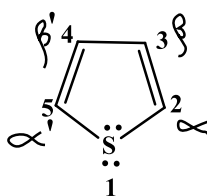


THIOPHENE

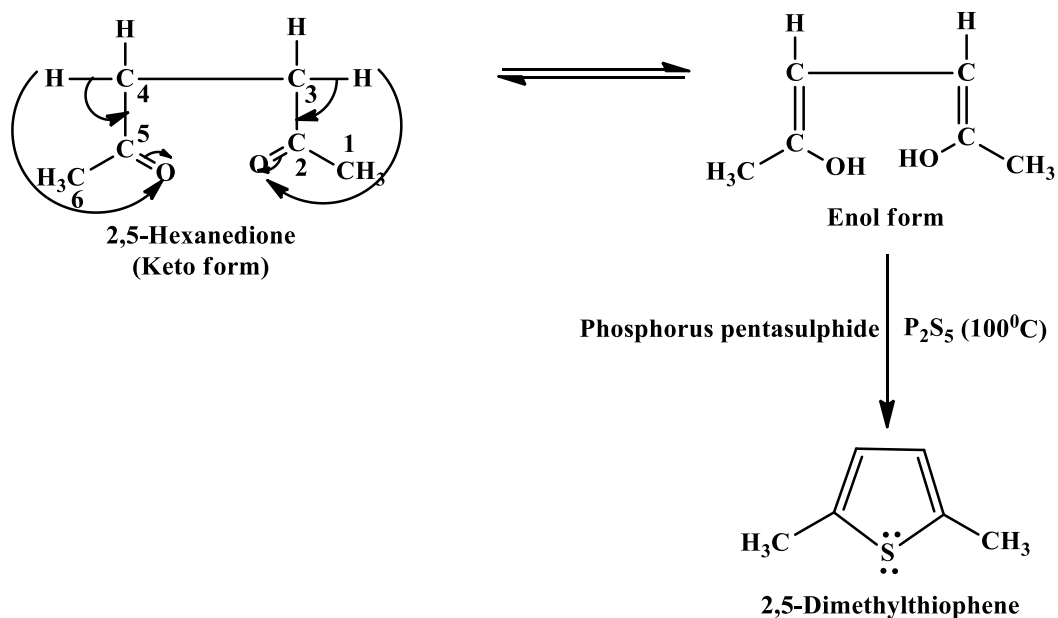


Molecular formula= C₄H₄S

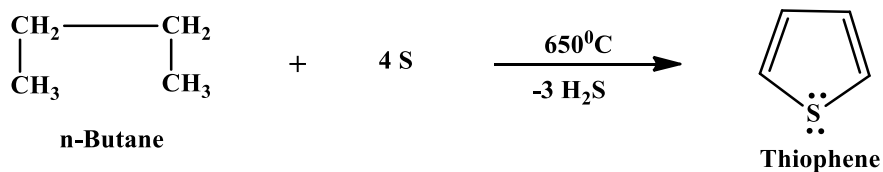
Nomenclature= 1-Thiacyclopent-2,4-diene or 1-Thiole

Preparation:

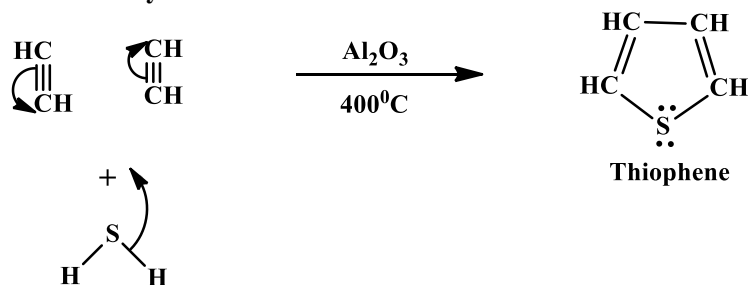
1. Paal-Knorr Synthesis:



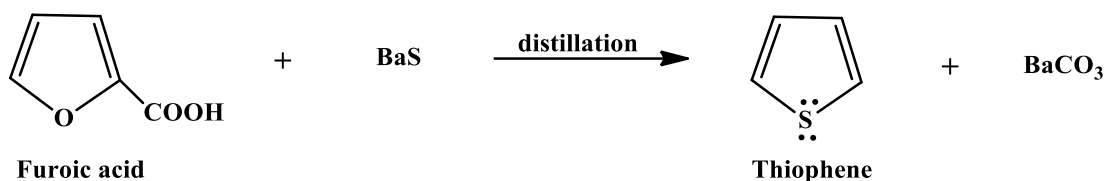
2. By the treatment of n-Butane with sulphur at 650°C:



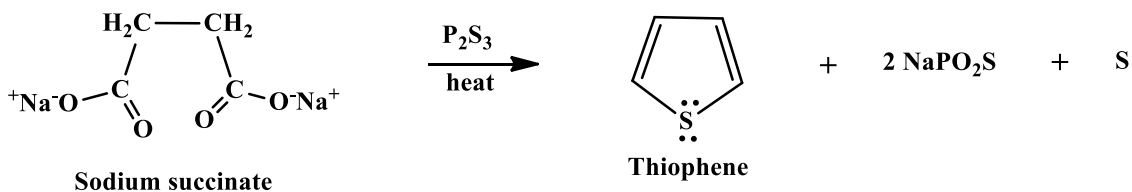
3. By passing a mixture of acetylene and H₂S over-heated Alumina at 400°C:



4. By distillation of furoic acid with barium sulphide:



5. By heating sodium succinate with Phosphorus trisulphide:



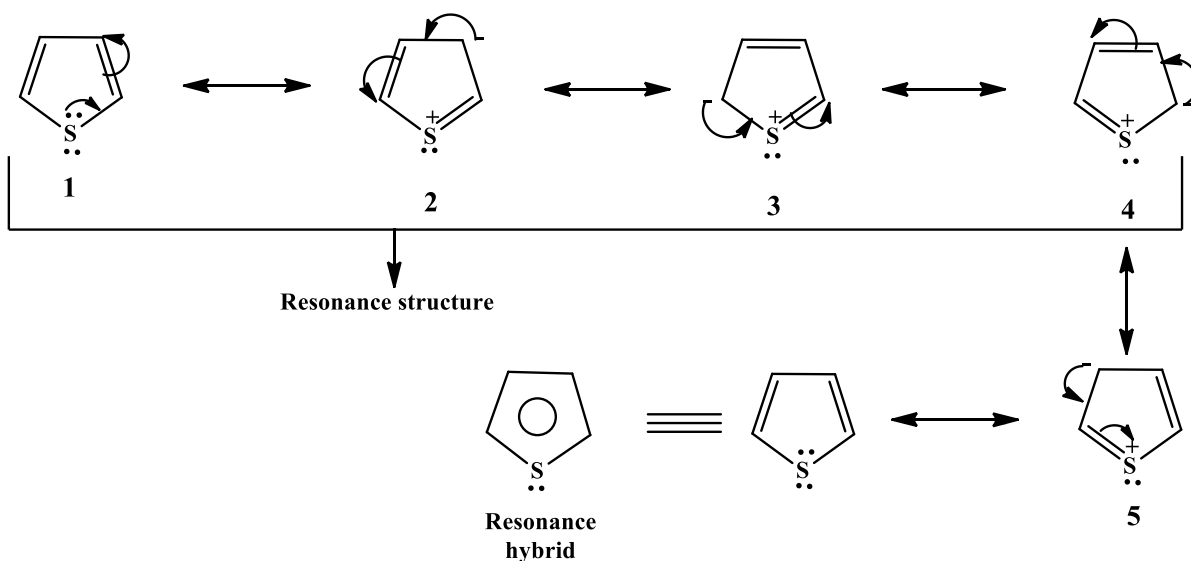
Chemical Properties:

1. Structure:

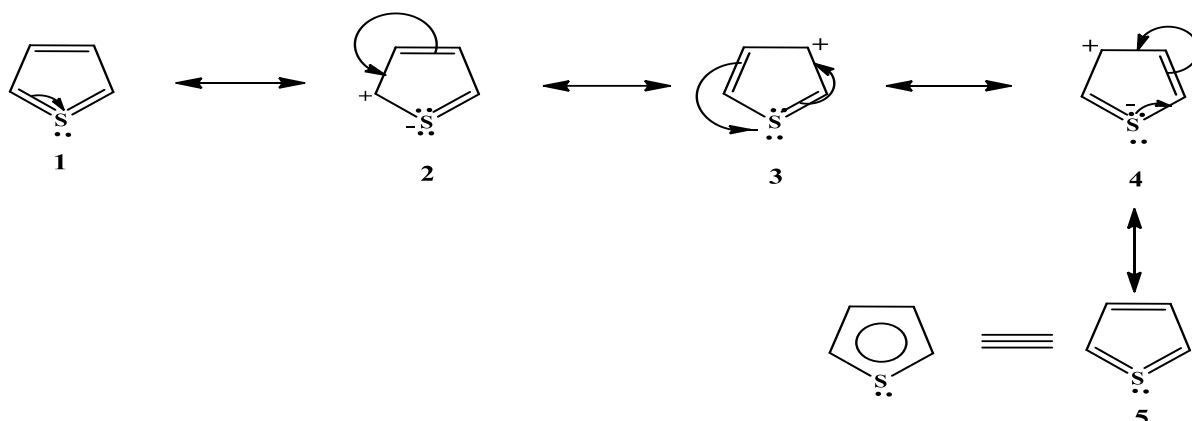
Thiophene is aromatic in nature because it follows Huckel's rule i.e. $(4n+2)\pi$ electrons. It has total six electrons two (one lone pair) electrons involved in resonance but second lone pair occupies an sp^2 hybrid orbital.

Sulphur can also use 3d orbitals (oxygen and nitrogen can not). Due to utilization of its 3d orbital, a greater number of resonating hybrid structures is possible for thiophene.

a. Resonating structure of p-Orbital:



b. Resonance structure of d-Orbitals:



Note:

- Thiophene does not show any basic properties. It is much more stable to acid than either pyrrole or furan.
- Thiophene does not undergo the Diels-Alder reaction.

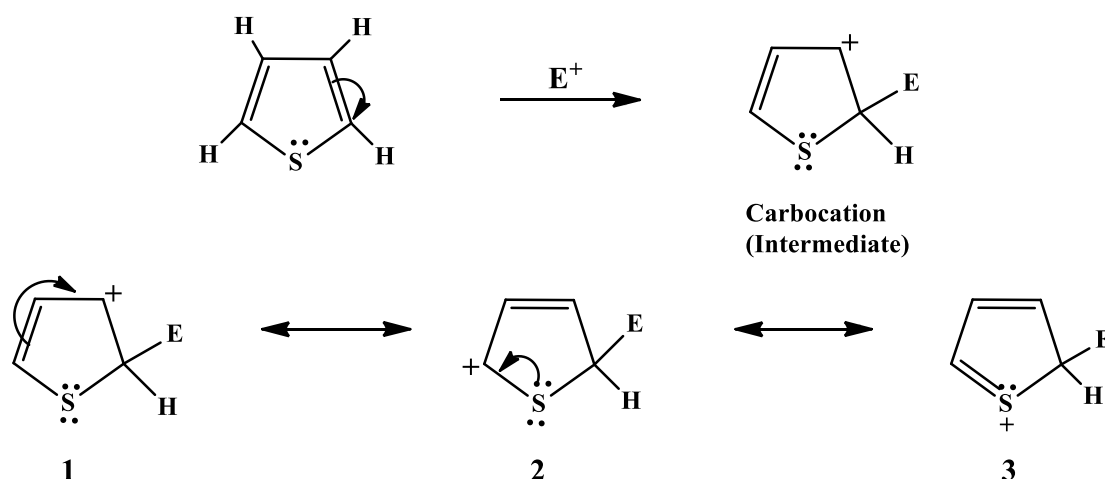
2. Electrophilic Substitution Reaction:

Thiophene is aromatic in nature and shows the usual reaction of aromatic compounds, the electrophilic substitution reactions.

Thiophene is more reactive than benzene towards electrophilic substitution reactions as it contains electron withdrawing sulphur atom.

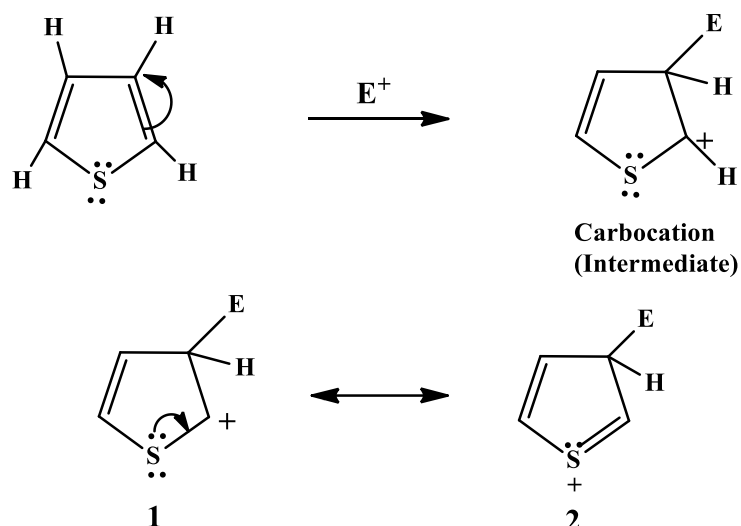
Electrophilic substitution of this ring system occurs at 2 or 5 (α or α') position. The intermediate carbocation resulting by the attack of an electrophile at 2 and 5 position is resonance stabilized to a greater extent than that in case of 3 or 4 substitution. Substitution at 3 or 4 position, can take place if 2 and 5 position blocked because intermediate carbocation is stabilized by the accommodation of the positive charge on the heteroatom.

2 or 5-(α)- substitution:



Resonance stabilization of intermediate Carbocation

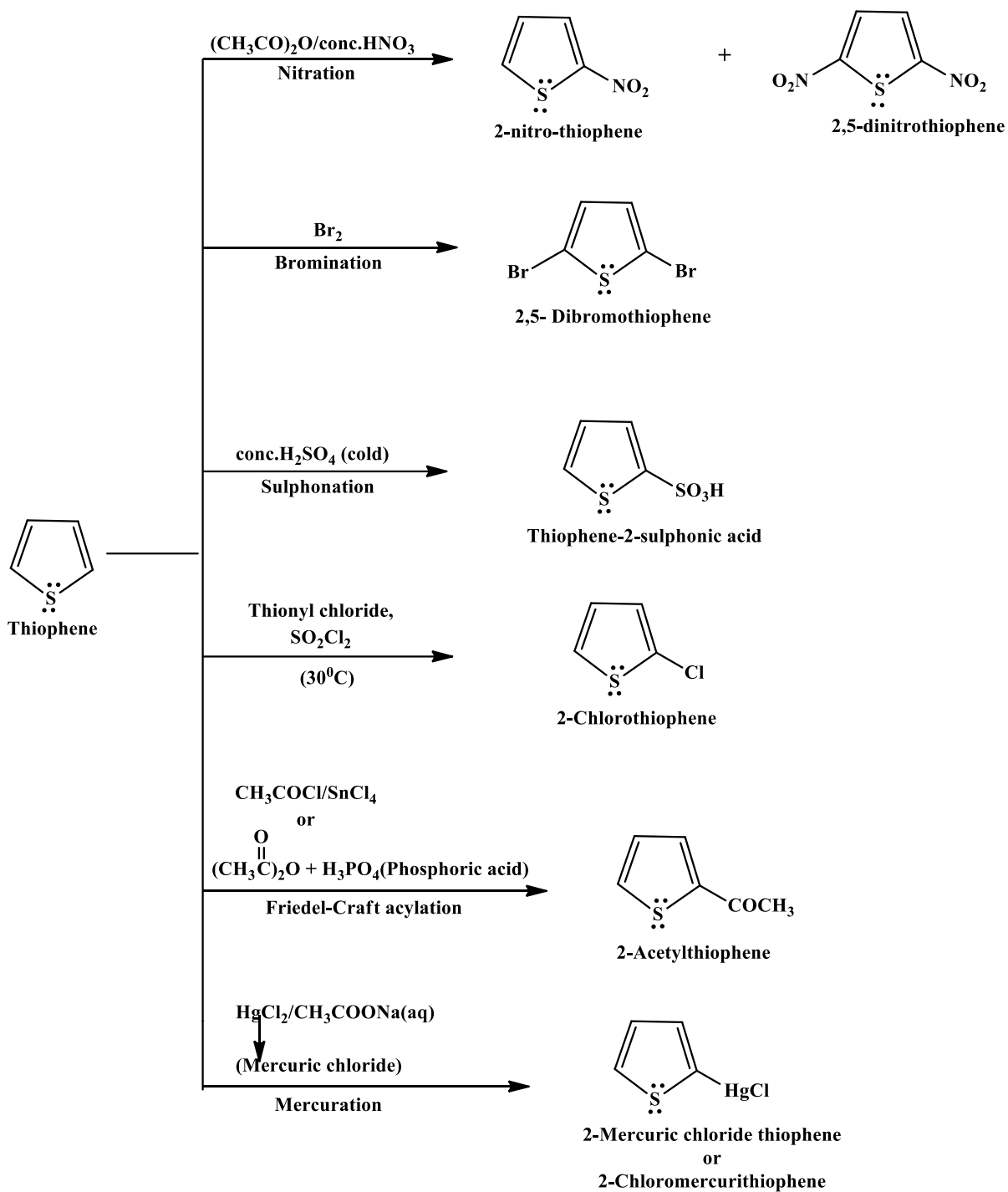
3- or 4(β)- substitution:

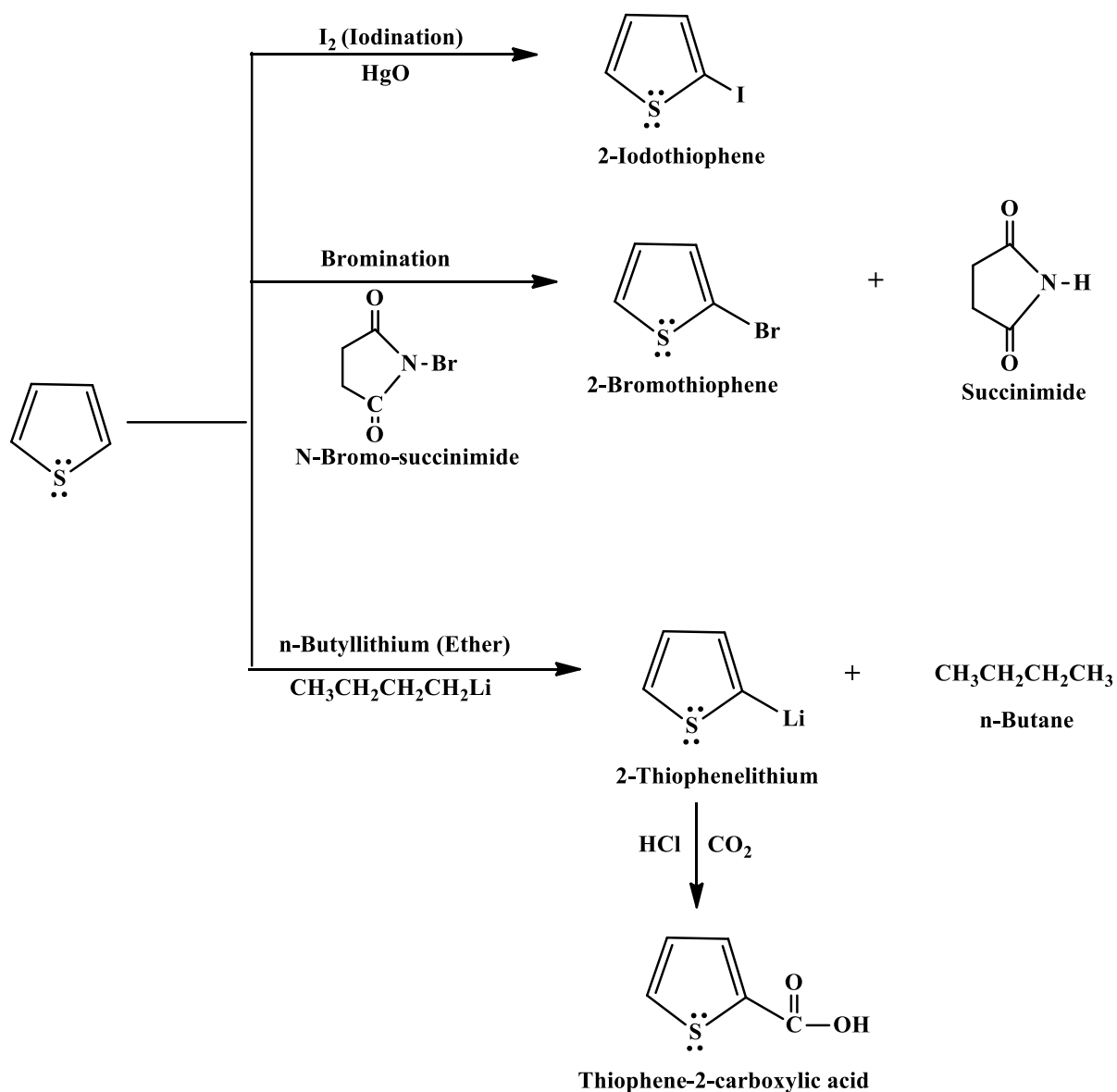


Resonance stabilization of intermediate Carbocation

Now comparing the resonating structures for both the attacks, it may be indicated that 3 resonating structures are possible for attack at 2nd position while only two for at 3rd position. Attack at position -2 preferred due to greater number of resonance structures, greater is the stability of the compound. So E^+ substitution in thiophene mainly takes place at position -2.

Important Reactions:

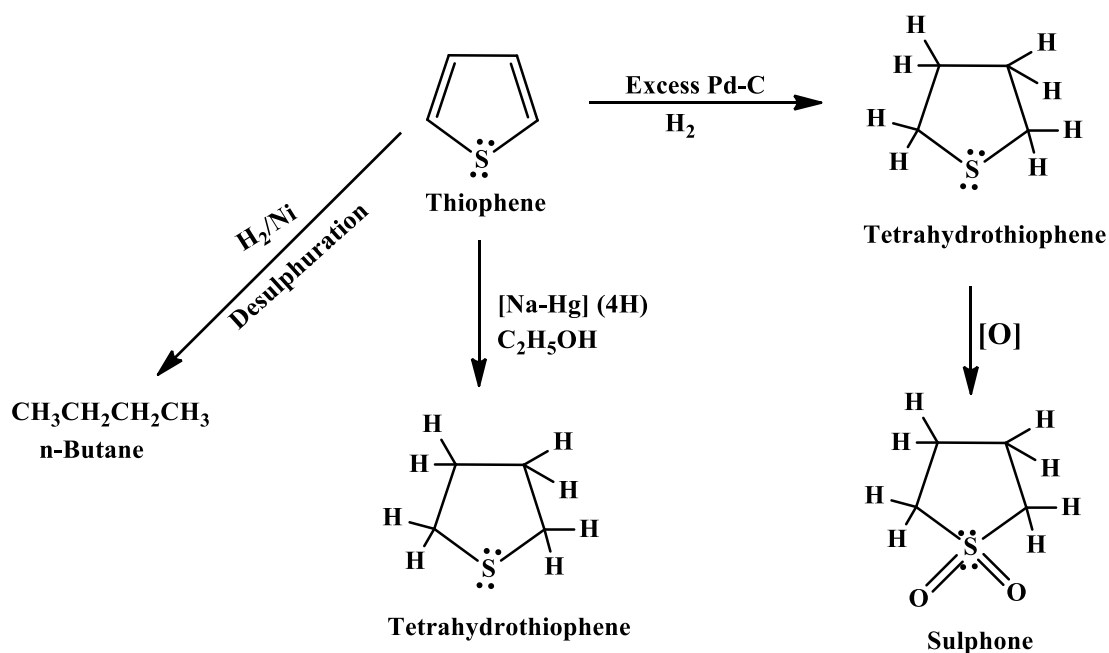




3. Addition reactions:

Hydrogenation (Reduction):

Thiophene needs excess of Pd-C for hydrogenation to overcome the poisoning effect of sulphur whereas Nickel hydrogenates it with destruction of the ring (Desulphuration) to form n-Butane.



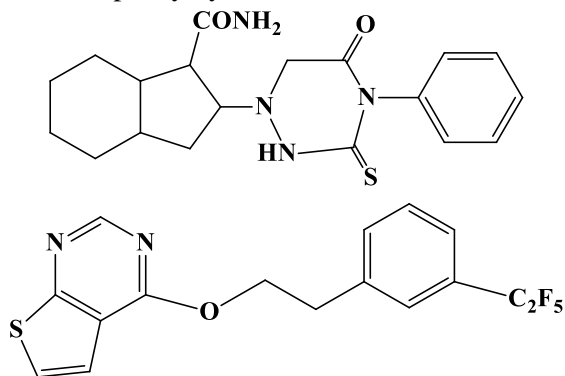
Note:

Reactivity of 5-membered ring compound:

Pyrrole > Furan > Thiophene > Benzene

Pharmaceutical Importance / Medicinal uses:

- i. Used in synthesis of Cephalosporin drug, production of dyes, resins, solvents.
- ii. As intermediate for preparation of thiophene acetic pyridine and pyrantel.
- iii. In Thiophene azo dye.
- iv. Thiophene derivatives- Thiophenylhydrozoneacetals have antimicrobial activity.



Thieno pyrimidine as pesticide

- v. 2-Alkoxy and 5-substituted Thiophene as local anaesthetic.

