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# UV DEGRADATION OF METHYLENE BLUE CATALYZED WITH BLACK NICKEL MUD

**Maroš SOLDÁN - Hana KOBETIČOVÁ - Kristína GERULOVÁ - Lenka BLINOVÁ - Annamarie VELIČ**

***ABSTRACT***

*The aim of this paper is to evaluate the degradation of methylene blue using progressive oxidation method. We have examined the effect of the intensity of the UV radiation and the influence of used catalytic layer on the methylene blue degradation efficiency. We have applied black nickel mud catalyst on glass fibers Saertex layer in order to higher the degradation rate. We have found out that higher intensity of UV light of positively affects the efficiency of the degradation. Use of the catalyst layer formed by deposition of alternative catalyst (black nickel mud) on glass fibers has increased the degradation efficiency of methylene blue.*

***KEY WORDS:*** *UV degradation, methylene blue, photochemical methods, catalyst, black nickel mud*

## 1. Introduction

Development of technologies to remove substances harmful to health, which can be removed using sunlight and natural substances is one of the greatest scientific efforts nowadays. The most important natural material used as the photocatalyst is a titanium dioxide having photocatalytic properties[1].

The biggest problem of wastewater treatment at present is to eliminate persistent and toxic substances in the waters occur at very low concentrations. The effective degradation processes increasing the mineralization of these compounds is requiblack nickel. One of the methods thus developed, which is one of the so-called advanced oxidation method is photocatalytic degradation and UV degradation of organic pollutants in water using colloidal semiconductor photocatalyst $TiO_2$ type using UV. The progressive method removes contaminants and the risk reduces to the available level[2,3].

Methylene blue (MB) is a cationic dye which is widely used mainly for dyeing cotton, wool and silk. The risk of this dye in wastewater can cause various negative effects on the body. Due to use of chemicals industry, this substance is increasingly getting into surface water[4].

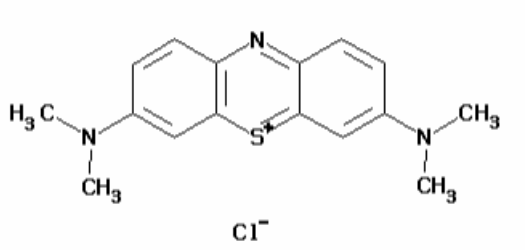


*Fig. 1: Methylene blue*

MB disposal considerable advantage when released into the environment is the use of knowledge that the substance is able to capture the surface. In the case of evaporation of the aqueous solution can be easily removed from the contaminated components of different remediation methods, by contaminated environmental media[5,6].

Black nickel mud (BNM) was created by leaching of nickel and cobalt from lateritic iron-ore. The black nickel mud containing chromium oxide, silicon, aluminium, calcium and the rest nickel is essentially iron concentrate. In Slovakia nickel was produced from the Albanian iron-nickel ore with a nickel content of about 1 %. Annual production of black nickel mud was about 300 000 kg and supplies in Slovakia are estimated at 5.6 million tons[7,8].

## 2. Experimental

To study the degradation of methylene blue using photochemical method photochemical reactor with a UV lamps with an output of 125 W or 400 W were used. The initial concentration of methylene blue was 5 mg $l^{-1}$. Glass UVVis spectrophotometer cells with optical paths of 10 mm were used. The efficiency of methylene blue degradation was determined at a wavelength of 660 nm when the absorption of the radiation reaching the maximum value:

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$$U = \frac{A_{660\,t0} - A_{660\,t1}}{A_{660\,t0}} \times 100 \qquad [\%]$$

10 g of black nickel mud were suspended in 20ml of distilled water. Prepared mixture was applied to the surface of the glass fiber Saertex (1.7 cm x 15 cm) with a brush, and was placed in a muffle furnace for 2 hours at 700 °C.

### 3. Results and discussion

**Photodegradation of methylene blue with 125 W UV lamp without catalyst**

As it could be seen from table 1 and figure 2 the degradation of MB using 125 W UV lamp is quite rapid. The efficiency after 60 min. of irradiation is 84.63%

*Table 1: Values of MB absorbance at 660 nm vs. time of degradation with 125 W UV lamp without catalyst*

| Time of degradation [min.] | 0 | 1 | 2 | 3 | 5 | 7 | 10 | 20 | 30 | 60 |
|---|---|---|---|---|---|---|---|---|---|---|
| $A_{660\,nm}$ | 1.039 | 0.960 | 0.942 | 0.703 | 0.612 | 0.569 | 0.428 | 0.310 | 0.219 | 0.142 |

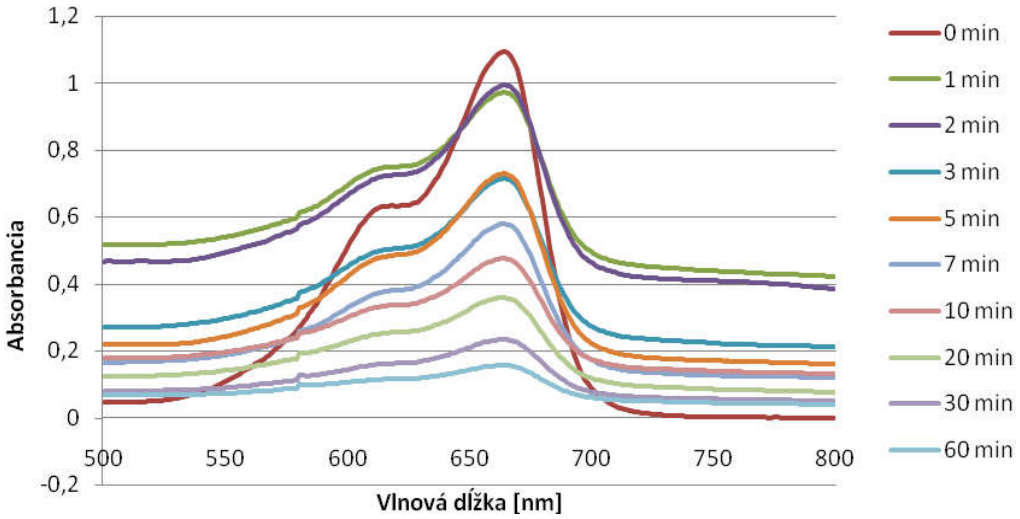


*Fig. 2: Absorbance of methylene blue solution vs. wavelength in different time of UV irradiation (125 W) without the use of black nickel mud as a catalyst*

**Photodegradation of methylene blue with 400 W UV lamp without catalyst**

In this experiment we have investigated the influence of intensity of UV lamp to the degradation rate. We have observed that the use of 400 W UV lamp instead of 125 W caused a slight increase in degradation rate (table 2, figure 3). The efficiency of MB degradation after 60 min. was 87.65 %.

*Table 2: Values of MB absorbance at 660 nm vs. time of degradation with 400 W UV lamp without catalyst*

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| Time of degradation [min.] | 0 | 1 | 2 | 3 | 5 | 7 | 10 | 20 | 30 | 60 |
|---|---|---|---|---|---|---|---|---|---|---|
| $A_{660\,nm}$ | 1.127 | 0.882 | 0.862 | 0.736 | 0.586 | 0.510 | 0.390 | 0.196 | 0.111 | 0.068 |

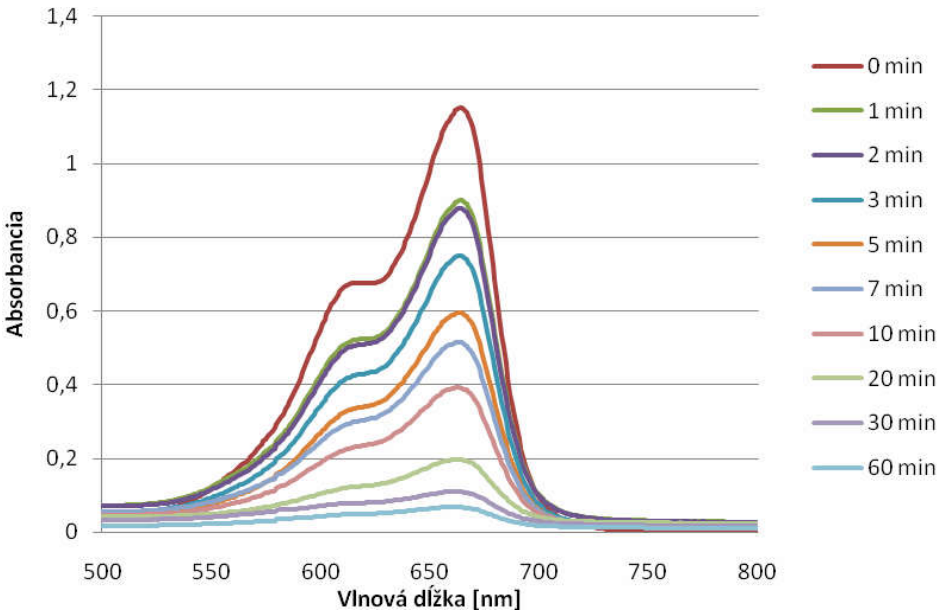


*Fig. 3: Absorbance of methylene blue solution vs. wavelength in different time of UV irradiation (400 W) without the use of black nickel mud as a catalyst*

**Photodegradation of methylene blue with 125 W UV lamp with the use of black nickel mud catalytic layer**

We have used black nickel mud catalytic layer to speed up the degradation rate of methylene blue. We have found out that the increase of degradation efficiency after 60 min. of irradiation is approximately 8 % (94.12 %). The use of prepared black nickel layer may reduce the cost for UV irradiation in shortening the time of complete degradation of methylene blue solution.

*Table 3: Values of MB absorbance at 660 nm vs. time of degradation with 125 W UV lamp with black nickel mud catalytic layer*

| Time of degradation [min.] | 0 | 1 | 2 | 3 | 5 | 7 | 10 | 20 | 30 | 60 |
|---|---|---|---|---|---|---|---|---|---|---|
| $A_{660\,nm}$ | 0.929 | 0.802 | 0.696 | 0.603 | 0.500 | 0.386 | 0.262 | 0.132 | 0.029 | 0.014 |

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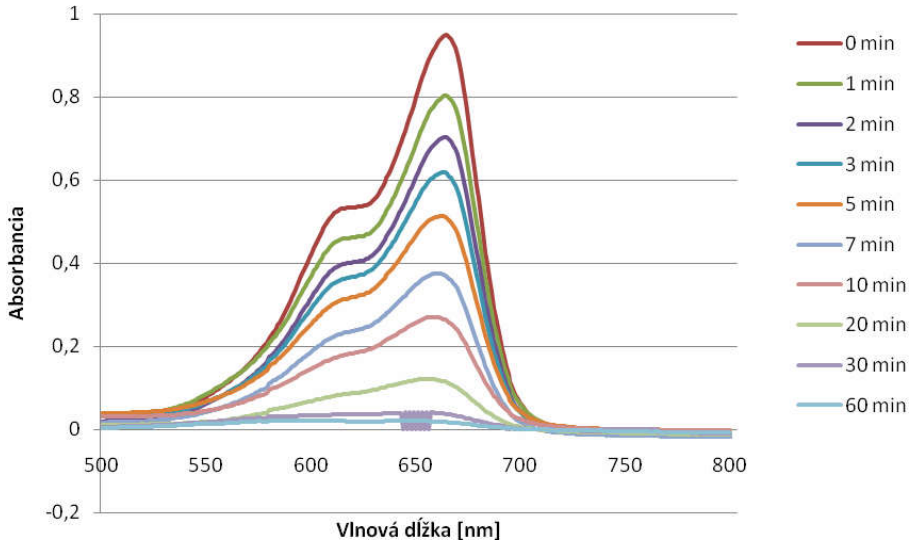


*Fig. 4: Absorbance of methylene blue solution vs. wavelength in different time of UV irradiation (125 W) with black nickel mud catalytic layer*

**Photodegradation of methylene blue with 400 W UV lamp with the use of black nickel mud catalytic layer**

We have found out that the increase of degradation efficiency after 60 min. of irradiation is approximately 10% (98.83 %). The use of prepared black nickel layer has led to completely full degradation of methylene blue after 60 min. of irradiation.

*Table 4: Values of MB absorbance at 660 nm vs. time of degradation with 400 W UV lamp with black nickel mud catalytic layer*

| Time of degradation [min.] | 0 | 1 | 2 | 3 | 5 | 7 | 10 | 20 | 30 | 60 |
|---|---|---|---|---|---|---|---|---|---|---|
| $A_{660\ nm}$ | 1.127 | 0.726 | 603 | 0.519 | 0.397 | 0.316 | 0.202 | 0.077 | 0.043 | 0.013 |

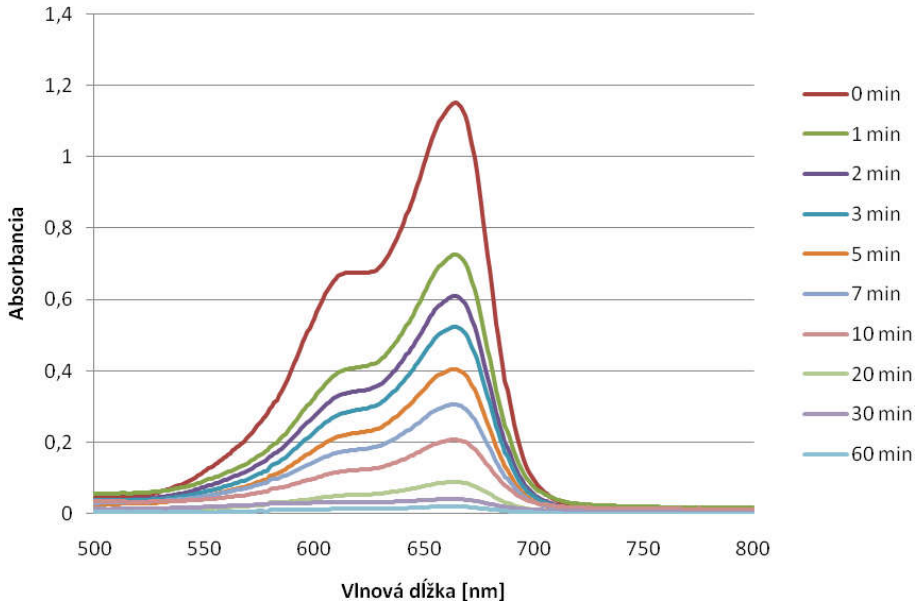


*Fig. 5: Absorbance of methylene blue solution vs. wavelength in different time of UV irradiation (400 W) with black nickel mud catalytic layer*

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**Conclusion**

Comparing the results of different experiments, we came to the following conclusions:

- The intensity of the UV radiation affects the degradation efficiency of MB solution
- Use of the catalyst layers formed by deposition of black nickel mud on glass fibers has increased the degradation efficiency of MB.
- 60 min. time of UV irradiation is sufficient for complete degradation of MB with the use of 400 W UV lamp and black nickel mud catalytic layer.

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