

AlkaloidsNicotine ($C_{10}H_{14}N_2$)

Nicotine is the chief alkaloid of tobacco plant (*Nicotina tabacum*). It occurs in the plant leaves as salts of malic acid and citric acid to the extent of 4 to 5 percent.

Isolation of Nicotine :-

- (i) Waste parts of the tobacco plant are finely powdered and extracted with dilute acid. The water soluble salts of alkaloids are thus removed in solution, leaving the insoluble cellulose, chlorophyll etc behind.
- (ii) The acid extract is then made basic with lime or sodium hydroxide and steam-distilled. Steam-distillation separates the nicotine from water soluble nonvolatile materials (sugars, inorganic salt etc).
- (iii) The distillate is acidified to about pH 3 with solid oxalic acid and concentrated to a syrup. On cooling the crystalline salt of nicotine and oxalic acid separates. Other alkaloids not forming slightly soluble oxalates are left in the solution.
- (iv) The crystalline nicotine oxalate is then transferred to a separating funnel and treated with excess of aqueous KOH. The nicotine thus set free rises to the surface as a brown oil and separated by extraction with ether.
- (v) The ethereal solution of the alkaloid is dried over solid anhydrous KOH and the ether evaporated. For further purification the residue is fractionally distilled under vacuum.

Properties of Nicotine :-

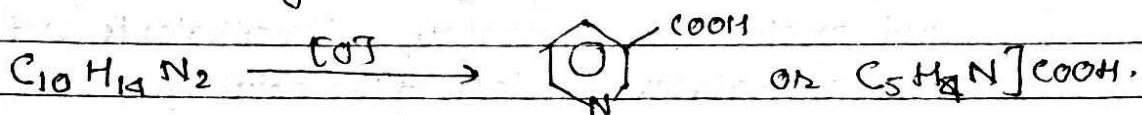
- (i) Nicotine is one of the few alkaloids known to exist in a liquid form colourless. It has boiling point 246°C.
- (ii) It has tobacco like smell and a burning alkaline taste.
- (iii) It is soluble in water and also in organic solvents such as ethanol, ether and benzene.
- (iv) The natural alkaloid is levorotatory.

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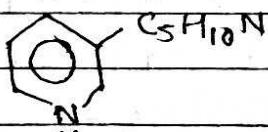
- (v) It is a deadly poison to animals and used commercially as an insecticidal spray for plants and animals.
- (vi) In small quantities nicotine stimulates the nervous system for a while which is followed by depression. A low nicotine content tobacco is used for smoking purposes even though it is definitely injurious to health, causing diseases like asthma and lung cancer.

Structure of Nicotine :-

- (1) Elemental analysis and molecular weight determination leads to the molecular formula $C_{10}H_{14}N_2$ for nicotine.
- (2) It absorbs two molecules of CH_3I suggesting the tertiary nature of both the nitrogen atoms.
- (3) On oxidation with chromic acid nicotine yields nicotinic acid (Pyridine-3-carboxylic acid)



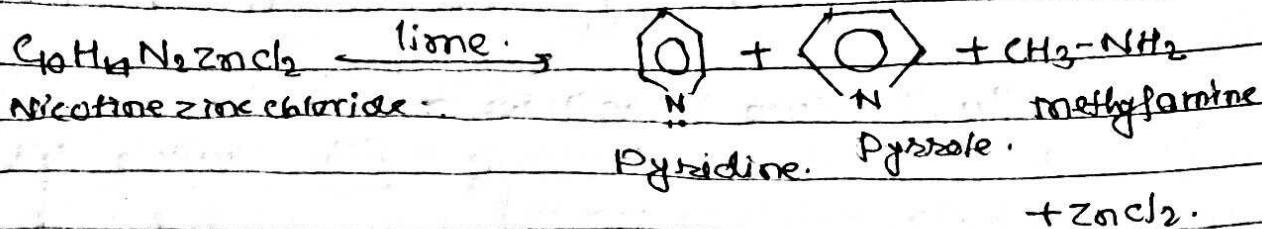
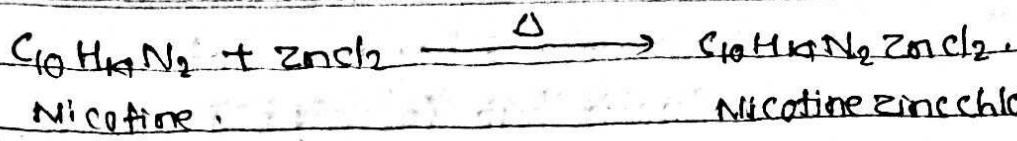
This shows that the alkaloid contains a pyridine nucleus with a side-chain at the 3-position. That is the side chain has the composition ($C_{10}H_{14}N_2 - C_5H_4N$) = $C_5H_{10}N$. Therefore the formula for nicotine may be written as:



From the above formula it is evident that the side-chain must be saturated.

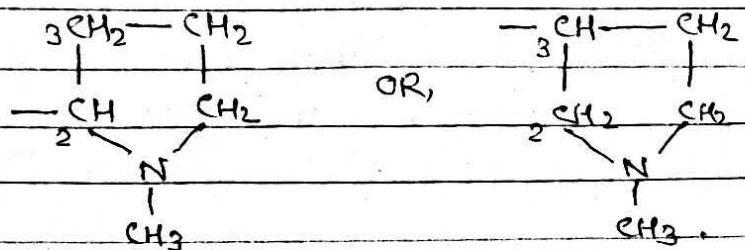
- (a) Nature and position of the side-chain -
- (ii) The alkaloid forms an addition compound with zinc-chloride $C_{10}H_{14}N_2 \cdot ZnCl_2$ which when heated with lime yields pyridine, pyrrole and methylamine.

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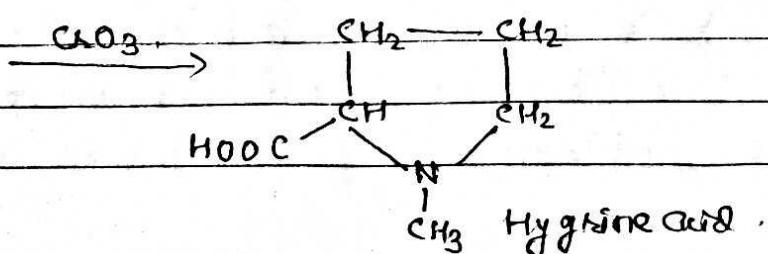
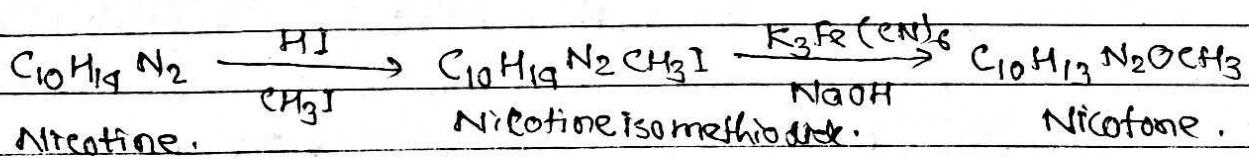
This suggests that the side-chain C₅H₁₀N is a pyrrole derivative.

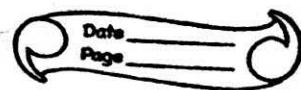
(ii) When heated with conc. hydroiodic acid at 200–300°C (Hözling and Meyer) nicotine yields CH₃I showing that methyl group is attached to N-atom. Therefore it appears that the side chain could be N-methylpyrrolidine.



The point of attachment of the side-chain to the pyrrole nucleus could be C₂ or C₃.

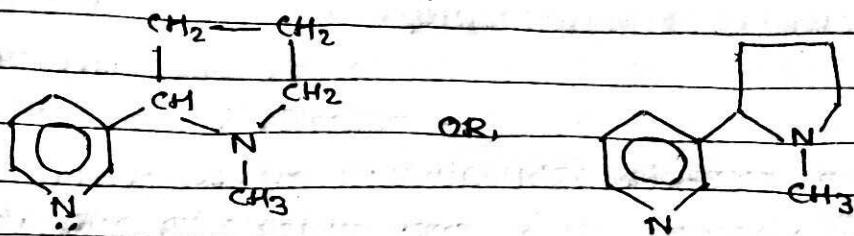
(iii) Nicotine hydroiodide and treated with CH₃I forms nicotine isomethiodide which on oxidation with potassium ferricyanide yields nicotine. This on further oxidation with chromium trioxide produces hygrine acid.





The formation of hygrine acid as above proves beyond double doubt that the side-chain N-methylpyrrolidine is attached to the pyridine nucleus through C₂.

- (5) The structure of nicotine may be written as -



(N-methylpyrrolidine-2-pyridine)