Topic: Antioxidants
Subject: General Chemistry
Class: F.Y. B. Pharm. (Sem.- I)
Academic Year: 2018-19
Programme: 2018-2022

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Mapping of TLO with Course outcomes (Cos)

Sr. No.	Topic Learning Outcomes	COs	BL
1	Explain theory and principle of Antioxidants and study official antioxidants.	CO4	L2

Antioxidants

"Agents which inhibit oxidation other molecules."

e.g. Hypophosphorus acid, Sodium bisulfite, Sodium nitrite etc

Oxidation is a chemical reaction that can produce free radicals, leading to chain reactions that may damage cells.

Antioxidants terminate these chain reactions.

Antioxidants

- Agents which prevents atmospheric oxidation. They have the capability of functioning chemically as reducing agents.

- Are added to pharmaceutical preparations containing easily oxidizable substances.

- To prevent oxidation and subsequent deterioration of the formulation.

Mechanism of antioxidant action

- Chemically they are reducing agents which prevent oxidation of other species by either

  -by getting oxidised themselves in place of active component as they under go oxidation more readily than the active component OR

  -by **reducing the already oxidized active component back** to the normal oxidation state.
- Action is based upon **oxidation-reduction (Redox)** reaction in which the antioxidant itself gets oxidized.

e.g.

Ox_A is the oxidised form of compound A Red_A is the reduced form of compound B then the half reaction can be written as,

$$Ox_A + e^- \longrightarrow Red_A$$

$$Red_B \longleftarrow Ox_B + e^-$$

The overall redox reaction can be given by

$$Ox_A + Red_B \rightleftharpoons Red_A + Ox_B$$

Selection Criteria of Antioxidants

1. Able to produce desired **redox reaction**, when used in pharmaceutical preparations.
2. Chemically **compatible**.
3. **Physiologically inert**.
4. **Non-toxic** both in the reduced and oxidized forms.
5. It should **not** create any solubility problem for various components of the formulation.
6. **Effective** in low concentration and should provide prolonged stability to the formulation.

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Official Inorganic Antioxidants

- ☑ Hypophosphorous acid
- ☑ Sodium Bisulfite
- ☑ Sodium Metabisulfite
- ☑ Sodium Nitrite
- ☑ Nitrogen

Sodium Metabisulfite I.P.

$Na_2S_2O_5$

Mol.Wt. 190.10

White crystal or white to yellowish crystalline powder having the odor of sulfur dioxide. It should contain an amount of sodium matabisulfite ($Na_2S_2O_5$) equivalent to not less than 66.0% and not more than 67.4% of SO_2.

It is a strong reducing agent and like sulfur dioxide contains S in the +4 oxidation state.

Exclusively used as an antioxidant in solutions of drugs that contain the **phenol or catechol nucleus** (e.g., phenylephrine hydrochloride and epinephrine hydrochloride solutions) to prevent oxidation of these compounds to **quinones or like substances**.

It is also used as a reducing agent in **ascorbic acid injection.**

Hypophosphorous acid (HPH_2O_2; Mol.Wt. 66.00)

☑It is a colorless or slightly yellow, odorless liquid containing not less than 30.0% and not more than 32.0% HPH_2O_2.

☑The oxidation state of the central phosphorous atom is +1, making the compound a very powerful reducing agent.

☑ It can function in dilute solution as a very effective reducing agent or antioxidant.

Uses

☑It serves to prevent the formation of free iodine in *Diluted Hydriodic Acid* and *Hydriodic Acid Syrup*.

☑ It is also present in *Ferrous Iodide Syrup* where it prevents the formation of both ferric ions and molecular iodine.

☑ The concentration ranges for hypophosphorous acid and its salts when used as antioxidants are never over 1%, and usually between 0.5 and 1%.

Sodium Bisulfite ($NaHSO_3$; MW.: 104.06)

- ☑ It is white or yellowish white crystals.
- ☑ It is a strong reducing agent and like sulfur dioxide contains sulfur in the +4 oxidation state.
- ☑ It is exclusively used as an antioxidant in solutions of drugs that contain the phenol or catechol nucleus (e.g., phenylephrine hydrochloride and epinephrine hydrochloride solutions) to prevent oxidation of these compounds to quinones or like substances.
- ☑ It is also used as a reducing agent in ascorbic acid injection.

Sodium nitrite ($NaNO_2$); MW: 69.0

- **Sodium nitrite** is the inorganic compound with the chemical formula $NaNO_2$.
- It is a white to slightly yellowish crystalline powder that is very soluble in water and is hygroscopic.
- It is a useful precursor to a variety of organic compounds, such as pharmaceuticals, dyes, and pesticides.
- Used as antioxidant in 0.1% concentration.

Nitrogen (N_2)

Mol wt 28

It is colourless, odourless, tasteless gas. Non flammable, non poisonous.

Slightly soluble in water

Slightly lighter than air.

Uses: It's inert gas so can be used to protect chemical, drugs, pharmaceuticals e.g. Vit, oil (Cod liver, shark liver, castor and olive oil) from air oxidation by displacing air from container.

Addition of such agents must be declared on label.

Storage: Under compression in metal cylinder (Grey color with black nek and shoulder).

References

- Inorganic medicinal and pharmaceutical chemistry, J.H. Block, E.B. Roche, T.O. Soine and C.O. Wilson. Lea & Febiger, Philadelphia, PA, 1986, Page no.: 146-157.
- A Hand Book of Inorganic Pharmaceutical Chemistry, Dr. K.G. Bothara, Nirali Prakashan, 2007, Page no.: 10.1-10.6.

Review questions to ensure attainment of TLOs/ COs

Sr. No.	Review questions	COs with Bloom's Level
1	Explain theory and principle of Antioxidants with official antioxidants.	CO4 (L2)
2	What are antioxidants? Explain with suitable examples	CO4 (L2)


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Thank You