

Regioselective Bromination of Aromatic Compounds Using N,N'-Dibromo-N,N'-1,2-ethylene bis(4-methyl benzene sulfonamide)

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Reaction between new compound N,N'-dibromo-N,N'-1,2-ethylene bis(4-methyl benzene sulfonamide) and aromatic compounds in carbon tetrachloride produces bromo aromatic compounds. In the case of benzene rings that contain mono activated substituted, only *p*-bromo isomer was formed.

Key Words: Activated benzene rings, Anion stability, Electrophilic bromination, Steric effect.

INTRODUCTION

N-bromosuccinimide (NBS) and N-chlorosuccinimide (NCS) commonly are used to effect allylic and aromatic halogenations¹. Despite the wide usage of these halogenating agents, many aspects of the mechanism of halogenation remain controversial. Allylic bromination by NBS generally is described as a free radical chain reaction. This process originally was proposed to involve succinimidyl radicals, but more recently studies have implicated bromine atoms² or equilibrium between both radicals³ as chain carriers. A similar mechanism for allylic chlorination by NCS may be presumed.

Nuclear halogenations of aromatic compounds with NBS and NCS to form haloarenes also are known. In polar solvents, the mechanisms probably are electrophilic aromatic substitutions and involve molecular halogen⁴.

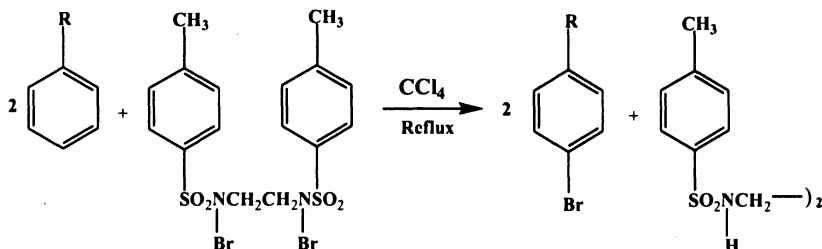
The mechanism for nuclear halogenation of aromatic compounds in non-polar solvents is less clear. For example, nuclear bromination of methyl anisole with NBS in carbon tetrachloride has been proposed to occur by electrophilic aromatic substitution⁵, whereas bromination of anthracene was proposed to involve a radical chain with bromine atom carriers⁶. On the other hand, when an *o*- and *p*-directing group is on a ring, it is usually difficult to predict how much of the product will be the *o*- isomer and how much the *p*- isomer. Indeed, these proportions may depend greatly on the reaction conditions⁷.

Another important factor is the steric effect. If either the group on the ring or the attacking group is large, then steric hindrance inhibits formation of the *o*- product and increases the amount of the *p*-isomer⁸. A few groups are so large that they direct almost entirely *para*. According to this idea, a new compound, N,N'-dibromo-N,N'-1,2-ethylene bis(4-methyl benzene sulfonamide) has been used, that is able to brominate aromatic rings containing *o*- and *p*-directing group almost entirely *para* (Scheme-1).

EXPERIMENTAL

Preparation of *N,N'*-dibromo-*N,N'*-1,2-ethylenebis(4-methylbenzene sulfonamide): The compound was prepared⁹ from the reaction of *p*-toluene sulfonyl chloride with ethylenediamine and then with Br₂ at 0°C.

Preparation of *p*-bromo anisole: In a 250 mL round-bottomed flask, 10 g



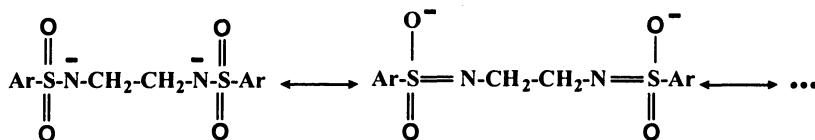
Scheme 1

(0.019 mol) of *N,N'*-dibromo-*N,N'*-1,2-ethylene bis(4-methyl benzene sulfonamide) and 30 mL of diethyl ether were placed. The flask was cooled in ice water and added, with stirring, 4.15 mL (0.038 mol) of anisole dropwise. The mixture was stirred for 25 min at room temperature. Then the flask was cooled; by this time the entire solid should have risen to the surface of the liquid. The primary sulfonamide [*N,N'*-1,2-ethylene bis(4-methyl benzene sulfonamide)] was filtered under suction. The diethyl ether was removed on a water bath and the *p*-bromo anisole was collected as a single product. The yield of product, b.p. 214°C, was 85%. Their physical constants, comparison with authentic samples and their IR and NMR spectra characterized all bromo products.

RESULTS AND DISCUSSION

Table-1 shows the results of reactions of *N,N'*-dibromo-*N,N'*-1,2-ethylene bis(4-methyl benzene sulfonamide) with different aromatic compounds.

The results showed that *N,N'*-dibromo-*N,N'*-1,2-ethylene bis(4-methyl benzene sulfonamide) is an effective bromination agent. In electrophilic aromatic substitution reactions, this reagent selectively brominates only *para* positions. One of the main factors of this reagent is releasing Br⁺ easily. The reason is resonance effect of anion with the SO₂ group, which makes them very stable. Simple presentation of the stabilities of the sulfonamide anion is shown in Scheme-2. Because of the bulky molecule, this reagent is selectively brominated only *para* position and also because of the steric effect, the *ortho* position is strictly prevented to brominate but the *para* position is freed of this problem.



Scheme-2

TABLE-1
BROMINATION OF AROMATIC COMPOUNDS WITH N,N'-DIBROMO-N,N'-
1,2-ETHYLENE BIS(4-METHYL BENZENE SULFONAMIDE) REAGENT

S. No.	Substrates	Products	Yield (%)	Time (min)	Temperature (°C)
1.	Anisole	<i>p</i> -Bromo anisole	85	25	25
2.	Acetanilide	<i>p</i> -Bromo acetanilide	85 ^a	40	62
3.	<i>o</i> -Anisaldehyde	5-Bromo <i>o</i> -anisaldehyde	70	60	25
4.	N,N'-Dimethyl aniline	<i>p</i> -Bromo-N,N'-dimethyl aniline	90	10	25
5.	N,N'-Diethyl aniline	<i>p</i> -Bromo-N,N'-diethyl aniline	90	10	25
6.	Phenol	<i>p</i> -Bromo phenol	85 ^a	15	62
7.	<i>p</i> -N,N'-Dimethylamino benzaldehyde	3-Bromo <i>p</i> -N,N'-dimethylamino benzaldehyde	80	45	25
8.	Benzamide	<i>p</i> -Bromo benzamide	75	60	25
9.	Naphthalene	1-Bromo naphthalene	75	45	25
10.	1-Naphthylamine	4-Bromo-1-naphthylamine	93	10	25
11.	Anthracene	9-Bromo anthracene	82	30	25

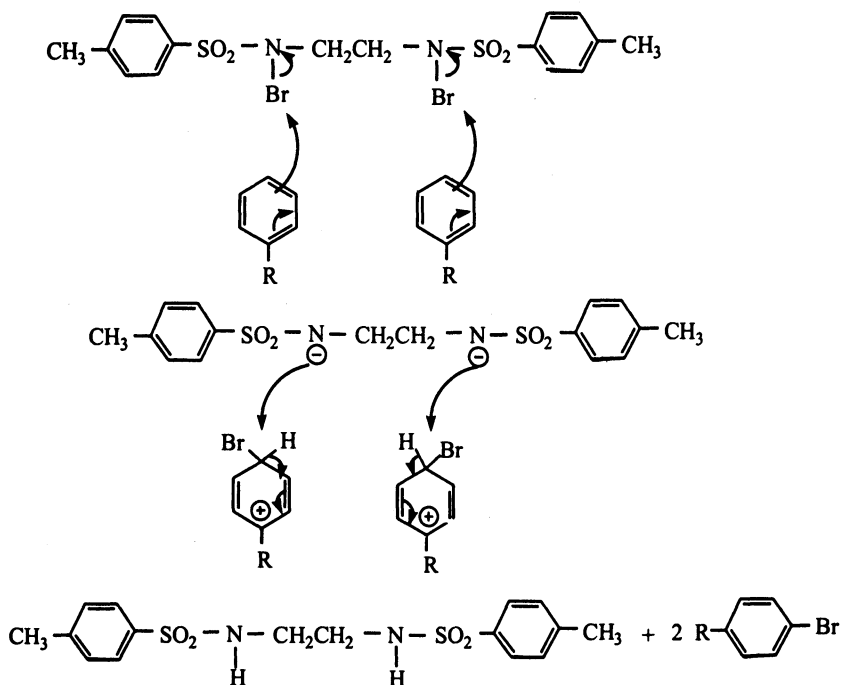
^a Chloroform as the reaction solvent and under reflux conditions

One of the greatest advantages of this method of bromination is that the starting material is recovered easily and can be reused many times without reducing the yield.

The advantages of this method of bromination are as follows:

1. The brominating reagent is solid and the reaction's procedure is very simple (does not need special precautions).
2. The reagent is acting selectively.
3. Reaction time is very short.
4. Work-up procedure is very simple.
5. The yields are good.
6. The other functional groups presented in the aromatic ring of the substrates do not react with this reagent (entries 3, 7 in Table-1), *e.g.*, aldehyde groups attached to the substrate ring, do not oxidize this reagent whereas Br₂ molecule can oxidize this group.
7. Aromatic rings containing the —NH₂, —NHR or —NR₂ group do not undergo classical bromination, partly because the strongly basic nitrogen ties up the Lewis acid needed for ionization of the bromine molecule, whereas by our method, this type of compounds are brominated selectively.
8. The starting material is recovered easily and can be reused many times without reducing the yield.

The proposed mechanism for bromination by title reagent is shown in Scheme-3.



Scheme-3

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