Color

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Pure water is colorless. However color is contributed to natural water by many sources.

SOURCES:

- End products of organic matter degradation are picked up by run-off water.

Decomposition of leaves, woods)

- Algal metabolism such as chlamydomnas excrete yellow substances into the water.
- Divalent species of ions of iron & manganese in both ground & surface water. In surface water these ions may convert to $Fe(OH)_3$ and MnO_2 as a result of oxidation and ultimately precipitated.
- Discharge of untreated & partially treated waste water from textile & drying operation, paper & pulp production, tanneries, food processing, chemical production & slaughter operation may contribute color to the water.

Textile industry ww produces the color

- Highly **colored** wastewater from textile industry
- High concentration of **non-biodegradable organics**, suspended solids, conductivity, turbidity and **intense color**


10%
*of the chemical in textile processing will remain on the fabric……


90%
*will be discharged in textile effluent
(IPPC, 2003)

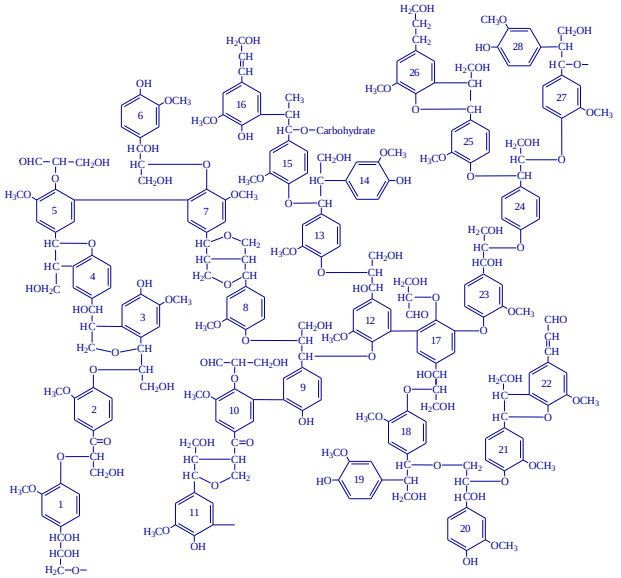
80 -100

***m³ of textile wastewater are generated per ton fabric**

(Savin et al, 2008)

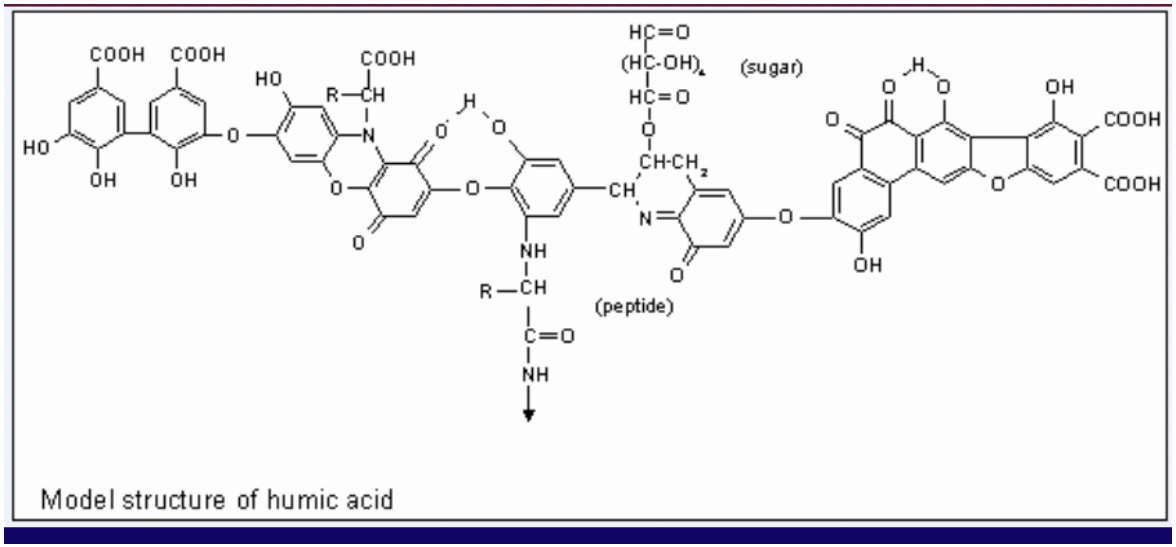
Pulp and Paper industry ww produces color

* Lignin
  * Colored
  * Resistant to biodegradation



Principal color bodies in water sources

* Tannins: ***Tannins*** are a group of phenol compounds found in plants, which create a group of chemicals called "***Polyphenols***"
* Humic acid
* Humates



Model structure of humic acid

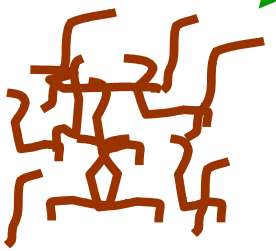
Formation of Humic Materials

Plant Vegetation

Decomposition

Humus
Carbon 68 %
Oxygen 22 %
Hydrogen 6 %

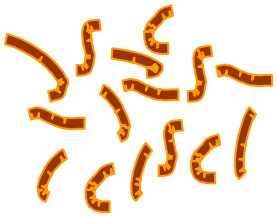
slow



HumicAcids
Carbon 52 %
Oxygen 40 %
Hydrogen 5 %

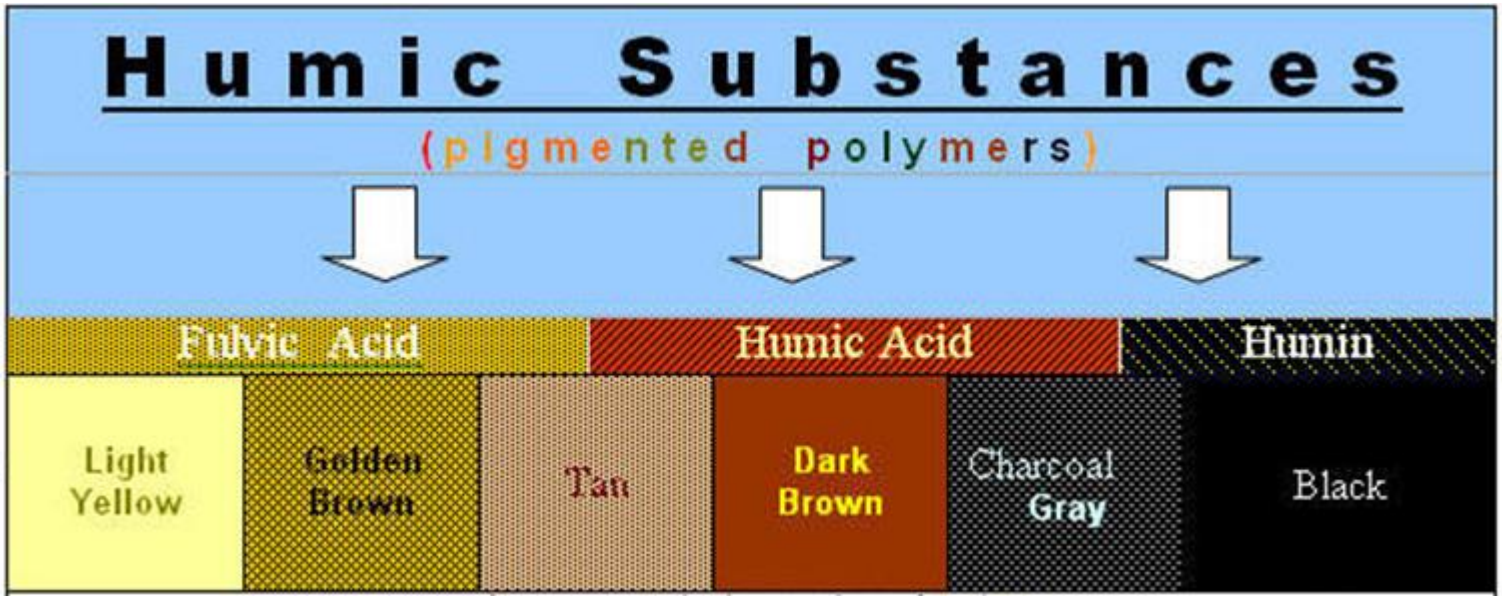
İs not soluble pH<2

slow



Fulvic Acids
Carbon 43 %
Oxygen 50 %
Hydrogen 5 %

soluble at all pH values


Humic Substances
(pigmented polymers)
Fulvic Acid
Humic Acid
Humin
Light Yellow
Golden Brown
Tan
Dark Brown
Charcoal Gray
Black

True vs apparent color

- Color caused by suspended matter is called Apparent color.
- Color caused by dissolved solids that remains after removal of suspended solids is called True color.
- Color intensity is affected by pH value.

Methods of Determination

* Pre-treatment is required to analyze true color
  * Centrifuge?
  * Filtration? ✖
    * ->Adsorption of color onto filter
* Methods:
  * Standard Color Solutions Method
  * Dilution Multiple Method
  * Spectrophotometric method

Standard Color Solutions

Waters containing natural color are yellow-brownish in appearance.

Solutions of potassium chloroplatinate (K_2PtCl_6) tinted with small amounts of cobalt chloride yield colors that are very much like the natural colors. In this method, the color produced by 1 mg/l of platinum (as K_2PtCl_6) and 0.5mg/l of cobalt (as $CoCl_2 \cdot 6H_2O$)is taken as the standard one unit of color.

Standard Color Solutions

* Potassium chloro platinate K_2PtCl_6 tinted with cobalt chloride

  Yellow – brownish color

1 mg/L platinum K_2PtCl_6 → Standard unit of color

Color comparison tubes

Usually, a **stock solution** of K_2PtCl_6 that contains **500mg/l** of platinum is prepared, which has a color of 500 units. Then, a series of working standards may be prepared from it by dilution.

Color-comparison tubes are usually used to contain the standards. A series ranging from 0 to 70 color units is employed and samples with color less than 70 units are tested by direct comparison with the prepared standards.

Dilution multiple method

Color of most domestic and industrial waste-waters are not yellow-brownish hue.

Other systems of measurement have to be used to measure and describe colors that do not fall into this classification.

For dilution multiple method, color is measured by *successive dilutions* of the sample with *color-free water* until the color is no longer detectable comparing with distilled water. The *total dilution multiple* is calculated and used to express the color degree.

Significance and application of color measurement

* Why to measure color?
  * Many people are reluctant to drink colored water
  * Some colored wastes are quite resistant to biologcal attack and persists for great distances after disposed of into natural watercourses

Significance and application of color measurement

* Why to measure color?
  * Color caused by natural organics→ formation of THM when chlorinated

$$NOM + Cl_2 \rightarrow THM$$

  * Many industrial processes require the use of color-free water. Removal of color is expensive.

Regulation of color

* USEPA: 15 Pt-Co
* WHO: 15 Pt-Co
* TS: 20 Pt-Co units