The relation between apparent and true water colour for pond water

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Abstract. The colour of the water can be considered as apparent colour, which is determined by the amount of suspended matter such as clay, phytoplankton and colloidal particles, and true colour, which is the proportion of suspended matter passing through a membrane filter of pore size the 0.45 μm. This study aimed to investigate the apparent and true water colour of pond water and evaluate the impact of filtration on water colour. Using a spectrophotometer, measurements and analyses were conducted on pond water samples. The results of the study showed that filtration can significantly affect the water colour, with a clear difference observed between the apparent and true water colour. The research findings provide a deeper understanding of the factors that influence water colour.

1 Introduction

The colour of the water may be of natural or anthropogenic origin. In the case of natural waters, the colour is mainly due to the presence of humic substances, such as fulvic acids, which make the water looks like yellow to yellow-brown. In addition to dissolved substances, water may also be coloured by suspended substances such as clay or phytoplankton. For this reason, a distinction is made between the true colour of the water, colour due only dissolved substances passing through the 0.45 μm pore size filter, and the apparent colour, which is expressed by the colour due both dissolved and undissolved substances, usually of a colloidal nature. For example, the green to green-blue colour of heavily eutrophicated waters is apparent because it is caused by the presence of cyanobacteria and algae, which can be eliminated by filtration. The colour of the water and its intensity is usually dependent on the pH value and must, in any case, be related to the value [1-4]. The studies on the determination of water colour discuss the objective evaluation, the relation of various water colour determinations and actual legislative standards [3-7]. The filtration process is needed for true water determination and the effect of various pore sizes and filter effects is studied [8-10].

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2 Experiment methodology

2.1 Determination of water colour

The Standard Methodology for the Determination of Water Colour specifies various methods for the determination of water colour. These include both visual colour determination and determination of the true colour of the water by optical instruments. The determination of water colour is carried out according to the Czech technical standard ČSN EN ISO 7887 of July 2012. This standard list four different methods for determining the colour of water [2].

The first method involves the determination of the apparent colour by visual observation of the sample in the bottle. This provides only preliminary information useful, for example, in field work. Only the apparent colour data is reported. The second method involves the determination of the true colour of a water sample measured with an optical instrument. The method can be used for raw and drinking water and for less coloured industrial water. The third method involves determining the true colour of a water sample using an optical instrument by comparison with the concentration of hexachloroplatinate at a wavelength of $\lambda = 410$ nm. The fourth method involves the determination of colour by visual comparison with standard solutions of hexachloroplatinate, which is applicable to raw and drinking water [2].

In this research, the method chosen was to determine the colour of a water sample using an optical instrument by comparison with the concentration of hexachloroplatinate at a wavelength of $\lambda = 410$ nm. This method was used to measure both the true colour of the water and the apparent colour of the water in order to compare the results as accurately as possible [2].

2.2 Characteristics of the measured data

The area of interest was a pond with a size of 30 m^2 and a volume of 10 m^3 located in a private garden in the village of Polanka nad Odrou. The pond is provided with aeration due to Koi carp breeding. Data were collected from June 2021 to March 2023. There were 142 pond water determinations made as part of the analysis. 71 measurements of apparent water colour and 71 measurements of true water colour. Water colour was determined according to EN ISO 7887 spectrophotometrically. Another measured value was the pH value.

3 Experiment evaluation

3.1 Basic description of measured values of apparent and true colour

The graph in Fig. 1 shows the colour values obtained by spectrophotometry in a series of measurements of the waters of the area of interest. The apparent colour value is shown by the full height of the bar, the true colour is shown in blue. The pH value has also been added to the graph on the minor axis. The pH values ranged from 7.1 to 10.4. When examining the values of the true colour, we can see lower values in the case of lower values of the apparent colour.

In addition to the graphical representation, it iss possible to summarize the measured values using descriptive statistics:

- The measured value of the apparent water colour ranged from 19 to 111 $mg \cdot l^{-1}$ Pt. The mean value was 49 $mg \cdot l^{-1}$ Pt and the standard deviation was 29 $mg \cdot l^{-1}$ Pt. For half of the determinations, the apparent water colour did not exceed 29 $mg \cdot l^{-1}$ Pt. In

half of the measurements, the apparent colour of the water ranged from 25 to 78 mg·l^{-1} Pt.

- The measured value of the true water colour ranged from 5 to 31 mg·l^{-1} Pt. The mean value was 13 mg·l^{-1} Pt and the standard deviation was 6 mg·l^{-1} Pt. For half of the determinations, the true water colour did not exceed 10 mg·l^{-1} Pt. In half of the measurements, the true water colour ranged from 8 to 18 mg·l^{-1} Pt.

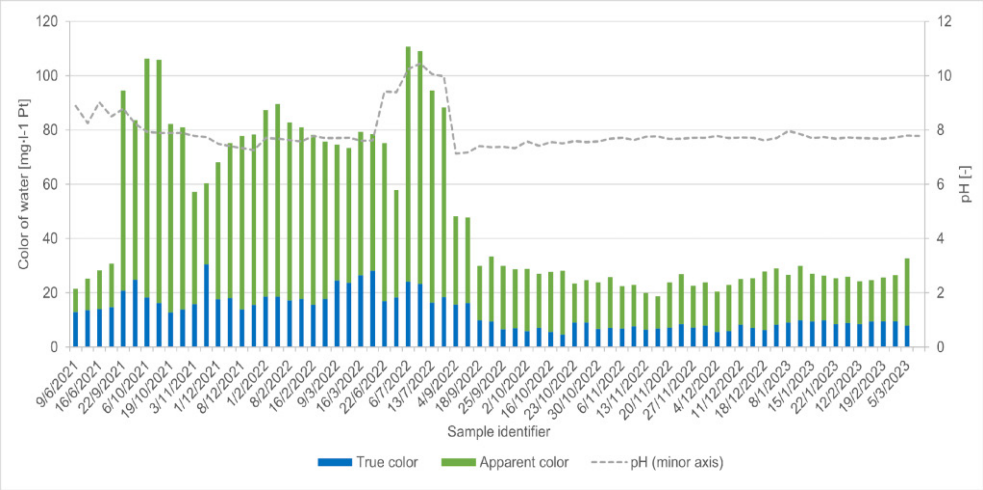

Fig. 1: Overview of apparent and true colour.

3.2 Evaluating the filtering effect when tracking apparent and true colour

In the data, the ratio of the difference between the apparent and true colour relative to the apparent colour was calculated. This ratio is used to monitor the effect of filtration in the determination of water colour.

Due to the wide range of apparent colour values, the investigated dataset was divided into 2 parts according to the water colour value of 40 mg·l^{-1} Pt, which was chosen when considering the histogram of apparent colour values in Fig. 2.

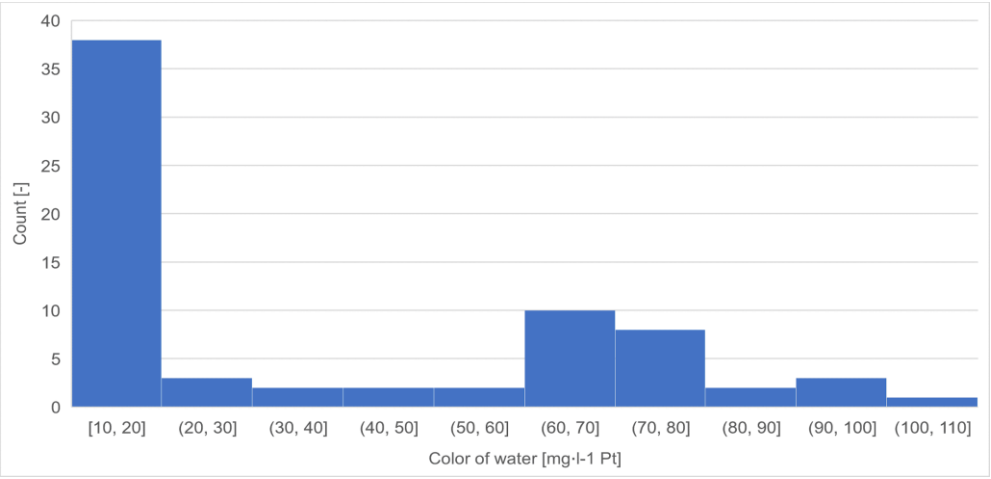

Fig. 2: Histogram of apparent water colour values.

Dividing the measured data according to the value of the apparent colour resulted in 2 groups of 40 measurements in the colour range 10-40 $mg \cdot l^{-1}$ Pt and 30 measurements in the range 41-110 $mg \cdot l^{-1}$ Pt.

The filtering effect ratio is shown in Fig. 3 using a box plot showing the range of the filtering effect. The first observed group of apparent colour value from the range 10-40 $mg \cdot l^{-1}$ Pt shows a percentage reduction in apparent colour of 40-83 %. Typically, the reduction in apparent colour was in the values of 63-72 %. The second observed group achieved a reduction in apparent colour in the range of 49-84 %, with fifty percent of the cases showing a 68-80 % colour reduction effect. The fact of higher colour reduction and therefore the effect of filtering on the colour is higher for the group with higher values of apparent colour.

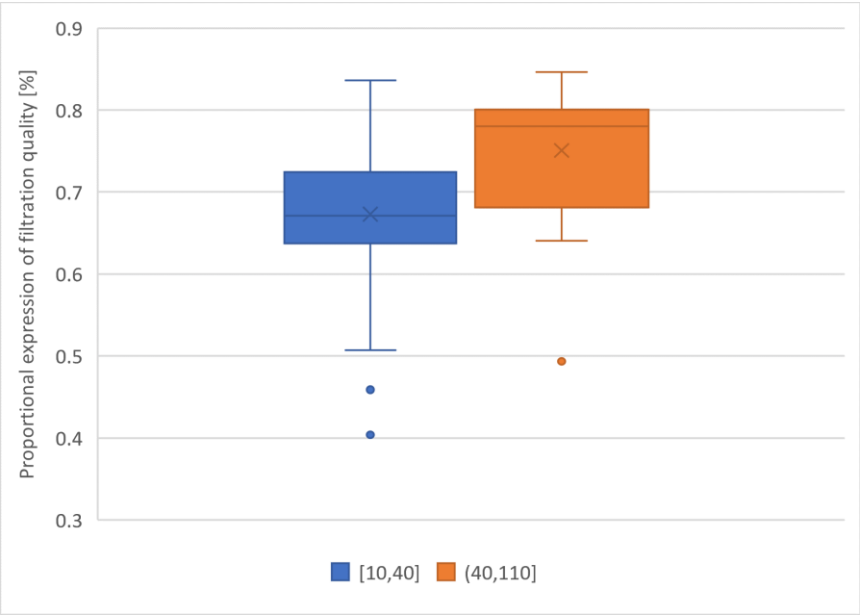

Fig. 3: Range of proportional reduction of water colour by filtration.

Pearson's correlation coefficient was calculated to evaluate the relationship between apparent and true colour. The correlation value of 0.81 indicates a strong linear dependence between the colour values. However, this dependence is not 100%, as confirmed by the dispersed values of the proportional colour reduction described above.

Conclusion

Measurements and analyses of pond water samples were carried out using a spectrophotometer. The results of the study showed that filtration can significantly affect water colour, and a clear difference between apparent and true water colour was observed.

In this study, a ratio was used to express the relationship between apparent and true colour. Due to the observation of the ratio value and correlation coefficient, it was concluded that it was not possible to find a mathematical conversion to express the true colour using the apparent colour. Therefore, it is necessary to make the determination of the true colour according to the standard and it is not possible to omit the filtering step and use only the apparent colour and its conversion.

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