PM SHRI KENDRIYA VIDYALAYA, DINJAN

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Subject: Chemistry

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Project: Investigatory Project on Toothpaste.

Acknowledgement

I would like to extend my sincere and heartfelt obligation towards all those who have helped me in making this project. Without their active guidance, help, cooperation and encouragement, I would not have been able to present the project on time.

I am extremely thankful and pay my sincere gratitude to my teacher Mrs. Manisha Bisht for her valuable guidance and support for completion of this project.

I also acknowledge a deep sense of reverence, my gratitude towards my parents, other faculty members of the school and friends for their valuable suggestions given to me in completing the project.

Date:

Place:

Certificate

This is to certify that the project work on Identification of Anions and Cations present in the Toothpaste based on the curriculum of CBSE has been completed by Ankish Debnath of class **XII** Section **A** of PM Shri Kendriya Vidyalaya, Dinjan.

The above mentioned project work has been completed under my guidance during the academic year 2024-25.

Signature of Teacher

Aim : - Identification of Anions and Cations present in Toothpaste.

THEORY: - Every toothpaste contains the following ingredients: Binders, Abrasives, Subsers, Humectants, Flavours, Sweeteners, Fluorides, Tooth Whiteners, A Preservative and Water. Binders thickens toothpaste – They prevent separation of the solid and liquid component, especially storage. They also affect the speed and volume of foam production, rate of flavour release and product dispersal, the appearance of tooth paste ribbon on the toothbrush. Some binders are gum solid alignat, methyl cellulose, carrageen, and magnesium aluminium silicate.

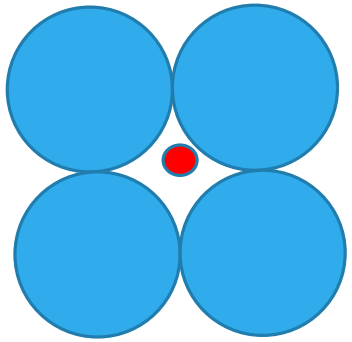
Contents : -

- Ionic Liquids : -
- Cations & Anions.
- Components are used in Toothpaste.
- Safety tips while doing this experiment.
- Ingredients: -
- Abrasives, Fluorides, Surfactants.
- Other Components: -
- Antibacterial agents, Flavorants, Demineralizers
- Miscellaneous Components

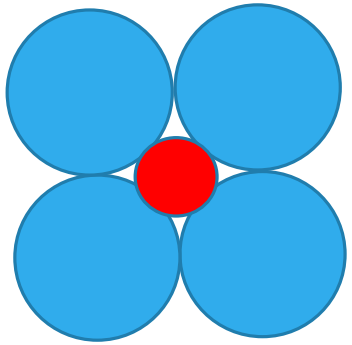
Identification of Anions and Cations present in the Toothpaste

Anions in an atom or molecule that carries an electric charge. Cations are positively charged ions created by the loss of electron. Anions are negatively charged loss created by the gain of electrons. In chemical reactions, all ions exhibit their own unique, characteristics behaviours.

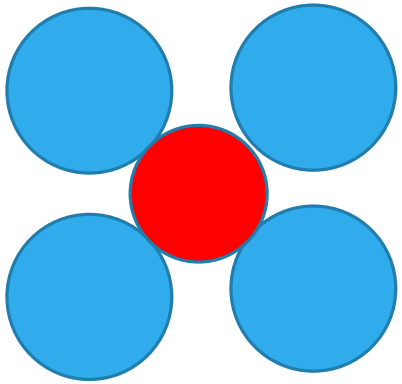
Unstable



Stability Limit



Stable



Anion

Cation

Toothpaste: -

Toothpaste is a vital dental care product used to promote oral hygiene by cleaning teeth, removing plaque, and preventing dental issues such as cavities, gum disease, and bad breath. It usually comes in the form of a paste or gel that is applied to a toothbrush. The formulation of toothpaste includes several key components: abrasives help to remove stains and plaque from teeth surfaces; fluoride is added to strengthen enamel and prevent decay; detergents create foam, aiding in the distribution of the paste; and flavors are included to provide a pleasant taste and encourage regular use.

Additionally, toothpaste contains humectants to keep the paste from drying out, binders and thickeners to maintain its consistency, and preservatives to prevent the growth of microorganisms. Some toothpastes are specially formulated to address particular dental needs, such as whitening teeth, reducing sensitivity, or controlling tartar buildup.

Components used in Toothpaste : -

- $HCLO_4$
- HBr
- HI
- H_2SO_4
- $HCLO_3$
- HCL
- HNO_3

Ingredients: -

In addition with 20 – 42% water. Toothpaste ingredients include abrasives, fluoride, detergents, humectants, flavors, thickeners, and preservatives. These components work together to clean teeth, prevent decay, and maintain product stability.

Abrasives : -

Abrasives in toothpaste are fine particles that help remove plaque, food debris, and surface stains from teeth. Common abrasives include silica, calcium carbonate, and dicalcium phosphate. They work by physically scrubbing the tooth surface without damaging the enamel. Abrasives play a crucial role in maintaining oral hygiene, contributing to a cleaner and brighter smile. However, their abrasiveness is carefully controlled to ensure effective cleaning while preventing enamel erosion.

Abrasives like the dental polishing agents used in dentists' offices, also cause a small amount of enamel erosion which is termed 'Polishing' action. Some brands contain powdered white mica which acts as a mild abrasive and, also adds cosmetically pleasing glittery shimmer to the paste.

Fluorides : -

Fluoride In various forms is the most popular active ingredients in the toothpaste to prevent cavities. Fluorides occur in small amount in plants, animals and some natural water sources. The additional fluorides in the toothpaste has beneficial effects on the formation of dental enamel and bones sodium fluoride (NaF) is the most common source of fluoride, but stannous fluoride (SnF), and sodium monofluorophosphate (Na_2PO_3F) are also used. Stannous fluoride has been shown to be more effective than sodium fluoride in reducing the incidence of dental careiesand controlling gingivitis.

Much of the toothpaste sold in the United States has 1000 to 1100 parts per million fluoride. In European countries, such as the UK or Greece, the fluoride content is often higher; NaF of 0.312% W/W (1,450 PPM Fluoride) is not uncommon.

Surfactants : -

Many, although not all, toothpaste contain sodium lauryl sulphate(SLS) or related surfactants (Detergents). SLS is well, such as shampoo, and is mainly a foaming agents

which enables uniform distribution of toothpaste, improving its cleaning power.

Other Components: -

Antibacterial Agents : -

Triclosan, an antibacterial agent, is a common toothpaste ingredient in the United Kingdom. Triclosan or Zinc Chloride prevent gingivitis and, according to the American Dental Association, helps reduce tartar and bad breadth. A 2006 review of clinical research concluded there was evidence for plaque and gingivitis.

Flavorants : -

Toothpaste comes in a variety of colours and flavours intended to encourage use of the product. Three most common Flavorants are Peppermint, Spearmint and Wintergreen. Toothpaste flavoured with peppermint. Anise oil is popular in Mediterranean region. These flavours are provided by the respective oils, e.g. Peppermint oil, more exotic flavours include Anethole Anise, Apricot, Bubble-gum, Cinnamon, Fennel, Lavender, Neem, Ginger, Vanilla, Lemon, Orange and Pine.

Remineralizers: -

Hydroxyapatite nanocrystals and Calcium phosphate are included in some formulations for Remineralizers, i.e. the reformation of enamel.

Miscellaneous Components: -

Agents are added to suppress the tendency of toothpaste to dry into a powder. Included are various sugar alcohols, such as glycerol, sorbitol, or xylitol, or related derivatives, such as 1, 2 – Propylene Glycol and Polyethylene glycol Strontium Chloride or Potassium Nitrate is included in some toothpastes to reduce sensitivity. Sodium Polyphosphate is added to minimize the formation of Tartar.

Colour of the Toothpaste - White

Experiment	Observation	Inference
Take part of the solution and $MgsO_4$ Solution	Formation of white PPT	CO_3^{2-} Confirmed
Take a part of the solution and add Ammonium Hydroxide (1- 2 ml)	Formation of white PPT	Ca^{2+} Confirmed
Take a part of solution and add magnesium mixture (Mixture of NH_4CL AND NH_4OH)	Formation of white PPT	PO_4^{2-} Confirmed
Acidify a portion of aqueous solution with dilute HNO_3. Boil and cool add $AgNo_3$.	A yellow PPT is formed which is in soluble in NH_4OH	I^- Confirmed
Take small quantity of solution and add oxalic acid. Prepare the paste of it with a few drops of water rub and smell.	Smells like that of vinegar.	CH_3COO^- Confirmed

To one part of the solution add KI	No Reaction	Pb Absent
To one part of the solution add solid NH_4OH in slight excess and then add Ammonium Phosphate.	A white PPT is formed.	Mg present.

Chemical Reaction: -

- $CO_3 + MgSO_4 \rightarrow MgCO_3 + SO_4^{2-}$ (White PPT)
- $CO_3 + 2CH_3COOH \rightarrow (CH3COO)_2Ca + H_2O$

  $(CH_3COO)_2Ca + (MgCl_4)_2C_2O_4 \rightarrow 2CHCOONA + Ca_2O_4$
- $NaHPO_4 + MgCl_2 + NH_4OH \rightarrow Mg(NH_4)PO_4 + 2NaCl + H_2O$
- $I + AgNo_3 \rightarrow NO_3 + AgI$ (Yellow PPT)
- $(COOH)_2 + 2CH_3COONa \rightarrow$ No reaction
- $Pb + 2KI \rightarrow$ No reaction
- $MgCl_2 + NH_4OH(NH_3)_2HPO_4 \rightarrow Mg(NH_4)PO_4 + 2NH_4 + H_2O$

Test on Colgate colour of paste: - White

Experiment	Observation	Inference
Take a part of the solution and add $MgSO_4$ solution.	Formation of White PPT	CO_3^{2-} Confirmed
Take a part of solution and add ammonium hydroxide.	Formation of White PPT	Ca^{2+} Confirmed
Take a part of solution and add magnesia mixture (Mixture of NH_4OH) and allow to stand.	Formation of White PPT	PO_4 Confirmed
Acidify a portion of aqueous solution with dilute HCl, boil and cool and add $AgNO_3$	A yellow PPT is formed which is insoluble in NH_4OH.	I^- Confirmed.

Take a small quantity of solution and add oxalic acid.	Smell like that of vinegar.	CH_3COO Absent
Prepare the paste of it with few drops of water rub and smell.		
Take one part of solution add KI.	No reaction.	Pb Absent.
Take one part of the solution add solid NH_4OH in slight excess then add ammonium phosphate.	A white PPT is formed.	Mg Present.

Ions present – Mg, I, PO_4, Ca, CO_3

Chemical reactions : -

- $CO_3 + MgSO_4 \rightarrow MgCO_3 + SO_4^{2-}$
- $CO_3 + 2CH_3COOH \rightarrow (CH_3COO)_2Ca + H_2O$
- $(CH_3COO)_2Ca + (NH_4)_2C_2O_4 \rightarrow 2CHCOONH_4 + CaC_2O_4$

- $NaHPO_4 + MgCl_2 + NH_4OH \rightarrow Mg(NH_4)PO_4 + 2NaCl + H_2O$
- $I + AgNO_3 \rightarrow NO_3 + AgI$ (Yellow PPT)
- $(COOH)_2 + 2CH_3COONa \rightarrow$ No reaction
- $Pb + 2KI \rightarrow$ No reaction
- $MgCl_2 + NH_4OH + (NH_3)_2HPO_4 \rightarrow Mg(NH_4)PO_4 + 2NH_4 + H_2O$

Test on Close Up toothpaste: Red Gel

Experiment	Observation	Inference
Take a part of solution and add $MgSO_4$ Solution.	Formation of White PPT.	CO_3^{2-} Confirmed.
Take a part of solution and add ammonium hydroxide (1-2ml).	Formation of White PPT.	Ca^{2+} Confirmed.
Take a part of solution and add magnesia mixture (Mixture of NH_4OH) and allow stand.	Formation of White PPT.	PO_4 Confirmed.

Acidify a portion of aqueous solution with dilute HNO_3 . Boil and cool and add $AgNO_3$.	Formation of White PPT.	I^- Confirmed.
Take a small quantity of solution and add KI.	Formation of White PPT.	CH_3COO Present.
Take one part of solution and add KI.	Formation of White PPT.	Pb Absent.
Take one part of the solution and add solid NH_4OH in slight excess then add ammonium phosphate.	A white PPT is formed.	Mg Present.

Ions present : - **Mg, I, PO_4, Ca, CO_3, CH_3COO**

Chemical Reactions: -

- $CO_3 + MgSO_4 \rightarrow MgCO_3 + SO_4^{2-}$ (White PPT)
- $CO_3 + 2CH_3COOH \rightarrow (CH3COO)_2Ca + H_2O$

  $(CH_3COO)_2Ca + (MgCl_4)_2C_2O_4 \rightarrow 2CHCOONA + Ca_2O_4$
- $NaHPO_4 + MgCl_2 + NH_4OH \rightarrow Mg(NH_4)PO_4 + 2NaCl + H_2O$
- $I + AgNo_3 \rightarrow NO_3 + AgI$ (Yellow PPT)
- $(COOH)_2 + 2CH_3COONa \rightarrow$ No reaction
- $Pb + 2KI \rightarrow$ No reaction
- $MgCl_2 + NH_4OH(NH_3)_2HPO_4 \rightarrow Mg(NH_4)PO_4 + 2NH_4 + H_2O$

Conclusion: -

Hence after testing different samples of toothpaste, we find that Colgate has all necessary for stronger and whiter teeth.

Anions: -	Cations: -
OH^-	H^+
SO_4^{2-}	Ca^{2+}
Cl^-	Cu^{2+}
Br^-	Fe^{3+}
CO_3^{2-}	Fe^{2+}
I^-	NH_4^+
NO_3^-	

Safety tips while doing this experiment: -

- Wear eye protection. Ammonia solution causes burns and gives off ammonia vapours which irritates the eyes, lungs and respiratory system.
- Sodium hydroxide can cause burns and is dangerous to the eyes.
- Hydrochloric acid can cause burns.
- Barium chloride is harmful by inhalation and if swallowed.
- Nitric acid causes burns.

Bibliography: -

1. Pradeep's Chemistry
2. Britannica Encyclopaedia
3. NCERT Chemistry
4. Google
5. Chemistry Today
6. ChatGPT