

**HETEROCYCLIC COMPOUND**

# **FURAN**

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**For:-B.Sc-III**

**Paper-VII**

**Group-B**

# 7. Heterocyclic Compound

## Furan

## FURAN

Molecular formula:  $C_4H_4O$ .

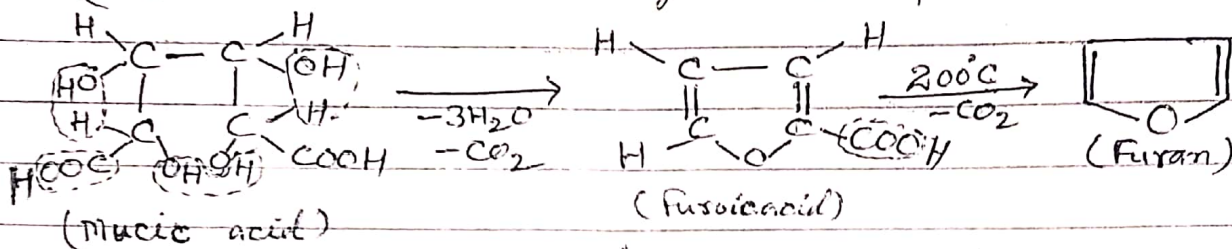
Structural formula: —



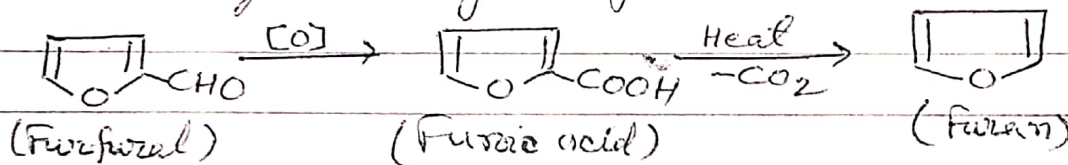
Molecular weight: —

Occurrence: → It is present in wood tar.

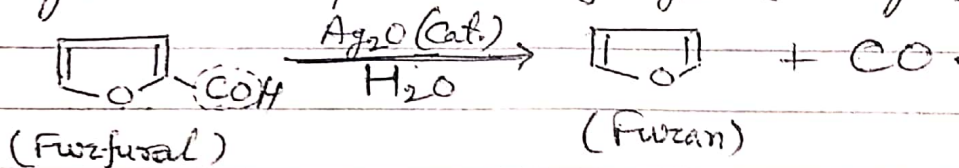
Preparations: → (i) It is obtained by dry distillation of mucic acid and heating the product (Fusic acid or Furan-2-Carboxylic acid) upto  $200^\circ$ .



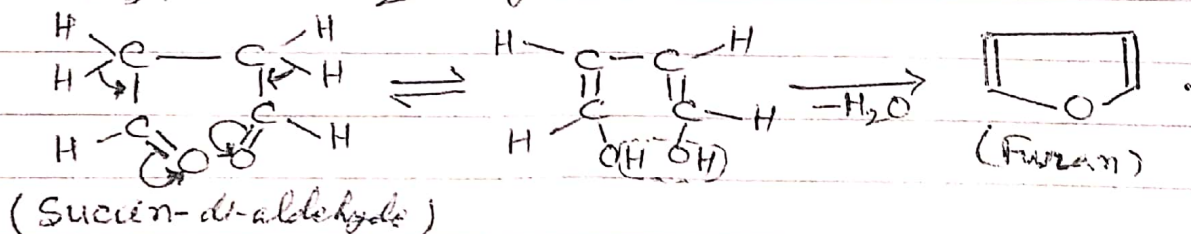
(ii) It is prepared by the oxidation of furfural with  $K_2Cr_2O_7$  gives fusic acid which on decarboxylation gives furan.



(iii) Furan is obtained by decarboxylation of furfural by steam in presence of  $Ag_2O$  (Catalyst).

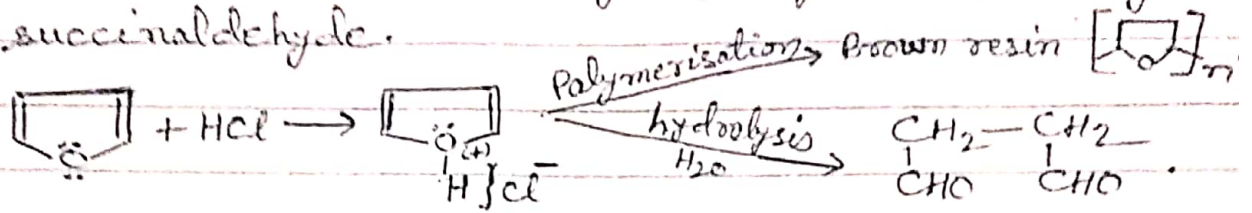



(iv) By heating succin-di-aldehyde in presence of  $H_2O_2$  or  $ZnCl_2$  anhydrous.



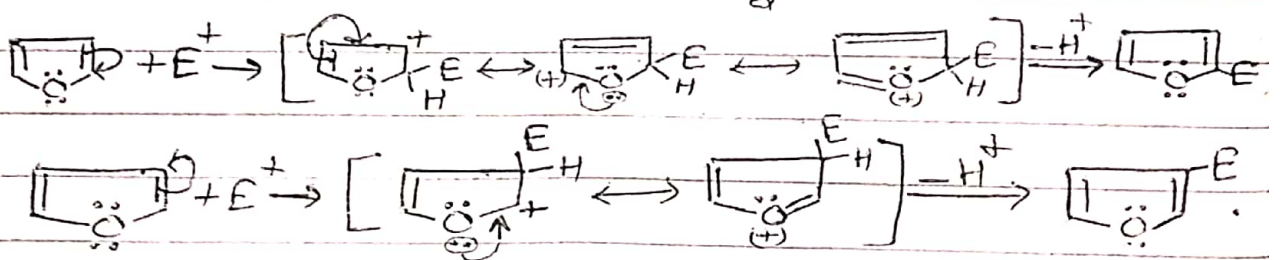
Properties: → It is a colourless liquid, B.P.  $32^\circ C$ , It is less soluble in  $H_2O$ , but soluble in organic solvents.

① It is a weak base form salt with mineral acids. The salts either polymers to give brown resin or undergo hydrolysis forming succinaldehyde.



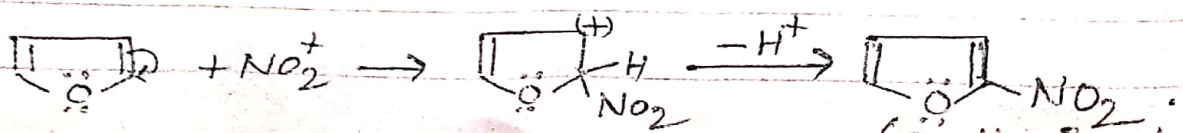
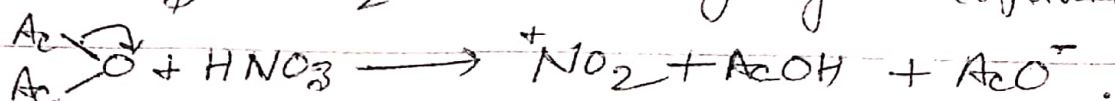
The weak basic character of furan is due only to involvement of lone pair of electrons on oxygen in the formation of delocalized  $\pi$ -molecular orbital (  ). If a proton is added to oxygen atom by reaction with acid, the resulting structure ceases to be aromatic and resonance energy is lost and furan cation also acts as conjugated diene and polymerises to give brown resin.

② Electrophillic substitution occurs at  $C_2$ . When both  $C_2$ -positions are blocked, then substitution occurs at  $C_3$ .



Former is more stable than latter. As former has three resonance form while latter only two.

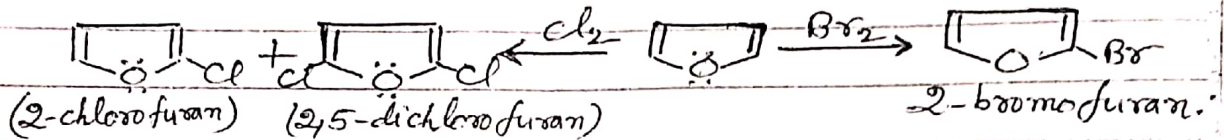
⊙ Nitration :  $\rightarrow$  Furan is nitrated with  $\text{HNO}_3$  in  $\text{Ac}_2\text{O}$  medium giving 2-nitrofuran.



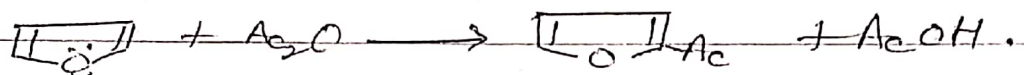
(b) Sulphonation :-> Furan is sulphonated by SO<sub>3</sub> in pyridine at 70° c.



(c) Halogenation :-> It reacts vigorously with chlorine and bromine but does not react with Iodine.

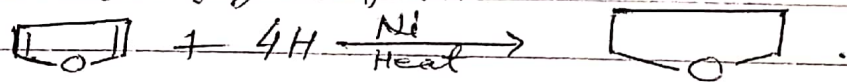


(3) Friedel-Craft reaction :-> Furan is acylated with Ac<sub>2</sub>O in presence of BF<sub>3</sub> at 0°c.

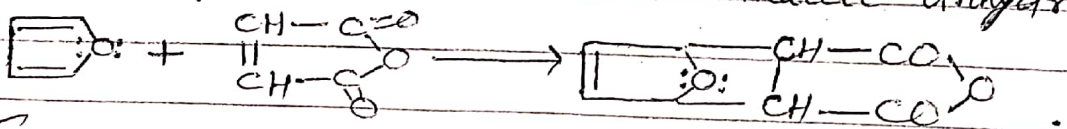


(4) Coupling reaction :-> It does not undergo coupling reaction with C<sub>6</sub>H<sub>5</sub>N<sub>2</sub>Cl.

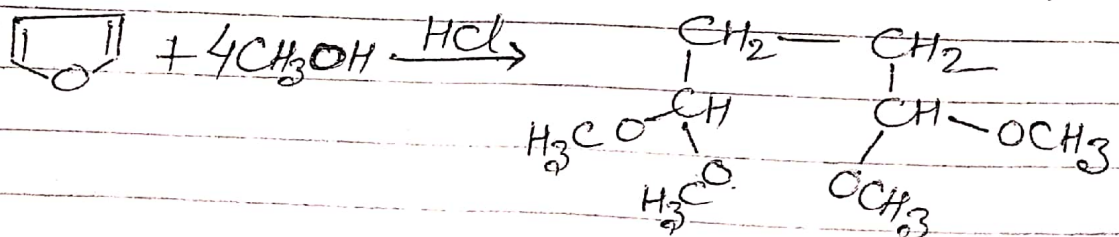
(5) Reduction :-> On Catalytic reduction (Ni) gives tetrahydrofuran.



(6) Diels-Alder reaction or (4+2)π electron reaction :-> It forms adduct with maleic anhydride.



Ring Opening :-> On treatment with CH<sub>3</sub>OH and HCl, ring is opened giving diacetal succinaldehyde.

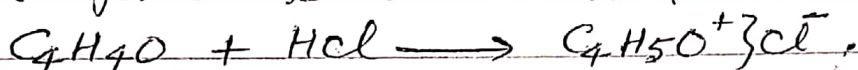


# Structure

Structure of furan follows from the following:—

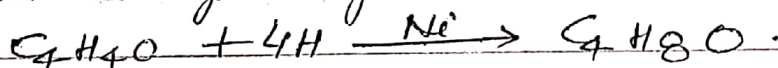
- ① Qualitative and quantitative analysis led its molecular formula to be  $C_4H_4O$ .
- ② An analytic view on its molecular formula reveals it to be a unsaturated compound, but usual test of unsaturation are not given at all. However, it undergoes electrophilic substitution such as nitration, sulphonation, halogenation and Friedel-Craft reaction, like those given by benzene, which is a closed chain compound. Hence, furan is a ring compound.

③ It forms salt with acid.



This indicates its basic nature.

④ It is catalytically reduced to tetrahydrofuran (T.H.F.).



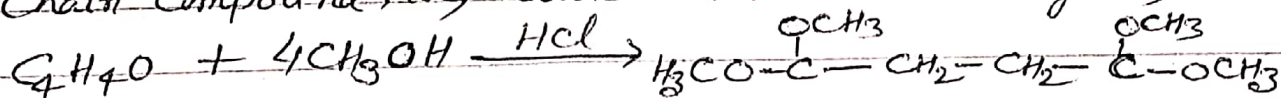
This indicates ~~the~~ presence of two double bonds.

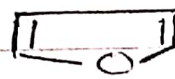
⑤ It forms adduct with maleic anhydride.



This indicates the presence of conjugated di-ene system.

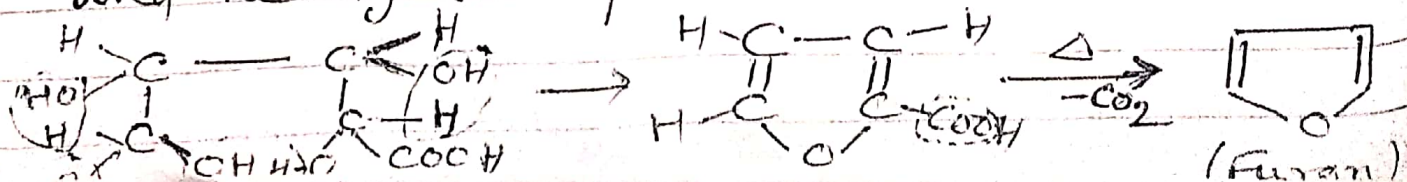
⑥ On reaction with  $CH_3OH$  and  $HCl$  gives open chain compound, i.e., diacetal-succinaldehyde.



On the basis of above evidences furan was assigned the structure — .

This structure is confirmed by synthesis:

① It is obtained by dry distillation of mucic acid and heating the product.



(ii) By heating succin-di-aldehyde in presence of  $P_2O_5$  or  $ZnCl_2$  anhydrous.

