Semi-Batch process

1.INTRODUCTION

In laboratory purposes, we use methyl orange and phenolphthalein indicators to determine pH and titrant value. These methyl orange and phenolphthalein indicators are usually referred as synthetic indicators. These indicators are used to indicate the presence of acid or base by changing its color. Though they are most commonly and efficiently used in laboratory purposes, they are quite harmful in nature. They cause effects such as diarrhea, pulmonary edema. They are also a chemical pollutant to our environment and quite expensive to use. To avoid these issues, we can substitute synthetic indicators by the usage of natural indicators. We are going to extract natural indicators from the petals of the plants such as Calotropis procera, Nerium oleander and Begonia crenata.

Calotropis procera plant is obtained from the local regions in Chennai. From the plant the flowers are collected and separated. This Calotropis procera plant has good medical values and uses. It has been used in treating skin diseases, jaundice and diarrhea. The scientific classification of Calotropis procera has been given in Table 1.

Kingdom	**Plantae**
Clade	**Angiosperms**
Family	**Apocynaceae**
Genus	**Calotropis**
Order	**Gentianales**
Species	**C. procera**

Table 1: The scientific classification of Calotropis procera

Nerium oleander plant flowers are obtained from the local gardens in Chennai. Nerium oleander has medicinal uses in skin treatment and diabetics. The scientific classification of Nerium oleander has been given in Table 2.

Kingdom	**Plantae**
Clade	**Tracheophytes**
Family	**Apocynaceae**
Sub family	**Apocynoideae**
Genus	**Nerium**
Order	**Gentianales**
Species	**N. oleander**

Table 2: The scientific classification of Nerium oleander

Begonia crenata plant flowers were obtained from the plant nursey located in Chennai. The various medicinal uses of this plant are treatment of respiratory infections and skin diseases. The scientific classification of Begonia crenata has been given in Table 3.

Kingdom	**Plantae**
Clade	**Tracheophytes**
Class	**Magnoliopsida**
Sub family	**Apocynoideae**
Genus	**Begonia**
Order	**Cucurbitales**
Species	**Begonia crenata Dryand.**

Table 3: The scientific classification of Begonia crenata

Thus, these three flower plant petals are used here for our experimental analysis

2. MATERIALS REQUIRED

Materials from Plants:

Here we required the fresh flower petals of Calotropis procera, Nerium oleander and Begonia crenata. These flowers are collected from the local regions, Gardens and Nursery located in Chennai

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Chemicals and Reagents Required:

Here we use all the reagents and chemicals of analytical or synthesis grade. The chemicals such as Sodium Hydroxide (NaOH), Ethyl acetate ($C_4H_8O_2$), Hydrochloric acid (Hcl), Methanol (CH_3OH), Phenolphthalein Indicators were mainly used here.

Apparatus Required:

Batch Reactor, Semi-Batch Reactor, Rotameter, Overhead tank, Standard flasks, Conical flasks, Burettes, Pipettes, Beakers are the required apparatus.

3. METHODOLOGY

Preparation of Flower extract:

The petals of Calotropis procera, Nerium oleander and Begonia crenata are taken in a separated beaker and it is washed with distilled water. Now dry those petals for two hours. After drying add those flower petals in a mixer or a blender to grind them. Now take the grinded flower petal extract in a separate beaker. Now from that grinded flower petal take 15gm separately in a beaker and soak them with methanol for 24 hours. After 24 hours we are going to filter the pure methanolic extract. Now that extract is used as natural indicator. The above procedure is shown in **Fig -1**

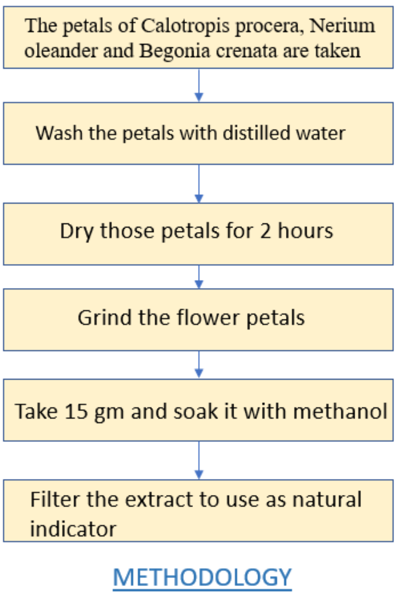

Fig -1: Methodology

Titrand or Analyte solution preparation:

Titrand or Analyte preparation using a Batch Reactor:

To prepare a titrand or an analyte solution from the batch reactor, we required 10 ml of Ethyl acetate and 10 ml of NaOH. They are added in five different beakers and kept for constant mixing. Now the mixed analyte solution is used for further analysis.

Titrand or Analyte preparation using a Semi-Batch Reactor:

To prepare this analyte solution, 150 ml of standard NaOH is added in a Semi-Batch Reactor. Required quantity of Ethyl acetate is added to the overhead tank. At a fixed flow rate the Ethyl acetate is added and mixed with the Sodium Hydroxide with the help of a stirrer. Now the mixed solution is used as Titrand or Analyte here.

EXPERIMENTAL PROCEDURE:

As of now we have prepared the flower extract and analyte solution. For a batch reactor we are having five different beakers. Each beaker is taken for analysis at a regular interval of 5 minutes. We use titrant as Sodium Hydroxide (NaOH) and analyte as the batch reactor mixed solution. Now titration is done with NaOH vs mixed analyte solution with Calotropis procera, Nerium oleander and Begonia crenata natural indicator extract as indicator. Here the normality of NaOH and Ethyl acetate is 0.05 N. The respective results are tabulated. The short experimental procedure for a batch process is given in **Fig -2**

For a semi-batch reactor, we take five set of values in which each beaker is taken for analysis at a regular interval of 5 minutes. We use titrant as Sodium Hydroxide (NaOH) and analyte as the semi-batch reactor mixed solution. Now titration is done with NaOH vs mixed analyte solution with Calotropis procera, Nerium oleander and Begonia crenata natural indicator extract as indicator. Here the normality of NaOH and Ethyl acetate is 0.05 N. The respective results are tabulated. The short experimental procedure for a batch process is given in **Fig -3.**

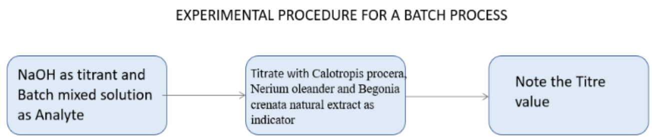

Fig -2: Experimental procedure for a batch process

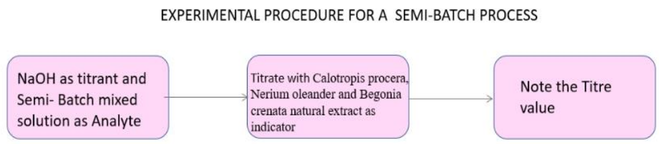

Fig -3: Experimental procedure for a semi-batch process

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4. RESULTS AND DISCUSSIONS

Here the results are discussed between both synthetic and natural indicator.

RESULTS FOR A BATCH PROCESS:

Titrant value obtained by using Phenolphthalein indicator is given in the **Table -4**

TIME	0	5	10	15	20
TITRATE VALUE	4.9	5.2	5.5	5.9	6.3

Table -4: Titrant value obtained by using Phenolphthalein indicator

Titrant value obtained by using Calotropis procera extract indicator is given in the **Table -5**

TIME	0	5	10	15	20
TITRATE VALUE	5.3	5.7	6.2	6.5	6.8

Table -5: Titrant value obtained by using Calotropis procera extract indicator

Titrant value obtained by using Nerium oleander extract indicator is given in the **Table -6**

TIME	0	5	10	15	20
TITRATE VALUE	5.1	5.3	5.7	6.0	6.4

Table -6: Titrant value obtained by using Nerium oleander extract indicator

Titrant value obtained by using Begonia crenata extract indicator is given in the **Table -7**

TIME	0	5	10	15	20
TITRATE VALUE	5.6	6.0	6.4	6.7	7.1

Table -7: Titrant value obtained by using Begonia crenata extract indicator

RESULTS FOR A SEMI-BATCH PROCESS:

Titrant value obtained by using Phenolphthalein indicator is given in the **Table -8**

TIME	3	6	9	12	15
TITRATE VALUE	6.5	6.7	6.8	7.0	7.2

Table -8: Titrant value obtained by using Phenolphthalein indicator

Titrant value obtained by using Calotropis procera extract indicator is given in the **Table -9**

TIME	3	6	9	12	15
TITRATE VALUE	6.8	7.0	7.4	7.6	7.9

Table -9: Titrant value obtained by using Calotropis procera extract indicator

Titrant value obtained by using Nerium oleander extract indicator is given in the **Table -10**

TIME	3	6	9	12	15
TITRATE VALUE	6.6	6.9	7.1	7.3	7.5

Table -10: Titrant value obtained by using Nerium oleander extract indicator

Titrant value obtained by using Begonia crenata extract indicator is given in the **Table -11**

TIME	3	6	9	12	15
TITRATE VALUE	6.9	7.3	7.6	8.0	8.2

Table -11: Titrant value obtained by using Begonia crenata extract indicator

GRAPHICAL RESULTS FOR BATCH PROCESS

The graphical analysis is done by plotting the graph between the time and titre value. The graph is simulated with the help of Matlab. The Batch process plot graph is given in **Fig -4.**

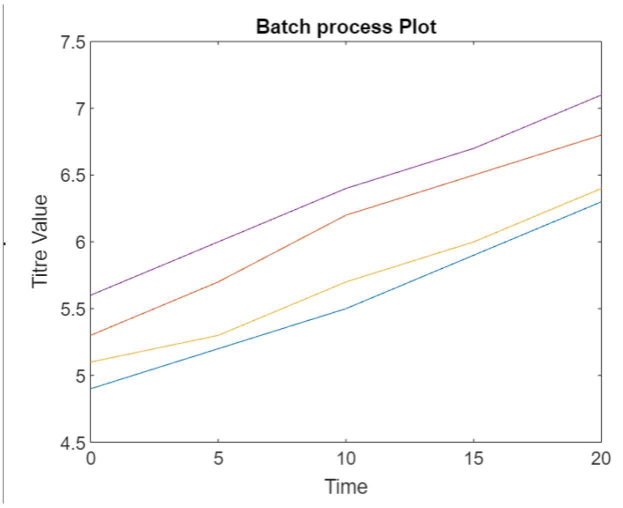

Fig -4: The Batch process plot graph

GRAPHICAL RESULTS FOR SEMI-BATCH PROCESS

The graphical analysis is done by plotting the graph between the time and titre value. The graph is simulated with the help of Matlab. The Semi-Batch process plot graph is given in **Fig -5.**

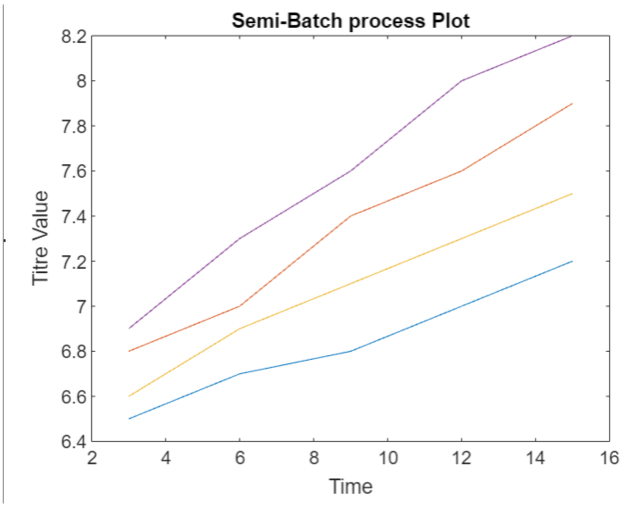

Fig -5: The Semi-Batch process plot graph

EXPANSION KEYS

PN	Phenolphthalein indicator
CP	Calotropis procera
NO	Nerium oleander
BC	Begonia crenata

Table -12: Expansion keys

4. CONCLUSION

Natural indicators have less harmful effects when compared to Synthetic indicators. From our experiment we observe that synthetic indicators can be replaced by natural indicators and natural indicators can give closer similar titre value of synthetic indicators. Here Calotropis procera, Nerium oleander and Begonia crenata extract natural indicators have very similar titre value of phenolphthalein indicator. Hence, we conclude that Here we conclude that Calotropis procera, Nerium oleander and Begonia crenata extract natural indicators as an ecologically innocuous method of replacement of phenolphthalein indicator in laboratory experiments.

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