Available online at http://www.journalijdr.com

International Journal of DEVELOPMENT RESEARCH

ISSN: 2230-9926

International Journal of Development Research
Vol. 07, Issue, 02, pp.11751-11755, February, 2017

Full Length Research Article

SPECTROSCOPIC COMPARATIVE ANALYSIS OF NICKLECHOLORIDE, COBALT SULPHATE, COPPER NITRATE AND COPPER CHLORIDE SOLUTION FILTERS

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ARTICLE INFO

Article History:
Received 12th November, 2016
Received in revised form
17th December, 2016
Accepted 15th January, 2017
Published online 28th February, 2017

Key Words:
Colorimetry,
Filter, Spectra.

ABSTRACT

The study of the filters is essential in colorimetry. The filters are mostly used to get monochromatic radiation of a particular frequency band. The best filter is that which gives minimum transmission for a give concentration and depth of cell. The observations of various experiments regarding the individual transmittance spectra, expected transmittance spectra superimposed spectra and observed spectra of solution filters shows various spectral region at 0.01 M concentration.

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INTRODUCTION

In colorimetric analysis the light of definite wavelength is necessary and it provides a simple means for determining minute quantities of the substances using proper filters. It has used widely to obtain approximately monochromatic radiation for photochemical investigations. They are also used to reduce the effect of stray radiations or undesired spectral orders in dispersing systems. In general, the narrower the transmitted wavelength band and the closer its peak agrees with the absorption maximum of the substance being analyzed. The filter whose color should be as close as possible to the complementary color of the solution in the visible region. The filter should give narrower transmitted wavelength band so that its[3] effective band width is small. The Beer Lambert's law states that when a monochromatic radiation passes through a solution of absorbing species, the absorbance is directly proportional to the concentration and width of the solution in the light pathway.

Types of filters

There are three main types of optical filters, namely interference filters, dispersion filters and colour filters. Interference filters are made on the basis of the interference principle. They consist of two partially reflecting evaporated metal films, separated by a transparent spacer of evaporated dielectric, together with glass protecting covers. The interference filters may be made so as to pass quite narrow bands, as narrow as 50Å at the points where transmission is 50% of the maximum transmission. They may transmit as much as 70% of the incident radiation of the peak wavelength. Interference filters are available commercially for maximum transmission at any wavelength within the range 3700 to 7000 Å. Dispersion filters or Christiansen filters referred to by boon which according to woldring require a complicated instrumental system combining optical systems and solutions maintained in thermostat. The dispersion filters have no other advantage than their power to acts as manochromators in the regions of yellow and blue. These filters have greater luminescence and selectivity than the coloured filters. Colour filters consist of a transparent medium, dyed to different shades. They are transparent but with a large transmittance range and therefore not very selective. There are two types of colour filters namely solid colour filters and liquid colour filters. Solid colour filters are simple coloured glass or film of coloured gelatin. Liquid colour filters consist of a glass cuvette with flat parallel walls containing coloured solutions of different shades in fixed concentrations or variable concentrations (Fox (1951), Hargue and Calfee (1932) and Barnes ans*et.al.* (1954)).The transparency depends upon the concentrations, the thickness of the liquid layer and the selective power as a function of its colour. Robinson and Overston (1951) have described a series of colour filters to give great selectivity. Mavrodineanu and

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Boiteux (1965) describe three selection systems for sodium, potassium and calcium which consist of gelatin filters and cuvettes of copper sulphate solution for the selection of sodium, and copper chloride solution for the selection of the calcium band. Dispersion filters are complicated instrumental systems combining with optical systems and solutions maintained in thermostat. The dispersion filters has no advantage than their power acts as monochromaters in the regions of the yellow and blue. The solutions filters are easy to prepare and their colours last for long time. Generally the solution filters give half band widths from 40 mμ to 250 mμ. Filters ofabsorption are usually made from dyed glass, lacquered gelatin, or synthetic polymers to offer a wide range of uses [3,4]. Metal complexes or salts dissolved or suspended in glass produce colour corresponding to the predominant wavelength transmitted [5,6].

Choice of absorption cell

In present study rectangular (1 cm layer) cell was used, which possess some particular characteristics. The rectangular cells are used for used for the liquids or solutions. The glass windows are sufficiently transparent for use in ultraviolet-and visible regions.

Operations of the spectrophotometer

Before taking the actual transmittance or absorption spectra, the instrument should be 'on' at least half on hour to stabilize electronic. The pilot light glows, indicating the electronics are on. When the power control switch is in the ideal or on, 100% transmittance is adjusted by REF front Panel taking reference solution in both rectangular cells.

Observation tables

Table 1. Percentage transmittance of 0.1M of different solutions at various wavelength

Sr. No.	Wavelength in (mμ)	Percentage of transmittance									
		Nickel chloride			Cobalt sulphate			Copper nitrate		Copper chloride	
1	300	85	85	85	95	95	95	20	20	35	35
2	320	85	82	82	95	95	95	55	55	47	47
3	340	82	67	67	95	95	95	95	95	58	58
4	360	76	50	50	95	95	95	96	96	65	65
5	380	40	35	35	93	95	93	97	97	74	74
6	400	30	32	32	90	93	90	98	98	81	81
7	420	50	43	43	80	90	80	98	98	85	85
8	440	80	54	54	65	80	65	98	98	88	88
9	460	87	65	65	50	65	50	98	98	88	88
10	480	92	80	80	40	50	40	99	99	88	88
11	500	95	90	90	35	40	35	99	99	87	87
12	520	95	94	94	50	35	50	97	97	85	85
13	540	95	97	97	75	50	75	97	97	82	82
14	560	95	98	98	90	75	90	97	97	79	79
15	580	90	93	93	93	90	93	93	93	74	74
16	600	82	85	85	94	93	94	85	85	69	69
17	620	75	81	81	95	94	95	78	78	60	60
18	640	67	76	76	95	95	95	68	68	50	50
19	660	62	73	73	95	95	95	58	58	40	40
20	680	60	70	70	95	95	95	48	48	30	30
21	700	58	70	70	95	95	95	35	35	25	25
22	720	58	72	72	95	95	95	24	24	18	18
23	740	60	74	74	95	95	95	18	18	12	12
24	760	63	79	79	-	-	-	15	15	35	11

MATERIALS AND METHODS

Preparation of solutions

The aqueous solutions of different metal ions are prepared in the concentration 0.1 M. All the chemicals used were of analytical grade and the water used was doubly distilled.

- **Nickel chloride ($NiCl_2$, $6H_2O$):** 2.3765 g of nickel chloride was dissolved in little distilled water and finally diluted to 100 ml to get 0.1 M solutions of it.
- **Cobalt sulphate ($CoSO_4$, $7H_2O$)**: In order to get 0.1 M solution of cobalt sulphate, 2.8099 g of it was dissolved in double distilled water and finally diluted to 100 ml.
- **Copper nitrate ($Cu\ (NO_3)_2$, $3H_2O$) :** 2.4152 g of solid copper nitrate was dissolved in double distilled water and finally diluted to 100 ml to get 0.1 M solution.
- **Copper chloride ($CuCl_2$, $2H_2O$):** 0.1 M solution of copper chloride was prepared by dissolving 1.7045 g of salt of it in distilled water and diluted to 100 ml.

The solutions or liquid which is to be used in the cell should be transparent and clear.

Measurement of transmittance and absorbance

A cell is cleaned and coloured solution is taken in a cell and the kept in the sample position. The power switch is made on. The percentage transmittance and absorbance are noted in the visible region i.e. 400 to 89 mμ. In similar way spectra of each solution under study is taken. The plots of the percentage transmittance versus wavelength in mg of each solution are plotted.

Superimposition of two curves

In the selected spectral region, maximum percentage transmittance of any two curves is subtracted from hundred percent transmittance and remainder is again subtracted from maximum percentage transmittance of other curve at the same wavelength.

Table 2. Expected and Observed percentage transmittance of mixture at various wavelength

Sr.No.	Wave length in (mµ)	mixture of nickel chloride and cobalt sulphate		Wave length in (mµ)	mixture of nickel chloride and copper nitrate	
		Expected	Observed		Expected	Observed
1.	400	25	27	300	20	15
2.	420	35	40	320	55	45
3.	440	55	58	340	68	60
4.	460	47	52	360	50	47
5.	480	37	42	380	35	35
6.	500	30	35	400	32	32
7.	520	25	30			
8.	400	25	27			

Table 3. Expected and Observed percentage transmittance of mixture at various wavelength

Sr. No.	Wave Length in(mµ)	mixture of nickel chloride and copper chloride		Wave length in (mµ)	mixture of copper nitrate and cobalt sulphate		Wave length in (mµ)	mixture of copper chloride and cobalt sulphate	
		Expected	Observed		Expected	Observed		Expected	Observed
1.	300	27	32	520	35	32	520	38	44
2.	320	39	43	540	48	42	540	51	57
3.	340	51	55	560	65	55	560	75	75
4.	360	43	45	580	83	74	580	70	70
5.	380	31	33	600	77	68	600	63	63
6.	400	31	32	620	66	57	620	53	53
7.				640	55	48	640	41	41
8.				660	45	39	660	32	32
9.				680	35	31	680	26	26
10.				700	28	26	700	22	22

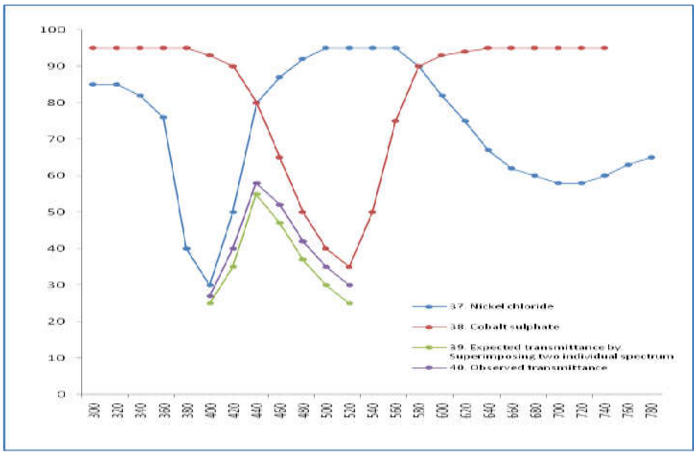

Fig. 1. Individual, expected and observed percentage transmittance of nickel chloride and cobalt sulphate at various wavelength

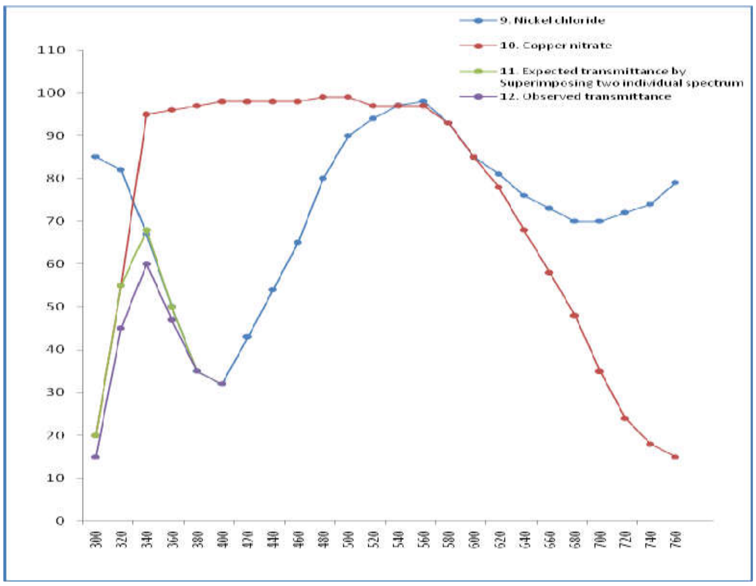

Fig. 2. Individual, expected and observed percentage transmittance of nickel chloride and copper nitrate at various wavelength

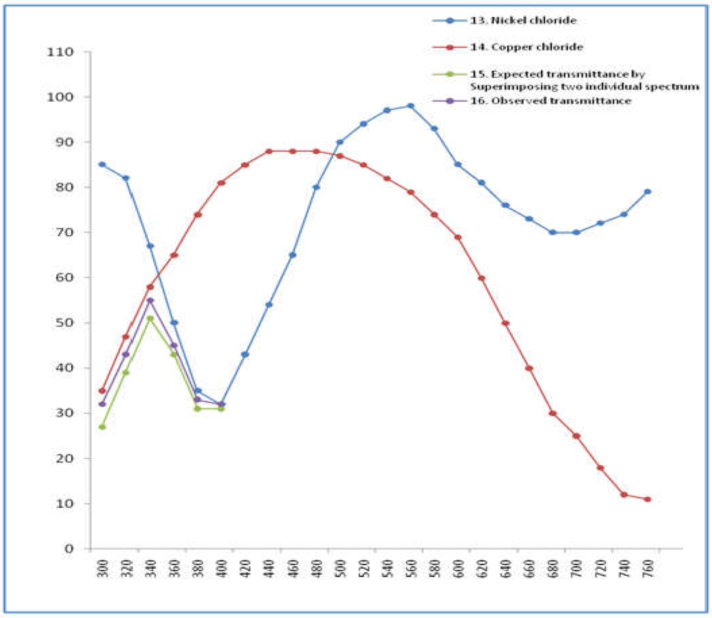

Fig. 3. Individual, expected and observed percentage transmittance of nickel chloride and copper chloride at various wavelength

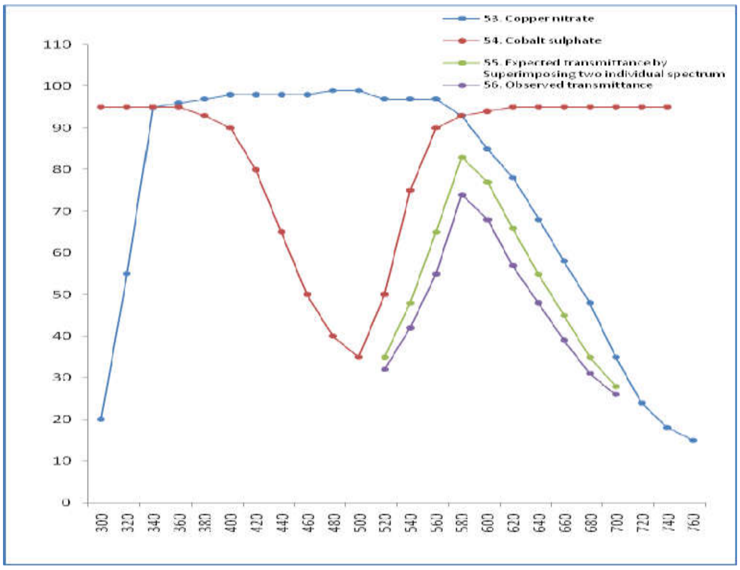

Fig. 4. Individual, expected and observed percentage transmittance of copper nitrate and cobalt sulphate at various wavelength

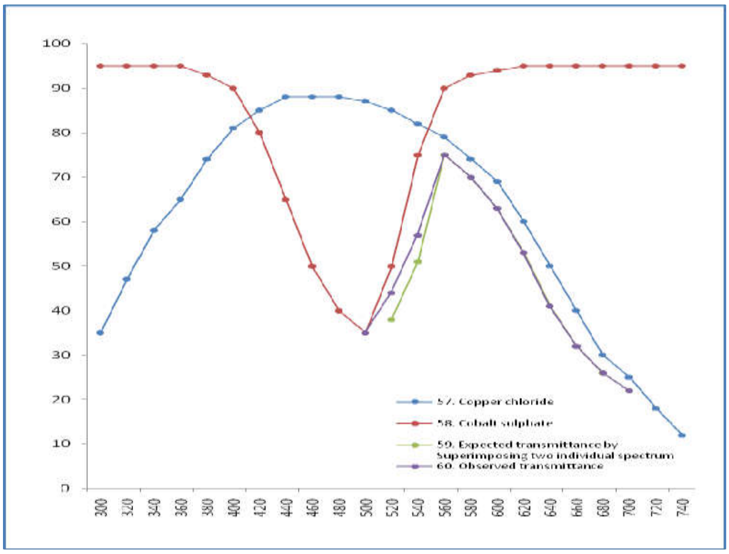

Fig. 5. Individual, expected and observed percentage transmittance of copper chloride and cobalt sulphate at various wavelength

Table 4. Comparative analysis of transmittance spectra, expected transmittance spectra superimposed spectra and observed spectra

Sr. No	Solution Mixture	λmax expected	λmax observed	%T expected	%T observed	$\Delta\lambda_{max}$ half band width (expected) mμ	$\Delta\lambda_{max}$ half band width (observed) mμ
1.	$CuCl_2$+$CoSO_4$	440	440	55	58	92	112
2.	$NiCl_2$+$Cu(NO_3)_2$	340	340	68	60	68	80
3.	$NiCl_2$ + $CuCl_2$	340	340	51	55	92	104
4.	$Cu(NO_3)_2$ + $CoSO_4$	590	590	83	74	132	140
5	$CuCl_2$ + $CoSO_4$	560	560	75	75	128	144

Similarly all the plots were plotted at different wavelengths in selected spectral region and that gives the expected transmittance spectrum for a mixture of two solutions. The combinations of solutions which are expected by superimposition of the curves are made in the range of concentrations 0.1 M and then the transmission spectrum of each mixture of two solutions is taken. That is the observed transmittance spectrum in the expected region. The expected and observed transmittance spectra are plotted on the same scale and on the same graph paper.

RESULTS AND CONCLUSION

The observations of different experiments regarding the individual transmittance spectra, expected transmittance spectra superimposed spectra and observed spectra of various solution filters are given in Table 01- 03 and Fig 01 to Fig 05. From these observations, results of expected wavelength of maximum absorption, observed wavelength of maximum absorption, expected percentage transmittance, observed percentage transmittance, expected half band width and observed half band width obtained are as given below. A mixture of solution of Nickel chloride (0.1 M) and Copper nitrate (0.1M), and Copper chloride (0.1M), Nickel chloride (0.1M) and Copper chloride (0.1M), Nickel chloride (0.1M) and Cobalt sulphate (0.1M), shows narrow spectral region of 370mμ to 400mμ. expected transmission could be found in the solution mixture of $CuCl_2$+$CoSo_4$.

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