5,5,5-Trichloropent-3-en-one as a Precursor of 1,3-Bi-centered Electrophile in Reactions with Arenes in Brønsted Superacid CF$_3$SO$_3$H. Synthesis of 3-Methyl-1-trichloromethylindenes

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Abstract: Reactions of 5,5,5-trichloropent-3-en-2-one Cl$_3$CCH=CHC(=O)Me with arenes in Brønsted superacid CF$_3$SO$_3$H at room temperature for 2 h–5 days afford 3-methyl-1-trichloromethylindenes, a novel class of indene derivatives. The key reactive intermediate, O-protonated form of starting compound Cl$_3$CCH=CHC(=OH$^+$)Me, has been studied experimentally by NMR in CF$_3$SO$_3$H and theoretically by DFT calculations. The reaction proceeds through initial hydroarylation of the carbon-carbon double bond of starting CCl$_3$-enone, followed by cyclization onto the O-protonated carbonyl group, leading to target indenes. In general, 5,5,5-trichloropent-3-en-2-one in CF$_3$SO$_3$H acts as a 1,3-bi-centered electrophile.

Keywords: enones; indenes; Friedel-Crafts reaction; carbocations; triflic acid

1. Introduction

Superelectrophilic activation under the action of strong Bronsted and Lewis acids is a useful tool in organic synthesis, giving access to a variety of compounds [1–8]. Protonation (or coordination) of basic centers of organic molecules in Bronsted (or Lewis) acids affords intermediate highly reactive cationic species. In particular, superelectrophilic activation of conjugated enones consequently gives rise to O-protonated and O,C-diprotonated species. The latter takes part in electrophilic aromatic substitution reactions with arenes (Scheme 1a) [9–18]. The formation of O,C-diprotonated species from various conjugated enone structures, such as butenones [9,18], indenones [12], cinnamic acids, and their esters and amides [13–16], was proved experimentally by NMR and theoretically by DFT calculations. It has been shown that these dications are key reactive intermediates in various Friedel–Crafts processes [9–18].
Based on our recent studies on superelectrophilic activation of electron deficient alkenes [19–21], we undertook this study on electrophilic activation of 5,5,5-trichloropent-3-en-2-one 1 (CCl₃-enone). The presence of two electron withdrawing groups, COMe and CCl₃, at the carbon-carbon double bond increases its electrophilicity, especially under protonation of the carbonyl oxygen-resulting O-protonated species A (Scheme 1b). The second protonation of C=C bond in cation A may be hampered due to the strong acceptor characteristics of substituents C(OH⁺)Me and CCl₃. However, species A possesses enough electrophilicity to react with aromatic nucleophiles.

The main goals of this study were to investigate the protonation of E-5,5,5-trichloropent-3-en-2-one 1 by NMR and DFT calculations and study its reactions with arenes under the action of strong Brønsted and Lewis acids.

2. Results and Discussion

Protonation of CCl₃-enone 1 in various Brønsted acids (CH₃COOH, CF₃COOH, H₂SO₄, CF₃SO₃H) was initially investigated by means of NMR. According to ¹H and ¹³C NMR data, CCl₃-enone 1 gives stable O-protonated form A in these acids at room temperature (Table 1). Upon increasing the acidity in the row CH₃COOH→CF₃COOH→H₂SO₄→CF₃SO₃H [1], signals of protons H³, H⁴ and carbons C², C⁴ are shifted more and more downfield. The corresponding differences in chemical shifts (Δδ = δ acids − δCDCl₃) for atoms H³, H⁴ and C², C⁴ are gradually increased (Table 1). These data reveal that the positive charge is mainly localized on carbons C² and C⁴ in cation A, and both these atoms may act as reactive electrophilic centers in consequent interactions with aromatic nucleophiles.
Then, DFT calculations of cations A–C derived from the protonation of CCl₃-enone 1 have been carried out. The thermodynamics of their formation, such as Gibbs energies ΔG₂₉₈ of protonation reactions, energies of HOMO/LUMO, electrophilicity indices ω [22,23], charge distribution, and contribution of atomic orbital into LUMO of species A–C have been estimated (Table 2, see full data in Supplementary Materials).

The formation of O-protonated species A is very favorable, as the ΔG₂₉₈ value of the protonation is negative (−35 kJ/mol). Secondly, the protonation of the C=C bond, both onto carbons C³ and C⁴, which leads to dications B and C, is, correspondingly, extremely unfavorable, due to the very high positive values of protonation Gibbs energies (Table 2). Thus, the generation of O,C-diprotonated species B and C from CCl₃-enone 1 is very unlikely; that is, in accordance with NMR data (Table 1). Apart from that, it has been found that dication B is extremely unstable. It is spontaneously rearranged into species B₁ via a shift of a chlorine atom.

Calculations show that the largest part of positive charge in species A is localized on atom C² (0.66 e). Apart from that, this carbon atom contributes significantly to LUMO by 28%. There are similarities between the charge and orbital factors of the electrophilic properties of carbon C². Contrary to that, carbon C⁴ bears no positive charge (−0.06 e), but it contributes significantly into LUMO by 21% (see LUMO visualization of cation A in Table 2). Electrophilic properties of atom C⁴ can be mainly explained by orbital factors.

Reactions of CCl₃-enone 1 with benzene under the action of various Brønsted and Lewis acids have also been conducted (Table 3). The use of strong Lewis acids AlCl₃ or AlBr₃ yields complex mixtures of oligomeric materials (entries 1–3). Reaction in H₂SO₄ results in the formation of alcohol 3 as a product of hydration of the carbon-carbon double bond; no reaction with benzene occurs (entry 4). Reaction in Brønsted superacid CF₃SO₃H (triflic acid, TIHOH) at room temperature for 5 days affords indene 2a in yields 29% (entry 7). Under other conditions (temperature and time) in CF₃SO₃H, the formation of 2a is unsatisfactory (entries 5, 6, 8, 9), as is the reaction in stronger acid FSO₃H at a low temperature of −78 °C (entry 10). In weaker acids, CH₃CO₂H and CH₃CO₂H, the reaction does not take place (entries 11–14). These data reveal that the formation of indene 2a in CF₃SO₃H is accompanied by cationic oligomerization processes, which leads to a decrease in the yield of the target compound. The formation of indene 2a points out that the starting compound 1 in CF₃SO₃H behaves as a precursor of the bi-centered electrophile, with reactive cationic centers on carbons C² and C⁴.

### Table 1. ¹H and ¹³C NMR data of CCl₃-enone 1 (in CDCl₃) and its O-protonated form A (in Brønsted acids).

| Compound 1 and Cation A | Solvent | ¹H NMR, δ, ppm | ¹³C NMR, δ, ppm |
|-------------------------|---------|----------------|----------------|
|                         |         | H¹ | H³ | H⁴ | C¹ | C² | C³ | C⁴ | ³⁵Cl |
| Cl₃C⁵O⁴Me² | CDCl₃ | 2.40  | 6.61 | 7.05 | 28.9 | 196.7 | 128.0 | 144.4 | 92.6 |
| CH₃CO₂Hᵃ | Δδᵇ | 2.29 | 6.56 | 7.06 | 27.6 | 198.4 | 128.1 | 144.3 | 92.4 |
| CF₃CO₂Hᵃ | Δδᵇ | 2.62 | 6.85 | 7.34 | 31.7 | 210.8 | 131.9 | 153.4 | 96.2 |
| H₂SO₄ᵃ | Δδᵇ | 3.03 | 7.11 | 7.86 | 26.4 | 221.8 | 123.9 | 158.5 | 89.3 |
| CF₃SO₃Hᵃ | Δδᵇ | 3.22 | 7.31 | 8.14 | 27.5 | 226.7 | 124.3 | 163.2 | 89.9 |

Notes. a CH₂Cl₂ was used as internal standard. b Δδ = δacid − δCDCl₃.
Table 2. Selected calculated (DFT) electronic characteristics of the protonated forms A, B, C of CCl3-enone 1, and values of Gibbs energies of protonation reactions (ΔG, kJ/mol).

| Entry | Species | E_{HOMO}, eV | E_{LUMO}, eV | ω, a | q(C^2) b | q(C1) b | q(C3) b | k(C^3)_{LUMO}, c | k(C1)_{LUMO}, c | k(C^3)_{LUMO}, c | ΔG, d kJ/mol |
|-------|--------|--------------|--------------|------|----------|----------|----------|-----------------|----------------|----------------|--------------|
| 1     | 1      | -7.62        | -2.61        | 2.6  | 0.57     | -0.26    | -0.18    | 9               | 10             | 14            | -            |
| 2     | A      | -8.87        | -4.21        | 4.6  | 0.66     | -0.31    | -0.06    | 28              | 4              | 21            | 1→A -35      |
| 3     | B1     | -9.73        | -5.51        | 6.9  | 0.75     | -0.53    | -0.29    | 5.4             | 8.9            | 15.3          | A→B1 196     |
| 4     | C      | -9.25        | -6.98        | 14.5 | 0.65     | 0.26     | -0.56    | 15              | 41             | 7             | A→C 268      |

Notes. a Global electrophilicity index ω = (E_{HOMO} + E_{LUMO})^2 / 8(E_{LUMO} - E_{HOMO}). b Natural charges. c Contribution of atomic orbital into the molecular orbital. d Gibbs energy of protonation reactions.

Table 3. Reactions of CCl3-enone 1 with benzene under the action of excess of various acids.

| Entry | Acid | Temperature      | Time   | Reaction Product, Yield, % |
|-------|------|------------------|--------|----------------------------|
| 1     | AlCl3| room temperature | 1 h    | oligomeric material a       |
| 2     | AlBr3| room temperature | 1 h    | oligomeric material b       |
| 3     | AlBr3| room temperature | 2 h    | oligomeric material a       |
| 4     | H2SO4| room temperature | 6 days | 3, 75%                      |
Reactions of CCl$_3$-enone 1 with other arenes (o-, m-, p-xylenes, pseudocumene, and veratrole) in CF$_3$SO$_3$H, leading to indenes 2b–f, are presented in Scheme 2. These reactions with electron donating arenes take much less time (2 h only) at room temperature compared to the reaction with benzene (5 days, Table 1, entry 7). The yields of target indenes 2b–f are moderate (20–47%) due to secondary cationic oligomerization processes.

**Scheme 2.** Reactions of CCl$_3$-enone 1 with arenes in CF$_3$SO$_3$H leading to indenes 2b–f.

However, the same reactions with anisole (methoxybenzene) and 1,3-dimethoxybenzene at room temperature for 2 h furnish compounds 4a,b as products of hydroarylation of the carbon-carbon double bond of starting CCl$_3$-enone 1 (Scheme 3). Running these reactions at the higher temperature of 60 °C does not lead to the consequent cyclization of compounds 4a,b into the corresponding indenes 2.

### Table 3. Cont.

| Entry | Acid         | Temperature | Time     | Reaction Product, Yield, %       |
|-------|--------------|-------------|----------|----------------------------------|
| 5     | CF$_3$SO$_3$H| room temperature | 0.5 h   | quantitative isolation of starting compound 1 |
| 6     | CF$_3$SO$_3$H| room temperature | 3 days  | 2a, 20% b                        |
| 7     | CF$_3$SO$_3$H| room temperature | 5 days  | 2a, 29% a                        |
| 8     | CF$_3$SO$_3$H| 60 °C       | 0.5 h   | oligomeric material a            |
| 9     | CF$_3$SO$_3$H| 80 °C       | 1 h     | oligomeric material a            |
| 10    | FSO$_3$H     | −78 °C      | 2 h     | quantitative isolation of starting compound 1 |
| 11    | CH$_3$CO$_2$H| room temperature | 2 days  | quantitative isolation of starting compound 1 |
| 12    | CH$_3$CO$_2$H| 80 °C       | 1 h     | quantitative isolation of starting compound 1 |
| 13    | CF$_3$CO$_2$H| room temperature | 2 days  | quantitative isolation of starting compound 1 |
| 14    | CF$_3$CO$_2$H| 80 °C       | 1 h     | quantitative isolation of starting compound 1 |

**Notes.** a Full conversion of starting compound 1. b Incomplete conversion of starting compound 1.
The data obtained allow proposing plausible reaction mechanisms for transformations of CCl₃-enone 1 in Brønsted acids (Scheme 4). The formation of compounds 4 reveals that the first interaction of arenes with cation A occurs at carbon C⁴ of the latter, leading to species D. Hydrolysis of these cations affords compounds 4 (Scheme 3). In the case of electron donating aryl groups, cations D undergo intramolecular cyclization into species E. At this stage of the reaction, carbon C² acts as an electrophilic center. Finally, dehydration of E gives rise to indenes 2. Another reaction pathway takes place in H₂SO₄. The interaction of cation A with hydroxosulfate anion HSO₄⁻ affords species F, which is hydrolyzed into alcohol 3. We additionally examined the reaction of alcohol 3 with benzene in TiOH to obtain indene 2a. However, only a mixture of oligomeric materials was obtained, with no target indene 2a. In general, upon the formation of indenes 2, starting CCl₃-enone 1 in CF₃SO₃H behaves as a precursor of 1,3-bi-centered electrophilic synthon.
It should be especially emphasized that the development of routes for the synthesis of novel indene derivatives such as compounds 2 is a highly important goal for organic chemistry. Indenes are valuable molecules for medicinal uses [24–26]. They are widely exploited as ligands in organometallic chemistry [27–31], as structural units in molecular machines [32] and organic photovoltaics [33].

3. Experimental Section

3.1. General Information

The NMR spectra of solutions of compounds in CDCl₃ and in acids (CD₃COOH, CF₃COOH, H₂SO₄, CF₃SO₃H) were recorded on a Bruker 400 spectrometer (Billerica, MA, USA) at 25 °C at 400 and 101 MHz for ¹H and ¹³C NMR spectra, respectively. The residual proton-solvent peaks CDCl₃ (δ 7.26 ppm) for ¹H NMR spectra and the carbon signals of CDCl₃ (δ 77.0 ppm) for ¹³C NMR spectra were used as references. NMR spectra in acids were referenced to the signal of CH₂Cl₂ added as internal standard: δ 5.30 ppm for ¹H NMR spectra, and δ 53.52 ppm for ¹³C NMR spectra. HRMS-APCI was carried out using the instruments Bruker maXis HRMS-ESI-QTOF (Billerica, MA, USA). Preparative TLC was performed on silica gel 5–40 μm (Merck Co., Kenilworth, NJ, USA) with petroleum ether or petroleum ether-ethyl acetate mixture elution.

3.2. DFT Calculations

All computations were carried out at the DFT/HF hybrid level of theory using hybrid exchange functional B3LYP, by using GAUSSIAN 2009 program packages [34]. The geometries optimization was performed using the 6-311+G(2d,2p) basis set (standard 6-311G basis set added with polarization (d,p) and diffuse functions). Optimizations were performed on all degrees of freedom and solvent-phase optimized structures were verified as true minima with no imaginary frequencies. The Hessian matrix was calculated analytically for the optimized structures in order to prove the location of correct minima and to estimate the thermodynamic parameters. For solvent-phase calculations, the Polarizable Continuum Model (PCM, solvent=water) was used.

3.3. Preparation and Characterization of Compounds 1–4

First, E-5,5,5-trichloropent-3-en-2-one 1 was obtained in a yield of 83% according to the procedure shown in the literature [35]. Yellow oil. ¹H NMR (CDCl₃, 400 MHz) δ, ppm: 7.06 d (J 15 Hz, 1H), 6.62 d (J 15 Hz, 1H), 2.41 s (3H). ¹³C NMR (CDCl₃, 101 MHz) δ, ppm: 196.58, 144.35, 127.95, 92.59, 28.85.

The general procedure for the synthesis of indenes 2, compounds 3 and 4 from E-5,5,5-trichloropent-3-en-2-one 1 and arenes in CF₃SO₃H. Solution of compound 1 (50 mg, 0.27 mmol) and arene (1.2 equiv., 0.320 mmol) in 2 mL of CF₃SO₃H involved stirring at room temperature for 2 h (or other temperature and time, see Table 3 and Scheme 3). Then, the reaction mixture was poured into water (25 mL) and extracted with CH₂Cl₂ (3 × 20 mL). Combined extract was washed with water (20 mL), saturated aqueous solution of NaHCO₃ (10 mL), water again (20 mL), and dried over Na₂SO₄. The solvent was distilled off under a reduced pressure. The residue was subjected to preparative TLC using petroleum ether or petroleum ether-ethyl acetate mixture elution (20:1, vol.) as eluent.

Reactions under the action of other Brønsted (H₂SO₄, FSO₃H) and Lewis (AlCl₃ and AlBr₃, 5 equiv. in 5 mL of benzene) acids were carried out in the same way (Table 1).

3-Methyl-1-trichloromethylinden (2a), yield of 29% (Table 3). Yellow oil. ¹H NMR (CDCl₃, 400 MHz) δ, ppm: 7.96 d (J 7.8 Hz, 1Hₚₜ), 7.44 d (J 7.4 Hz, 1Hₚₜ), 7.35–7.27 m (2Hₚₜ), 6.32 br. s. (1H, =CH), 4.49 br. s. (1H, CR₃H), 2.22 t (J 1.8 Hz, 3H, CH₃). ¹³C NMR (CDCl₃, 101 MHz) δ, ppm: 146.5, 144.1, 141.0, 128.6, 128.4, 125.8, 125.1, 119.4, 100.0 (CCl₃), 67.5 (CR₃H), 13.0 (Me). HRMS-APCI: m/z calc. C₁₁H₆Cl₂ [M + H]⁺ 246.9848, found 246.9843.

3,4,7-Trimethyl-1-trichloromethylinden (2b), yield of 20% (Scheme 2). Yellow oil. ¹H NMR (CDCl₃, 400 MHz) δ, ppm: 7.04 d (J 7.8 Hz, 1Hₚₜ), 6.97 d (J 7.8 Hz, 1Hₚₜ), 6.25 br. s.
(1H, =CH), 4.50 br. s. (1H, CR3H), 2.56 s (3H, C_arom-CH3), 2.54 s (3H, C_arom-CH3), 2.35 t (J 1.6 Hz, 3H, C_aliph-CH3). 13C NMR (101 MHz, CDCl3) δ, ppm: 146.3, 144.3, 132.8, 132.0, 131.2, 130.5, 129.1, 128.8, 101.8 (CCl3), 65.7 (CR3H), 22.6 (Capom-CH3), 19.5 (Capom-CH3), 17.8 (CH3). HRMS-ESI: m/z calc. C13H13Cl3 [M + Ag + CH3CN]+ 421.9399, found 421.9394.

3,5,6-Trimethyl-1-trichloromethyliden (2c), yield of 35% (Scheme 2). Yellow oil. 1H NMR (CDCl3, 400 MHz) δ, ppm: 7.72 s (1H_arom), 7.11s (1H_arom), 6.22 br. s. (1H, =CH), 4.43 br. s. (1H, CR3H), 2.35 s (6H, C_arom-CH3), 2.19 t (J 1.7 Hz, 3H, C_aliph-CH3). 13C NMR (CDCl3, 101 MHz) δ, ppm: 144.47, 143.88, 138.72, 136.85, 134.05, 127.53, 126.50, 120.70, 100.40 (CCl3), 67.28 (CR3H), 20.21 (C_arom-CH3), 20.09 (C_arom-CH3), 13.03 (CH3). HRMS-APCI: m/z calc. C13H15Cl3 [M + H]+ 275.0161, found 275.0156.

3,5,7-Trimethyl-1-trichloromethylen (2d), yield of 23% (Scheme 2). Yellow oil. 1H NMR (CDCl3, 400 MHz) δ, ppm: 6.94 s (1H_arom), 6.92 s (1H_arom), 6.29 br. s. (1H, =CH), 4.54 br. s. (1H, CR3H), 2.58 s (3H, C_arom-CH3), 2.39 s (3H, C_arom-CH3), 2.15 t (J 1.6 Hz, 3H). 13C NMR (CDCl3, 101 MHz) δ, ppm: 147.8, 144.4, 138.7, 136.56, 134.8, 129.9, 129.8, 118.0, 101.6 (CCl3), 66.6 (CR3H), 22.8 (C_arom-CH3), 21.3 (C_arom-CH3), 13.0 (CH3). HRMS-ESI: m/z calc. C13H13Cl3 [M + Ag + CH3CN]+ 421.9399, found 421.9394.

3,4,5,7-Tetramethyl-1-trichloromethylen (2e), yield of 47% (Scheme 2). Yellow oil. 1H NMR (CDCl3, 400 MHz) δ, ppm: 6.90 s (1H_arom), 6.25 br. s. (1H, =CH), 4.44 br. s. (1H, CR3H), 2.52 s (3H, C_arom-CH3), 2.44 s (3H, C_arom-CH3), 2.37 s (J 1.6 Hz, 3H, C_aliph-CH3), 2.30 s (3H, C_arom-CH3). 13C NMR (CDCl3, 101 MHz) δ, ppm: 146.4, 144.4, 138.2, 138.1, 132.1, 131.2, 130.8, 127.9, 102.0 (CCl3), 65.1 (CR3H), 22.4 (CH3), 20.2 (CH3), 18.8 (CH3), 14.8 (CH3). HRMS-APCI: m/z calc. C14H15Cl3 [M + H]+ 289.0318, found 289.0312.

5,6-Dimethoxy-3-methyl-1-trichloromethylen (2f), yield of 28% (Scheme 2). Yellow oil. 1H NMR (CDCl3, 400 MHz) δ, ppm: 7.54 s (1H_arom), 6.85s (1H_arom), 6.21 br. s. (1H, =CH), 4.39 br. s. (1H, CR3H), 3.97 s (3H, OCH3), 3.94 s (3H, OCH3), 2.19 t (J 1.8 Hz, 3H, CH3). 13C NMR (CDCl3, 101 MHz) δ, ppm: 149.7, 147.4, 143.6, 139.7, 133.4, 127.2, 109.6, 102.9, 100.3 (CCl3), 67.2 (CR3H), 56.4 (OCH3), 56.1 (OCH3), 13.2 (CH3). HRMS-APCI: m/z calc. C15H17Cl3O2 [M + H]+ 307.0059, found 307.0054.

5,5,5-Trichloro-4-hydroxypentane-2-one (3) [36], yield of 75% (Table 3). Yellow oil. 1H NMR (CDCl3, 400 MHz) δ, ppm: 5.03 d (J 9.9 Hz, 1H), 3.44 d (J 17.4 Hz, 1H), 3.24 dd (J 17.4, 9.3 Hz, 1H), 2.29 c (3H). 13C NMR (CDCl3, 101 MHz) δ, ppm: 201.9, 100.4, 67.2, 48.4, 30.6.

5,5-Trichloro-4-(4-methoxyphenyl)pent-2-one (2a), yield of 68% (at room temperature for 2 h), 47% (at 60 °C for 0.5 h) (Scheme 3). 1H NMR (CDCl3, 400 MHz) δ, ppm:7.40 d (J 8.8 Hz, 2H_arom), 6.88 d (J 8.8 Hz, 2H_arom), 4.32 dd (J 9.2, 3.5 Hz, 1H), 3.80 s (3H, OCH3), 3.41 dd (J 17.4, 3.5 Hz, 1H), 3.32 dd (J 17.4, 9.2 Hz, 1H), 2.11 s (3H, CH3). 13C NMR (CDCl3, 101 MHz) δ, ppm: 204.2 (C=O), 159.7 (C_arom-OCH3), 131.3 (C_arom), 128.7 (C_arom), 113.6 (C_arom), 103.6 (CCl3), 59.7, 55.2, 46.5, 30.6 (CH3). HRMS-APCI: m/z calc. C12H12Cl2O2 [M + H]+ 295.0054, found 295.0054.

5,5-Trichloro-4-(2,4-dimethoxyphenyl)pent-2-one (2b), yield of 47% (at room temperature for 2 h), 56% (at 60 °C for 0.5 h) (Scheme 3). 1H NMR (CDCl3, 400 MHz) δ, ppm: 7.39 d (J 9.3 Hz, 1H_arom), 6.55–6.44 m (2H_arom), 5.02 d (J 7.9 Hz, 1H), 3.89 s (3H, OCH3), 3.81 s (3H, OCH3), 3.38 dd (J 16.7, 3.6 Hz, 1H), 3.26 dd (J 16.7, 10.2 Hz, 1H), 2.09 s (3H, CH3). 13C NMR (CDCl3, 101 MHz) δ, ppm: 204.6 (C=O), 160.8 (C_arom-OCH3), 159.4 (C_arom-OCH3), 128.8 (C_arom), 117.81 (C_arom), 104.4 (C_arom), 103.9 (C_arom), 98.8 (CCl3), 55.1 (OCH3), 55.3 (OCH3), 50.7, 46.6, 30.2 (CH3). HRMS-APCI: m/z calc. C13H15Cl2O3 [M + H]+ 325.0165, found 325.0160.

4. Conclusions

A novel method for the synthesis of 3-methyl-1-trichloromethylenes has been developed based on the reaction of 5,5,5-trichloropent-3-en-2-one with arenes in Brønsted superacid CF3SO3H. In this transformation, the initial 5,5,5-trichloropent-3-en-2-one in CF3SO3H behaves as a 1,3-bi-centered electrophile.
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