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Effect of the Acidic and Alkaline Solutions on K_2CrO_4 and $K_2Cr_2O_7$ by Ultraviolet and Visible Measurement

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Abstract

In this work different amount of acidic (HCl) and alkaline (NaOH) solutions were added to stoke solutions of K_2CrO_4 and $K_2Cr_2O_7$ to show the effect of pH values on their spectra. The results of UV-Visible spectroscopy shows that, the Changing of solution pH value when drops of HCl were added led to shift wavelength of K_2CrO_4 spectrum while no change has been occurred in $K_2Cr_2O_7$ spectrum. However, Changing PH values solution by adding drops of NaOH led to change in wavelength red shift for $K_2Cr_2O_7$ while no changes has been occurred in spectrum of K_2CrO_4.

Keywords: Alkaline, Stoke solutions, pH values, Wavelength, Red shift, Spectrum.

الخلاصة

تم دراسة تأثير إضافة كميات مختلفة من محلول حامض (HCl) ومحلول قاعدة (NaOH) على طيف محلول كرومات البوتاسيوم (K_2CrO_4) ومحلول ثنائي كرومات البوتاسيوم ($K_2Cr_2O_7$). أظهرت نتائج الأشعة الفوق البنفسجية والمرئية بأن تغير قيمة pH للمحلول عند اضافة قطرات من محلول حامض (HCl) تؤدي إلى إزاحة حمراء(نحو الأطوال الموجية الطويلة) في طيف محلول كرومات البوتاسيوم (K_2CrO_4) بينما لايحدث أي تغير في طيف محلول ثنائي كرومات البوتاسيوم ($K_2Cr_2O_7$). بينما يحدث العكس عند اضافة قطرات من محلول قاعدة (NaOH) حيث تحدث ازاحة طيفية حمراء لمحلول ثنائي كرومات البوتاسيوم ($K_2Cr_2O_7$) بينما لايحدث أي تغير في طيف محلول كرومات البوتاسيوم (K_2CrO_4).

Introduction

Spectroscopy is the study of interaction of radiation (absorption and emission) with matter and imparts information regarding molecular structure (molecular symmetry, bond distances, bond angles), chemical properties (electronic distribution, bond strength, intra and inter-molecular spectra)[1].

Spectroscopic methods have proved to be very useful for studying the properties of molecules. The principle exploratory work in it may now be completed, but the theory is still interesting because of its applications, because of the way it illustrates many principles of quantum mechanics and group theory, and the way theory is used to solve more complex problems, spectroscopy means the energy-level structure charting of the physical systems that measured experimentally [2-5].

Potassium chromate K_2CrO_4

It is an inorganic solid compound, which has a yellow color for the potassium salt of chromate anion. It is known as a laboratory chemical material, whereas sodium chromate is an important in industrial material [6, 7].

Potassium dichromate $K_2Cr_2O_7$

Potassium dichromate is one of the crystalline inorganic chemical reagents. Hexavalent chromium compounds are harmful to health. $K_2Cr_2O_7$ is widely used in laboratories and industry as an oxidizing agent because it is not deliquescent. Potassium dichromate looks very bright and red-orange color [8, 9]. Table 1 shows the physical and chemical properties of both K_2CrO_4 and $K_2Cr_2O_7$ compounds.

Table 1: Shows physical and chemical properties for K_2CrO_4, $K_2Cr_2O_7$.

physical and chemical properties	Potassium Chromate	Potassium Dichromate
Molecular Formula	K_2CrO_4	$K_2Cr_2O_7$
Molecular Weight	194.19 g/mol	294.18 g/mol
Physical State	Poly crystalline powder	Poly crystalline powder
Appearance	Yellow coloured powder	Orange coloured powder
Ph (5% , 20 ˚C)	8.6 – 9.8	3.7 - 4
Specific Gravity/Density	2.73 g/cm^3	2.676 g/cm^3
Melting Point	968 ˚C	398 ˚C
Boiling Point	1000 ˚C	500 ˚C
Solubility in Water (20 ˚C)	62.9 g/100 ml	125 g/L
Solubility in Alcohol	Insoluble	Insoluble
Refractive Index (n_D)	1.74	1.738

Materials and Methodology

K_2CrO_4 with H_2O and HCl

The stock solution of (K_2CrO_4) is prepared by dissolving (1.456 gm) of potassium chromate in (150 ml) distilled water to get (0.05 M). The stock dilute solution of Hydrochloric acid is prepared by adding (0.5 ml) of (11.45 M) HCl to (150 ml) distilled water to get (0.038 M).The samples are prepared from up stock solutions, the first sample contains (20 ml) (K_2CrO_4) value of pH (8). The second sample is prepared by adding (1 ml) (HCl) to (20 ml) (K_2CrO_4) to reach the value of pH (7.5). The third sample is prepared by adding (2 ml) (HCl) to (20 ml) (K_2CrO_4) to reach the value of pH (7.35). The fourth sample is prepared by adding (3 ml) (HCl) to (20 ml) (K_2CrO_4) to reach the value of pH (7.2). All (pH) measurements recorded by using (pH meter) type (Inolab pH 7110) at (25˚C).

$K_2Cr_2O_7$ with H_2O and HCl

The stock solution of ($K_2Cr_2O_7$) is prepared by dissolving (2.27 gm) of potassium dichromate in (150 ml) distilled water to get (0.05 M). The stock dilute solution of Hydrochloric acid is prepared by adding (0.5 ml) of (11.45 M) HCl to (150 ml) distilled water to get (0.038 M).The samples is prepared from up stock solutions, the first sample contains (20 ml) ($K_2Cr_2O_7$) value of pH (4.9). The second sample is prepared by adding (1 ml) (HCl) to (20 ml) ($K_2Cr_2O_7$) to reach the value of pH (3.4). The third sample is prepared by adding (2 ml) (HCl) to (20 ml) ($K_2Cr_2O_7$) to reach the value of pH (2.7). The fourth sample is prepared by adding (3 ml) (HCl) to (20 ml) ($K_2Cr_2O_7$) to reach the value of pH (2.5). All (ph) measurements recorded by using (pH meter) type (Inolab pH 7110) at (25 ˚C).

K_2CrO_4 with H_2O with NaOH

The stock solution of (K_2CrO_4) is prepared by dissolving (1.456 gm) of potassium chromate in (150 ml) distilled water to get (0.05 M). The stock solution of (NaOH) has been prepared by dissolving (1 gm) (NaOH) in (50 ml) distilled water to get (0.5 M). The samples are prepared from up stock solutions, the first sample contains (20 ml) (K_2CrO_4) with value of pH (8). The second sample is prepared by adding (1 ml) (NaOH) to (20 ml) (K_2CrO_4) to reach the value of pH (12.2). The third sample is prepared by adding (2 ml) (NaOH) to (20 ml) (K_2CrO_4) to reach the value of pH (12.4). The fourth sample is prepared by adding (3 ml) (NaOH) to (20 ml) (K_2CrO_4) to reach the value of pH (12.6). All (pH) measurements recorded by using (pH meter) type (Inolab pH 7110) at (25 ˚C).

$K_2Cr_2O_7$ with H_2O and NaOH

The stock solution of ($K_2Cr_2O_7$) is prepared by dissolving (2.27 gm) of potassium dichromate in (150 ml) distilled water to get (0.05 M). The stock solution of (NaOH) has been prepared by dissolving (1 gm) (NaOH) in (50 ml) distilled water to get (0.5 M). The samples is prepared from up stock solutions, the first sample contains (20 ml) ($K_2Cr_2O_7$) with value of pH (4.9). The second sample is prepared by adding (1 ml) (NaOH) to (20 ml) ($K_2Cr_2O_7$) to reach the value of pH (6.27). The third sample is prepared by adding (2 ml) (NaOH) to (20 ml) ($K_2Cr_2O_7$) to reach the value of pH (6.67). The fourth sample is prepared by adding (3ml)

(NaOH)to (20 ml) ($K_2Cr_2O_7$) to reach the value of pH (7.13). All (pH) measurements recorded by using (pH meter) type (Inolab pH 7110) at (25 ˚C).

Results and Discussion

Figure (1) shows the absorption spectra of K_2CrO_4 solutions in four different samples PH by adding different amount of HCl in the stock K_2CrO_4 solution molarity 0.05 M at the wavelength in the range of 200-550 nm. In this figure it can be seen that all samples solutions of K_2CrO_4 have the same characteristic peak at the wavelength 465 nm, also it can be seen that the first sample of K_2CrO_4 solution of PH value 8 has a red shift at the wavelength 490 nm, the second sample of K_2CrO_4 solution of PH value 7.5 has a red shift at the wavelength 495 nm, the third sample of K_2CrO_4 of PH value 7.35 has a red shift at the wavelength 500 nm, the fourth sample of K_2CrO_4 PH value 7.2 has a red shift at the wavelength 505 nm. This indicates when adding acidic solution to Alkaline solution a red shift occurred (Bath chromic shift) of the spectrum

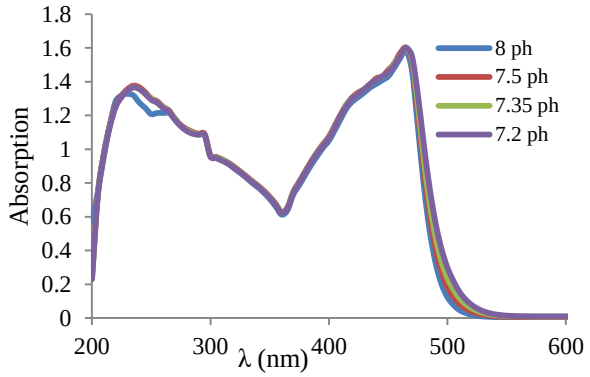

Figure 1: shows the UV-Visible spectra of K_2CrO_4 at different pH values when HCl drops are added.

Figure 2 shows the absorption spectra of $K_2Cr_2O_7$ solutions in four different PH samples by adding different amounts of HCl in the stock $K_2Cr_2O_7$ solution molarity of 0.05 M at the wavelength range of 200-600 nm. In this Figure, it can be seen that all samples solutions of $K_2Cr_2O_7$ have the same characteristic peak at the wavelength 500 nm. This indicates when adding acidic solution to acidic solution, noticeable changes in wavelength shift or intensity of the spectrum have not been occurred.

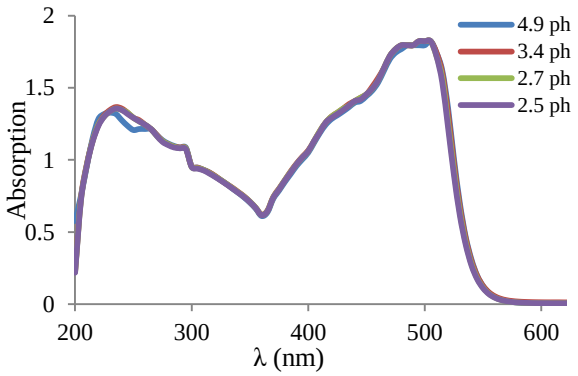

Figure 2: shows the UV-Visible spectra of $K_2Cr_2O_7$ at different PH values when HCl drops are added.

Figure 3 shows the absorption spectra of K_2CrO_4 solutions in four different pH samples by adding different amounts of NaOH in the stock K_2CrO_4 solution molarity of 0.05 M at the wavelength ranges of 200-550 nm. In this Figure, it can be seen that all samples solutions of K_2CrO_4 have the same characteristic peak at the wavelength 460 nm. This indicates when adding alkaline solution to alkaline solution noticeable changes in shift or intensity of the spectrum have not been occurred.

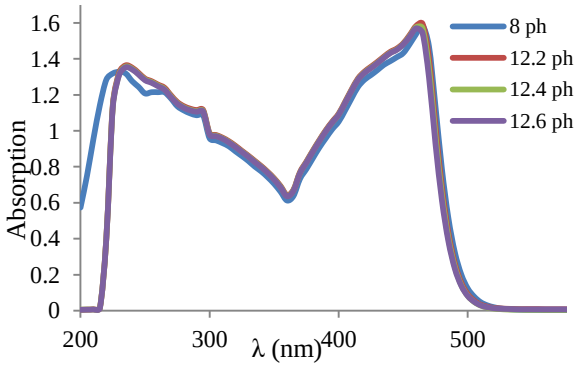

Figure 3: shows the UV-Visible spectra of K_2CrO_4 at different PH values when NaOH drops are added.

Figure 4 shows the absorption spectra of $K_2Cr_2O_7$ solutions in four different pH samples by adding different amounts of NaOH in the stock $K_2Cr_2O_7$ solution molarity of 0.05 M at the wavelength ranges of 200-600 nm. In this fig., it can be seen that the first sample of $K_2Cr_2O_7$ PH solution value 8 has characteristic

peak at the wavelength 475 nm, the second sample of $K_2Cr_2O_7$ solution of PH value 12.2 has characteristic peak at the wavelength 490 nm, the third sample of $K_2Cr_2O_7$ of pH value 12.4 has characteristic peak at the wavelength 505 nm, the fourth sample of $K_2Cr_2O_7$ of pH value 12.6 has characteristic peak at the wavelength 510 nm. This indicates when adding alkaline solution to acidic solution red shift (Bath chromic shift) of the spectrum has been occurred.

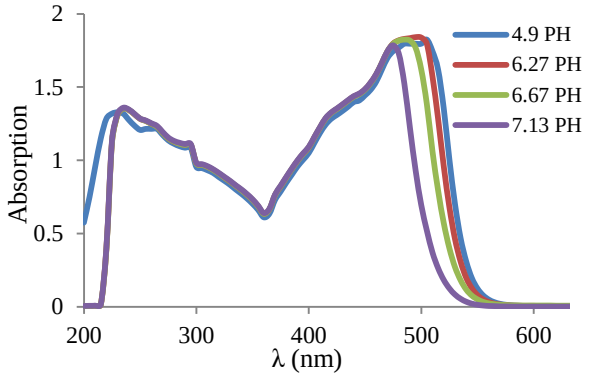

Figure 4: shows the UV-Visible spectra of $K_2Cr_2O_7$ at different PH values when NaOH drops are added.

Conclusions

The wavelength shift of bands was due to the short-range interaction between the soluble molecules and solvent molecules. When adding acidic solution to Alkaline solution a red shift occurred (Bath chromic shift) of the spectrum.

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