Waughter

AKTION CONSULTANCY

Volume 1 : Edition 2 - The Chemistry of Water

Dear Water Warriors,

Everything comes at a price sans **Waughter** that is actually priceless.

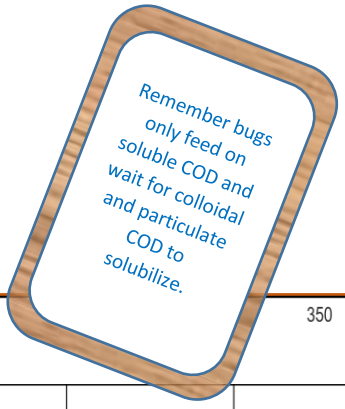
Mr Sanjay Mehta – Director of Pure Water Enterprises Pvt Ltd came forward to support us to cover it's cost for full 1 year i.e., 12 editions.

Team Aktion thanks this gesture and hope for a larger reader base and far-reaching coverage.

Sanjeev Srivastava

When you read a water analysis report, we talk of Turbidity, TSS, Colour. COD etc. The 2nd edition covers some interesting insights on these simple words that most of us understand. Let's detail on:

- What is COD? Are there different types?
- Textile segment wastes significant water; mainly coloured. Let's differentiate colour, dye & pigment
- TSS Vs Turbidity – are they same?
- ..



Chemical Oxygen Demand – COD mg/l

Remember $CaCO_3$ of last edition. That was the common unit to measure Inorganic impurities. COD is nothing but the common unit to measure pollution potential of organic impurities.

Let's find out how much COD is constituted by 1 ppm of Ethanol.

$C_2H_6O + 3O_2 \rightarrow 2CO_2 + 3H_2O$

Molecular Weight of C_2H_6O = 46 g/mol
Molecular Weight of O_2 = 32 g/mol

Oxygen required to oxidize Ethanol = 3*32 ÷ 46

Hence, COD of 1 ppm Ethanol = 2.09 mg/l

"COD is used to measure the oxygen equivalent of the organic material in wastewater that can be oxidized chemically using dichromate in an acid solution". Thus, giving us an indirect measurement of the amount of organic matter in a sample.

pCOD – Particulate, bsCOD – Biological Soluble rbCOD – Readily Biodegradable, nbCOD – Non-Biodegradable fraction etc. are thus immense importance.

Total COD									350
Fractionation by	Particle size	Suspended			200	Collodial	65	Soluble	85
	Biodegradability	Inert 50	Biomass 70	Slowly biodegradable 80		Inert 10	Easily bio-degradable 55	Inert 10	Directly bio-degradable 75

Image 1.1 : COD Break Up – Size & Bio-degradability

COD measurement is done by using a strong chemical oxidant - ***Potassium Dichromate $K_2Cr_2O_7$***

Organic matter + Oxidant ($Cr_2O_7^{2-}$) + Acid (H^+) + Heat
$\rightarrow CO_2 + H_2O + NH_4^+ + Cr^{3+}$

Upon oxidation of C of Organics, Chromium is reduced from its hexavalent to trivalent form thereby changing its color from bright orange to dull green. ***$Cr^{+6} \rightarrow Cr^{+3}$***

One can use Titrimetric or Calorimetric method to determine COD. Important NH4 is kept in reduced form. COHNS will be referred as Organic matter in future.

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Have you ever heard of plastic in the belly of a fish?

That's exactly what happens when there are nbCOD available in effluent.

All kinds of pollution are removed by the end of secondary biological treatment **BUT**

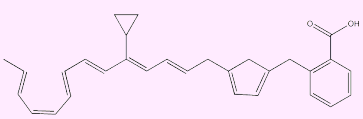
Unfortunately, nbCOD cannot be eaten by bugs!!

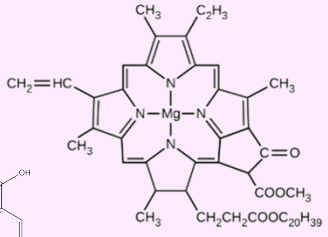
Hence, nbCOD is the current challenge for the humanity as they require more energy for degradation and thus an advanced treatment for its removal.

Well it's time to start worrying about nbCOD if you have any of these substance in your production process or effluent:

Category	Example
PAH (Polycyclic Aromatic Hydrocarbons)	2-Vinylnaphthalene, Naphthalene
Sequestering agents	EDTA
Dyes	Complex Organics
Pesticides	Dimethoate, Triazophos
Pharmaceuticals	Paracetamol
Detergent	Alkyl Benzene Sulfonate
Nitro-aromatics	Trinitrotoluene, PAI's
Solvents	Low M. Wt Alcohols & Ketones
Phenolic compounds	Benzoic & cinnamic acid.
Humic-like compounds	Herbicides
Halogenated aliphatic compounds	Chloroform
Xenobiotic pollutants	polychlorinated biphenyls (PCBs)
Naturally occurring	Lignin and Cellulosic compounds

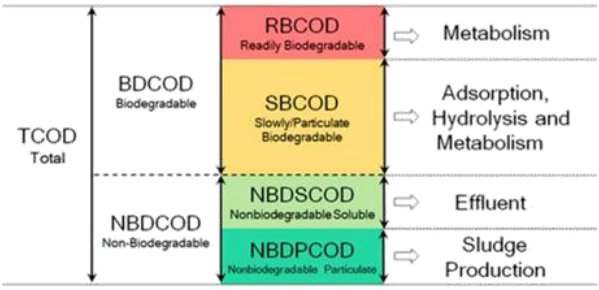
Want to tell more ? Look at them





So how do we treat the nbCOD when it consists of such wide variety of compounds?

Naturally first we understand pic below and try to reach nbdsCOD.



And then we apply our knowledge of Chemistry to understand the properties of the nbdsCOD available such as

- Absorptivity
- pH
- Toxicity
- Polarity
- Size
- Types of reactions it undergoes
- Its redox reactivity
- Conductance (post oxidation)
- Ionic properties
- Types of bonds
- Its volatility
- Etc.

Once we have gathered and analyse all the above properties, we can choose the most appropriate technology for your nbdsCOD !!

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All dyes are coloured but all *colors* are not dyes

Answer of this question can be explained from defintion of color. In our world, when we speak of colors we generally specify the color of objects: “the apple is red”, “the leaves are green”. In physcis, color is associated with light- wavelength to be precise.

Whatever color we say is because that color is perceived by our eyes. We can only see a color that lies in wavelength 400-700 nm.

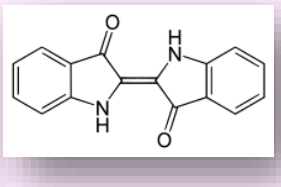
This wavelength also known as “Visible Range”

VIBGYOR

Dyes are one of the ways to produce colour. They are aromatic or heteroaromatic organic molecules, which exhibit colour because of following:

1. They absorb and emit light in visible region(400-700nm)
2. Have chromophore (which is responsible for colour)
3. Have a conjugated system (double and single bonds alternatively),
4. Exhibit resonance of electrons.

Below, we can see Jeans dyed with *Indigo* (naturally and synthetically produced well known colour compound) and its structure.



Dyes have the affinity for applied substrate (wool, silk, cotton, polyamide, leather…). It is known as “substantivity”. They form covalent or physical bonds or both bonds with substrates. So, they can’t washout easily from substrate.

Now on the basis of above concept we can differentiate between dyes and color.

Think if red wine spills on your white shirt what will happen? The shirt will no longer be white. The Red Color in Red wine is because some material named R

Consider your shirt material is cotton. Cotton has a material called **C** and if it can bond with R, we will have a stain on shirt that will appear R♡C

If a detergent, D is applied, that is able to break the bond 💔 we are able to split R and C, thus making cotton white again.

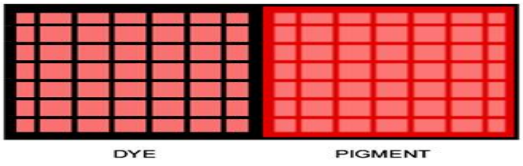
So, the color R in red wine is a color, not a dye.

What if it’s a Dye. The answer hangs in form of the Green Cotton Sari. Here a chemical that appears Green G is bonded with cotton.

G♡C, the bond formation is permanent, and D can not 💔

Pigments usually have special properties that make them ideal for coloring other materials. Colorants are either dyes or pigments. The difference is that:

1. Dyes are soluble in the host material : typically water, while pigments are not.
2. Dyes do not scatter light and look transparent. On the other hand, pigments do scatter light and, thus, they are opaque.
3. Another difference between dyes and pigments is that dyes are absorbed by the colored substrate and pigments need a binding agent in order to adhere to the surface.



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Nidhi Jain
our youngest engineer on board shall add Civil Engineering competence to our team and has contributed to, this magazine with below note on TSS & Turbidity;

We wish her good luck!!

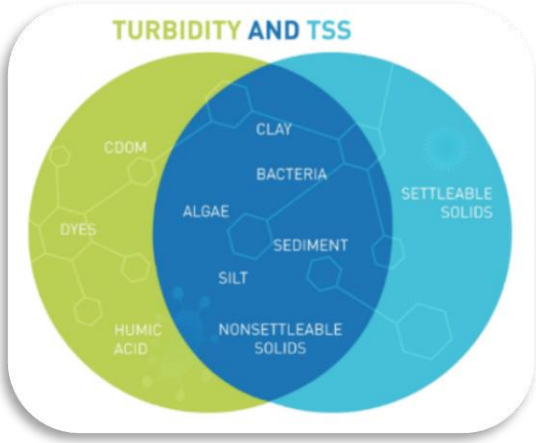
TSS Vs Turbidity – are they same?

TSS is matter of Biological, Inorganic or Organic origin present in water but out of Inter Molecular Space (IMS). The unit is mg/l.

Turbidity is an optical determination of water clarity. Its unit is NTU. Turbid water will appear cloudy, murky, or otherwise coloured, affecting the physical look of the water.

If 100 mg chalk is suspended in 1 litre of water, the TSS will be 100 mg/l and turbidity will be say ~ 70 NTU. But if chalk is grinded into very fine particles, TSS remains still 100 mg/l but Turbidity increases to ~ 120 NTU.

The picture below further suggests these are two different things often misunderstood as same.



जल जीवन जननी !!

Our world is Waughter

The technical knowledge share attempt of Aktion Consultancy and the contents in the magazine shall be qualified by Sanjeev Srivastava our Technology Lead.

Our next edition focuses on Microbiology: Bugs & More

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