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TOPICAL AGENTS

Definition : Topical agents are the compound which are act locally on the body surface like skin and mucous membrane.

- They act mainly by physical and mechanical manners.
- Topical application of these drugs may extend to such body cavities that are open to the out side which includes oral, vaginal and colonic cavities.
- Topical agents may produce variety of effects such as adsorbent, astringent, demulcent, emollient and protective.
- Some topical agents may exhibit antimicrobial activity.

Categories of Topical Agents

Topical agents are categorized according to mechanism of action:

1) **Protectives:** They are the substances which are tend to form a coating and protect the expose skin or mucous membrane from harmful stimuli.

- They should be chemically as well as biologically inert**.**
- Example like, dusting powders like Zinc stearate, Zinc oxide, Purified Talc.

2) **Adsorbents and demulcents:** These are the substance similar to protective but they are exert their surface action due to its chemical properties.

- They adsorb moisture from the skin surfaces which help to decrease mechanical friction and irritation.
- Adsorbents and demulcents having small particle size which offers a large surface area and adhere better to the surface of the skin,
- The protectives and adsorbents activities increases as particle size get decreases.

3) **Emollients:** They are the fatty substances like waxes and vegetable oils which are topically applied to the skin and mucous membrane

4) **Astringents:** They are the substances that brings about protein precipitation.

- They are having low cell permeability therefore the action is essentially limited to the cell surface and interstitial spaces.
- Example like Alum, Aluminium citrate, Calamine, Zinc oxide and Zinc sulphate

5) **Caustics:** They are the substances which are able to induce the destruction of tissue at the site of application,

- They are find use to destroy warts, moles and hyperplastic tissues
- Example like Potassium hydroxide and Silver nitrate etc.

PROTECTIVES

- Protectives are substances applied to protect area of skin which are subject to constant irritation due to moisture and / or friction , or areas that have become irritated or inflamed due to friction, allergy, and the like.
- Many protectives are also adsorbents that adsorb moisture from the surface of the skin.
- Protectives are not applied to the areas that are abraded and exuding fluid as the likelihood of systemic absorption is enhanced and they may mix with the exudates and form protective layer on the surface of the skint, which adheres to the open tissue.
- The protective action is maximized with small particle size because a fine state of subdivision of particles possesses good adhering properties, enhances the soothing effect and minimize irritation.
- Protectives generally marketed in the form of dusting powders, suspensions or ointments.
- Topical inorganic protectives include formulations containing talc, zinc oxide, calamine, zinc stearate, basic aluminum carbonate, and titanium oxide.
- The compounds of substances most suitable as protectives have the following properties:
    1) They are insoluble hence it minimize systemic absorption.
    2) They are chemically inert to prevent interaction with the tissue.

Some of the important examples and there detailed explanation of inorganic protectives as per IP' 2007 :

1) <u>Purified Talc:</u>

Chemical formula: $Mg_6 (Si_2O_5)(OH)_4$

- Talc is powdered, selected natural hydrated magnesium silicate. It may contain varying amounts of aluminium and iron forms insoluble in 1M sulphuric acid.
- In nature , it occurs as soap stone or French chalk.
- It is the sofest mineral and having more free flow property than kaolin.

Properties:

Physical properties:

Colour: very fine, White or greyish white powder
Odor: Odorless
Taste : Tasteless
Solubility: practically insoluble in water, in alcohol and in dilute solutions of acids and alkali hydroxides.

- It is free from grittiness, readily adhere to skin; unctuous to the touch.

Chemical properties:

- Its solution is neutral to litmus .
- When heated strongly about 850 - 960 ^{o}C, it looses water and gets converted to $Mg_4 SiO_{12}$.

Identification Test:

1) When a fine powder examined microscopically, shows irregular plates, the majority less than 50 µm in length. The particle are not notably stained by a 0.1 % w/v solution of methylene blue in ethanol (95%).
2) Melt 0.5gm of purified talc in a metal crucible with 1gm of potassium nitrate and 3gm of anhydrous sodium carbonate, add 20ml of boiling water and filter. To the filtrate add 1ml of 9M ammonia and 1ml of ammonium chloride solution and filter. To the filtrate add 1ml of disodium hydrogen phosphate solution; a white crystalline precipitate is produced.
3) These test is specific for the presence of silicates. In this test a lead or platinum crucible mix by means of a copper wire to obtain a thin slurry the prescribe quantity of the purified talc with 10mg of sodium fluoride and a few drops of sulphuric acid. Cover the crucible with a thin transparent plate of plastic under which a drop of water is suspended and warm gently; within a short time a white ring is formed around the drop of water.

Test for purity:

It is tested for acid soluble substances, phosphate, water soluble substances , water soluble iron salts, carbonates and loss on drying. as per IP'2007.

Storage Condition:

- it is stored in a well closed containers

Uses:

- It finds use as a dusting powder in a cosmetic preparation.
- It is generally used along with ZnO, Starch and small amounts of boric acid.
- It is also used as a filtering media for clarifying liquids and as a distributing medium for elixirs.
- It is used as a lubricant for tablet granules.

2) Calamine:

Synonym:

Prepared calamine

- Calamine is zinc oxide having small amount of ferric oxide.
- Calamine contains not less than 98.0 per cent and not more than 100.5 per cent of ZnO, calculated with reference to the ignited substance

Preparation:

On commercial scale, zinc oxide needed for calamine is obtained by heating native zinc carbonate. The calamine is prepared by thoroughly mixing of zinc oxide with ferric oxide.

$$ZnCO_0 \xrightarrow{\Delta} Zno + Co_2$$

Properties:

Physical properties:

Colour: Fine, amorphous, impalpable, pink or reddish-brown powder

Odour: Odourless

Taste: Tasteless

Solubility: Insoluble in *water*. Practically completely soluble in mineral acids.

Identification Test:

1)To 1 g of calamine add 10 ml of dilute hydrochloric acid, heat to boiling and filter. To the filtrate add a few drops of ammonium thiocynate solution; a reddish colour is produced.

2)Shake 1 g calamine with 10 ml of dilute hydrochloric acid and filter; the filtrate add 0.2ml of sodium hydroxide solution ; a white precipitate is produced. Add further 2ml of sodium hydroxide solution; the precipitate; the precipitate is dissolves. Add 10ml of ammonium chloride solution remains clear. Add 0.1ml of sodium sulphide solution; a flocculent, white precipitate is produced.

3)Dissolve 0.1gm of calamine in 5ml of water . Acidify it with dilute sulphuric acid and add one drop of a0.1 % w/v solution of cupric sulphate and 2ml of ammonium mercurithiocyanate solution; a violet precipitate is formed

4)Dissolve 0.1gm of calamine in 5ml of water. Add 2ml of potassium ferrocyanide solution; a white precipitate is produced which is insoluble in dilute hydrochloric acid.

Test for purity:

- It is tested for the substances such as acid insoluble substances, alkaline substances, arsenic, calcium, magnesium, lead and loss on ignition as per IP' 2007.

Assay:

Weigh accurately about 1.5 g calamine and digest with 50 ml of 0.5M sulphuric acid, applying gentle heat until no further solution occurs. Filter and wash the residue with hot water until the last washing is neutral to litmus paper. To the combined filtrate and washings, add 2.5 g of ammonium chloride, cool and titrate with 1M sodium hydroxide using methyl orange solution as indicator.

Ammonium chloride is added to disallow precipitation of zinc hydroxide during the titration because precipitation of zinc hydroxide causes poor end point.

Factor

Each ml of 0.5M sulphuric acid is equivalent to 0.04068 g of ZnO.

Storage condition:

Store in well-closed containers

Uses:

- It is find use as a mild astringent, antiseptic and protectant for the skin.
- It is having a soothing effect in eczema.
- It is used for soothing purposes in ointments and lotions for sun burns.

3) Calamine lotion:

Synonym:

Calam. Lot.

Composition of calamine lotion:

Ingredients	Quantity
Calamine	150gm
Zinc oxide	50gm
Bentonite	30gm
Sodium Citrate	5gm
Liquefied Phenol	5ml
Glycerin	50ml
Purified Water, freshly boiled and cooled sufficient to produce	1000ml

- Triturate the Calamine, the Zinc Oxide and the Bentonite with a solution of the Sodium Citrate in about 700 ml of Purified Water and add the Liquefied Phenol, the Glycerin and sufficient Purified Water to produce 1000 ml.

Storage condition:

Store in well-closed containers in a cool place. Do not freeze.

Uses:

- It find use as a skin protective in sun burn. It has a soothing effect.
- The liquefied phenol provides a local anesthetic and antipruritic (anti itching effect) action apart from antiseptic .
- Other product of calamine is : Aqueous calamine cream, calamine ointment

4) Zinc Oxide:

Chemical formula: ZnO

Molecular weight: 81.38

Zinc Oxide contains not less than 99.0 per cent and not more than 100.5 per cent of ZnO, calculated with reference to the ignited substance.

Preparation:

1) On large scale, ZnO is obtained by heating a metallic zinc in current of air to a high temparature. The metal vapour burns to form the oxide which is collected as a fine white powder. Zinc oxide is obtained by this method is not pure.

$$2Zn + O_2 \longrightarrow 2ZnO$$

2) The medicinal grade of ZnO is obtained from zinc sulphate. A solution of zinc sulphate is added to a boiling solution of sodium carbonate. The precipitate of zinc carbonate is collected which is washed until it becomes free from sulphate.

- Now it is dried and ignited which leads to losses of CO_2 and water and leaving zinc oxide.

$$ZnSO_4 + Na_2CO_3 \longrightarrow ZnCO_3 + Na_2SO_4$$
$$ZnCO_3 \longrightarrow ZnO + CO_2$$

Properties:

Physical properties:

Colour: Soft, white or faintly yellowish white amorphous powder, free from grittiness. It gradually absorbs carbon dioxide from air.:

Odour: Odourless

Tate: Tasteless

Solubility: Practically insoluble in water and in ethanol (95%). It dissolves in dilute mineral acids.

Chemical properties:

Zinc oxide is amphoteric in nature, it is soluble in solution of alkali hydroxide and in dilute mineral acids.

$$ZnO + H_2SO_4 \longrightarrow ZnSO_4$$

$$ZnO + 2NaOH \longrightarrow Na_2ZnO_2 + H_2O$$

Identification Test:

1) It becomes yellow when strongly heated; the yellow colour disappears on cooling.
2) Dissolve 0.1 g of zinc oxide in 1.5 ml of 2M hydrochloric acid and dilute to 5 ml with water. add 0.2ml of sodium hydroxide solution ; a white precipitate is produced. Add further 2ml of sodium hydroxide solution; the precipitate; the precipitate is dissolves. Add 10ml of ammonium chloride solution remains clear. Add 0.1ml of sodium sulphide solution; a flocculent, white precipitate is produced.
3) Dissolve 0.1gm of zinc oxide in 5ml of water . Acidify it with dilute sulphuric acid and add one drop of a0.1 % w/v solution of cupric sulphate and 2ml of ammonium mercurithiocyanate solution; a violet precipitate is formed
4) Dissolve 0.1gm of zinc oxide in 5ml of water. Add 2ml of potassium ferrocyanide solution; a white precipitate is produced which is insoluble in dilute hydrochloric acid.

Test for Purity:

- It has to be tested for alkalinity, carbonate and substances insoluble in acids, arsenic, iron, metallic zinc and loss on drying as per IP’ 2007.

Assay:

An accurately weight amount of sample is to dissolve in 50ml of 1N sulphuric acid. To it add 2.5gm of ammonium chloride is added and the excess of acid is titrated with 1N NaOH using methyl orange as an indicator.

Factor:

Each ml of 1N H2SO4 equivalent to 0.04096gm of ZNO

Principle of Assay:

It is based on acidimetric back titration method. Zinc oxide is a base, it is insoluble ion water and therefore it can not be directly titrated with acid so it is dissolve excess of standard acid and the acid is back titrated with standard sodium hydroxide using methyl orange as an indicator. Ammonium chloride is used in titration to prevent the precipitation of zinc hydroxide because gelatinous white precipitate of zinc hydroxide interferes in detection of end point hence it gives a poor end point.

Uses:

- It is act as a mild antiseptic and an astringent.
- It is widely used in the treatment of skin disease like eczema, ringworm, varicose ulcer, and psoriasis.
- It is also used in the manufacture of adhesive tapes and bandages.
- Dentists use it as a dental cement and for temporary fillings.

Formulation of zinc oxide available in market:

Zinc oxide compound paste, Hydrous zinc oxide ointment, Zinc oxide ointment, Zinc gelatin.

5) Zinc stearate:

Chemical formula: $(C_{17}H_{35}COO)_2Zn$

Molecular weight: 632.34

- Zinc Stearate consists mainly of zinc stearate but many contain variable proportions of zinc palmitate, $(C_{15}H_{31}COO)_2Zn$, and zinc oleate, $(C_{17}H_{33}COO)_2Zn$.
- Zinc Stearate contains not less than 10.0 per cent and not more than 12.0 per cent of zinc, Zn.

Preparation:

Zinc stearate is obtained by adding zinc sulphate solution to a solution of sodium stearate and washing the precipitate with water until it gets free from sulphate.

Stearic acid is obtained by the hydrolysis of fats which is used for preparing sodium stearate which always contain different proportion of palmitic acid.

Preparation of zinc stearate involves the following steps:

1) Sodium stearate is obtained by adding gradually with constant mixing of calculated quantity of stearic acid to a hot solution of sodium hydroxide or sodium carbonate.

$$NaOH + \underset{\text{Stearic acid}}{C_{17}H_{35}COOH} \longrightarrow C_{17}H_{35}COONa + H_2O$$

$$Na_2CO_3 + 2\,C_{17}H_{35}COOH \longrightarrow 2C_{17}H_{35}COONa + H_2O + CO_2$$

2) The solution of sodium stearate is allowed to cool and a solution of zinc sulphate is added to it. The precipitates of zinc stearate is collected, washed with water until free from sulphate and dried.

$$\underset{\text{Sodium stearate}}{2\,C_{17}H_{35}COONa} + \underset{\text{Zinc sulphate}}{ZnSO_4} \longrightarrow \underset{\text{Zinc stearate}}{(C_{17}H_{35}COO)_2\,Zn} + \underset{\text{Sodium sulphate}}{Na_2SO_4}$$

Properties:

Physical properties:

Colour: Fine, white, bulky, amorphous powder, free from grittiness

Odour: faint and characteristic

Taste: Tasteless

Solubility: Practically insoluble in water, in ethanol (95%) and in ether.

Chemical properties:

- It is neutral to moistened litmus paper.
- When exposed to air, it slowly absorb carbon dioxide from the air.

Identification Test:

1) To 5.0 g add 50 ml of ether and 40 ml of a 7.5% v/v solution of nitric acid in distilled water and heat under a reflux condenser until dissolution is complete. Allow to cool, separate the aqueous layer and shake the ether layer with two quantities, each of 4 ml, of distilled water. Combine the washings with the aqueous layer, wash with 15 ml of ether and heat on a water-bath until ether is completely eliminated. Allow to cool and dilute to 50.0 ml with distilled water (solution A). Evaporate the ether layer to dryness and dry the residue at 105^o. The freezing point of the residue is not lower than 53^o.
2) Neutralise 5 ml of solution A to red litmus paper with 10M sodium hydroxide. The solution gives the reactions of zinc salts mentioned in above calamine identification test no. (2), (3) and (4).

Test fro purity:

It has to be tested for acidity or alkalinity, colour of solution, alkalis and alkaline earths, heavy metal, arsenic, chloride , sulphate as per IP' 2007.

Assay:

Weigh accurately about 1 g and boil with 50 ml of 1N sulphuric acid until the fatty acid layer which separates is clear, adding more water if necessary to maintain the original volume. Cool, filter and wash the filter and the flask thoroughly with water until the last washing is not acidic to blue litmus paper. To the combined filtrate and washings, add strong ammonia- ammonium chloride solution and also add 0.2ml of eriochrome black T solution as indicator, the resulting solution is heated to about 40^o and is titrated with 0.05M disodium edetate until deep blue colour appear.

Factor:

Each ml of 0.05M EDTA equivalent to 0.004069gm of ZnO

Principle of assay:

The assay is based on acidimetric back titration method and also assayed by complexometric titration.. Zinc forms a complex with disodium EDTA. Ammonia – ammonium chloride is used as a buffer to adjust the pH 10 so that the complex will remain stable.

Uses:

- It is act as mild astringent and has antimicrobial properties.
- It finds use in dermatology for its protective properties and dusting powder.
- It is used as lubricant in tableting.

6) Titanium Dioxide:

Chemical formula: TiO_2

Molecular weight: 79.88

Titanium Dioxide contains not less than 98.0 per cent and not more than 100.5 per cent of TiO_2.

Preparation:

It is obtained from natural samples of ilmenite or from rutile. The ore is heated with concentrated sulphuric acid when sulphate of iron and titanium are dissolved in water. The precipitate of titanium dioxide is obtained.

Properties:

Physical properties:

Colour: White or almost white, infusible powder

Odour: Odourless

Taste: Tasteless

Solubility: Practically insoluble in water and in dilute mineral acids, slowly soluble in hot sulphuric acid.

Chemical Properties:

The precipitates of titanium dioxide is obtained by hydrolysis.

Identification Test:

1) When strongly heated it becomes pale yellow; the colour is discharged on cooling.
2) To 0.5 g add 5 g of anhydrous sodium sulphate and 10 ml of water and mix. Add 10 ml of sulphuric acid and boil gently until clear; cool, add slowly 30 ml of a 25% v/v solution of sulphuric acid and dilute with water to 100 ml (solution A). To 5 ml of solution A add 0.1 ml of strong hydrogen peroxide solution; an orange-red colour is produced.
3) To 5 ml of solution A add 0.5 g of zinc, in granules; after 45 minutes a violet-blue colour is produced.

Test for purity:

It has to be tested for clarity and colour of solution, acidity or alkalinity, water soluble substance, arsenic, barium, heavy metal and iron as per IP'2007.

Assay:

It is assayed by complexometric sodium edetate back titration method. Accurately weighed sample is dissolved by heating in a mixture of 20ml of sulphuric acid and 8gm of ammonium sulphate. Carefully dilute the solution to 100ml with water. Boil this solution with continuous stirring. After cooling to room temperature, filter it. Wash the residue with 10ml of water several times. Add 10ml of strong ammonia solution to the combined filtrate and washings and dilute to 200ml with water. To 50ml of resulting solution, add 100ml of water and 4ml of strong hydrogen peroxide solution. After addition of 50ml of 0.05M disodium EDTA, allow to stand for 5 minutes. Adjust the pH of the solution to 5 with sodium hydroxide solution and add 5gm of hexamine. Titrate the resulting solution with 0.05M Zinc chloride using xylenol orange solution as an indicator.

Factor:

Each ml of 0.05M disodium edetate is equivalent to 0.003995gm of TiO_2

Storage condition:

Store in well-closed containers. Avoid contact with aluminium.

Uses:

It is a good topical protective and the protective action is due to opacity of compound.

It protect the skin from harmful ultraviolet radiation so it is commonly employed in skin protective creams, paste etc.

ASTRINGENTS

- Astringents are the compounds that brings protein precipitation. This action may be on mucosal membrane when taken internally or on the skin for topical use.
- Astringent when applied topically, cause precipitate of protein on the surface of cell by coagulation. The action depends upon extent of penetration of agent and the type of chemical action resulting with protein.
- It reduces the cell permeability and inhibit the trans capillary movement of plasma proteins. Which help to reduce local edema, exudation and inflammation. Astringent in low concentration are found to stimulate the growth of new tissue while high concentration astringent cause corresponding effect on contact with tissue.
- The protein precipitation caused by astringent due to the presence of metallic ions having large charge or strong electrostatic fields. The metal forms complex with various polar groups present on the protein.
- Astringent have a variety of uses which include:--

1) To treat diarrhoea.
2) To arrest hemorrhage by coagulation of the blood.
3) To reduce inflammation of the mucous membrane.
4) To decrease sweating and to make skin tougher.
5) To promote healing process.
6) Astringent also possess deodorant properties.

Some of the important examples and there detailed explanation of inorganic protectives as per IP' 2007 :

1) Alum:

Chemical formula: $KA\,l(SO_4)_2 . 12H_2O$

Molecular weight: 474.4

Alum is potassium aluminium sulphate.

Preparation:

It is obtained by adding concentration solution of K_2SO_4 to a hot solution of equimolecular proportion of aluminium sulphate. When the solution is concentrated and cooled, characteristic octahedral crystals separate out.

$$K_2SO_4 + Al_2(SO_4)_3 + 24H_2O \rightarrow KA\,l(SO_4)_2 . 12H_2O$$

Properties:

Physical properties:

Colour: Colourless, transparent or granular crystal
Odour: Odourless
Taste: Sweet astringent
Solubility: Soluble in water but insoluble in alcohol

Identification Test:

It gives characteristic test for aluminium, potassium and sulphate as per IP' 2007.

Test for Purity:

It has to be tested for arsenic, heavy metals, iron and zinc as per IP' 2007.

Assay:

It is assayed by gravimetric method. an accurately weight sample of alum dissolve in water. To it add ammonium chloride solution, add few drops of methyl red and add sufficient quantity of ammonia solution to produce a distinct yellow colour. The solution heated to boiling. Solution is filter and precipitate is washed with solution of ammonium nitrate until it becomes free from chloride. The precipitates of aluminium trioxide is dried to constant weight at 120°C.

Factor

Each gm of residue is equivalent to 9.307gm [illegible] $l(SO_4)_2 . 12H_2O$

Uses:

2) Aluminium chloride:

Chemical Formula: $AlCl_3 . 6H_2O$

Molecular weight: 241. 43

Preparation:

1) Aluminium chloride is prepared by heating metallic aluminium in a current of chlorine and then dissolve in water and crystallized it.

$$2\,Al + Cl_2 \longrightarrow 2AlCl_3$$

2) Aluminium hydroxide is dissolve in hydrochloric acid upon concentrating the liquid and allow it cool, crystals of aluminium chloride separates out.

$$Al\,(OH)_3 + 3HCl + 3H_2O \longrightarrow AlCl_3 . 6H_2O$$

Properties:

Physical Properties:

Colour: White - deliquescent crystalline powder

Odour: Faint

Taste: Sweet astringent

Solubility: Very soluble in water and freely soluble in alcohol.

Chemical Properties:

In non polar solvent it exists as a dimmer Al_2Cl_6.

It gets hydrolysed in water and liberates hydrochloric acid so aqueous solution is acidic to litmus.

Uses:

The aqueous solution of the compound in 10 – 25% find use as mild antiseptic and astringent.

Note: Due to tissue irritation and staining of clothes hence the compound is not used.

3) Zinc chloride:

Chemical Formula: $ZnCl_2$

Molecular Weight: 136.29

Zinc Chloride contains not less than 95.0 per cent and not more than 100.5 per cent of $ZnCl_2$.

Preparation:

It is prepared by reacting metallic or granular zinc with hydrochloride and the solution evaporated to dryness.

$$Zn + HCl \longrightarrow ZnCl_2 + H_2$$

It is also prepared by treating zinc oxide or carbonate with appropriate amount of hydrochloric acid.

Properties:

Physical properties:

Colour: White deliquescent crystalline powder

Odour: Odourless

Solubility: Very soluble in water; freely soluble in ethanol (95%) and in glycerin.

Chemical properties:

Aqueous solution of zinc chloride is acidic to litmus because it hydrolysis to form hydrochloric acid.

Test of purity:

It has to be tested for aluminium, calcium, heavy metals, iron, magnesium, ammonium salt, oxychloride and sulphate as per IP' 2007.

Storage condition:

Store in tightly-closed, non-metallic containers.

Assay:

It is assayed by complexometric titration method using disodium edetate as titrant. An accurately weight amount is dissolve in water and a definite volume made. To a known volume of solution, ammonia – ammonium chloride is added as a buffer, eriochrome black T as indicator is added and the solution is titrated with standard disodium edetate.

Uses:

It finds use in pharmaceutical aid for insulin preparations.

4) <u>Zinc sulphate</u>:

Chemical formula: ZnSO4,7H2O

Molecular weight: 287.54

Zinc Sulphate contains not less than 99.0 per cent and not more than 104.0 per cent of ZnSO4,7H2O.

Preparation:

1) It is obtained by heating zinc blend (zinc sulphide) in the presence of air under specified conditions. The heated mass is dissolve in hot water, filtered and the solution is concentrated for crystallization.

$$ZnS + 2O_0 \longrightarrow ZnSO_4$$

2)It is prepared by digesting metallic zinc granules in dilute sulphuric acid. The solution is filtered to separate the undissolve metallic zinc and filtrate is treated with chlorine to oxidize any ferrous sulphate impurity to ferric sulphate which is then precipitated by hydroxide and removed. The filtrate is concentrated and left for crystallization.

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$$

Properties:

Physical properties:

Colour: Colourless transparent crystals, prisms or needles or as a granular powder

Odour: Odourless

Taste: Astringent and metallic

Solubility : Very soluble in water; practically insoluble in ethanol (95%).

Chemical properties:

1) It effloresces in dry air.
2) Aqueous solution of zinc sulphate has been acidic to litmus due to hydrolysis of salt.
3) The dehydration of zinc sulphate is reported to occur by following way:-

$$ZnSO_4 . 7H_2O \xrightarrow{50\,^{o}C} ZnSO_4 . 2H_2O \xrightarrow{100^{o}C} ZnSO_4 . H_2O \xrightarrow{450^{o}C} ZnSO_4 \xrightarrow{740^{o}C} ZnO$$

4) It is reported to form double salts with potassium and ammonium sulphate.

$$ZnSO_4 + (NH4)_2SO_4 \longrightarrow ZnSO_4 . (NH4)_2SO_4 . 6H_2O$$

5)A white precipitate of zinc sulfide is formed when zinc sulphate react with hydrogen sulfide. The precipitate becomes soluble in hydrochloric acid but remain insoluble in acetic acid.

6)A white precipitate of zinc ferrocyanide is formed when zinc sulphate reacts with potassium ferrocyanide. The precipitate remain insoluble in dilute hydrochloric acid solution.

$$2\ ZnSO_4 + K_4[Fe(CN)_6] \longrightarrow Zn_2\ [Fe(CN)_6] + 2\ K_2SO_4$$

7) A white precipitate of zinc hydroxide is formed when zinc sulphate react with sodium hydroxide. The precipitate is solubilized in excess of sodium hydroxide.

$$ZnSO_4 + 2\ NaOH \longrightarrow Zn\ (OH)_2 + 2\ NaCl$$

$$Zn\ (OH)_2 + 2\ NaOH \longrightarrow Na_2\ ZnO_2 + 2H_2O$$

Identification Test:

Dissolve 2.5 g in sufficient carbon dioxide-free water to produce 50 ml (solution A). Solution A gives the reactions of zinc salts and sulphate as per IP' 2007.

Test of purity:

It has to be tested for clarity and colour of solution, arsenic, iron, chloride as per IP' 2007.

Storage condition:

Store in tightly-closed, non-metallic containers.

Assay:

Principle of Assay:

Zinc sulphate is assayed by gravimetrically. In the first step zinc sulphate is converted to zinc carbonate by sodium carbonate. Then it is converted to zinc oxide by ignition.

$$ZnSO_4 + Na_2CO_3 \longrightarrow ZnCO_3 + Na_2SO_4$$

$$ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$$

Procedure of Assay:

An accurately weight substance dissolve in water and then heated to about 90 ^{o}C. To the hot solution, sodium carbonate solution is added with constant stirring until complete precipitation of zinc carbonate. The precipitated zinc carbonate solution is boiled for a few minutes, filter it and wash with hot water until it is free from alkali. The residue is dried, ignited and weighed.

Factor:

1gm residue equivalent to 1.984gm of zinc sulphate

Uses:

- Zinc sulphate act as an emetic action on vomiting reflux. When used internally.
- Externally it is used in solution and powders as astringent.
- It is also use for 0.25% ophthalmic preparation.
- Aqueous solution of zinc sulphate employed for protein precipitation.

ANTI MICROBIAL AGENTS

Definition:

Antimicrobial agents that are effective against micro organisms with reference to their specific activity.

Anti microbial agent may be:

Antiseptic: An agent s that kills or inhibits the growth of micro organisms when applied to the tissue.

Germicidal: This refers specifically to agents that kill micro organism. Depending on the various organisms they may be bactericidal, amoebicidal etc.

Disinfectant: An agents used to destroy micro organism that cause disease in man, animals or plants, commonly applied to inanimate objects like equipment, instruments, rooms etc.

Mechanism action of inorganic anti microbial agents:

They are mainly act by oxidation, halogenation and protein precipitation.

1) **Oxidation:** Antimicrobial agents that function through oxidative mechanism are hydrogen peroxide, metal peroxides, permanganates, halogens like chlorine, iodine, and certain oxohalogens anions. They act on the –SH group in cysteine present in most proteins to form a disulphide bridge between two – SH group. Which alters the specific function of the protein in the micro organism and over all change is responsible for the ultimate destruction of the micro organism.
2) **Halogenation mechanism:** This category of agents act on peptide linkage and alter its potential and property. The destruction of specific function of protein causes death of micro organisms. Most of the enzymes are proteineous in nature. A protein molecule is composed of variety of amino acids connected through a peptide (- CONH-)linkage.
3) **Protein Precipitation:** Many metal ions exhibit protein binding or protein precipitation. The nature of interaction with protein takes place through polar group of protein which act as ligand and metal ions as a lewis acid. The complex formed may be strong chelate giving rise to inactivation of protein.

Characteristics of antimicrobial agents:

- It should have rapid onset of action and sustained activity which will able to reduce incidence of resistance.
- It must be possess good therapeutic index indicating usefulness in the given concentration.
- It should not cause local cellular damage or should not interfere with bodydefenses.
- It should show no systemic toxicity from topical applications.
- It should have in general broad spectrum activity against bacteria, fungi, protozoa, virus etc.

Some of the important examples and there detailed explanation of inorganic Antimicrobial agents as per IP' 2007 :

1) Hydrogen Peroxide:

Chemical formula: H_2O_2

Molecular weight: 34.016

- Hydrogen Peroxide Solution (20 Vol) is an aqueous solution of hydrogen peroxide. It may contain a suitable stabilising agent.
- Hydrogen Peroxide Solution (20 Vol) contains not less than 5.0 per cent w/v and not more than 7.0 per cent w/v of H_2O_2, corresponding to about 20 times its volume of available oxygen.

Preparation:

1) From barium peroxide:

This is the method for the industrial manufacture of hydrogen peroxide. Barium peroxide is made into a thick paste in ice cold water. A required quantity of dilute sulphuric acid is also cooled in ice. The barium peroxide paste is then added to the well cooled dilute sulphuric acid. Hydrogen peroxide and insoluble precipitates of barium sulphate is formed which is filtered off.

$$BaO_2 + \text{Dil. } H_2SO_4 \longrightarrow H_2O_2 + BaSO_4$$

2) Hydrogen peroxide can also prepared by decomposing barium peroxides with phosphoric acid or by passing carbon dioxide through a suspension of barium peroxide in water.

$$BaO_2 + 2\,H_3PO_4 \longrightarrow 3H_2O_2 + Ba_3(PO_4)_2$$

3) From sodium peroxide:

By treating sodium peroxide with dilute sulphuric acid at low temperature. Sodium peroxide crystallize and hydrogen peroxide is distilled under 10mm Hg pressure.

$$Na_2\,O_2 + \text{Dil. } H_2SO_4 \longrightarrow H_2O_2 + Na_2SO_4$$

4) Manufacture of H_2O_2

Nowadays H_2O_2 is manufactured by electrolysis of 50% ice cold sulphuric acid. Persulphuric acid is obtained first, which on distillation under reduced pressure gives hydrogen peroxide with 30% yield.

$$2\,H_2SO_4 \xrightarrow{\text{Electrolysis}} H_2S_2O_8 + H_2$$

$$H_2S_2O_8 + 2H_2O \xrightarrow[\text{reduce pressure}]{\text{Distilled under}} H_2O_2 + 2\,H_2SO_4$$

Properties:

Physical chemistry:

Colour: Clear, colourless liquid
Odour: Odourless
Taste: Slightly acidic
Solubility: it is miscible in water from which it can be extracted with solvent ether.

Chemical properties:

1) It decomposes in contact with oxidisable organic matter and with certain metals and also if allowed to become alkaline.
2) Small quantity of acid such as sulphuric acid (H_2SO_4), phosphoric acid (H_3PO_4) and alcohol if added which retards the decomposition of hydrogen peroxide.

Identification Test:

1) When it made alkaline and heated it is decomposed with effervescence of evolving O_2.
2) The ethereal layer gets coloured blue if hydrogen peroxide shake with ether layer in presence of dilute sulphuric acid and solution of potassium chromate.

Test for purity:

It has to be tested for acidity, non-volatile matter; organic stabilisers as per IP' 2007.

Assay:

Principle of assay:

Hydrogen peroxide and acidified potassium permanganate bot are oxidising agents. These two oxidising agents reduce one another with the evolution of gaseous oxygen. Hydrogen peroxide reduces potassium permanganate solution and causes its discoloration. At the end point, excess drops of potassium permanganate gives pink colour so here, potassium permanganate itself act as an indicator.

$$2KMnO_4 + H_2SO_4 + H_2O_2 \rightarrow K_2SO_4 + 2\ MnSO_4 + 8\ H_2O + 5O_2$$

Assay procedure:

Assay is carried out by the permanganate method. 10ml of the sample is diluted to 250ml in a volumetric flask with purified water. To 25ml of the diluted solution is added to 10ml 5N sulphuric acid and the resultant solution is titrated with 0.1N potassium permanganate till pink colour appears and persists.

Factor:

Each ml of 0.1 N $KMnO_4$ is equivalent to 0.001701gm of H_2O_2

Storage condition:

Store in light-resistant containers resistant to hydrogen peroxide in a cool place. If the solution does not contain a stabilising agent, it should be stored at a temperature below 15^o. It should not be stored for long periods.

Uses:

- It finds use as a germicide and deodorant.
- It is find use as cleaning action on cuts and wounds . This action is provide by lubrication of gaseous oxigen.
- It is use for bleaching the hair.
- It is considered as an effective oxidizing antidote for phosphorous and cyanide poisoning.
- It is act as a very strong oxidising agent because it yields nascent oxygen.

2) Potassium permanganate:

Chemical formula: KMnO4

Molecular weight: 158.03

Potassium Permanganate contains not less than 99.0 per cent and not more than 100.5 per cent of KMnO4.

Preparation:

It is prepared by heating a solution of potassium hydroxide with manganese dioxide and potassium chlorate.

$$6\ KOH + 3\ MnO_2 + KClO_3 \longrightarrow 3\ K_2MnO_4 + KCl + 3\ H_2O$$

The solution is evaporated to a green mass of potassium manganate (K_2MnO_4). The green mass is extracted with boiling water and a current of chlorine is passed through the solution until all the potassium permanganate is converted to $KMnO_4$.

$$2\ K_2MnO_4 + Cl_2 \longrightarrow 2\ KCl + 2\ KMnO_4$$

Carbon dioxide can also be passed through the solution in place of chlorine, where 2/3rd of manganate is converted as follows:

$$3\ K_2MnO_4 + 2\ CO_2 \longrightarrow 2KMnO_4 + MnO_2 + 2\ K_2CO_3$$

The solution is evaporated to crystallisati

Properties:

Physical properties:

Colour: Dark purple or brownish black, granular powder or dark purple or almost black slender, prismatic crystals, having a metallic lustre

Odour: Odourless

Taste: Sweet astringent

Solubility: Soluble in cold water; freely soluble in boiling water.

Chemical properties:

1) It decrepitates and decomposed at a high temperature (240°C).

$$2KMnO_4 \longrightarrow K_2MnO_4 + MnO_2 + O_2$$

2) It act as a powerful oxidizing agent.

3) When H_2S is passed through potassium permanganate solution which is acidified with hydrochloric acid, the violet colour disappear and sulphur gets precipitated.

$$2\ KMnO_4 + 6\ HCl + 5\ H_2S \longrightarrow 2MnCl_2 + KCl + 5\ S + H_2O$$

4) When solution of H_2O_2 is added to an acidified $KMnO_4$ solution the colour of the permanganate solution gets discharge.

$$2\ KMnO_4 + 2\ H_2SO_4 + 5\ H_2O_2 \longrightarrow K_2SO_4 + 2\ MnSO_4 + H_2O + 2O_2$$

5) When HCl is added to a solution of $KMnO_4$, chlorine gas gets produced.

$$2\ KMnO_4 + 16\ HCl \longrightarrow 2\ KCl + 2\ MnCl_2 + 8\ H_2O + 5\ Cl_2$$

6) Alkaline or neutral solution of $KMnO_4$ is able to oxidise iodide to iodate.

$$2\ KMnO_4 + H_2O + KI \longrightarrow MnO_2 + KOH + KIO_3$$

7) In acidic medium iodine gets liberated from iodides.

$$2\ KMnO_4 + 8\ H_2SO_4 + 10\ KI \longrightarrow 6\ K_2SO_4 + 2\ MnSO_4 + 5\ I_2 + 8\ H_2O$$

8) In acidic solution, ferrous salts get oxidised to ferric salts.

$$2\ KMnO_4 + 8\ H_2SO_4 + 10\ FeSO_4 \longrightarrow K_2SO_4 + 2\ MnSO_4 + 5\ Fe_2(SO4)_3 + 8\ H_2O$$

Identification test:

1) Heated to redness, it decrepitates, evolves oxygen and leaves a black residue which with water forms potassium hydroxide solution; the resulting solution when neutralised with dilute hydrochloric acid gives the reactions of potassium salts as per IP' 2007.

2) When potassium permanganate solution is acidified with sulphuric acid and heated to 70°C, it gets decolourised by a solution of hydrogen peroxide.

Test for purity:

It has to be tested for colour of solution, water insoluble matter, chloride and sulphate as per IP'2007.

Storage condition:

Store in tightly-closed containers. It must be handled with care because an explosion may occur when it brought in contact with readily oxidisable substances.

Assay:

Principle of assay:

- The principle is based on the iodometry redox type of titration. Potassium permanganate is a strong oxidizing agent in acidic medium. Due to acidic pH of the media reduction is MnO_4 to Mn^{+2} is possible with intermediate oxidation states of manganate (+6, +4, +3). So reaction is carried out in acidic media.
- Potassium permanganate is standardized with 0.1 N $Na_2S_2O_3$ solutions. Potassium permanganate oxidizes potassium iodide in acidic media and iodine is liberated. Liberated iodine is titrated against sodium thiosulphate using starch as an indicator.
- In the reaction sulphuric acid is added instead to hydrochloric acid to provide acidic media because HCl reacts with potassium permanganate to liberate chlorine gas which will interfere in the sample reading.
- Sodium thiosulphate is a secondary standard which can be standardized using potassium bromate.

$$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{+2} + 4\,H_2O$$

$$I_2 + 2e \rightarrow 2I^-$$

Assay procedure:

Weigh accurately about 0.3 g, dissolve in sufficient water to produce 100.0 ml. To 20.0 ml add 20 ml of water, 1 g of potassium iodide and 10 ml of 2M hydrochloric acid and titrate the liberated iodine with 0.1M sodium thiosulphate using starch solution, added towards the end of the titration, as indicator.

Factor:

Each ml of 0.1M sodium thiosulphate is equivalent to 0.003160 g of $KMnO_4$.

Uses:

- It is used as an antiseptic in mouth wash and in cleaning ulcer or abscesses.
- It is used in the treatment urethritis.
- It finds use as an antidote in case to poisoning by barbiturates, chloral hydrate, many alkaloids etc. it is able to destroy poison and prevents absorption.
- In veterinary practice, it has been very much used as an antiseptic.

3) Iodine:

Chemical formula: I_2

Molecular weight: 253.81

Iodine contains not less than 99.5 per cent and not more than 100.5 per cent of I.

Preparation:

Iodine is manufactured by extracting kelp (sea weeds ash) with water. The solution is concentrated when the sulphate and chloride of sodium and potassium get crystallised out, leaving freely soluble sodium and potassium iodides in the mother liquor. Sulphuric acid is added to the mother liquor and sulphur which gets liberated . The mother liquor treated with manganese dioxide and warm to collect iodine which distilled over.

$$2NaI + 2\ H2SO4 + MnO2 \longrightarrow MnSO_4 + Na_2SO_4 + I_2 + 2\,H_2O$$

Alternatively the solution containing freely soluble iodides is treated with required proportion of chlorine and the precipitated iodine is collected and purified by distillation.

Impurities like ICl, IBr and ICN present in iodine are removed by heating crude iodine with KI.

$$ICl + KI \longrightarrow KCl + I_2$$

$$IBr + KI \longrightarrow KBr + I_2$$

$$ICN + KI \longrightarrow KCN + I_2$$

Properties:

Physical properties:

Colour: Greyish violet brittle plates or small crystals with a metallic sheen

Odour: irritant

Solubility: Soluble in chloroform and in ethanol (95%); slightly soluble in glycerin; very slightly soluble in water. Very soluble in concentrated solutions of iodides.

Chemical properties:

1) It volatalises slowly at room temperature.

2) It react directly with some non metals and with many metals.

$$2\,P + 3\,I_2 \longrightarrow 2PI_3$$

$$Fe + I_2 \longrightarrow FeI_2$$

3) At higher temperature, the density of iodine decrease as it dissociated.

$$I_2 \rightleftharpoons 2\,I$$

4) Reducing agents react with aqueous solutions of iodine and are oxidised.

$$H_3AsO_3 + I_2 + H_2O \longrightarrow 2HI + H_3AsO_4$$

$$H_2S + I_2 \longrightarrow 2HI + S\downarrow$$

$$2Na_2S_2O_3 + I_2 \longrightarrow 2NaI + Na_2S_4O_6$$

5) With an alkaline iodine reacts to form an iodide and iodate, especially with the aid of heat.

$$3\,I_2 + 6\,NaOH \longrightarrow 5NaI + NaIO_3 + 3\,H_2O$$

6) Potassium iodide is able to dissolve large quantities of iodine due to formation of the ion.

$$KI + I_2 \longrightarrow KI_3$$

7) Iodine is able to added to the unsaturated acid which is present in the oils.

$$R - CH = CH - COOH + I_2 \longrightarrow R - CHI - CHI - COOH$$

Identification Test:

1) When heated gently it gives violet vapours which condense forming a bluish-black crystalline sublimate.

2) saturated solution yields a blue colour in the presence of starch solution which disappears when the solution is heated and reappears when it is cooled.

Test for purity:

It has to be tested for bromides and chlorides, non volatile matter as per IP' 2007.

Assay:

Weigh accurately about 0.2 g, transfer to a flask containing 1 g of potassium iodide and 2 ml of *water*, add 1 ml of 2M acetic acid, dissolve completely and add 50 ml of *water*. Titrate with 0.1M sodium thiosulphate using *starch solution* as indicator.

Factor:

Each ml of 0.1M sodium thiosulphate is equivalent to 0.01269 g of I.

Uses:

- Iodine find use as a counter irritant and disinfectant.
- It is find use as local germicide.
- For proper thyroid functioning iodine is to be supplied to the body, to be utilized physiologically either elemental form or in the form of iodine ion as in sodium or potassium iodide.

4) Mercury:

Molecular formula: Hg

Molecular weight: 200.6

It occurs naturally as a sulphide ore called cinnabar mercury sulphide. It is also occurs in small globules disseminated throughrocks and as an amalgum silver and gold.

Preparation:

It is obtained by roasting cinnabar in a current of air.

$$HgS + O_2 \longrightarrow Hg + SO_2$$

The free mercury gets liberated. It may be either purified by volatilisation or chemically by dropping mercury into a column of dilute nitric acid for remaining basic impurities.

Properties:

Physical properties:

Colour: Shining, silvery white, heavy liquid, easily divisible into globules.

Solubility: Insoluble in water, alcohol and hydrochloric acid.

Density: 13.5 gm/ml at 25 °C

Chemical proprties:

1) It is dissolve in cold and dilute nitric acid, giving mercurous nitrate and nitric oxide.

$$6\ Hg + 8\ HNO_3 \longrightarrow 3\ Hg_2(NO_3)_2 + 2\ NO + 4\ H_2O$$

2) it is attacked by concentration sulphuric acid only on heating with the evolution of sulphur dioxide and formation of mercury sulphate.

$$Hg + 2\ H_2SO_4 \longrightarrow HgSO_4 + SO_2 + 2H_2O$$

3) It is easily volatilises on heating, it boils at 359.58 °C.

Test for purity:

It has to be tested for weight per ml at 25 °C, non volatile matter residue at 300 °C.

Assay:

An accurately weight quantity is dissolved in equal parts of water and nitric acid. It is heated gently until the solution becomes colourless. The solution is then diluted with water and sufficient quantity of potassium permanganate is added till a permanent pink colour is produced. The solution is titrated with standard 0.1M ammonium thiocynate using ferric ammonium sulphate as indicator. The temperature during the titration should not exceed above 20 °C.

$$3\,Hg + 8\,HNO_3 \longrightarrow 3\,Hg(NO_3)_2 + 4\,H_2O + 2\,NO\uparrow$$

$$Hg(NO_3)_2 + 2\,NH_4SCN \longrightarrow 2\,NH_4NO_3 + Hg(SCN)_2$$

Factor:

Each ml of 0.1 N ammonium thiocynate equivalent to 0.01003gm of mercury

Uses:

- Metallic mercury has find use as cathartic and parasiticide.
- It is used as a pharmaceutical aid
- Compound of mercury now a days are used as diacitic, germicidal, anti bacterial and anti infective.

5) Silver nitrate:

Chemical formula: AgNO3

Molecular weight: 169.87

Silver Nitrate contains not less than 99.0 per cent and not more than 100.5 per cent of AgNO3.

Preparation:

It can be synthesize by the action of dilute nitric acid on pure silver. In this procedure 3 parts of silver is added to a solution of 10 parts of nitric acid. Then it is heated to remove the nitrous fumes, and filtered and evaporated until it becomes dry. Dissolve the product obtained in hot water, filtered and kept undisturbed in a dark place for crystallization.

$$3\,Ag + 4\,HNO_3 \longrightarrow 3\,AgNO_3 + NO + 2H_2O$$

The purification of silver nitrate is costly therefore it becomes essential to use pure silver and nitric acid free from halogen, sulphur and iron.

Properties:

Physical properties:

Colour: Colourless crystalline compound

Odour: Odourless

Taste: Bitter and metallic

Solubility: Very soluble in water; soluble in ethanol (95%).

Chemical properties:

1) When it is exposed to light or organic matter, it turns to grey or grayish black due to its reduction to metallic silver.

2) When heated at 212^{o}C, it melts to yellowish liquid and when heated to red heat it gets decomposed into metallic silver with the evolution of NO_2 and O_2.

$$2\,AgNO_3 \xrightarrow{\Delta} 2\,Ag + 2\,NO_2 + O_2$$

3) When hydrochloric acid or soluble chloride is added to neutral solution of silver nitrate, a white curdy precipitate of silver chloride is formed.

$$AgNO_3 + HCl \longrightarrow AgCl\downarrow + HNO_3$$

4) When treated with alkali hydroxide, it yields which decomposes to yield a brown silver oxide.

$$AgNO_3 + NaOH \longrightarrow Ag(OH)\downarrow + NaNO_3$$

$$2\,Ag(OH) \longrightarrow Ag_2O + H_2O$$

5) If sodium carbonate is added to silver nitrate, a precipitate of silver carbonate is formed which is decomposes when boiled to yield brown silver oxide.

$$2\ AgNO_3 + Na_2CO_3 \longrightarrow Ag_2CO_3 + NaNO_3$$

$$2Ag_2CO_3 \xrightarrow{\Delta} Ag_2O + CO_2$$

6)If ammonia is added to a solution of silver nitrate, most of silver ions get converted to silver ammonium complex and few of silver ion as it is in solution. If reducing agents like glucose or formaldehyde are added to this, the free silver ions get reduced to metallic silver and form silver mirror.

$$HCHO + 2\ Ag(NH_3)_2OH \longrightarrow HCOONH_4 + 2\ Ag \downarrow + 3\ NH_3 + H_2O$$

7)Silver nitrate yield salts when a number of reagents such as phosphate or borate are added to it . It reacts with protein to yield a heavy precipitate of silver protein compound.

Identification test:

It gives reactions which are characteristic of silver and nitrate ions as per IP' 2007.

Test for purity:

It has to be tested for acidity or alkalinity, clarity and colour of solution, aluminium, bismuth, copper and lead, and foreign salts as per IP' 2007.

Storage condition:

Store in tightly-closed, light-resistant, non-metallic containers.

Assay:

Weigh accurately about 0.3 g, dissolve in 50 ml of water, add 2 ml of 2M nitric acid and 2 ml of ferric ammonium sulphate solution and titrate with 0.1M ammonium thiocyanate using ferric ammonium sulphate as an indicator, until a reddish yellow colour is produced.

$$AgNO_3 + NH_4SCN \longrightarrow AgSCN \downarrow + NH_4NO_3$$

$$6\ NH_4SCN + Fe_2(SO4)_3(NH_4)_2SO_4 \longrightarrow \underset{\text{Reddish yellow}}{2\ Fe(SCN)_3} + 4\ (NH_4)_2SO_4$$

Factor:

Each ml of 0.1M ammonium thiocyanate is equivalent to 0.01699 g of $AgNO_3$

Uses:

- It find use as an germicide and astringent.
- An ammonical silver nitrate solution find use in dentistry.
- Silver nitrate solutions find use for ophthalmic purposes as an instillation into the eyes of new born for the prevention of ophthalmia neonatorum.
- Silver nitrate is active against gonococcal infection of new born.
- Silver nitrate is very successfully used to treat severely burnt patients.

6) Boric acid:

Chemical formula: H_3BO_3

Molecular weight: 61.83

Boric Acid contains not less than 99.5 per cent and not more than 100.5 per cent of H_3BO_3, calculated with reference to the dried substance.

Occurrence:

Free boric acid occurs in sea wa[illegible] many plants and nearly all fruits.

Preparation:

1)Boric acid is prepared from borax and from borates by reacting them with hydrochloric or sulphuric acid.in laboratory , boric acid is prepared by adding a mixture of concentrated sulphuric acid and water to a boiling solution of borax. The solution is filtered and kept a side for crystallization. The crystals of boric acid are separated and then washed until they become free from sulphate ions. Finally they are dried at room temperature.

$$Na_2B_4O_7 + H_2SO_4 + 5\ H_2O \longrightarrow 4\ H_3BO_3 + Na_2SO_4$$

2) Commercial method:

1)Boric acid is prepared by decomposing certain naturally occurring borates like colemanite, resonite, borax etc. Here boric acid is prepared from powdered colemanite. It is suspended in boiling water and the suspension is then treated with sulphur dioxide gas to liberate boric acid. When the solution is allow to cool, acid crystallizes out.

$$Ca_2B_6O_{11}.5\ H_2O + 2\ SO_2 + 4\ H_2O \longrightarrow 6\ H_3BO_3 + 2\ CaSO_3$$

2) When borax is treatedwith hydrochloric acid, a high grade of medicinal boric acid is obtained.

$$Na_2B_4O_7.\ 10H_2O + 2\ HCl \longrightarrow 4\ H_3BO_3 + 2\ NaCl + 5\ H_2O$$

Properties:

Physical properties:

Colour: White, crystalline powder or colourless shiny plates unctuous to the touch or white crystals

Odour: Odourless

Taste: Slightly acidic and bitter

Solubility: Soluble in water and in ethanol (95%); freely soluble in boiling water, in boiling ethanol (95%) and in glycerin.

Chemical properties:

1) Boric acid heating to certain temperature, yields various dehydration products like boric acid heating to 100^oC, loses one molecule of water to give meta boric acid.

$$H_3BO_3 \xrightarrow{100^oC} HBO_2 + H_2O$$

Heating to approximately 160^oC causes further loss of water from metaboric acid to produce tetra boric acid.

$$4\ HBO_2 \xrightarrow{160^oC} H_2B_4O_7 + H_2O$$

Heating still higher temperature tetra boric acid to produces the anhydride of boric acid, boron trioxide (B_2O_3) which is glassy appearing solid.

$$H_2B_4O_7 \xrightarrow{\Delta} 2\ B_2O_3 + H_2O$$

Identification Test:

1) Dissolve 0.1 g by gently warming with 5 ml of *methanol* to which a few drops of *sulphuric acid* have been added. Ignite the solution; the flame has a green border.
2) Dissolve 3.0 g in 90 ml of boiling *distilled water*, cool; the solution is faintly acid.

Test for Purity:

it has to be tested for clarity and colour of solution, arsenic, heavy metals, sulphate and loss on drying as per IP’ 2007.

Storage condition:

Store in well-closed containers.

Assay:

Principle of assay:

It is assayed by titrimetric method. Boric acid being very weak acid, it can not be directly titrated accurately with strong alkali. When it is dissolved in a mixture of water and glycerin, it behaves like a strong monobasic acid and then it can be titrated with alkali using phenolphthalein as an indicator.

Assay procedure:

Weigh accurately about 2 g, dissolve in a mixture of 50 ml of water and 100 ml of glycerin, previously neutralised to phenolphthalein solution. Titrate with 1M sodium hydroxide using phenolphthalein solution as indicator.

Factor:

Each ml of 1M sodium hydroxide is equivalent to 0.06183 g of H_3BO_3.

Uses:

- It is weak germicide therefore it is find use as a local anti infective.
- Its aqueous solution is not irritant so it is used as an eye wash and mouth wash.
- Boric acid if dilute with some other inert material used as dusting powder or incorporated into ointment bases.
- It is helpful for maintaining pH at about 6, it find use as buffer in epinephrine barbiturate ophthalmic solution.
- Boric acid can be very dangerous if ingested therefore its container should bear the warning “Not for internal use”.

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