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Organic Chemistry

Haloform Reaction (Oxidative Cleavage)

Given

The given molecule (4.41) is shown as a nitro-alkene connected to an acetylenic unit, treated with Sodium Hypochlorite (NaOCl) and Sodium Hydroxide (NaOH).

Introduction

The reaction shown typically represents the haloform reaction where a methyl ketone or a molecule with a similar structure reacts with a halogen in the presence of a base to form a carboxylate and a haloform (in this case, NaOCl acting as the halogen source).

Step-by-Step Solution

Step 1: Structure of the Reactant

The given structure is:

```
HO-N=CH-C≡C-R
```

Where R is a variable substituent.

Explanation:
The structure shows a hydroxylamine moiety connected to a conjugated ketone and alkyne unit.

Step 2: Mechanism Initiation

The hydroxylamine functionality is converted to a nitroso compound through oxidation.

```
HO-N=CH-C≡C-R ⟶ O=N-CH-C≡C-R
```

Explanation:
In the presence of NaOCl, a deprotonation and rearrangement happen, forming a nitroso (N=O) compound. NaOCl acts as an oxidizing agent.

Step 3: Formation of an Intermediate

A nucleophilic attack by the NaOH forms an intermediate:

```
O=N-CH(C≡C-R) ⟶ O=N-(CH-OH)(C≡C-R)
```

Explanation:
The -OH group from NaOH attacks at the carbon linked to nitroso group, creating a hydroxyl substituted alkyl chain.

Step 4: Cleavage of Triple Bond

This leads to cleavage induced by the base, and formation of a carboxylate intermediate and a potentially leaving group forms acetylene:

```
O=N-(CH-OH)(C≡C-R) ⟶ R-COOH + Acetylene derivatives
```

Explanation:
The base NaOH cleaves the bond at the triple bond leading to formation of individual components.

Final Step: Product Formation

The terminal product will commonly be a carboxylate (converted to free acid under acidic or neutralization step) and a haloform in actual cases.

```
R-COOH + volatile derivatives.
```

Final Solution

Major Product: R-COOH (Carboxylic acid)
Acetylene unit: Expected volatile derivative

Supporting Final Statements

Each step involves typical organic transformations including nucleophilic attack, oxidation and stabilization to form the final products. The entire mechanism follows traditional nitroso-amine handling leading to fragmentation/claving forming primary acid.

Structural Representation for better visualization:

- Start; `HO-N=CH-C≡C-R`
- Oxidation; `O=N-CH-C≡C-R`
- Deprotonation; `O=N-CH(C≡C-R)OH`
- Cleavage: `R-C=O + acetylene`

Hope the detailed mechanism explanation above justifies every step involved in the reaction.

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