

Chapter Three

Results and Discussion

3.1 Introduction:

The application of UV light induced photocatalytic process was studied in this work to deduce the chloroform degradation in water.

The results obtained in this study are presented here in two categories:

- 1) The dependence of the chloroform degradation on the irradiation time.
- 2) The dependence of the chloroform degradation on the amount of the Fe_2O_3 .

The data concerning the behaviour of chloroform degradation were obtained using different amounts of Fe_2O_3 semiconductor (300, 400 and 700mg), and three different exposure times (15, 30 and 45minute). Furthermore, data are presented as absorption spectra where the intensity of the absorption band of chloroform (281.7049 nm) is compared for both categories, before and after irradiation.

3.2 Spectrum of the pure distilled water:

The absorption spectrum of the pure distilled water was recorded as shown in the figure (3.1).

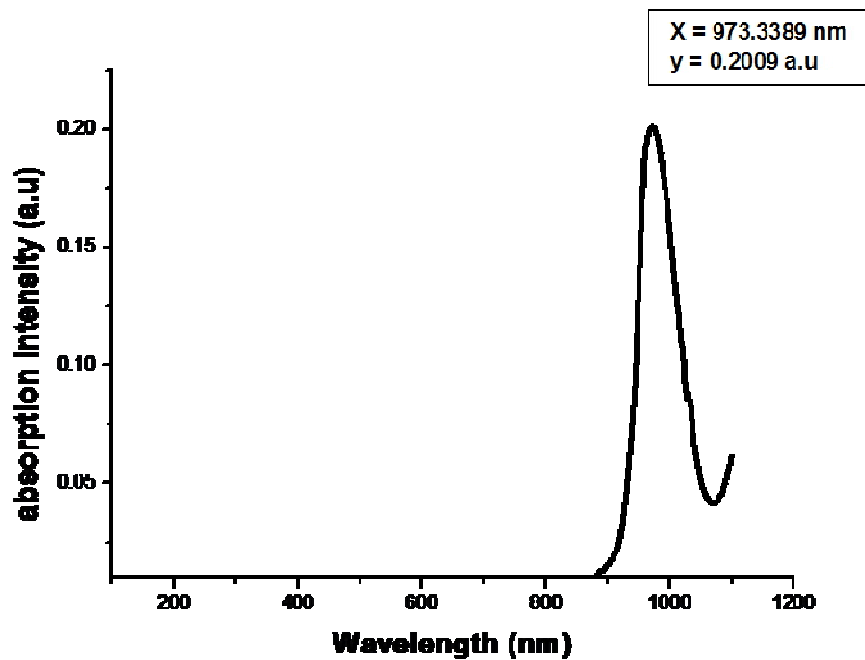


Figure (3.1) The absorption spectrum of the pure distilled water

The spectrum shows that the distilled water has a strong absorption band centered at 973.3387nm.

3.3 The absorption spectrum of chloroform in distilled water:

One ml of chloroform was added to 100ml distilled water, and the absorption spectrum of the mixture was recorded as shown in figure (3.2).

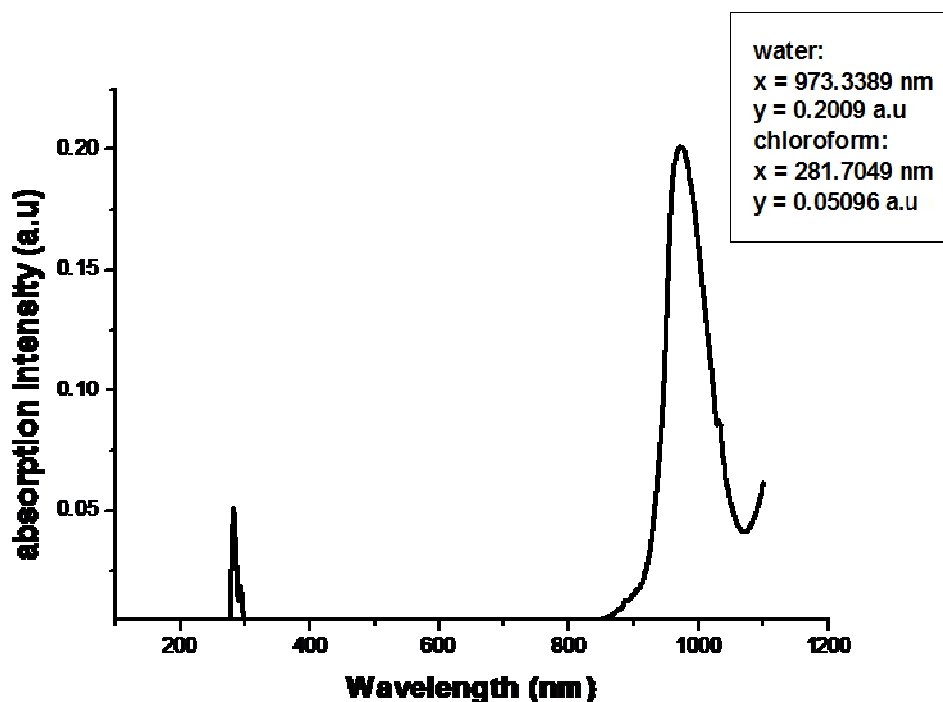


Figure (3.2)The absorption spectrum of 1ml from chloroform in 100ml distilled water.

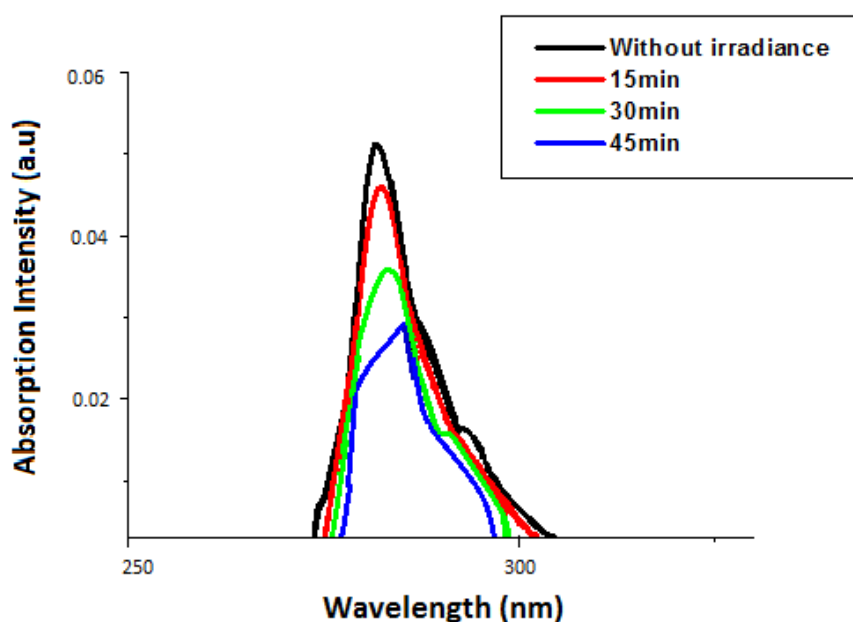
Figure (3.2) shows that when the mixture of 1ml chloroform and 100ml of distilled water, has an absorption peak at 281.7049nm. So when compared with figure (3.1) one can conclude that the new peak is an absorption band of chloroform.

3.4 Degradation of chloroform:

The absorption spectra of chloroform after irradiation by the UV source (365nm) with output power 1200mW for different times and different amounts of Fe_2O_3 catalyst were recorded and compared.

3.4.1 The spectra after adding 300mg Fe₂O₃ and irradiation with different times:

After adding 300mg from Fe₂O₃ to 1ml chloroform dissolved in 100ml of distilled water, the mixture was irradiated by the UV source for different times (15min, 30min and 45min). After that, the Fe₂O₃ was filtered out and the absorption spectra were recorded as shown in figure (3.3). The spectra were compared with that obtained before irradiation as shown in the figure.



Figure(3.3) The spectra of a mixture composed of 1ml chloroform and 300mg Fe₂O₃ irradiated for different times.

Table (3.1) lists the results of the comparison between the intensities of the band at 281.704 in each case.

Table (3.1): The absorption intensities of the band at 281.704nm using 300mg from Fe₂O₃ for different exposure times.

Weight of Fe ₂ O ₃ (mg)	Exposure time (min)	Wavelength (nm)	Absorption band intensity (a.u)	Degradation percentage (%)
Without Fe ₂ O ₃	No exposure time	281.7049	0.051	0.00
300	15	281.7049	0.045	11.77
300	30	281.7049	0.035	31.38
300	45	281.7049	0.029	43.14

Figure (3.4) shows the relation between the exposure time and the intensity of the absorption band of the chloroform and 300 mg Fe₂O₃ irradiated for different times.

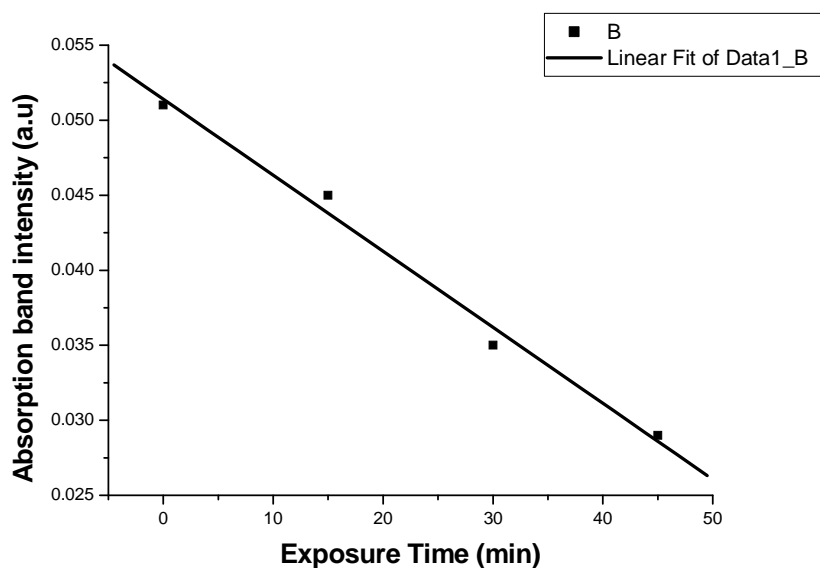


Figure (3.4) The relation between the exposure time and absorption intensity of a mixture composed of 1 ml chloroform and 300 mg Fe₂O₃ irradiated for different times.

3.4.2 The spectra after adding 400mg Fe₂O₃ and irradiation with different times:

After adding 400mg from Fe₂O₃ to 1ml chloroform dissolved in 100ml of distilled water, the mixture was irradiated by the UV source for different times (15min, 30min and 45min). After that, the Fe₂O₃ was filtered out and the absorption spectra were recorded as shown in figure (3.5). The spectra were compared with that obtained before irradiation as shown in the figure.

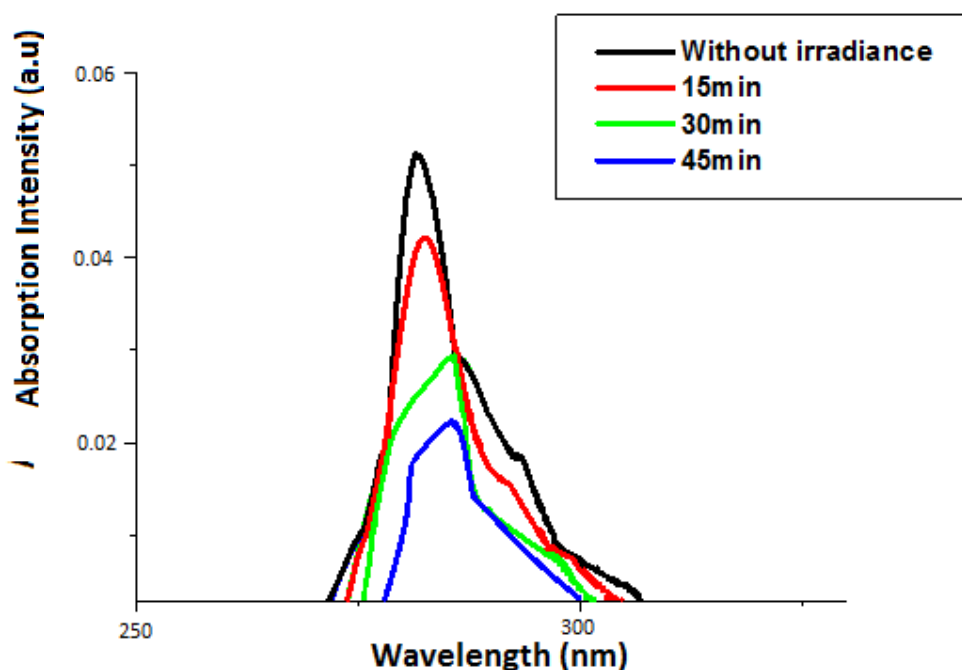


Figure (3.5) The spectra of a mixture composed 1ml chloroform and 400mg Fe₂O₃ irradiated for different times.

Table (3.2) lists the results of the comparison between the intensities of the band at 281.704 in each case.

Table (3.2): The absorption intensities of the band at 281.704nm using 400mg from Fe₂O₃ for different exposure times.

Weight of Fe ₂ O ₃ (mg)	Exposure time (min)	Wavelength (nm)	Absorption band intensity (a.u)	Degradation percentage (%)
Without Fe ₂ O ₃	No exposure time	281.7049	0.051	0.00
400	15	281.7049	0.042	17.77
400	30	281.7049	0.029	43.14
400	45	281.7049	0.022	56.87

Figure (3.6) shows the relation between the exposure time and the intensity of the absorption band of the chloroform and 400 mg Fe₂O₃ irradiated for different times.

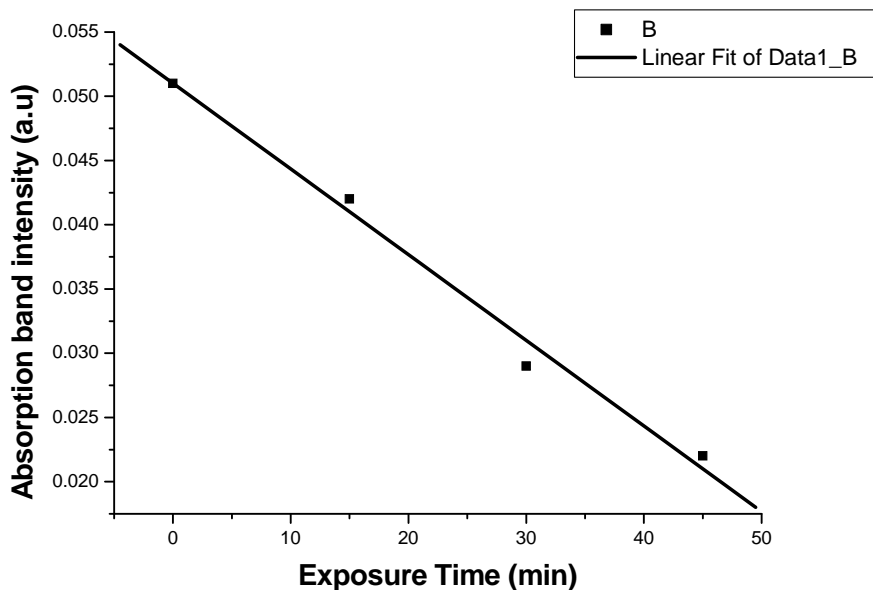


Figure (3.6) The relation between the exposure time and absorption intensity of a mixture composed 1 ml chloroform and 400 mg Fe₂O₃ irradiated for different times.

3.4.3 The spectra after adding 700mg Fe₂O₃ and irradiation with different times:

After adding 700mg from Fe₂O₃ to 1ml chloroform dissolved in 100ml of distilled water, the mixture was irradiated by the UV source for different times (15min, 30min and 45min). After that, the Fe₂O₃ was filtered out and the absorption spectra were recorded as shown in figure (3.7). The spectra were compared with that obtained before irradiation as shown in the figure.

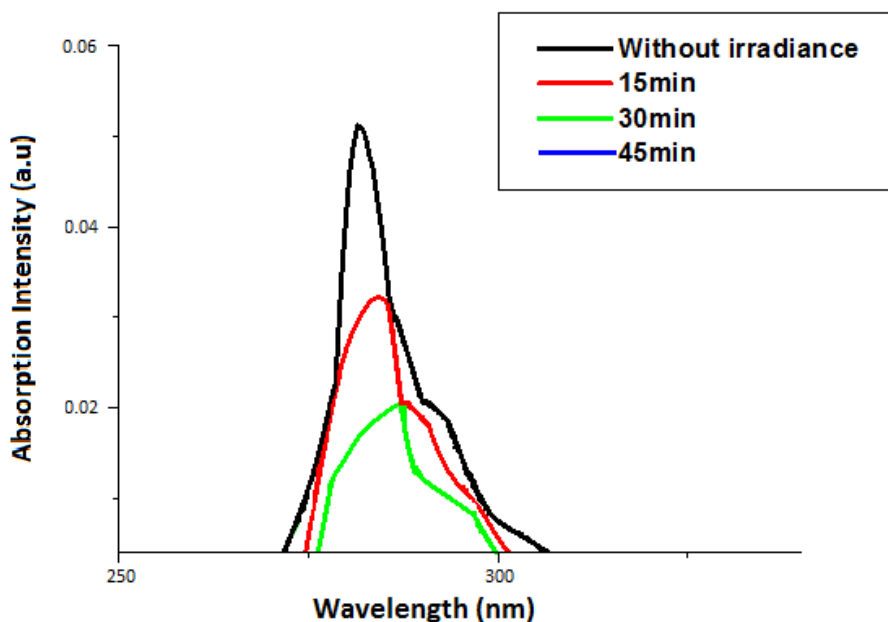


Figure (3.7) The spectra of a mixture composed of 1ml chloroform and 700mg Fe₂O₃ irradiated for different times.

Table (3.3) lists the results of the comparison between the intensities of the band at 281.704 in each case.

Table (3.3): The absorption intensities of the band at 281.704nm using 700mg from Fe₂O₃ for different exposure times.

Weight of Fe₂O₃ (mg)	Exposure time (min)	Wavelength (nm)	Absorption band intensity (a.u)	Degradation percentage (%)
Without Fe ₂ O ₃	No exposure time	281.7049	0.051	0.00
700	15	281.7049	0.032	37.26
700	30	281.7049	0.019	62.75
700	45	281.7049	0.000	100

Figure (3.8) shows the relation between the exposure time and the absorption intensity of the band at 281.704 nm of the chloroform and 700 mg Fe₂O₃ irradiated for different times.

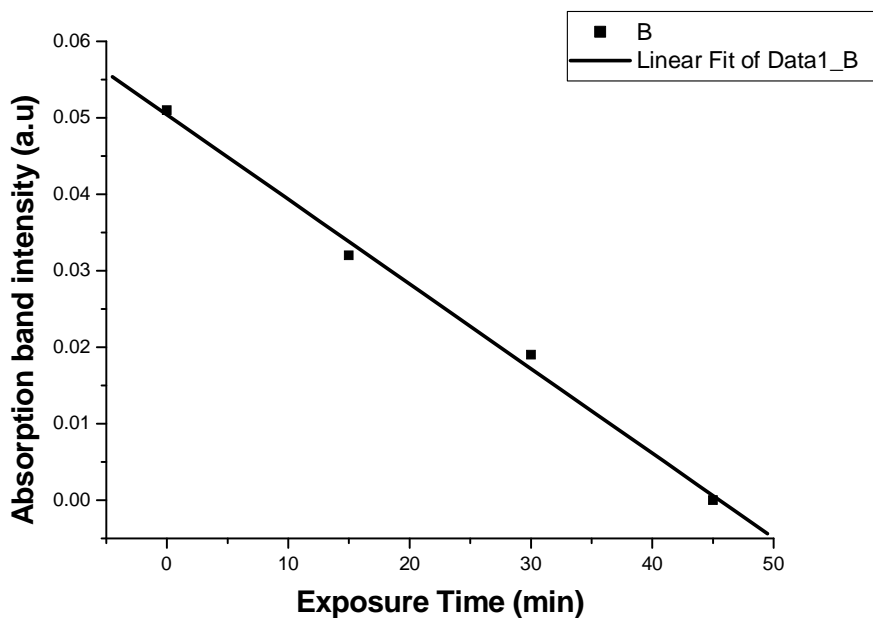


Figure (3.8) The relation between the exposure time and absorption intensity of a mixture composed of 1 ml chloroform and 700 mg Fe₂O₃ irradiated for different times.

Table (3.4) lists the results of the comparison between the intensities of the band at 281.704 nm for a mixture of chloroform and Fe₂O₃ (different weights) after irradiation with 15 min.

Table (3.4): The absorption intensities of the band at 281.704 nm after irradiation with 15 min and different weights of Fe₂O₃.

Weight of Fe₂O₃ (mg)	Exposure time (min)	Wavelength (nm)	Absorption band intensity (a.u)	Degradation percentage (%)
Without Fe ₂ O ₃	No exposure time	281.7049	0.051	0.00
300	15	281.7049	0.045	11.77
400	15	281.7049	0.042	17.77
700	15	281.7049	0.032	37.26

Figure (3.9) shows the relation between the weights of Fe₂O₃ and the absorption intensity of the chloroform irradiated for 15 min.

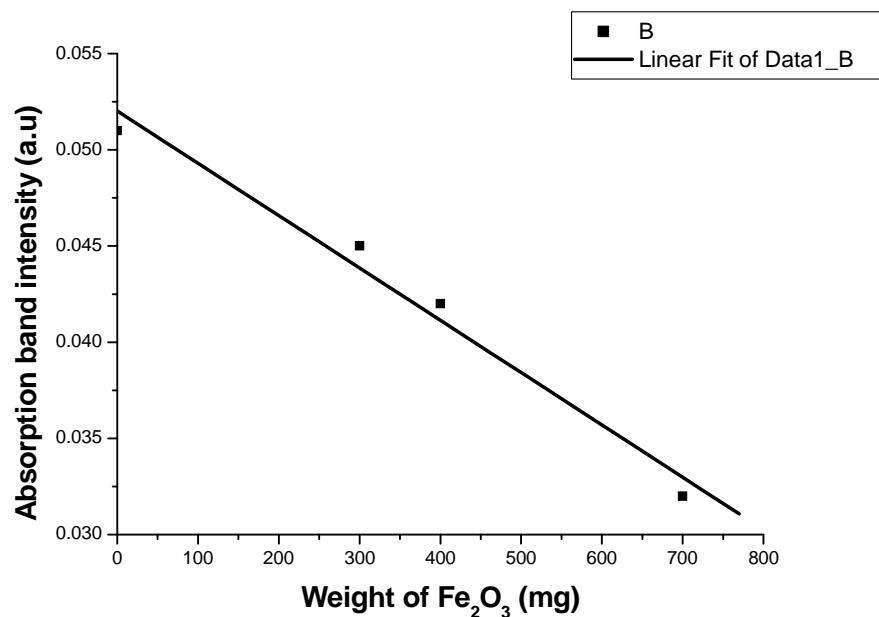


Figure (3.9) The relation between the weights of Fe₂O₃ and the absorption intensity of a mixtures composed of 1 ml chloroform and different weights of Fe₂O₃ irradiated for 15 min

Table (3.5) lists the results of the comparison between the intensities of the band at 281.704 nm with 30min exposure time and different weights of Fe₂O₃.

Table (3.5): The absorption intensities of the band at 281.704nm after irradiation for 30min and different weights of Fe₂O₃.

Weight of Fe₂O₃ (mg)	Exposure time (min)	Wavelength (nm)	Absorption band intensity (a.u)	Degradation percentage (%)
Without Fe ₂ O ₃	No exposure time	281.7049	0.051	0.00
300	30	281.7049	0.035	31.38
400	30	281.7049	0.029	43.14
700	30	281.7049	0.019	62.75

Figure (3.10) show the relation between the weights of Fe_2O_3 and the absorption intensity of the chloroform irradiated for 30 min.

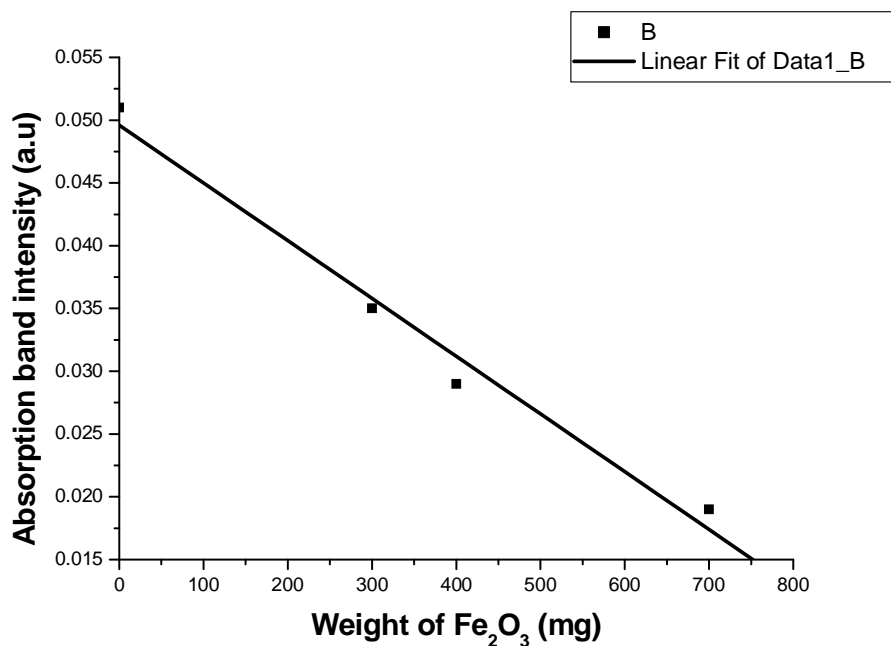


Figure (3.10) The relation between the weights of Fe_2O_3 and the absorption intensity of a mixture composed of 1 ml chloroform and different weights of Fe_2O_3 irradiated for 30 min

Table (3.6) lists the results of the comparison between the intensities of the band at 281.704 nm with 45min exposure time and different weights of Fe_2O_3 .

Table (3.6): The absorption intensities of the band at 281.704nm after irradiation of 45min and different weights of Fe₂O₃.

Weight of Fe₂O₃ (mg)	Exposure time (min)	Wavelength (nm)	Absorption band intensity (a.u)	Degradation percentage (%)
Without Fe ₂ O ₃	No exposure time	281.7049	0.051	0.00
300	45	281.7049	0.029	43.14
400	45	281.7049	0.022	56.87
700	45	281.7049	0.00	100

Figure (3.11) shows the relation between the weights of Fe₂O₃ and absorption intensity of the chloroform irradiated for 45 min.

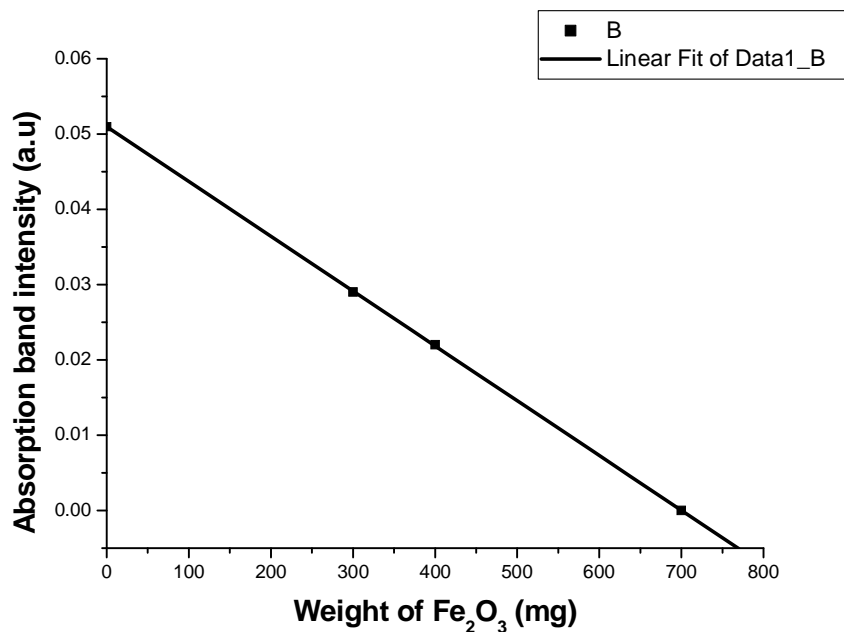


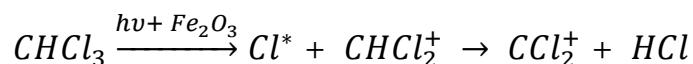
Figure (3.11) The relation between the weights of Fe₂O₃ and the absorption intensity of the chloroform irradiated for 45 min

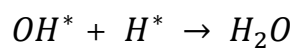
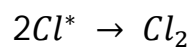
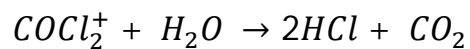
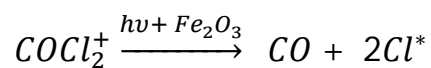
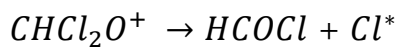
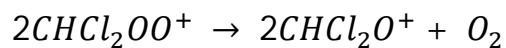
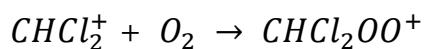
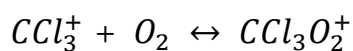
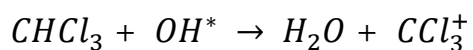
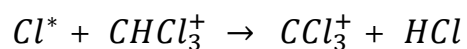
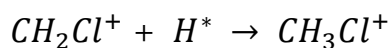
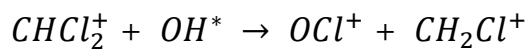
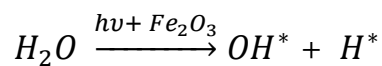
3.5 Discussion:

As shown in figures (3.3), (3.4) and (3.5), the chloroform degradation is observable and that is due to many reasons. For example in figure (3.3), when the amount of Fe_2O_3 was 300mg and the exposure time was increased from 15min, 30min to 45min, the intensity of the chloroform absorption peak (at 281.7049 nm) was decreased significantly with increasing the exposure time, which increase the amount of produced charge carriers. That is also noticed in figures (3.4) and (3.5), where the amount of Fe_2O_3 was 400mg and 700mg respectively, and the exposure time increased from 15min to 30min and 45min, the intensity of the chloroform absorption peaks decreased significantly with increasing the exposure time. The degradation percentage of the chloroform was increased by increasing the exposure time and the weight of Fe_2O_3 .

As one can see in figures (3.3), (3.4) and (3.5), and tables (3.1), (3.2) and (3.3), the intensity of the chloroform absorption peak (at 281.7049 nm) was decreased significantly with increasing the Fe_2O_3 weight and this peak was completely disappeared when the Fe_2O_3 weight reach 700mg and the exposure time was 45min by 100% degradation percentage as shown in figure (3.5) and table (3.3). Increasing the semiconductor weight lead to more production of electron-hole pairs and that means increasing the carrier charges. When the semiconductor particles exposed to the UV source, where its energy is higher than the band gap of Fe_2O_3 , the production of electron-hole pairs is increased and these species are capable to reduce.

A possible reaction pathway for the photocatalytic degradation of chloroform is as follows (W. Abu Bakar, R. Ali and M. Othman, 2010):





3.6 Conclusions:

From the results obtained in this work the follows can be concluded:

1. The objectives of this study were achieved successfully.
2. Degradation of chloroform is increased with increasing the exposure time.
3. The degradation of chloroform is increased with increasing the semiconductor catalyst amount.
4. The degradation percentage of chloroform is 100%, in case of 700mg Fe_2O_3 irradiated with UV source for 45minute.

4.7 Recommendations:

The following ideas can be recommended:

1. Study the photodegradation process for other organic compounds which can be considered as water pollutants such as aston and cresol.
2. Using other semiconductors such as WO_3 , TiO_2 and NiO .
3. Study the photodegradation process under solar irradiation.

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<https://www.ox.ac.uk>, (2015), [Online] Available from https://www.ox.ac.uk/devic/magnetic_stirrer, visited at 31/10/2015 in 5:15:07 pm.

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