**ZAR K OBED 7663612 PETROLEUM ENGINEERING**

**P:1:1:3**

**PRE-LAB**

1. The solution was heated to 60°C so as to increase the rate of the reaction because an increase in temperature increases the kinetic energy of the molecules therefore the molecules move faster. This increases the number of collision per unit time and thus the number of effective collision which increases the rate of the reaction. An increase in temperature also increases the proportion of molecules with energy greater or equal to the activation complex and thus increases in the rate of reaction. The cooling of the mixture to 25°C was done so as to terminate the reaction.

2. a) It was ensured that all readings were taken accurately.

b) The tip of the thermometer should not touch the side or the bottom of the glass during heating.

c) The titration process was carried out carefully to ensure accuracy.

d) Avoidance of huge reaction time when recording time readings for the respective temperature.

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**COURSE:** PETROLEUM ENGINEERING

**INDEX:** 7663612

**EXPERIMENT:** P.1.1.3

**DEMONSTRATOR:** MRGYASI JUSTICE

**DATE:** 30TH NOVEMBER, 2012.

**TITLE: VELOCITY CONSTANT BY TITRATION METHOD**

**AIMS AND OBJECTIVES**

The aims and objectives of this experiment Is to enable one be able:

* to determine the velocity constant of a reaction by using titration.
* to determine the rate of the reaction.
* to determine the order of the overall reaction.
* to become conversant with the use laboratory equipment.

**INTRODUCTION**

Rates of chemical reactions refer to the amount of reactants consumed per unit time. It could be also referred to as chemical kinetics which also means the change in the concentration of the reactants or product per unit time. The rate of a reaction tells about how fast a given reactant is consumed or how much of a given product is formed within a given time. During chemical reactions,the rate tells reactants the amount of reactants and products change as the reaction proceeds with time.

Generally the rate equation of a reaction may be expressed in the form of:

∆c = k (A) n1 (B) n2  (1)

∆t

Where k is the velocity constant of the reaction and the order of

the reaction n is the sum of the exponents in the rate equation, that is

n = n1 + n2

In the second order reaction involving the oxidation of iodide with per sulphate

2I- + S2O8 → I2 +2SO4-2

The rate equation may be written as:

∆c = k2 (a-x)(b-x) (2)

∆t

Where a and b are the initial concentrations of per sulphate and iodide respectively.

The reaction will follow a first order kinetics when the concentration of one of the reactants is in excess such that the concentration is appreciably constant during the reaction. Assuming that the concentration of iodide in the above reaction is so large that it will be approximately unaltered during reaction, equation (2) will reduce to

∆c = k2 (a-x) b (3)

∆t

By applying calculus, integrate and apply the condition that when t = 0, x = 0, we have

bk2 = - 1 ln a

t a-x

ln (a-x) = - k’t + lna (4)

Where k’ = b.k2

Eqn (4) has the form of a linear equation, y = mx + c

Where m = slope of the line

y = ln (a-x)

m = -k

x = t

c = ln a

Thus, a plot of log (a-x) versus t will give a straight line with a slope of –k. This will allow us to calculate the rate constant / velocity constant, k.

In a reaction there are factors that influence the rate at which they occur and they are:

* Concentration: Base on the collision theory which states that for a reaction to occur particles must collide, when there is an increase in the concentration of the reactants this increase the amount of molecules or particles per unit volume and hence an overall increase in the frequency of molecular collision and thus an increase in the effective collision which increases the rate of the reaction
* Temperature: An increase in temperature increases the kinetic energy of the molecules therefore the molecules move faster. This increases the number of collision per unit time and thus the number of effective collision which increases the rate of the reaction. An increase in temperature also increases the proportion of molecules with energy greater or equal to the activation complex and thus increases in the rate of reaction.
* Catalyst: In a reaction catalysts reduce the activation energy and hence increase the proportion of molecules with energy greater or equal to the activation energy. Number of effective collision per second increases and hence an increase in the reaction rate.
* Surface area: when the reactants in a reaction are solids an increase in the surface area exposes more particles and hence an increase in the number of collision and effective collision. Rate of reaction therefore increase. Molecules reacting in the gaseous states are faster than that of liquids and solids and molecules reacting in liquid state are also faster than that of solids state all because of the number of exposed surfaces for reaction

**EQUIPMENT**  **CHEMICALS**

a. Saturated solution of potassium persulphate Pipette b. 0.4N potassium iodide solution

* Beaker c. 0.1N sodium thiosulphate solution
* Thermometer d. Distilled water
* Conical flask Graduated cylinder
* Stop watch

**PROCEDURE**

* 50ml of the 0.4N solution of the Potassium iodide is delivered into a conical flask.
* 20ml of the saturated solution of potassium persulphate is diluted with 80.0ml of water.
* The resulting solution is divided equally that is 50ml each into two separate conical flasks.
* 50ml each of the potassium iodide solution was poured into the two potassium persulphate solutions at the same time and the stop watch started simultaneously.
* At measured and recorded intervals in time (3, 8, 15, 20, 30, 40, 50, 60 minutes), 10.0 ml of one of the reaction mixture was withdrawn with a pipette and allowed to run into a large volume of water.
* Each 10.0ml sample was titrated with freshly prepared 0.01N sodium thiosulphate (x ml) using starch indicator.
* 50ml of the other mixture was then heated to 60°C using a heater and allowing to cool down to 25°C
* 10.0ml was titrated with 0.1N sodium thiosulphate (a ml).

**TABLE OF RESULTS**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Time (t)/min** | **Titration (a)/ml** | **Titration (x)/ml** | **a-x** | **Log (a-x)** |
| 3 | 5.65 | 0.70 | 4.95 | 0.695 |
| 8 | 5.65 | 0.90 | 4.75 | 0.677 |
| 15 | 5.65 | 1.00 | 4.65 | 0.673 |
| 20 | 5.65 | 1.35 | 4.30 | 0.633 |
| 30 | 5.65 | 1.40 | 4.25 | 0.628 |
| 40 | 5.65 | 2.00 | 3.65 | 0.562 |
| 50 | 5.65 | 2.40 | 3.25 | 0.512 |
| 60 | 5.65 | 2.35 | 3.30 | 0.519 |

**CALCULATION**

Gradient (k’) = = = -0.003 s-1

**DISCUSSION**

At the start of the experiment, when potassium iodide was added to persulphate, a yellow colour was formed and as time went by the colour changed to orange and then to deep red colour at the end. The mixture also turned blue-black in colour when starch indicator was added to it. This was due to the presence of iodine in the solution. When the resulting solution was titrated with the thiosulphate, the blue-black colour turned colourless at its endpoint.

There was also a colour change of the second mixture made with potassium iodide and dilute per sulphate from yellow to orange. As it was being heated to 60 this was done to increase the rate of the reaction of the mixture and this resulted in the formation of a deep orange colour of the solution. The cooling of the solution to 25 was done to terminate the reaction process. When the starch indicator was added to 10ml of the resulting solution it turned blue black due to the presence of the iodine in the solution. When it was titrated with thiosulphate, it gave a colourless solution at the endpoint.

It was also observed that, as the time increased, the value of ‘x ml’; (the volume of thiosulphate used in the first part of the experiment) also increased steadily as the reaction proceeded, the rate increased more rapidly. This is because with time, persulphate ions reacted with iodide to form more iodine molecules. Since thiosulphate reacts with iodine when introduced, more thiosulphate will be used up.

According to the collision theory, for species to react chemically with each other they must collide. The rate of a chemical reaction depends on the frequency of effective collisions, the higher the rate of the reaction. Generally increase in temperature increases the rate of reaction and vice-versa. When the temperature is increased, the colliding particles gain more kinetic energy therefore there are more effective collisions per unit time between the reacting particles so the rate of reaction increase. This accounted for the increase in the rate of reaction of ‘x’. An increase in temperature also increases the proportion of molecules with energy greater or equal to the activation complex and thus increases in the rate of reaction. A decrease in temperature causes a decrease in rate of the reaction.

The rate constant was also obtained as a negative value. This means that the rate of this reaction depended on the concentration of reactants and as such, decreased as the reaction proceeded. From the fact that, the slope of the line for a first-order reaction is equal to -k, this reaction is first-order overall.

**ERROR ANALYSIS**

1. Exact values were not used as they were approximated.

**PRECAUTIONS**

1. Safety goggles and laboratory coats were worn in order to protect the body from direct injury.
2. All burette and pipette readings were taken accurately from the bottom of the meniscus.
3. It was ensured that all bubbles were eliminated from the pipette from the pipette before taking the readings.
4. The glassware was washed with the sample of the solutions before use.
5. Hands were thoroughly washed before leaving the laboratory.

**REFERNECES**

1. Physical Chemistry Laboratory Experiments - John M. White (1976), pages 258-360.
2. Essential Chemistry (Second Edition) – Raymond Chang – pages 430 – 439.
3. Modern Chemistry (New Edition)-Sarpong F.K.- Pages 319 -325