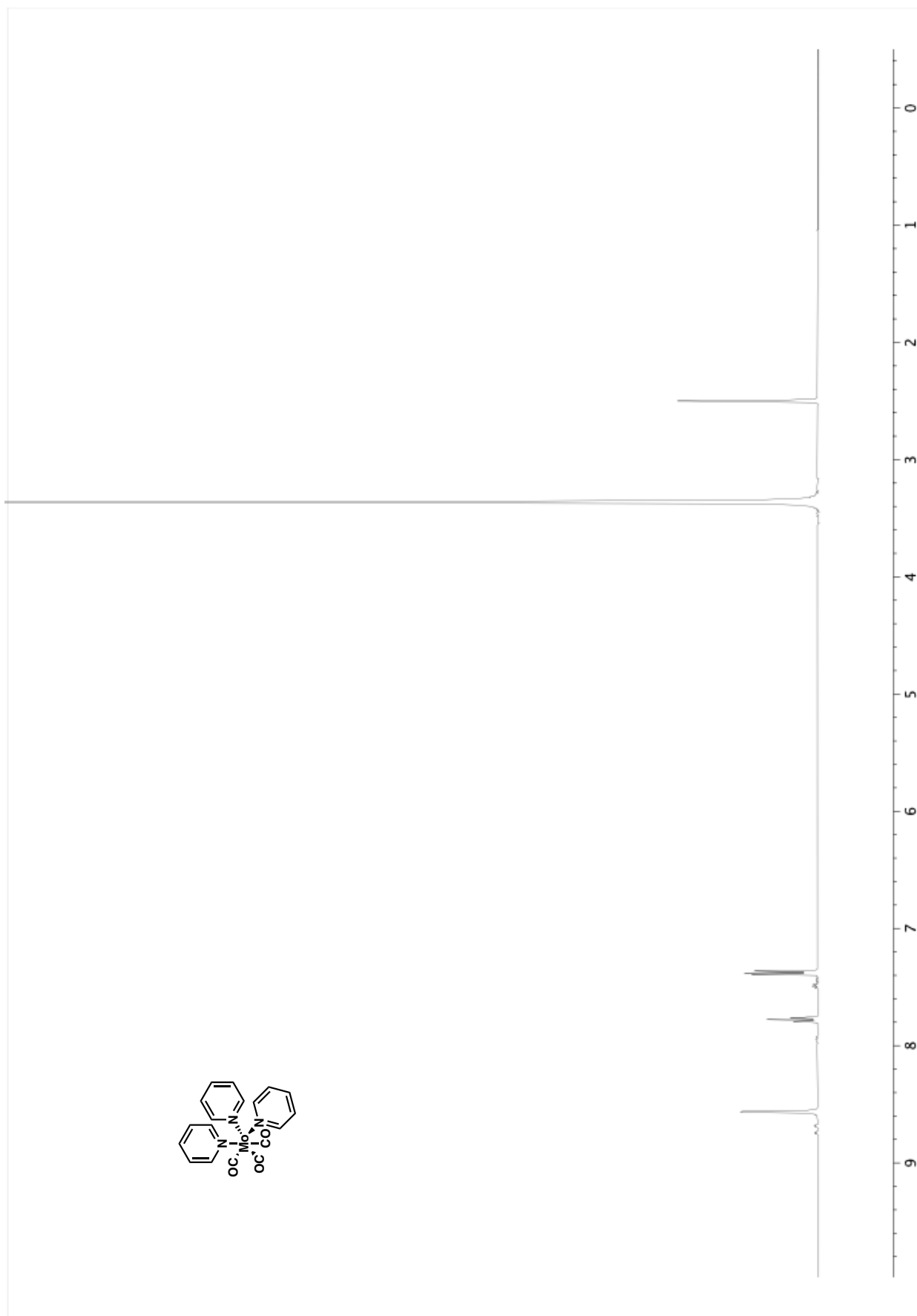


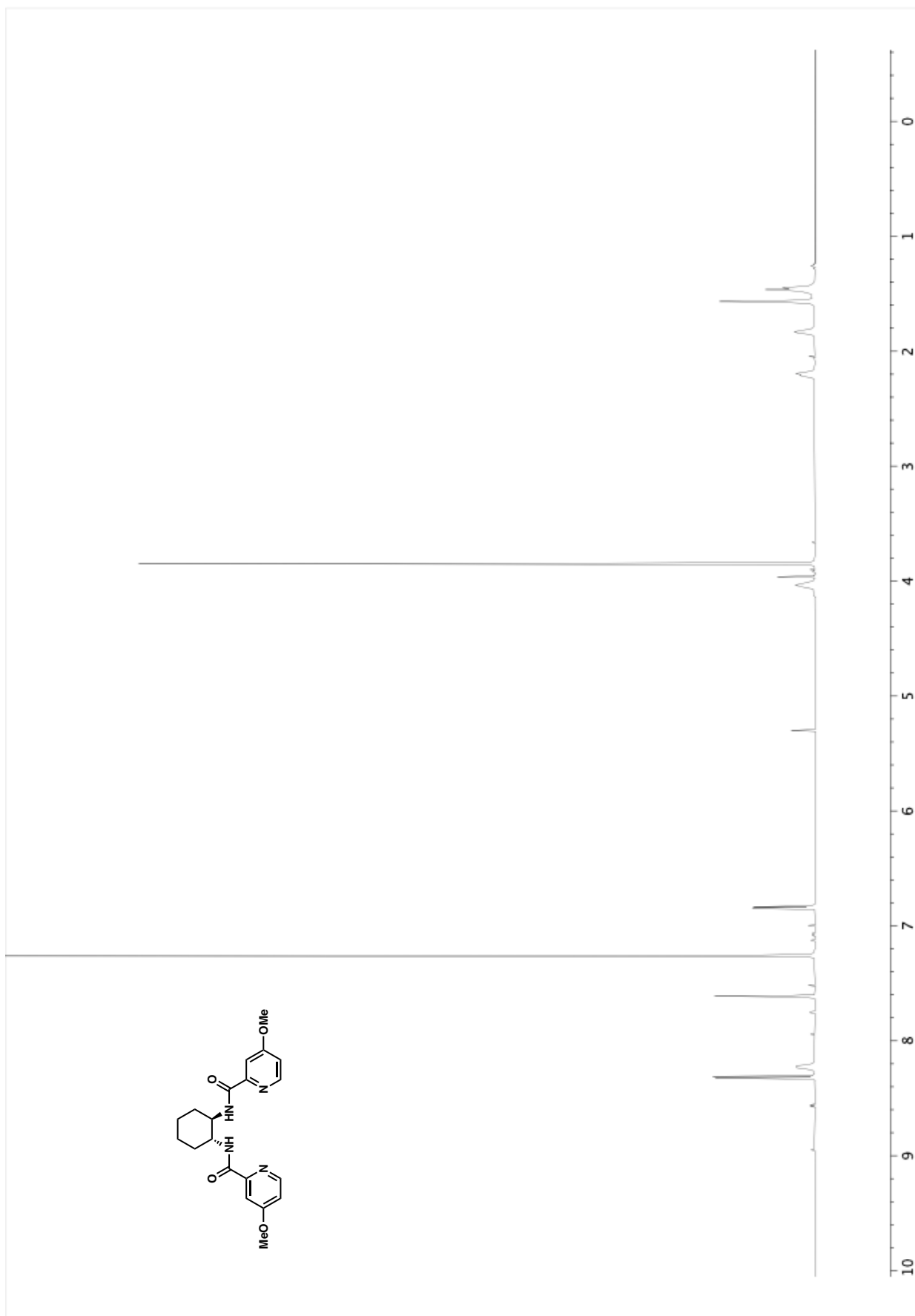
## ***APPENDIX 3***

*Spectra Relevant to Chapter 2:*

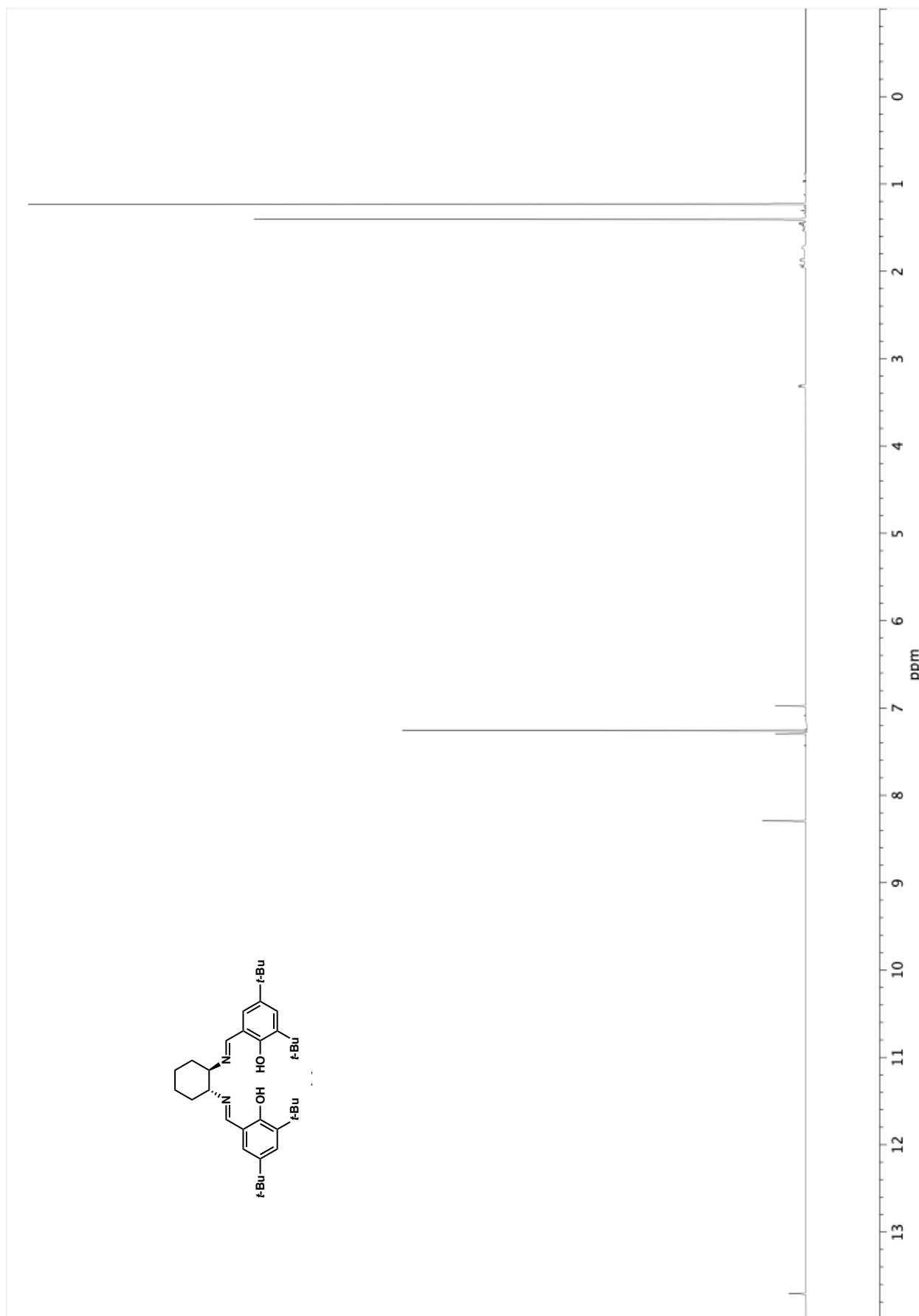
*Mo-Catalyzed Asymmetric Allylic Alkylation Enabling the Construction  
of Highly Enantioenriched 1,4-Dicarbonyl Scaffolds*



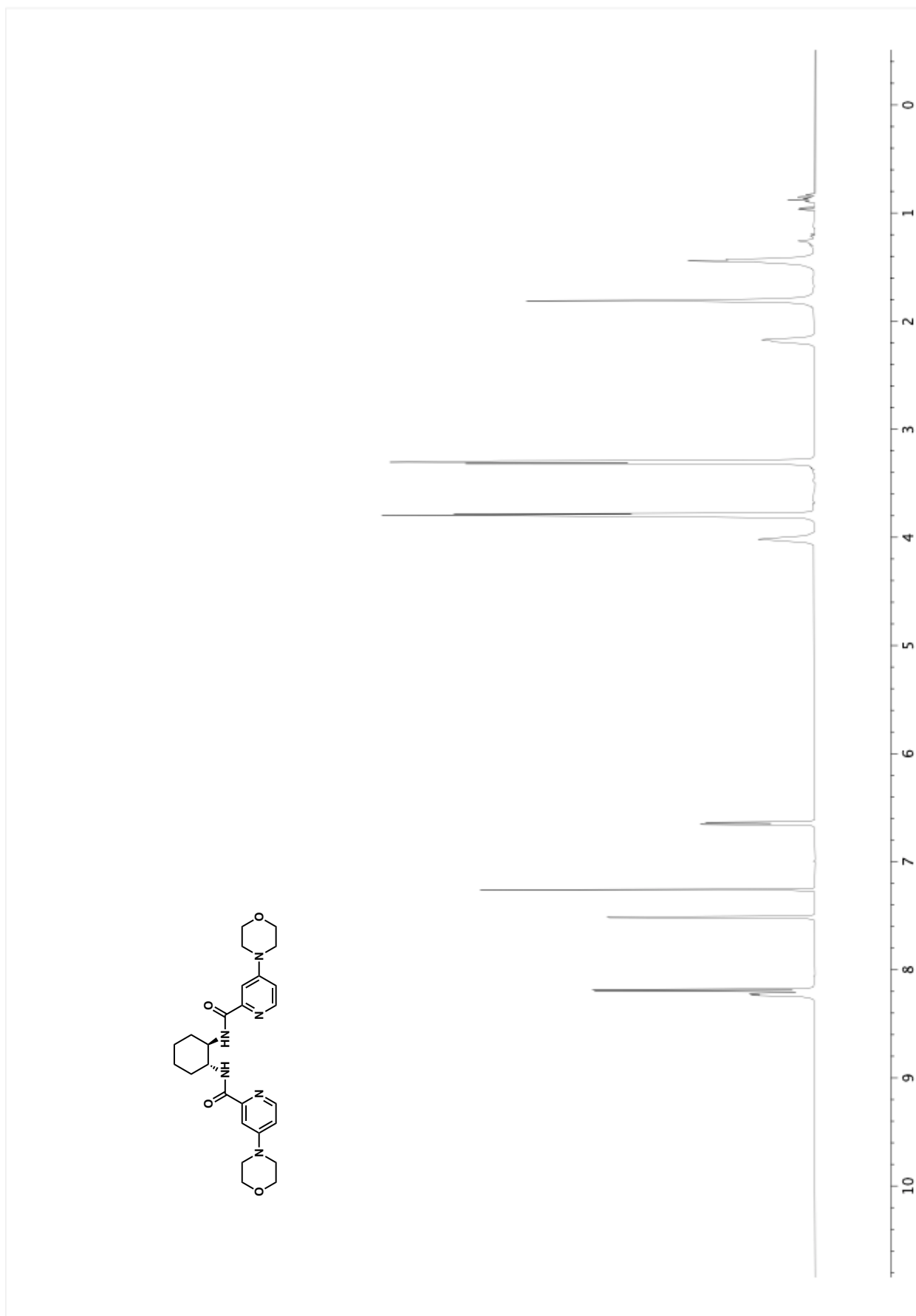
**Figure A3.1.**  $^1\text{H}$  NMR (500 MHz,  $\text{DMSO-}d_6$ ) of  $\text{Mo(CO)}_3(\text{pyr})_3$ .



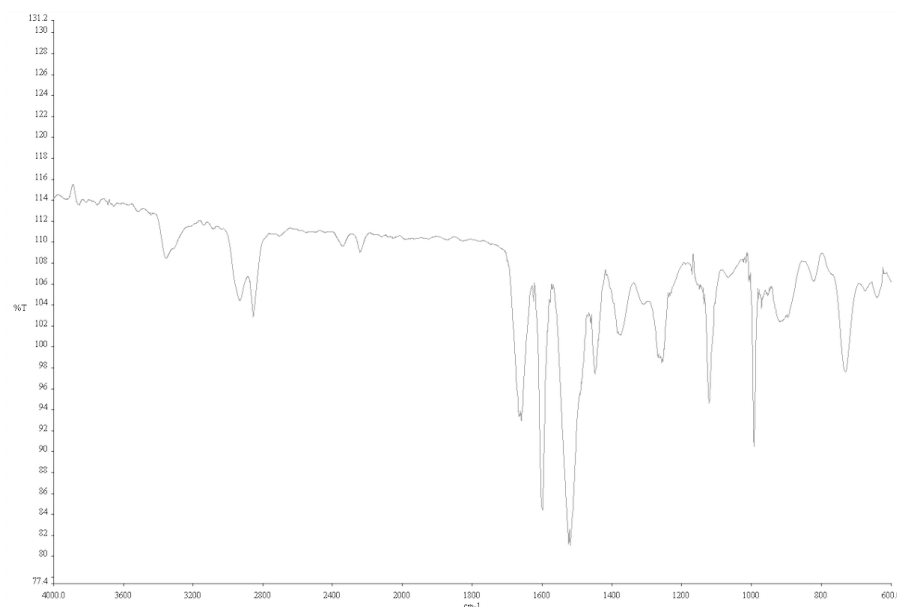
**Figure A3.2.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **L4**.



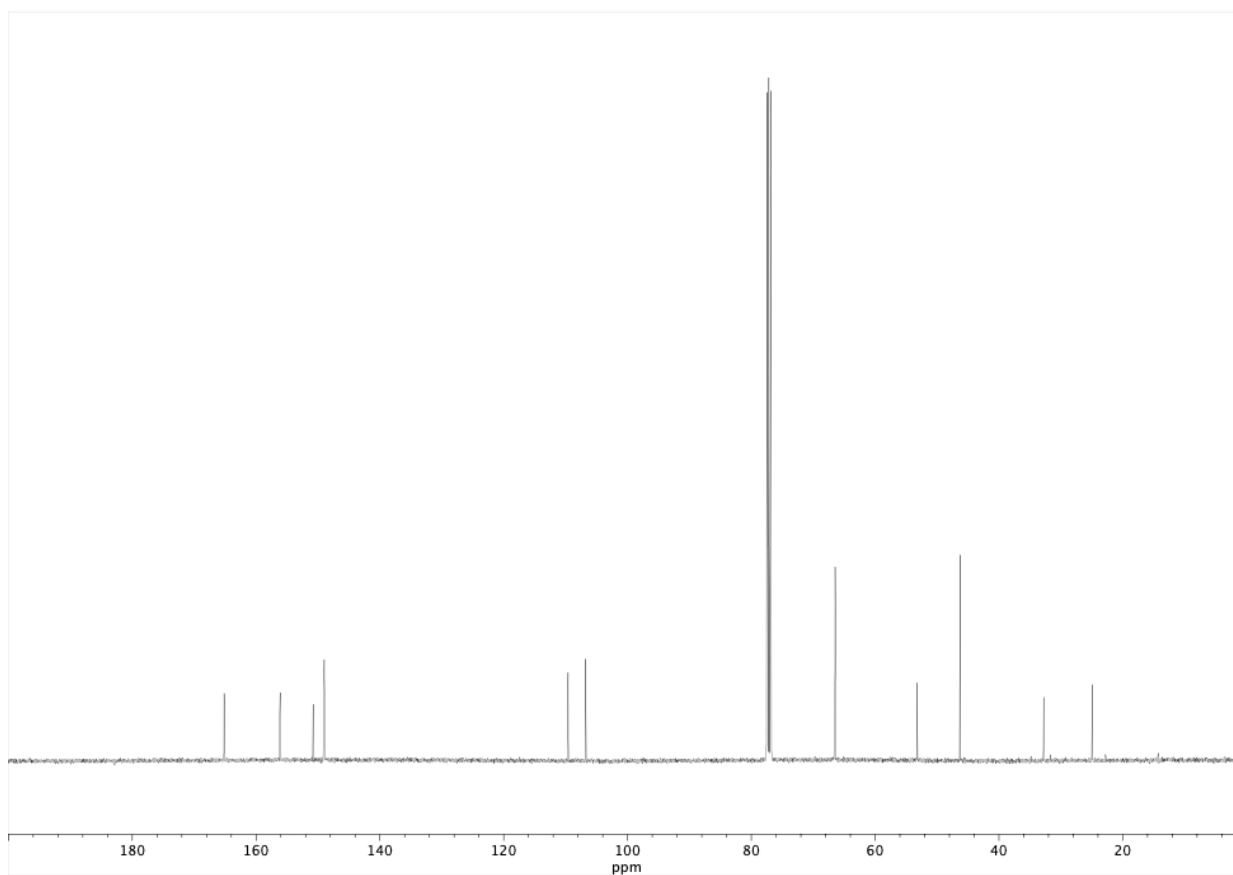
**Figure A3.3.**  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ ) of **L7**.



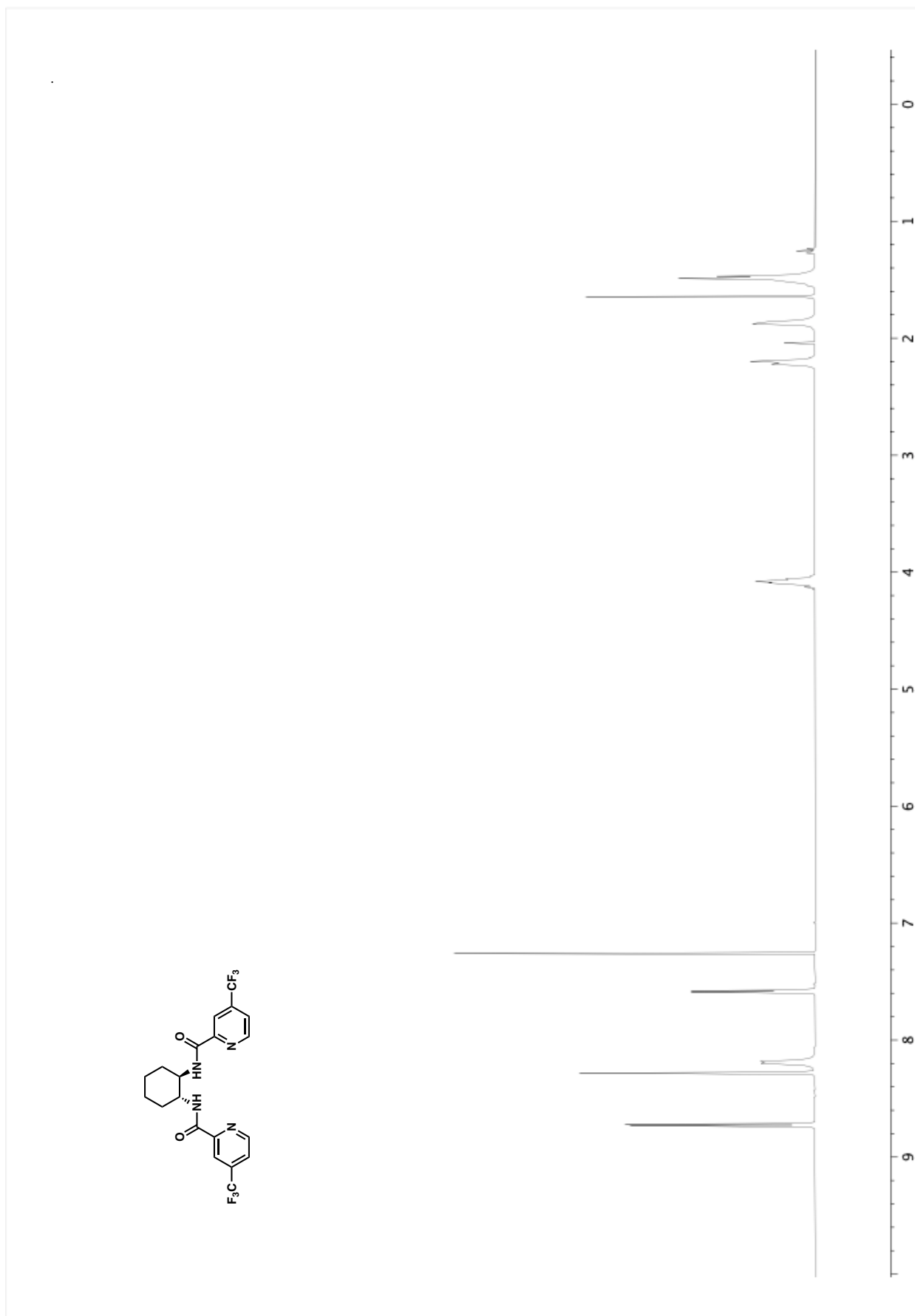
**Figure A3.4.** <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) of **L8**.



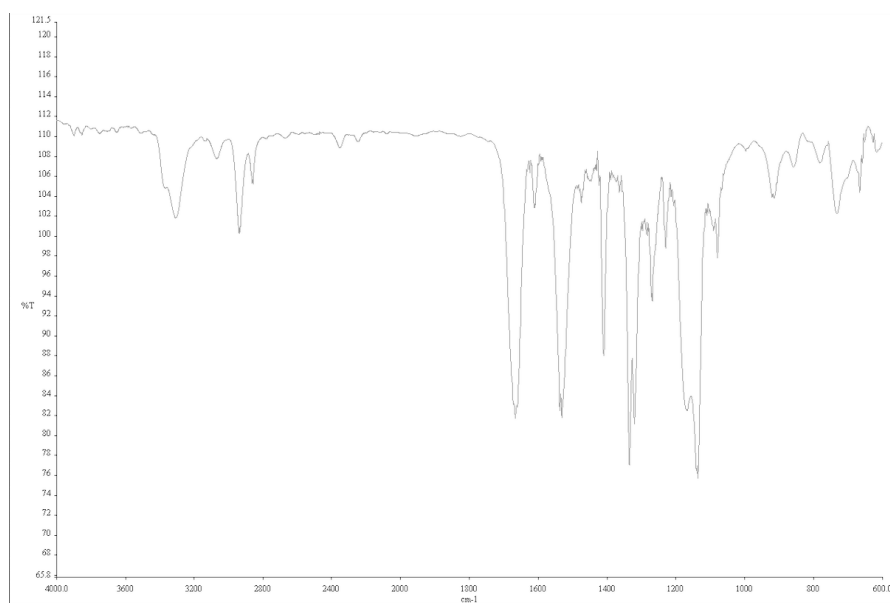
**Figure A3.5.** Infrared spectrum (Thin Film, NaCl) of **L8**.



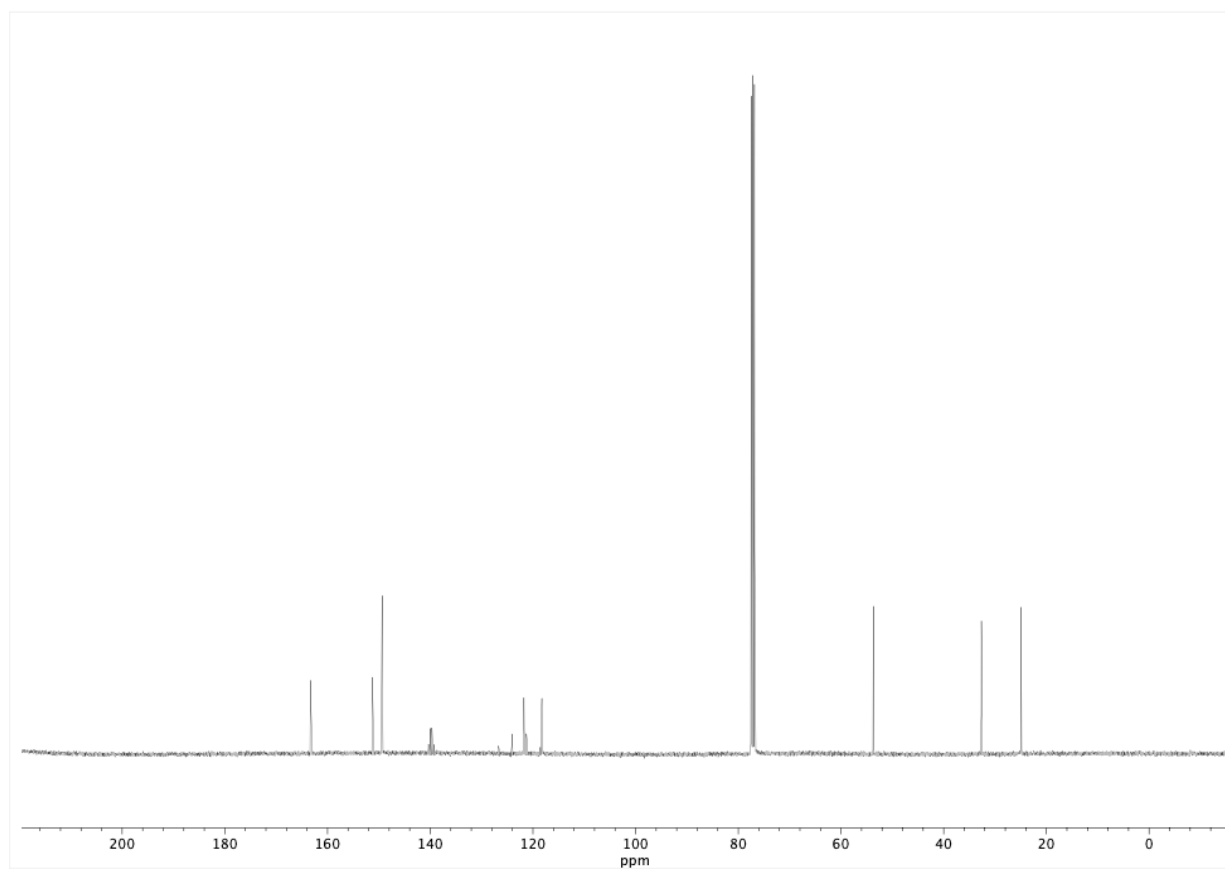
**Figure A3.6.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **L8**.



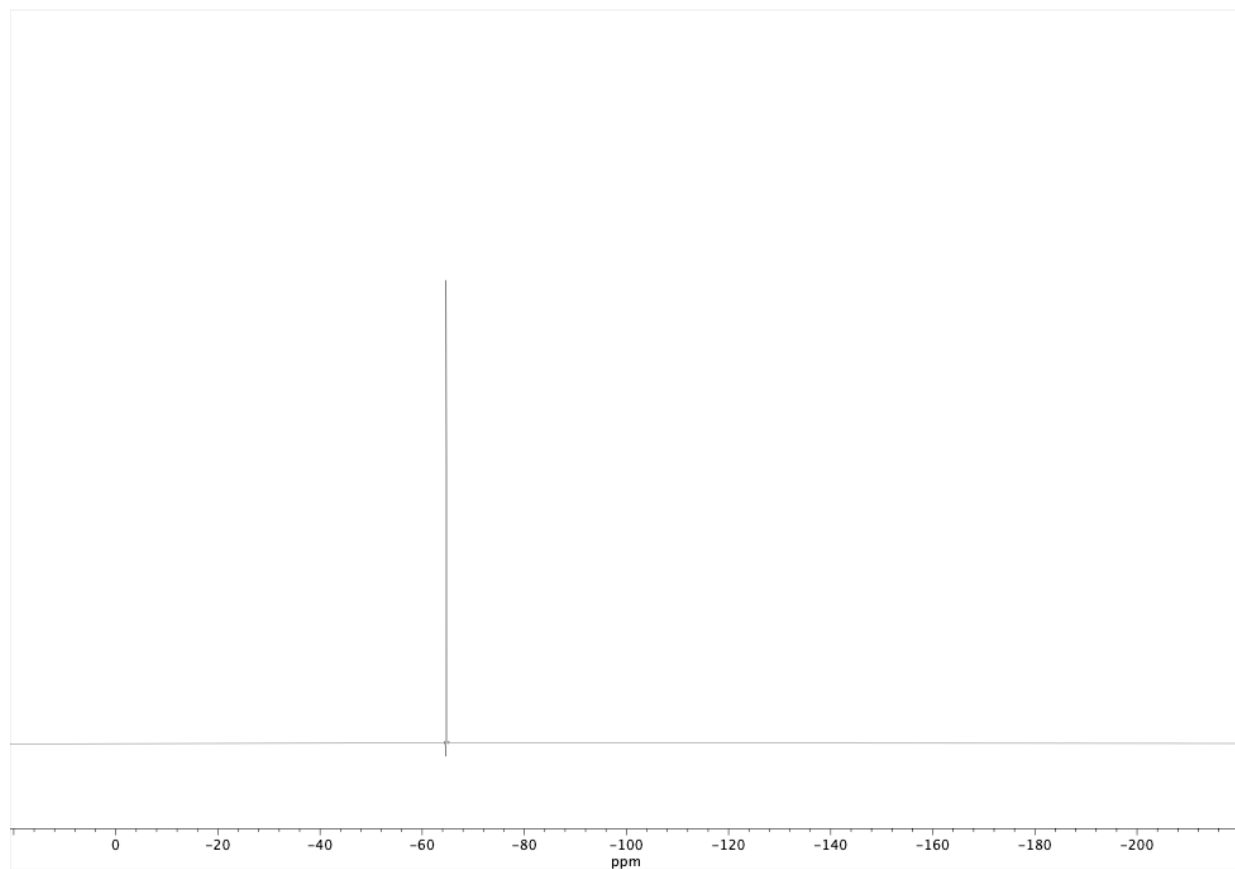
**Figure A3.7.** <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) of **19**.



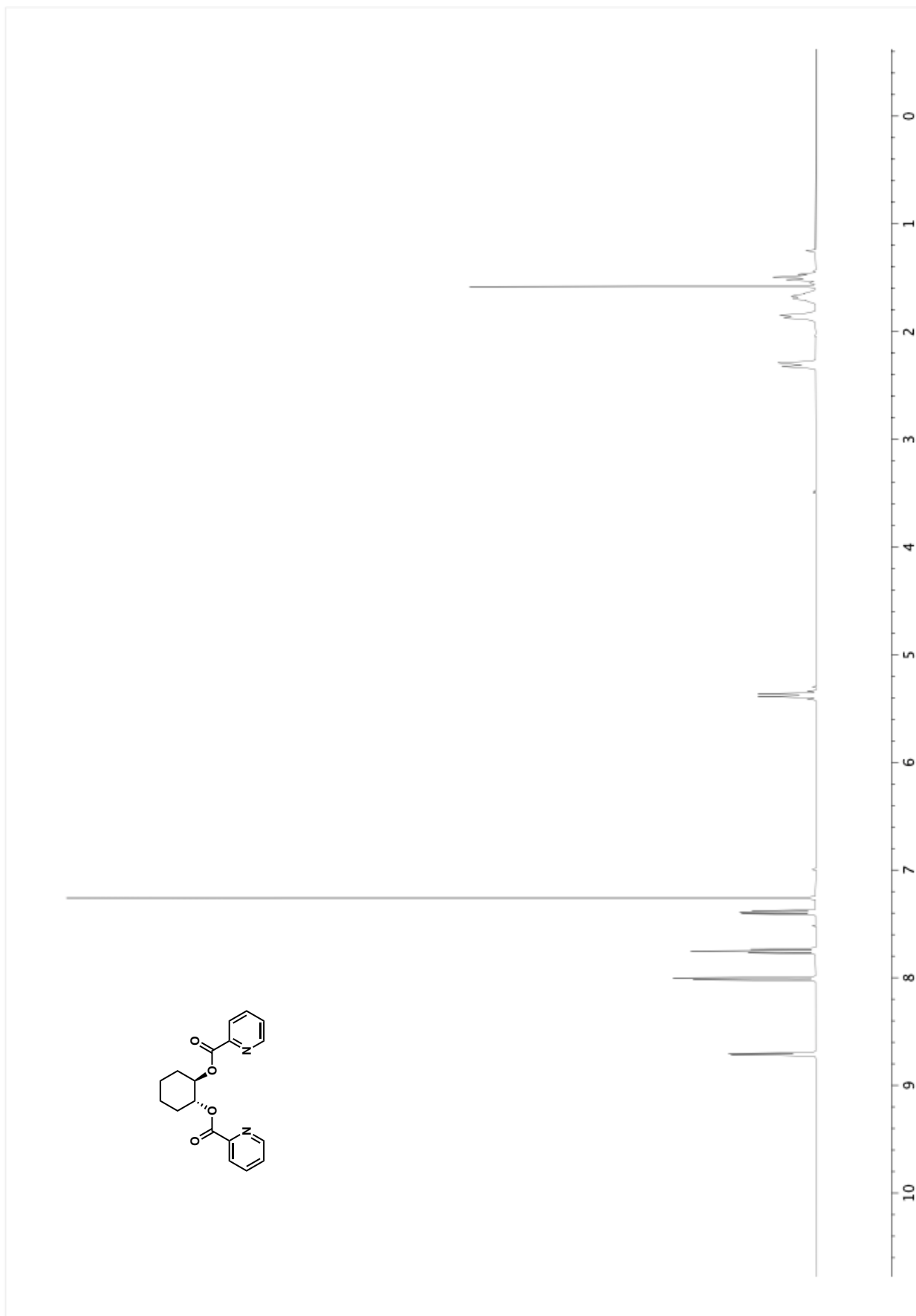
**Figure A3.8.** Infrared spectrum (Thin Film, NaCl) of **L9**.



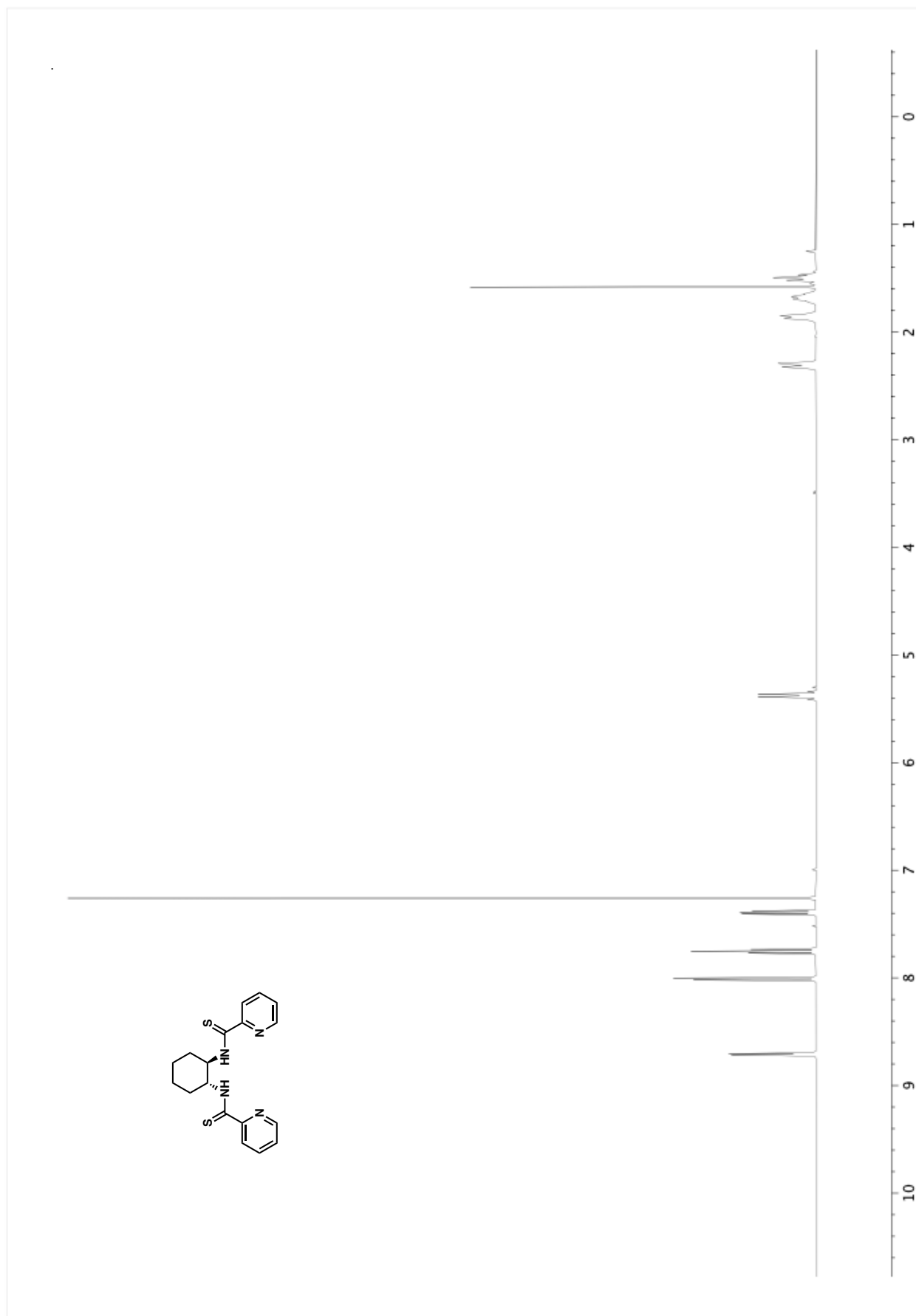
**Figure A3.9.**  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) of **L9**.



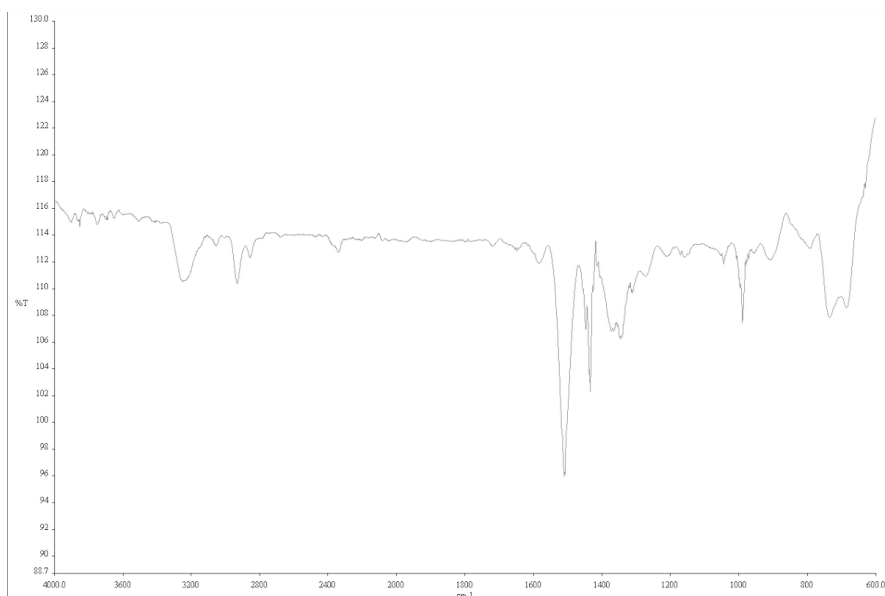
**Figure A3.10.**  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ ) of **L9**.



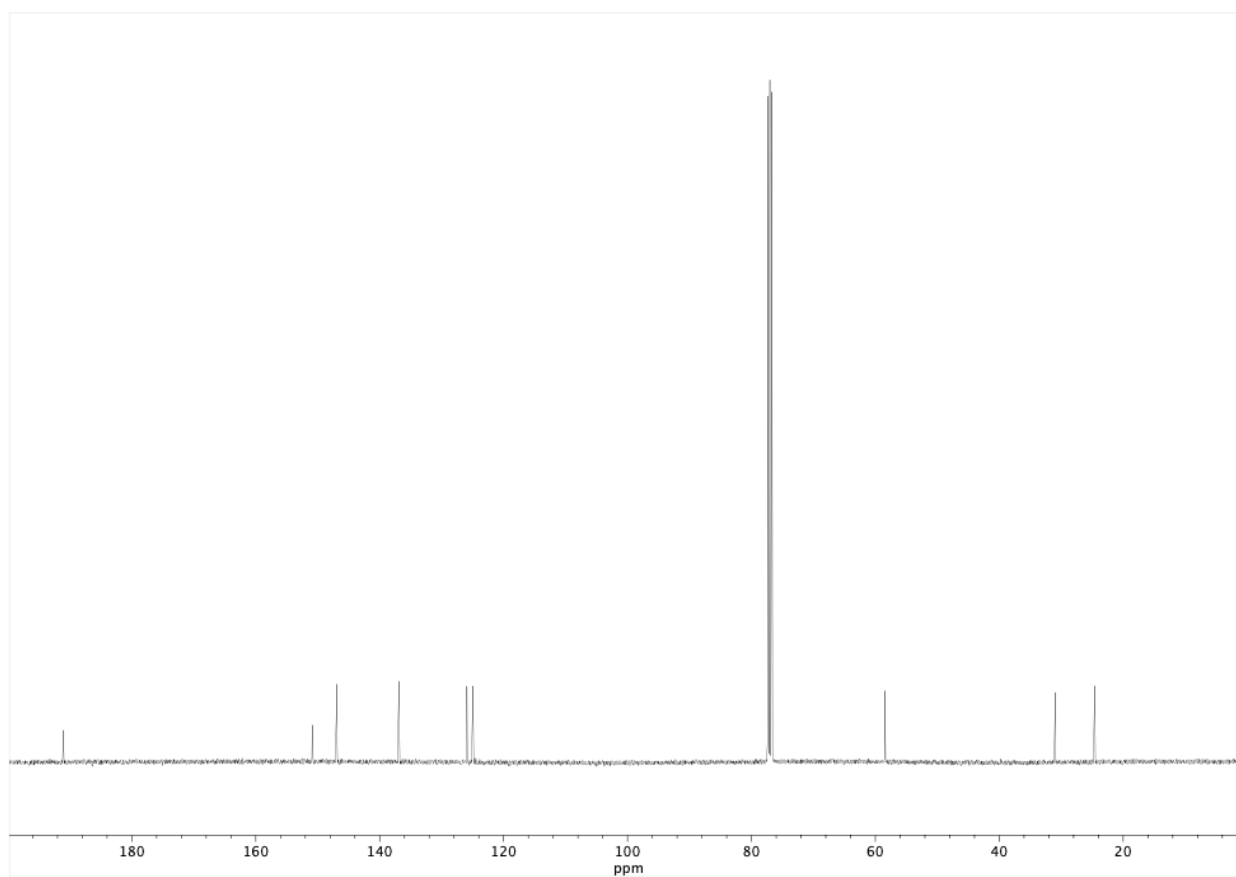
**Figure A3.11.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **L11**.



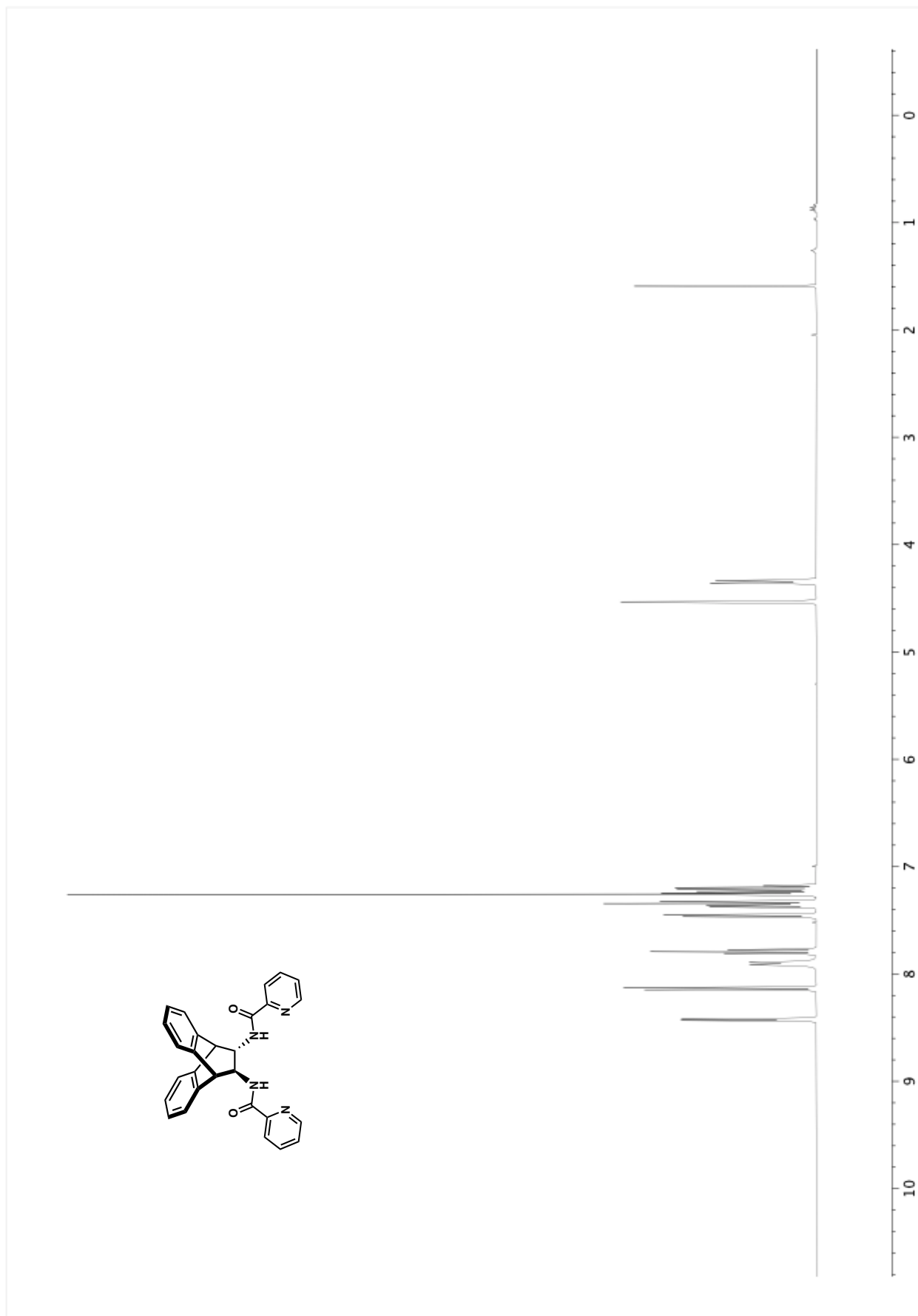
**Figure A3.12.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **L12**.



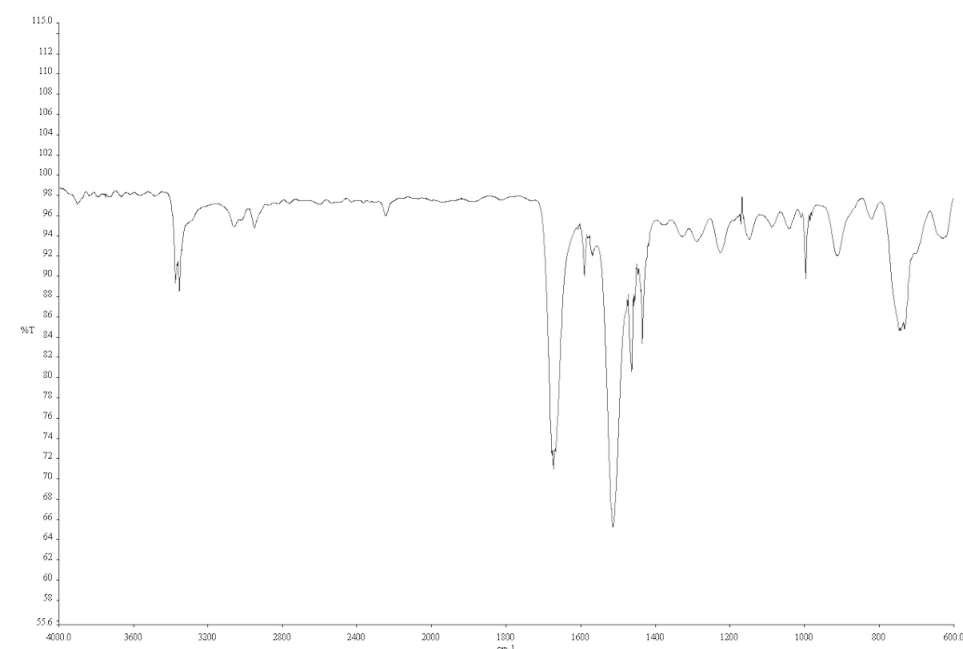
**Figure A3.13.** Infrared spectrum (Thin Film, NaCl) of **L12**.



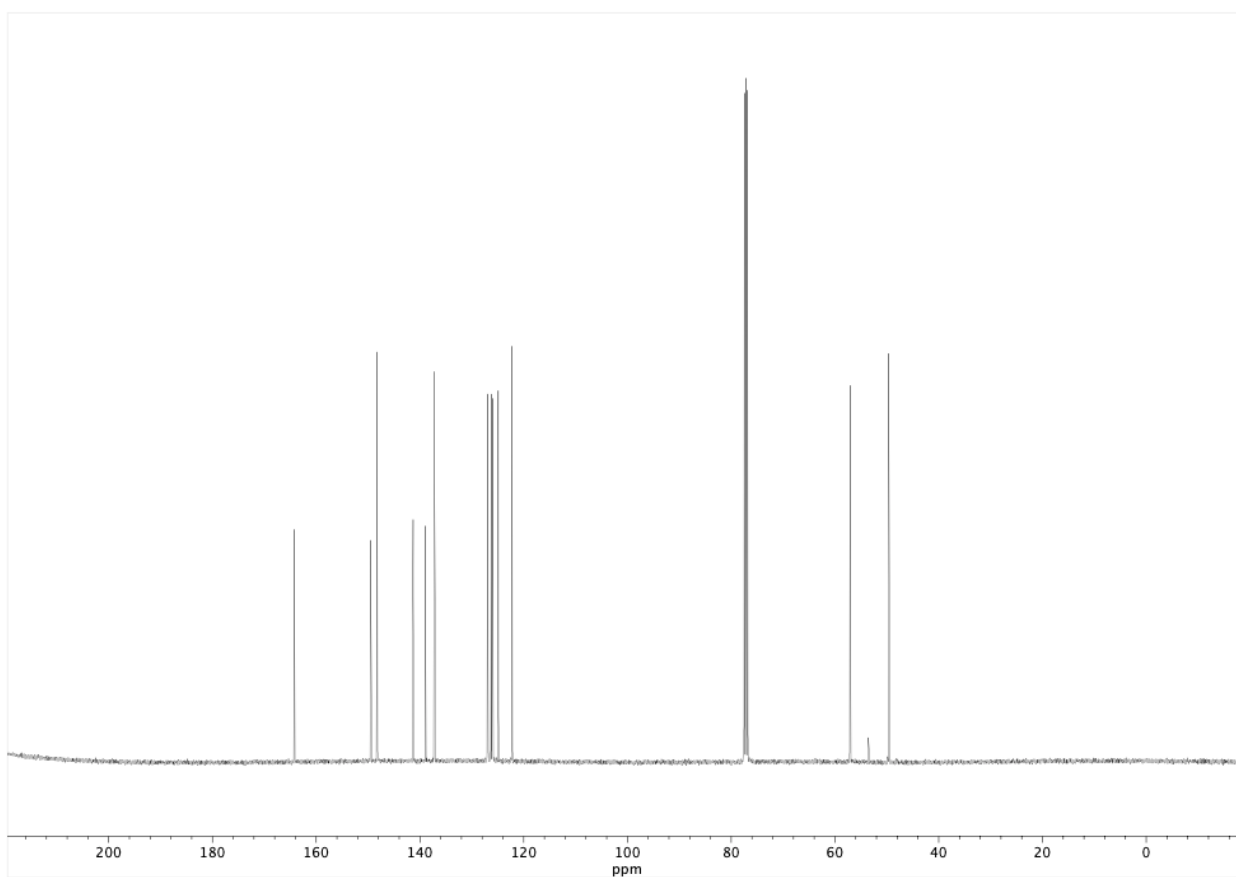
**Figure A3.14.**  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) of **L12**.



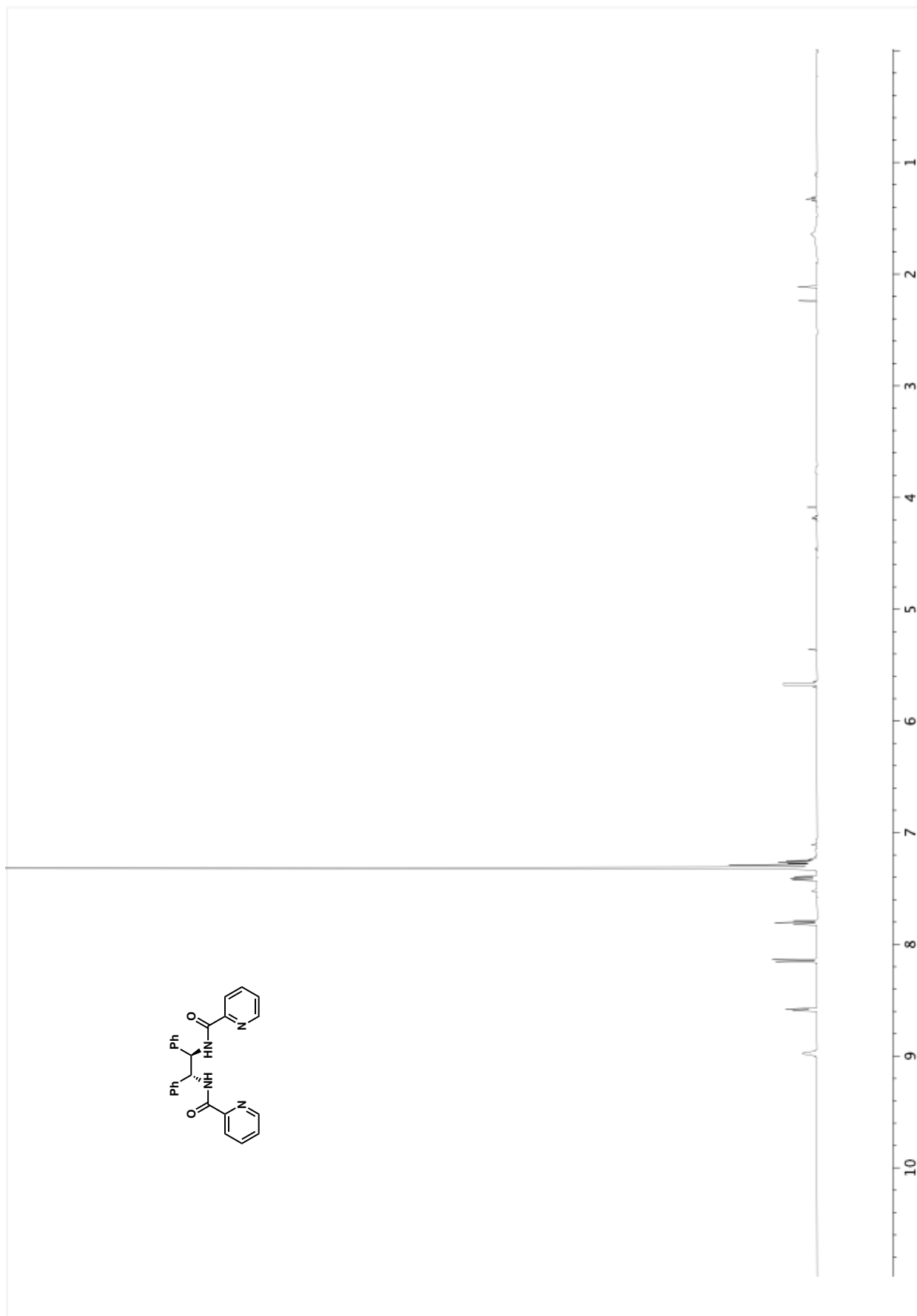
**Figure A3.15.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **L14**.



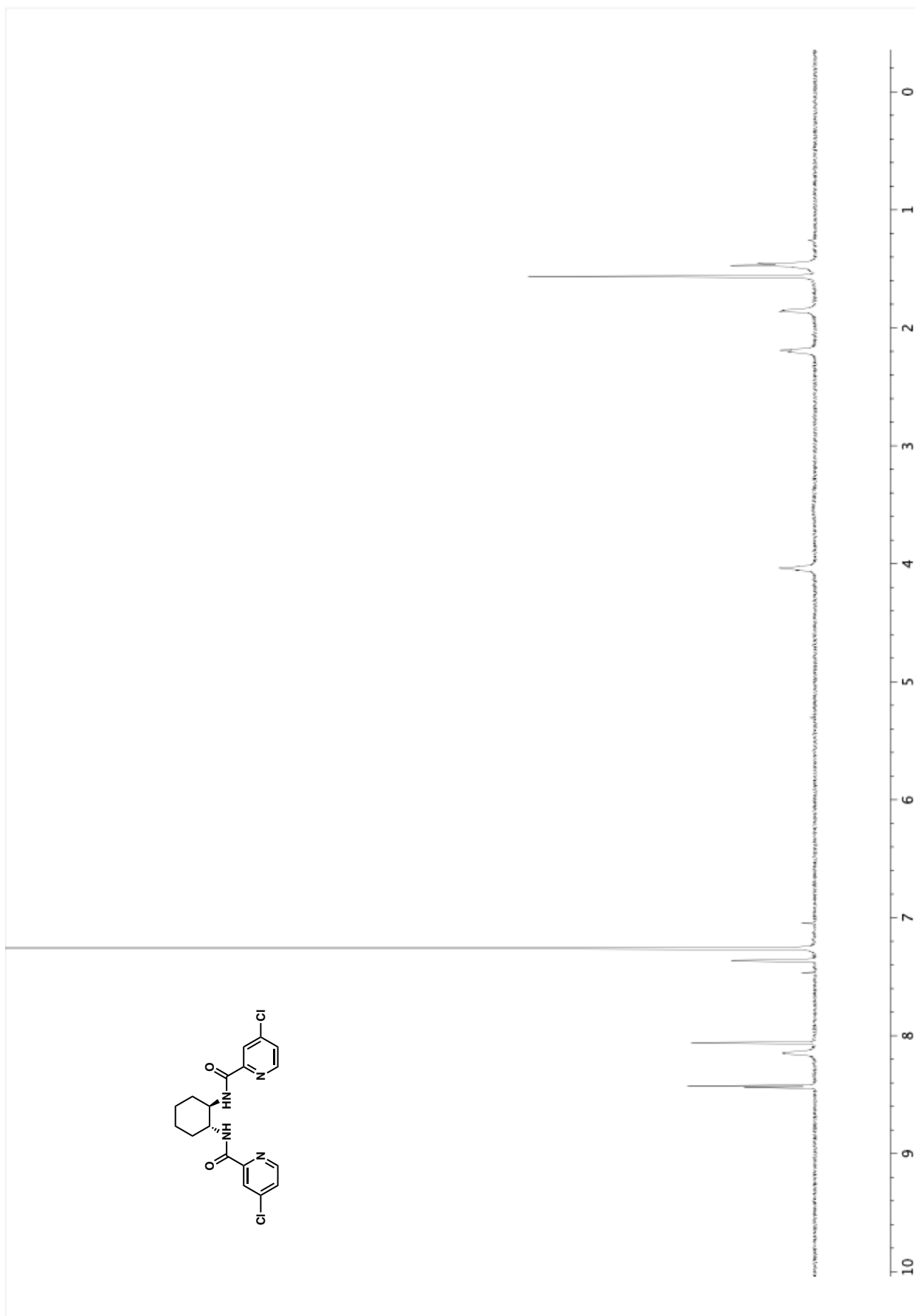
**Figure A3.16.** Infrared spectrum (Thin Film, NaCl) of **L14**.



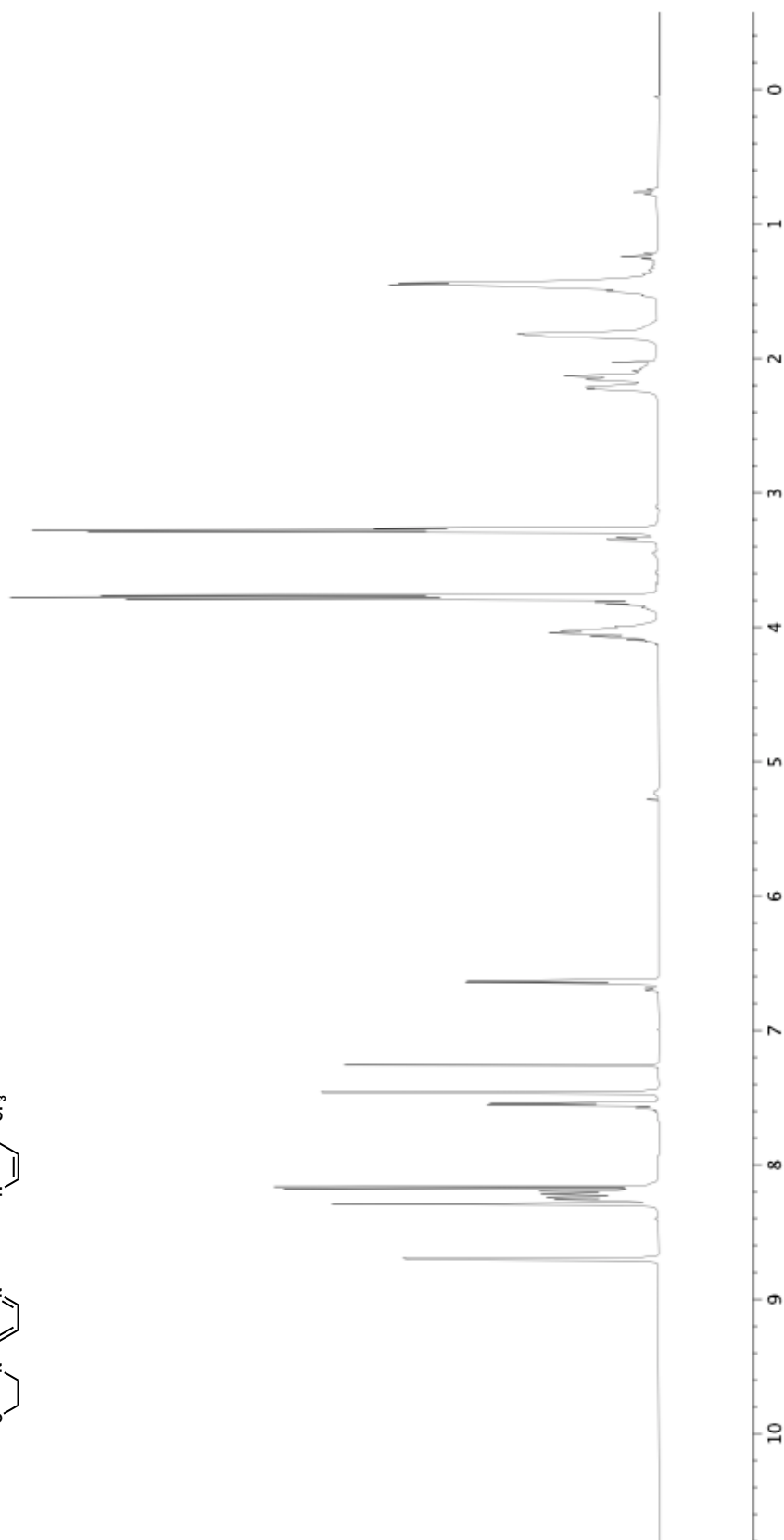
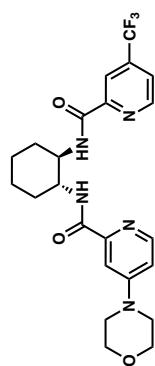
**Figure A3.17.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **L14**.



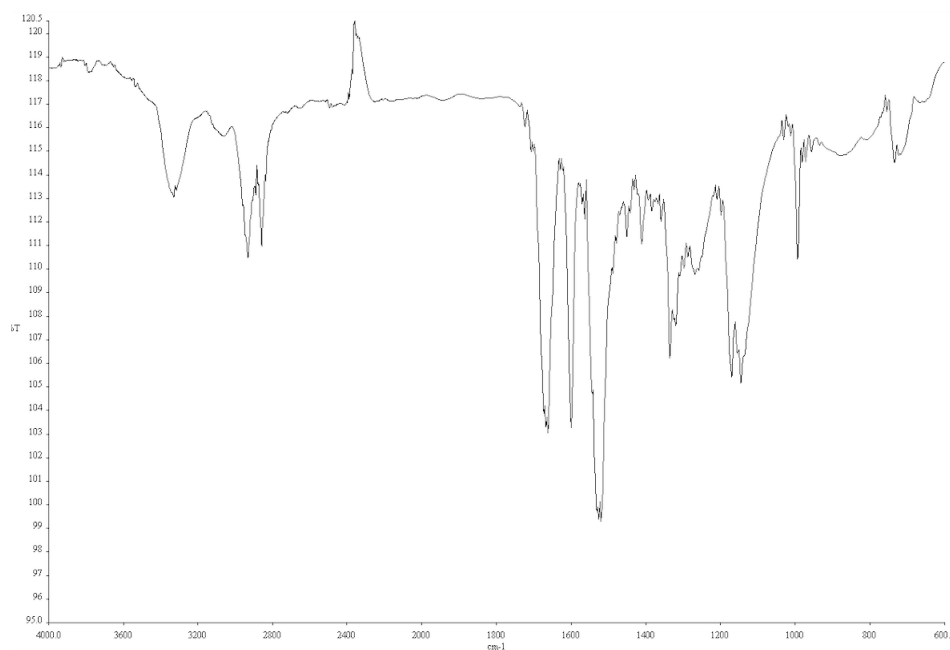
**Figure A3.18.**  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ ) of **L15**.



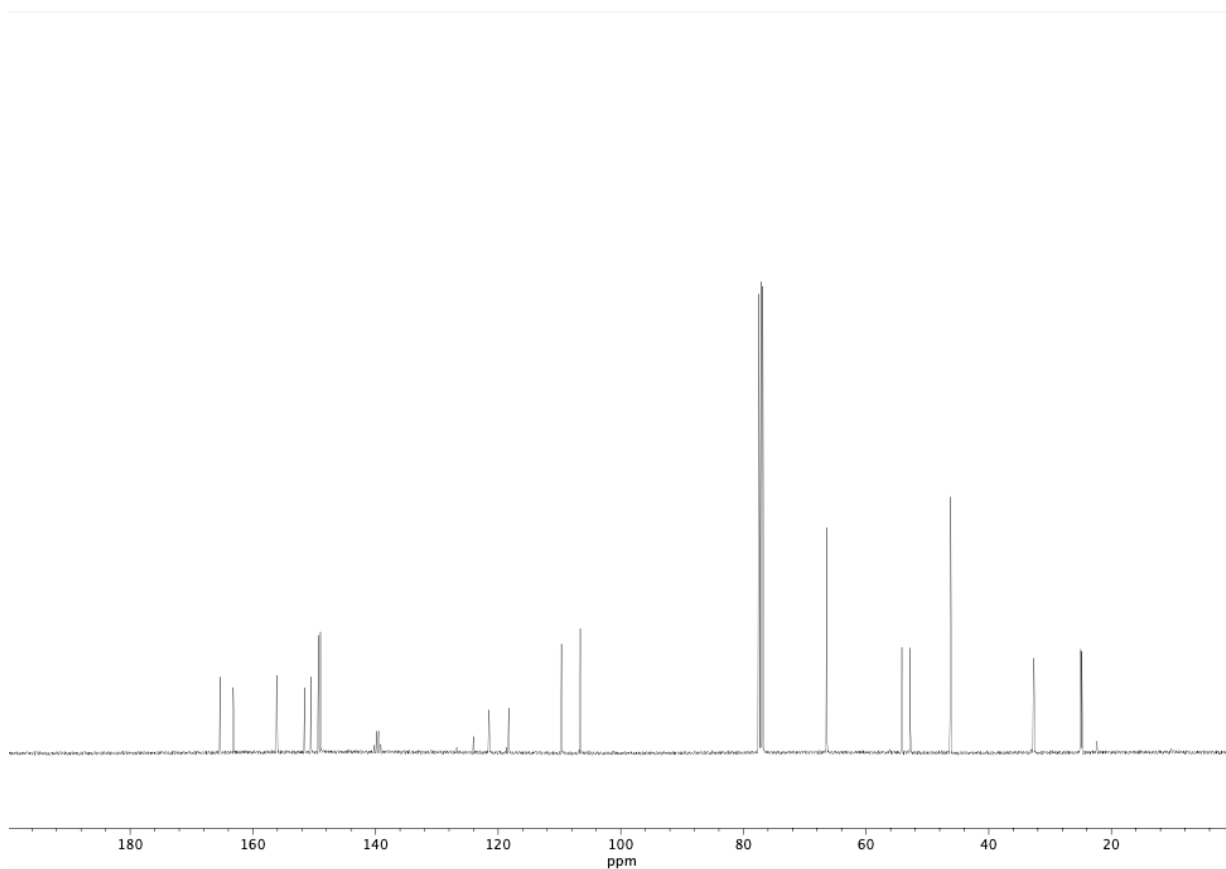
**Figure A3.19.**  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ ) of **L17**.



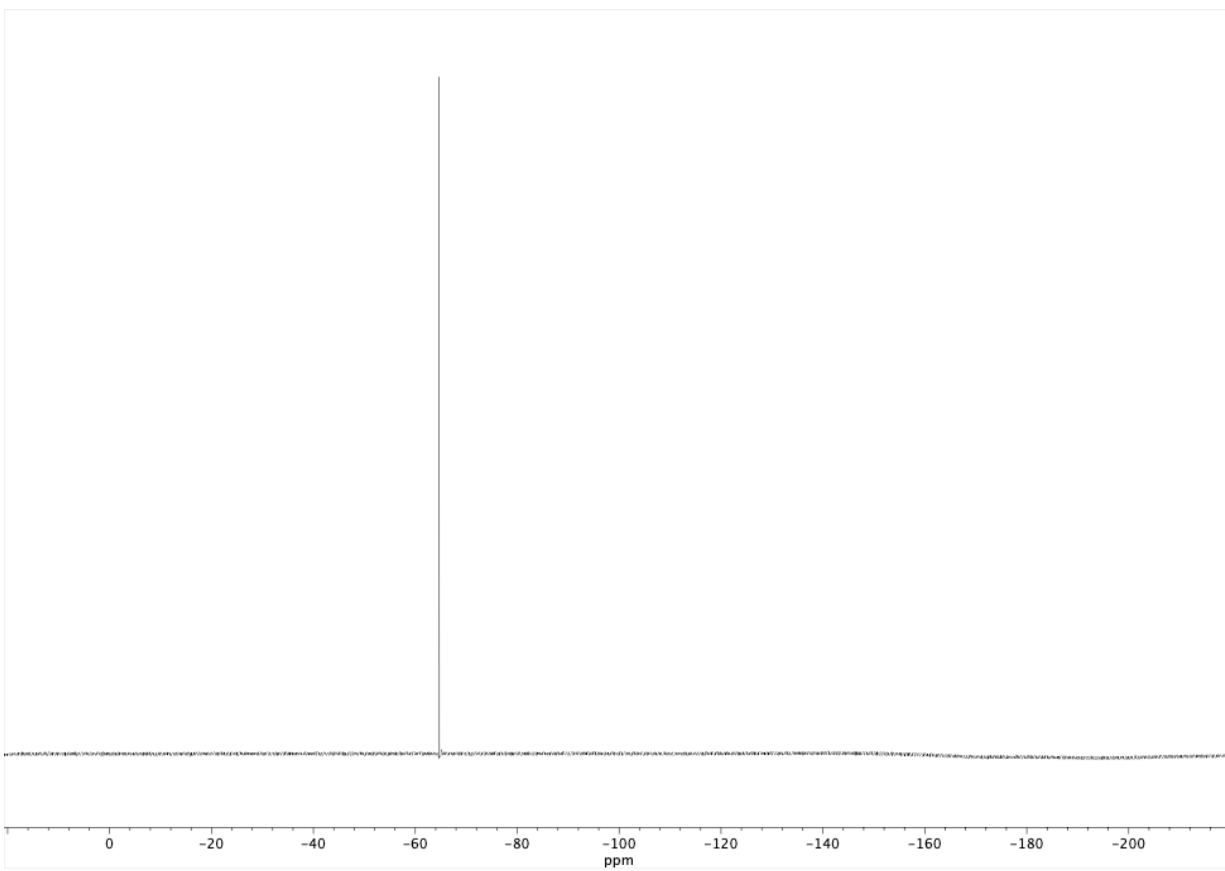
**Figure A3.20.** <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) of **L10**.



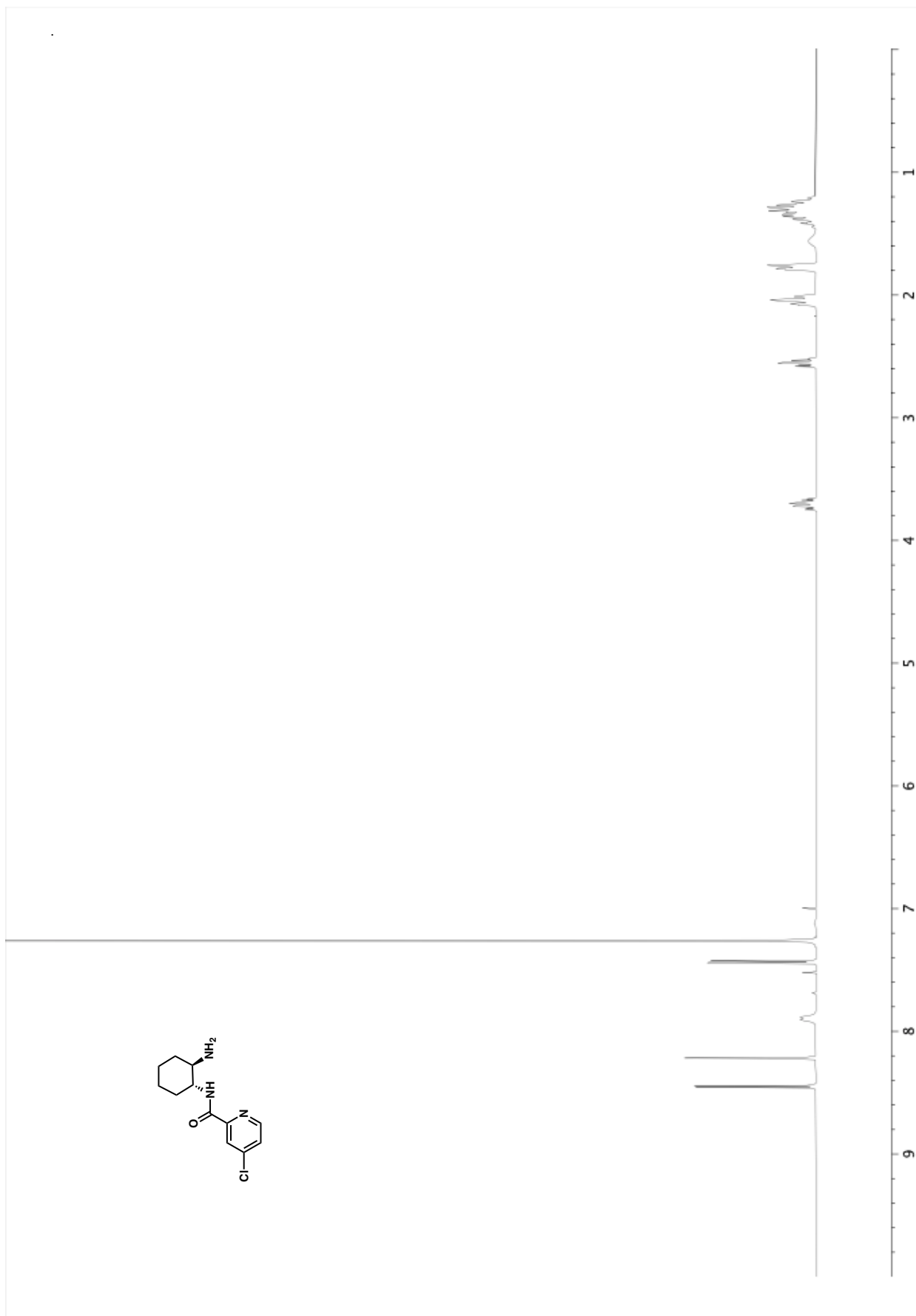
**Figure A3.21.** Infrared spectrum (Thin Film, NaCl) of **L10**.



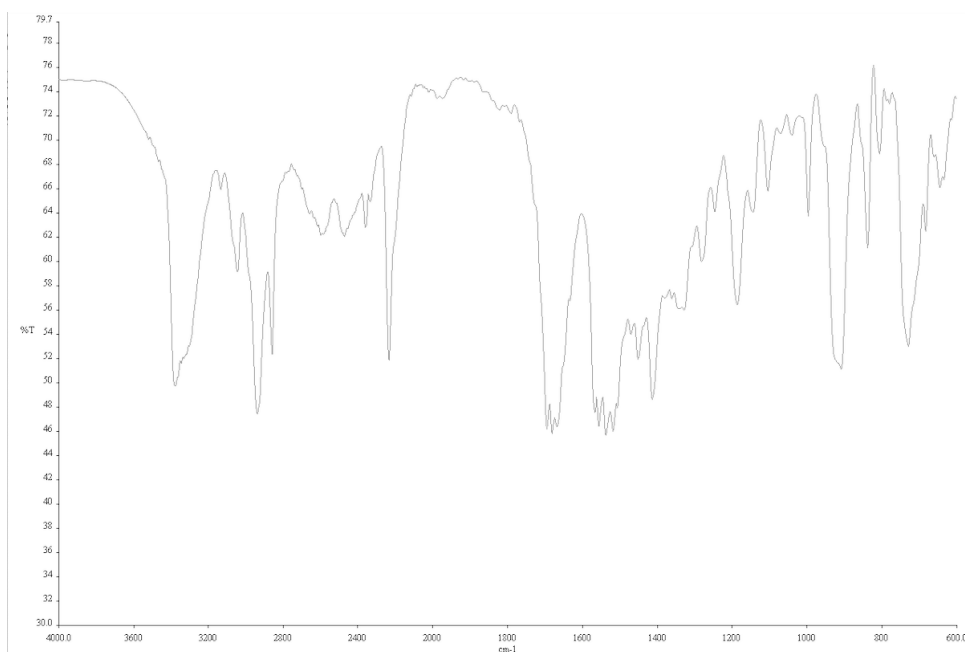
**Figure A3.22.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **L10**.



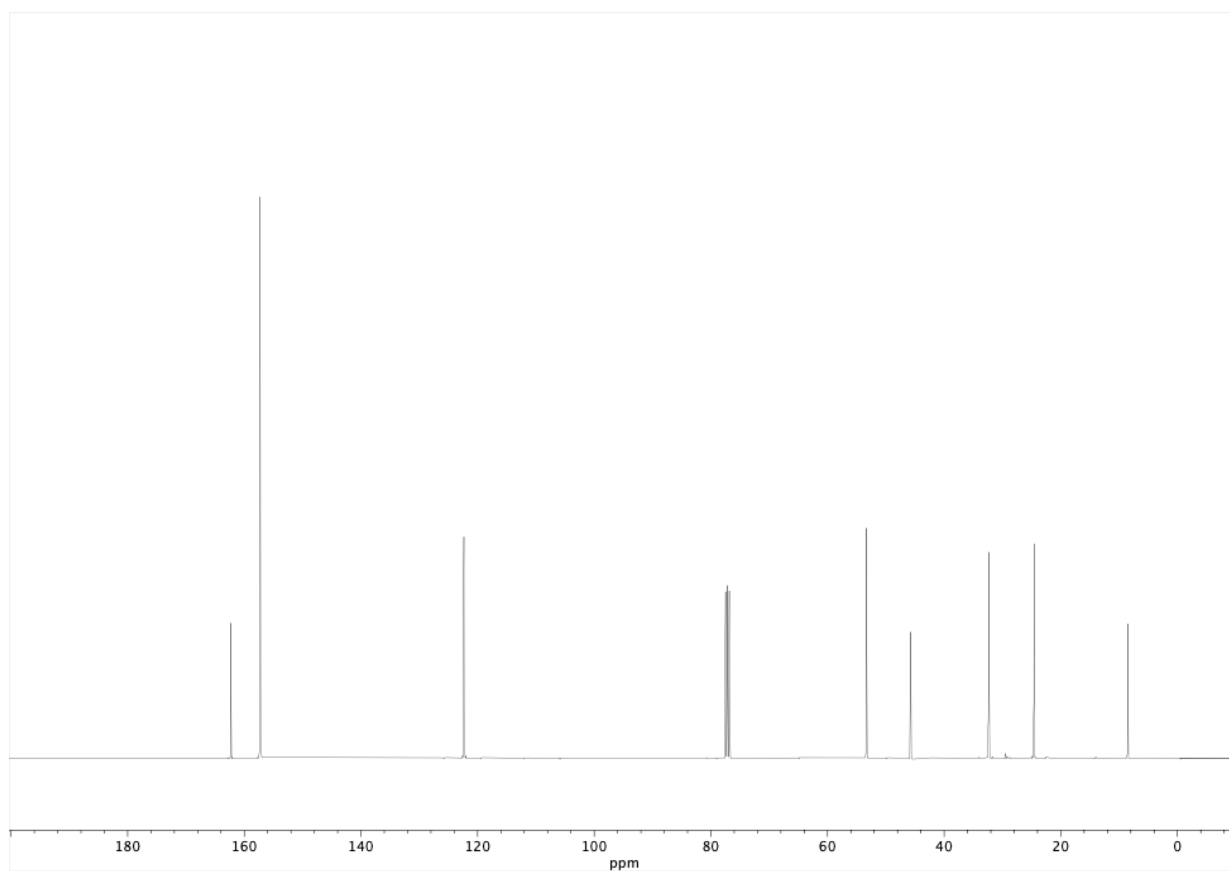
**Figure A3.23.**  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ ) of **L10**.



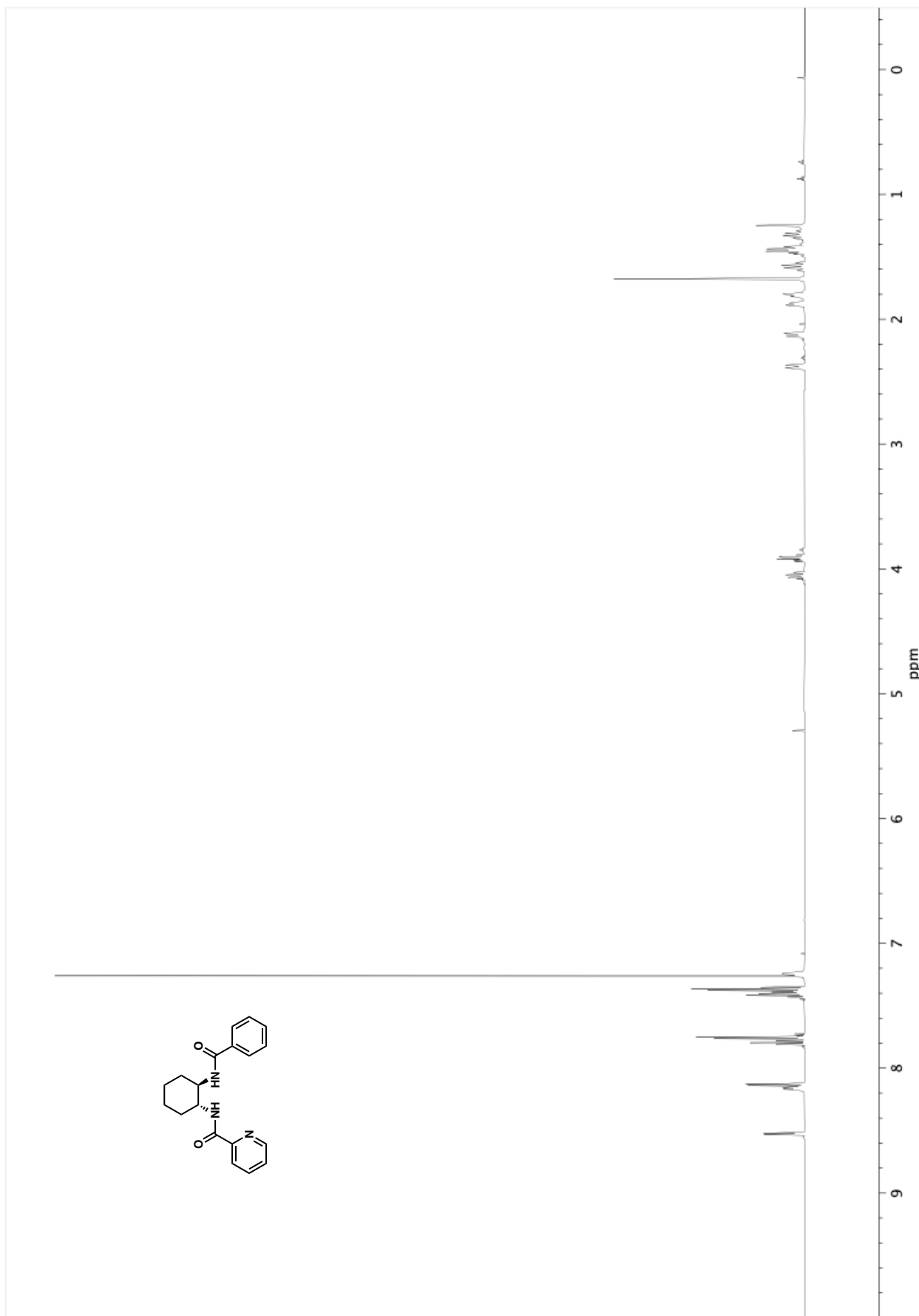
**Figure A3.24.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **S2**.



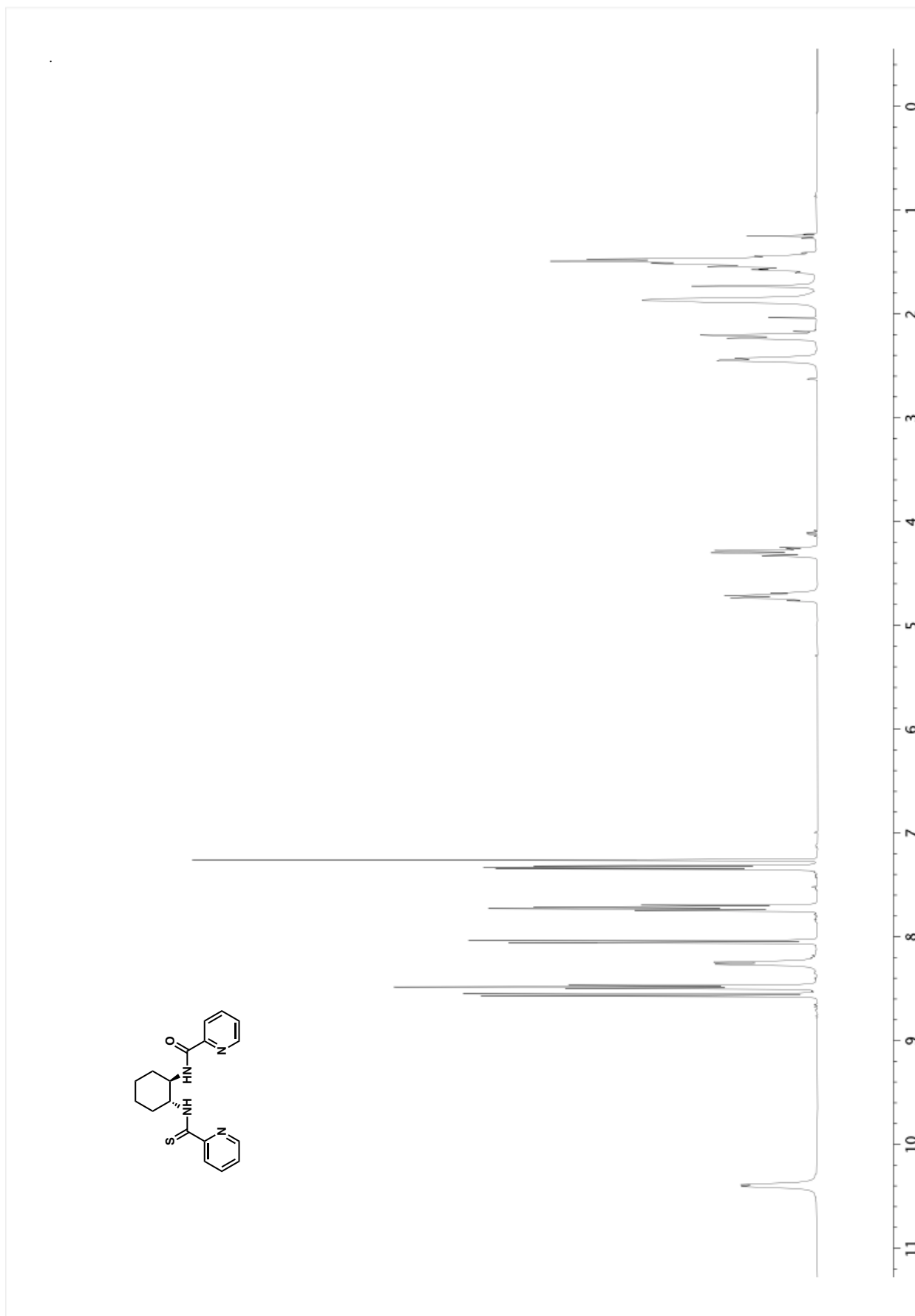
**Figure A3.25.** Infrared spectrum (Thin Film, NaCl) of **S2**.



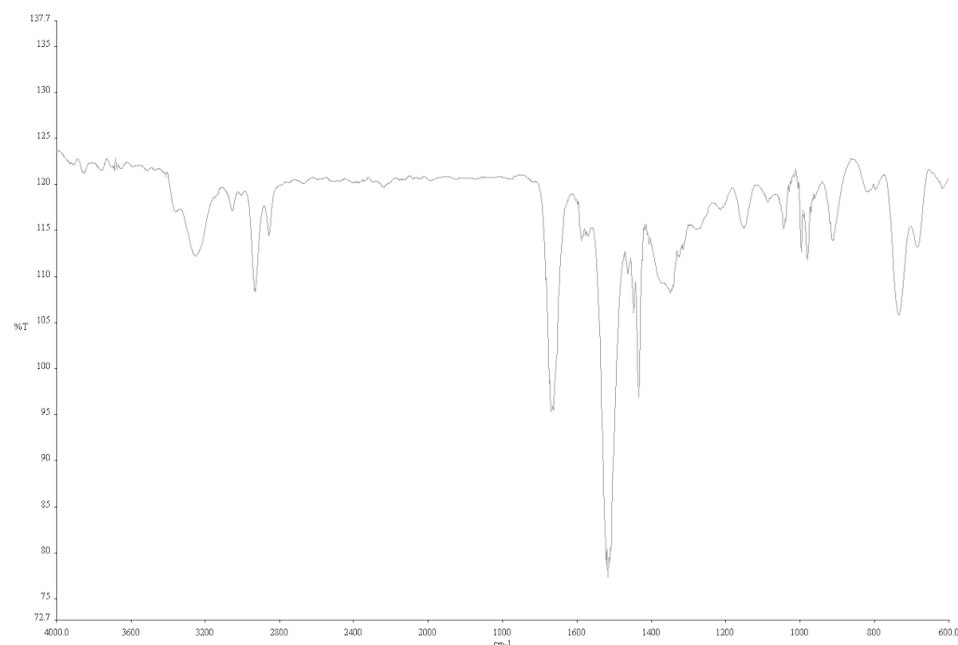
**Figure A3.26.**  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) of **S2**.



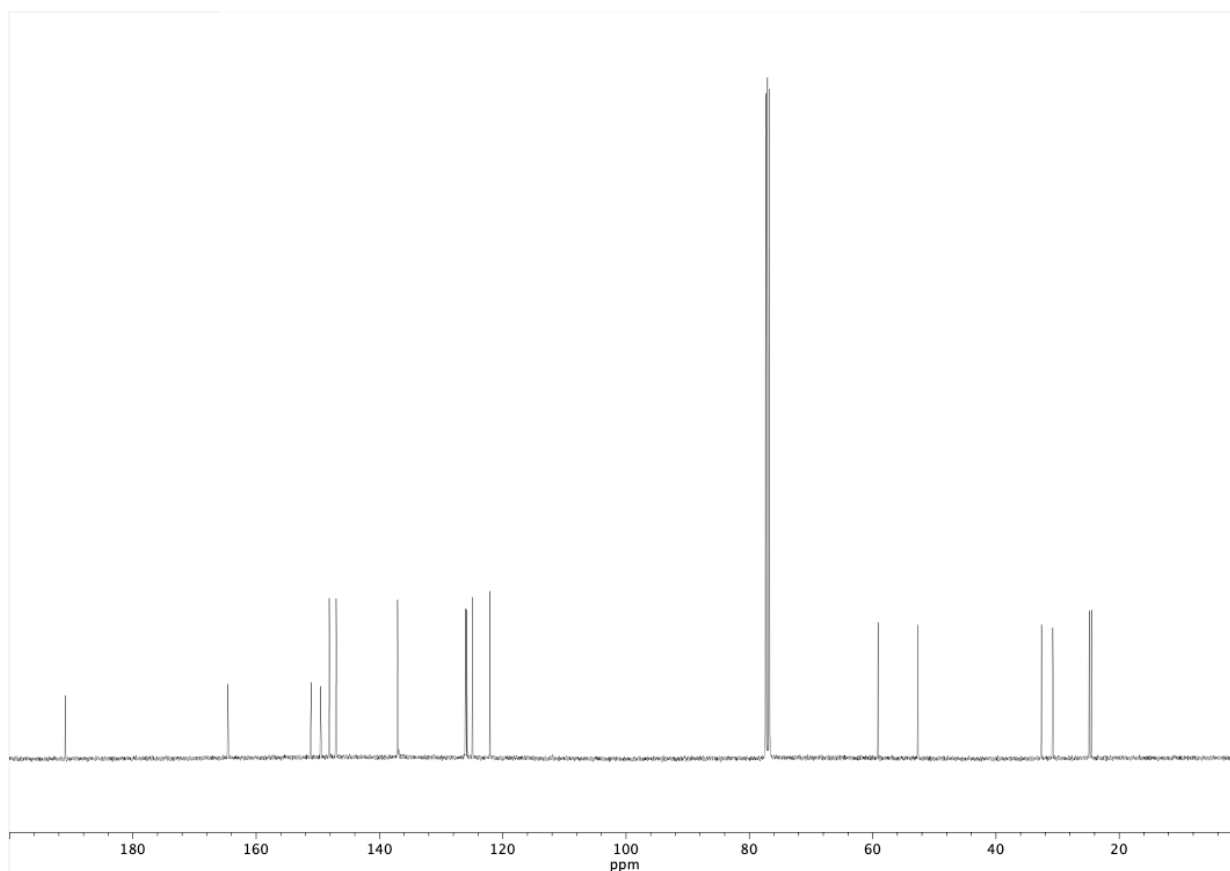
**Figure A3.27.**  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ ) of **16**.



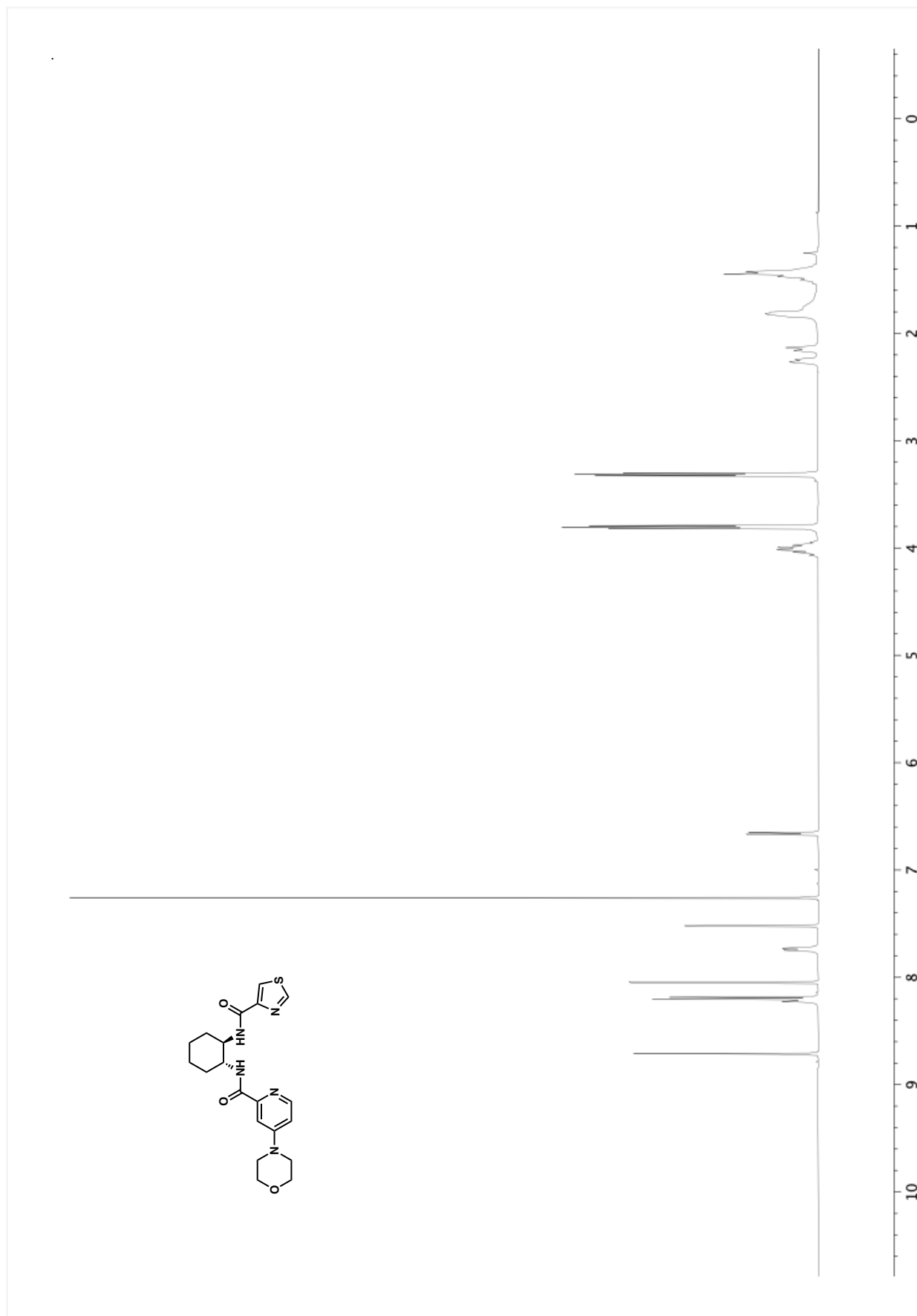
**Figure A3.28.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **L13**.



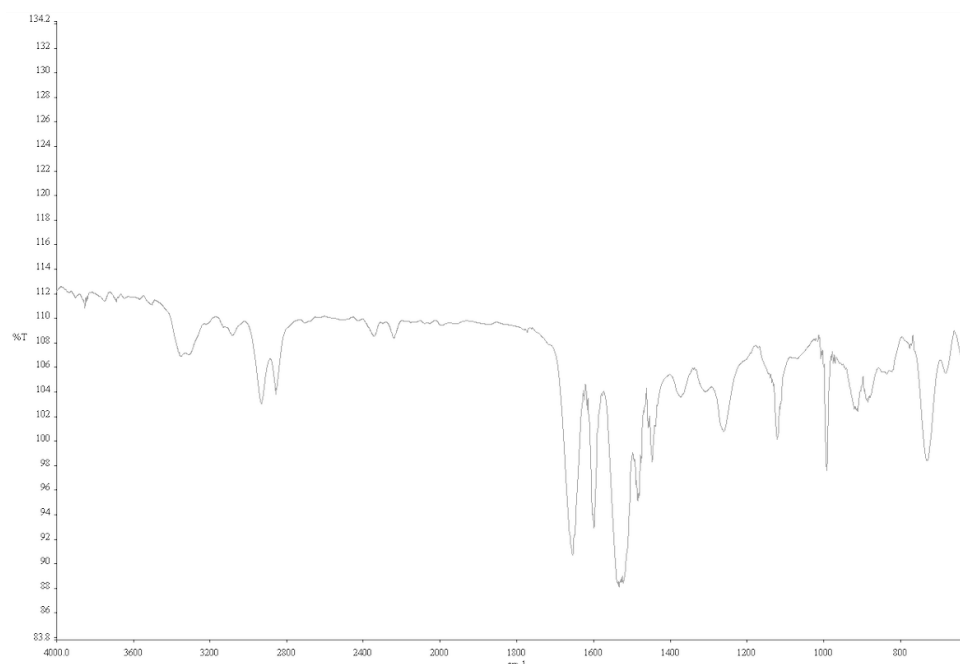
**Figure A3.29.** Infrared spectrum (Thin Film, NaCl) of **L13**.



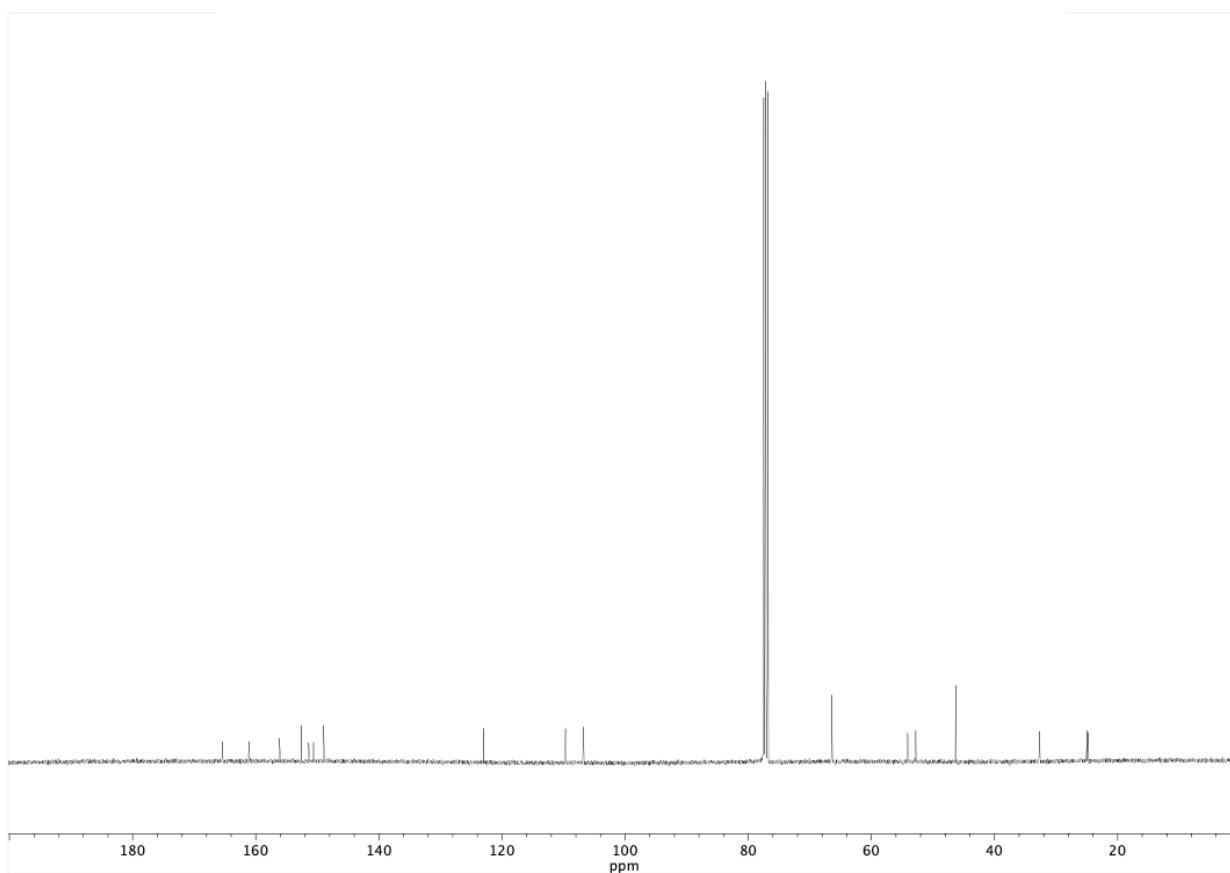
**Figure A3.30.**  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) of **L13**.



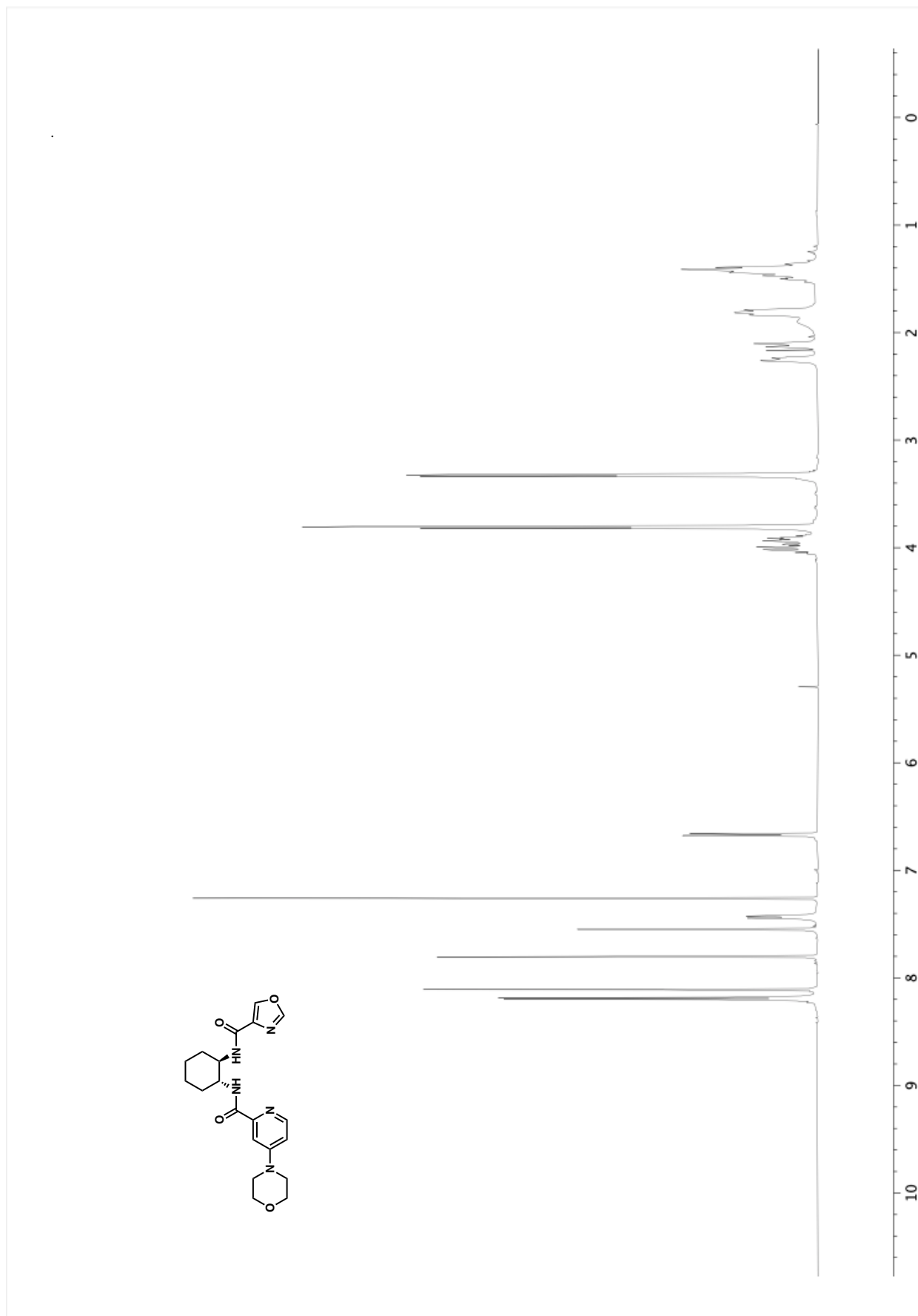
**Figure A3.31.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **L18**.



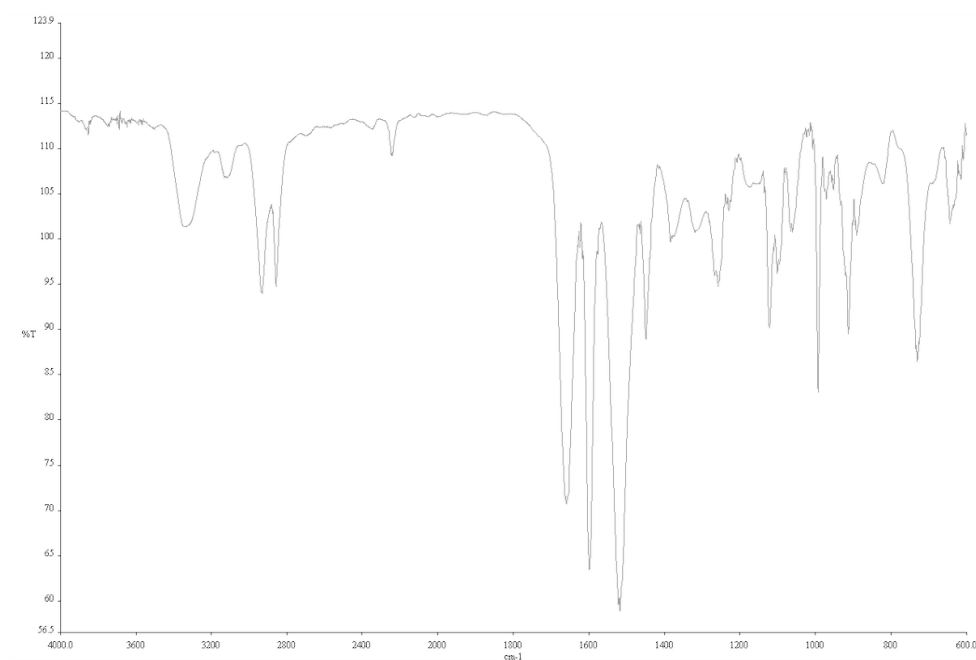
**Figure A3.32.** Infrared spectrum (Thin Film, NaCl) of **L18**.



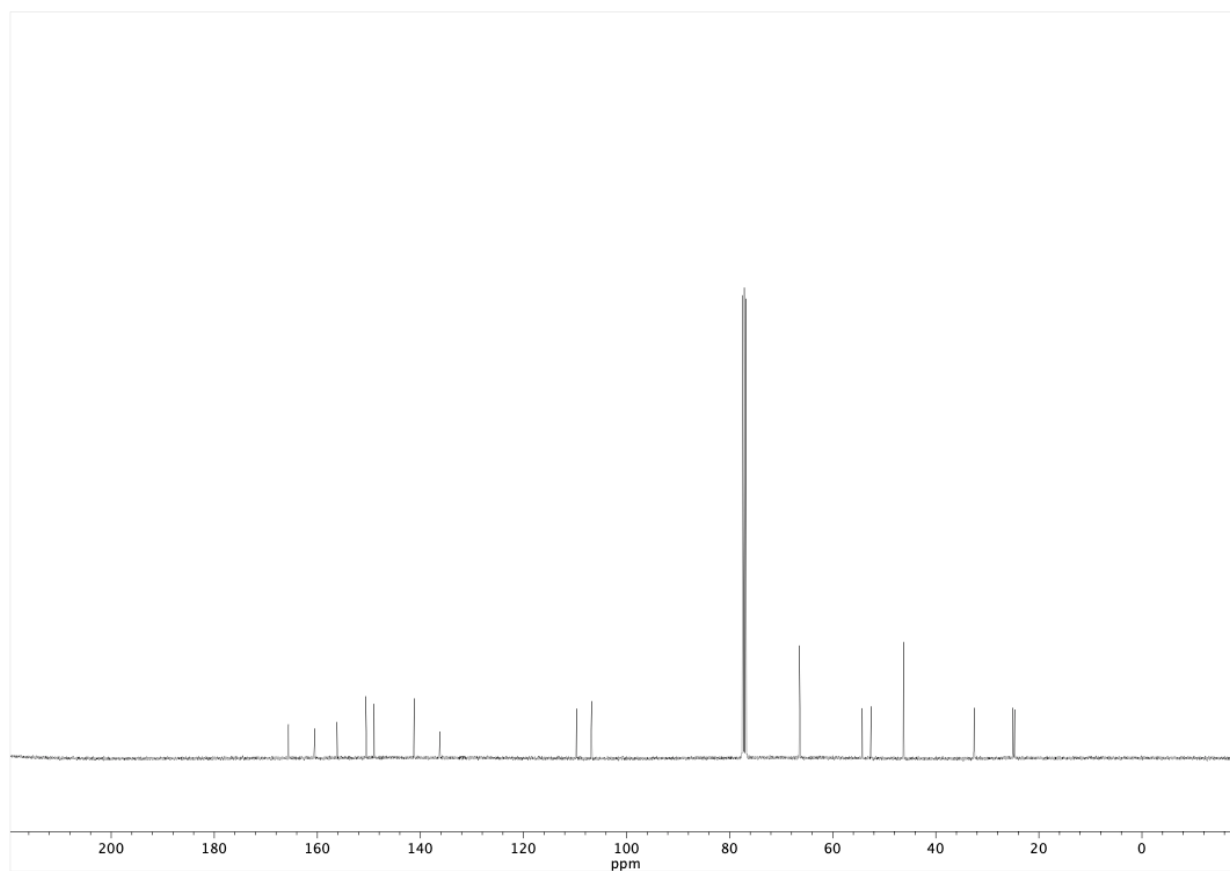
**Figure A3.33.**  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) of **L18**.



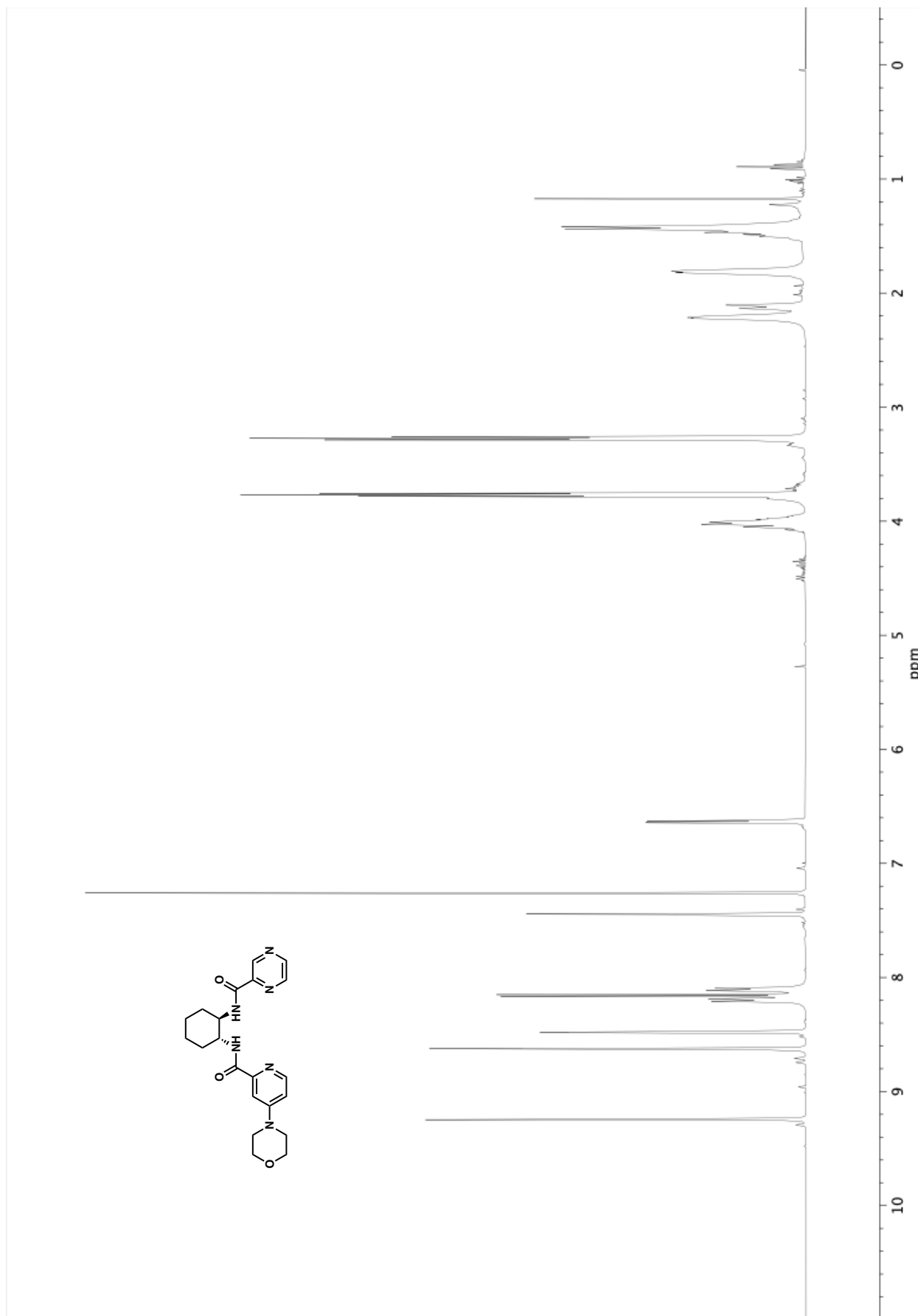
**Figure A3.34.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **L19**.



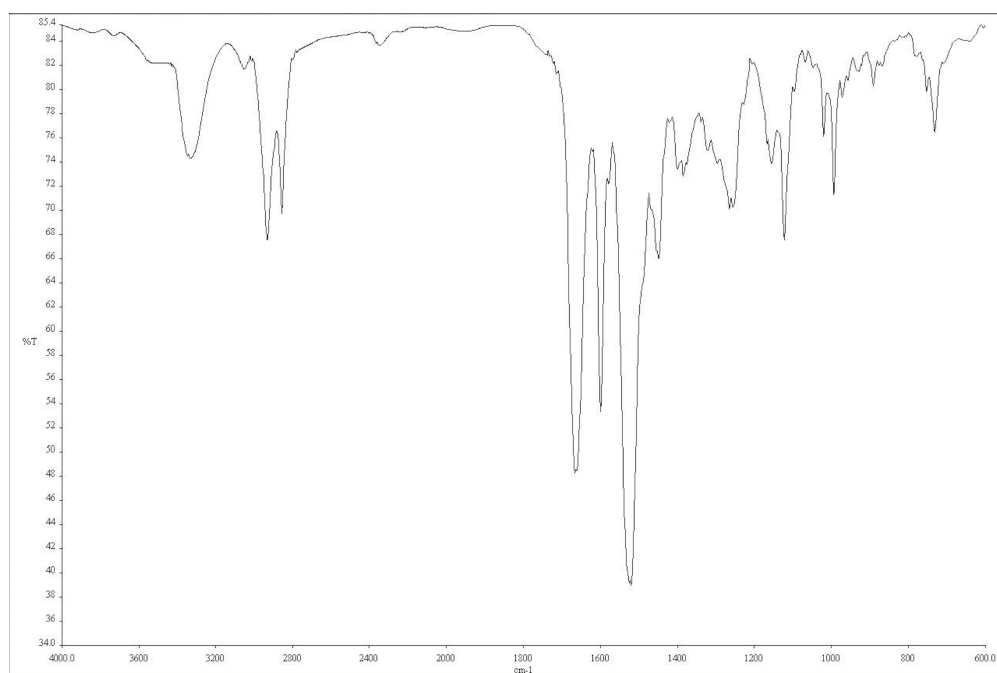
**Figure A3.35.** Infrared spectrum (Thin Film, NaCl) of **L19**.



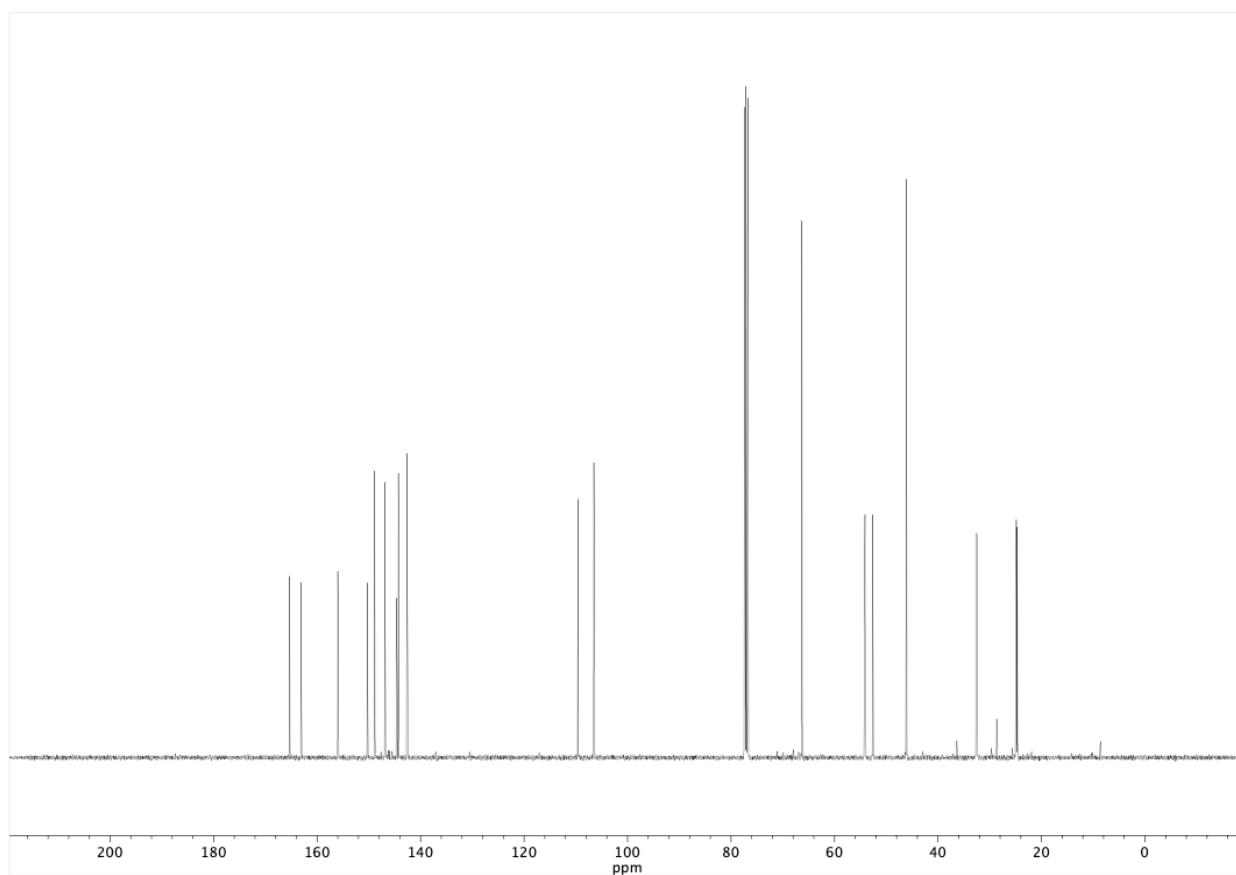
**Figure A3.36.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **L19**.



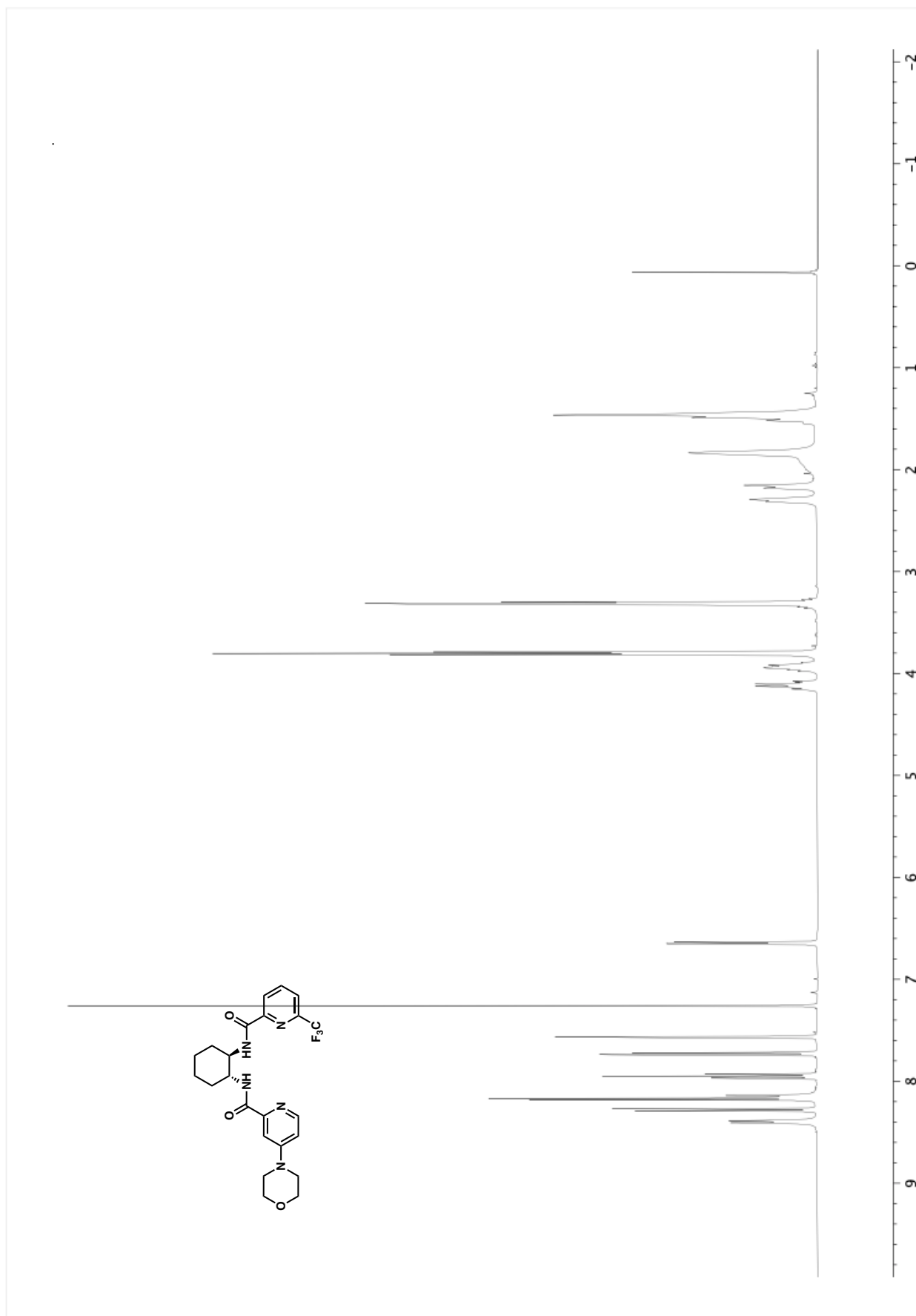
**Figure A3.37.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **L20**.

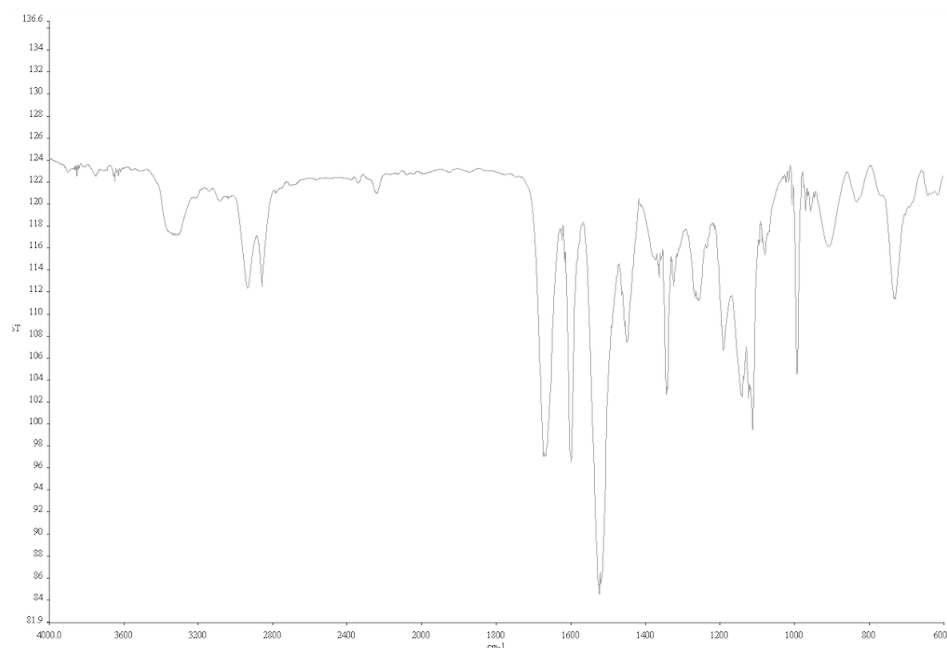


**Figure A3.38.** Infrared spectrum (Thin Film, NaCl) of **L20**.

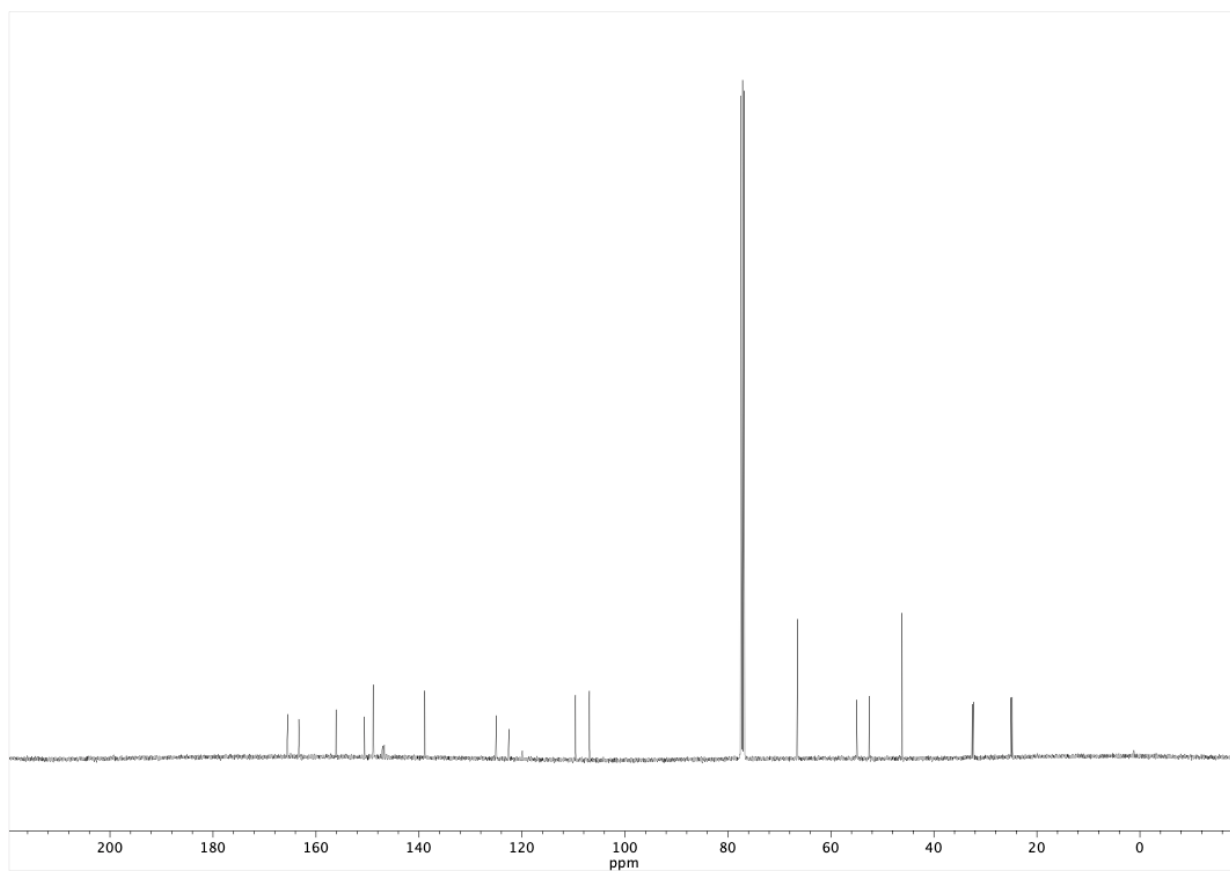


**Figure A3.39.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **L20**.

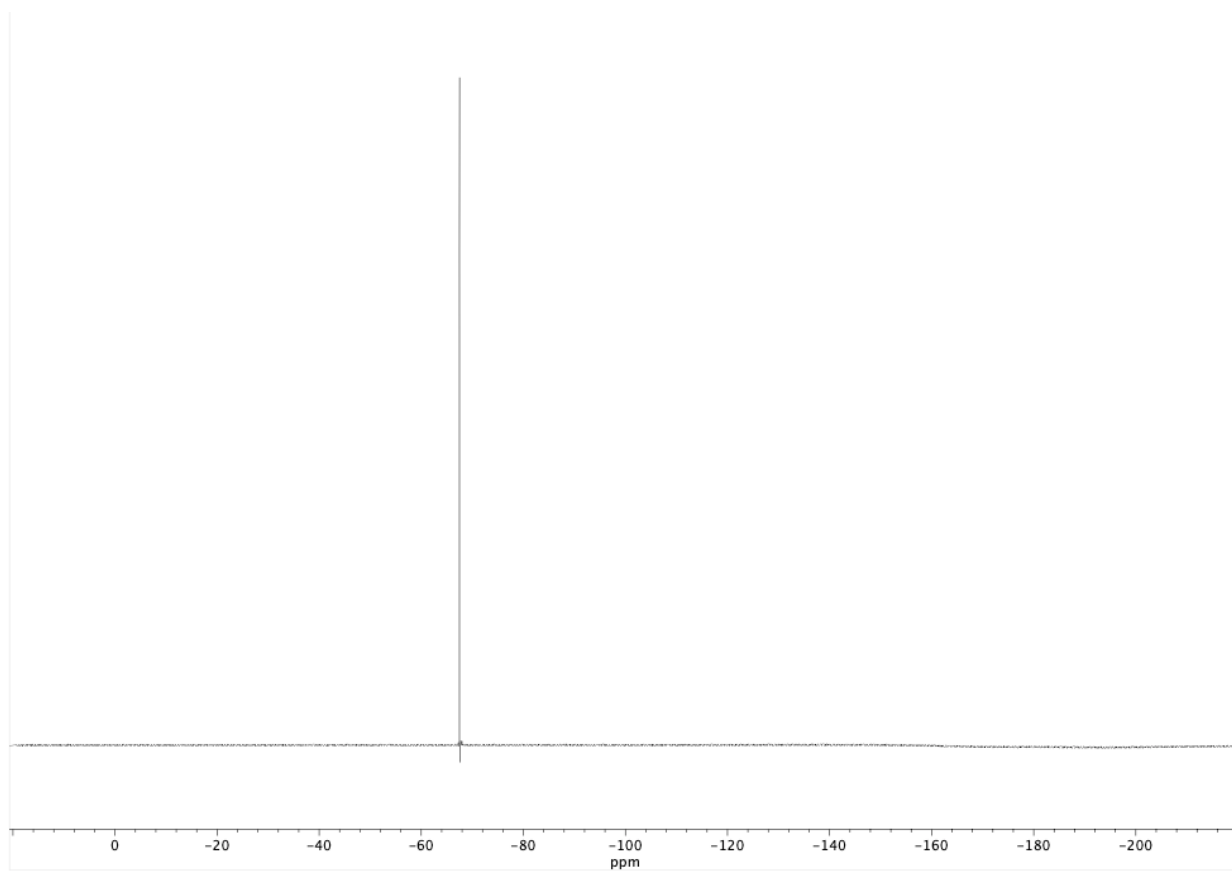
**Figure A3.40.** <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) of L21.



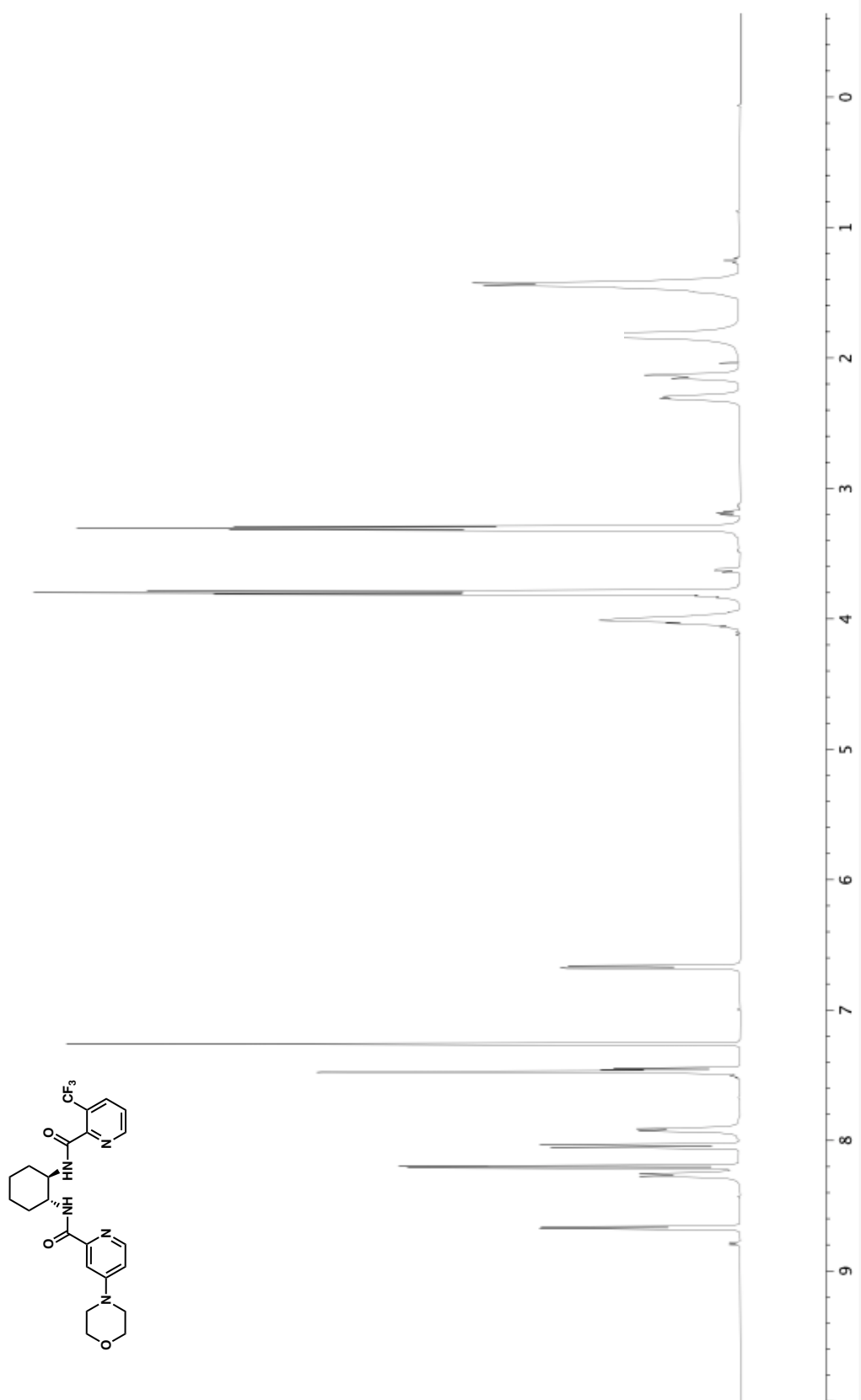
**Figure A3.41.** Infrared spectrum (Thin Film, NaCl) of **L21**.



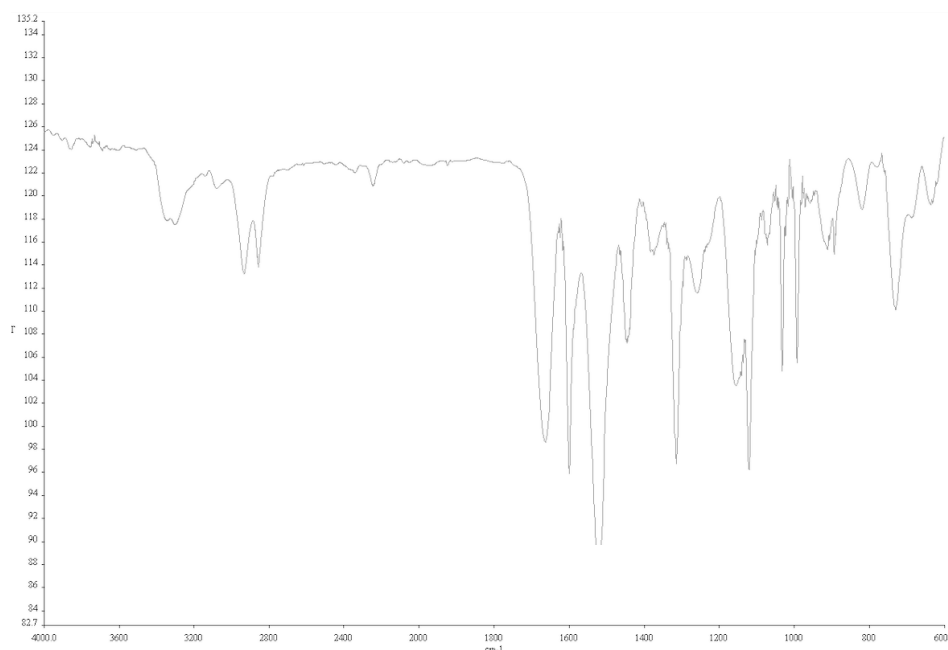
**Figure A3.42.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **L21**.



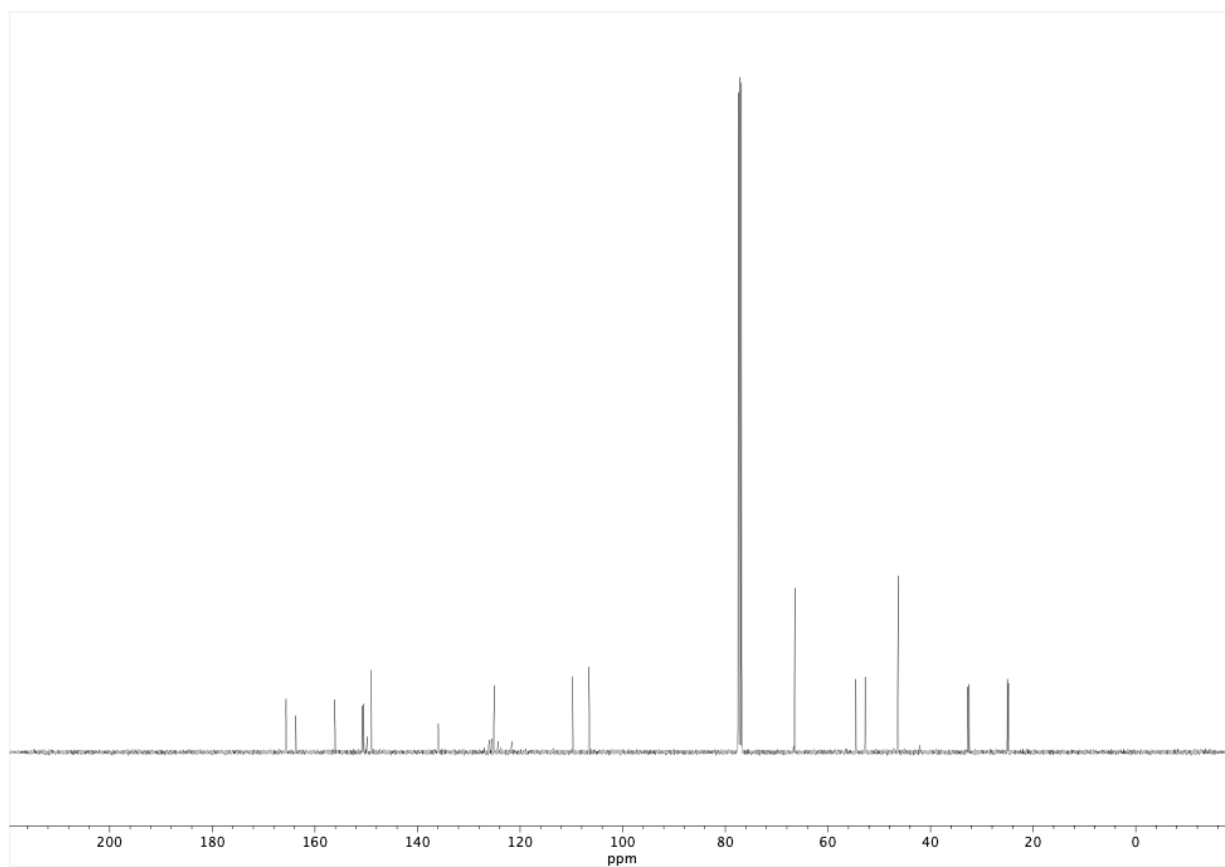
**Figure A3.43.**  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ ) of **L21**.



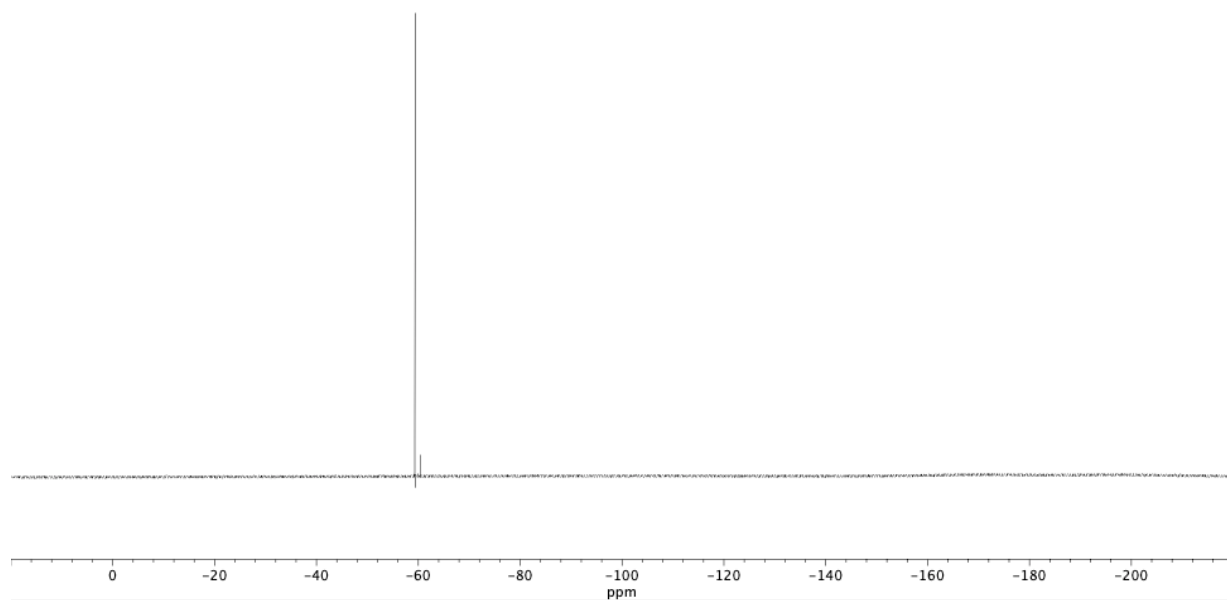
**Figure A3.44.** <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) of **L22**.



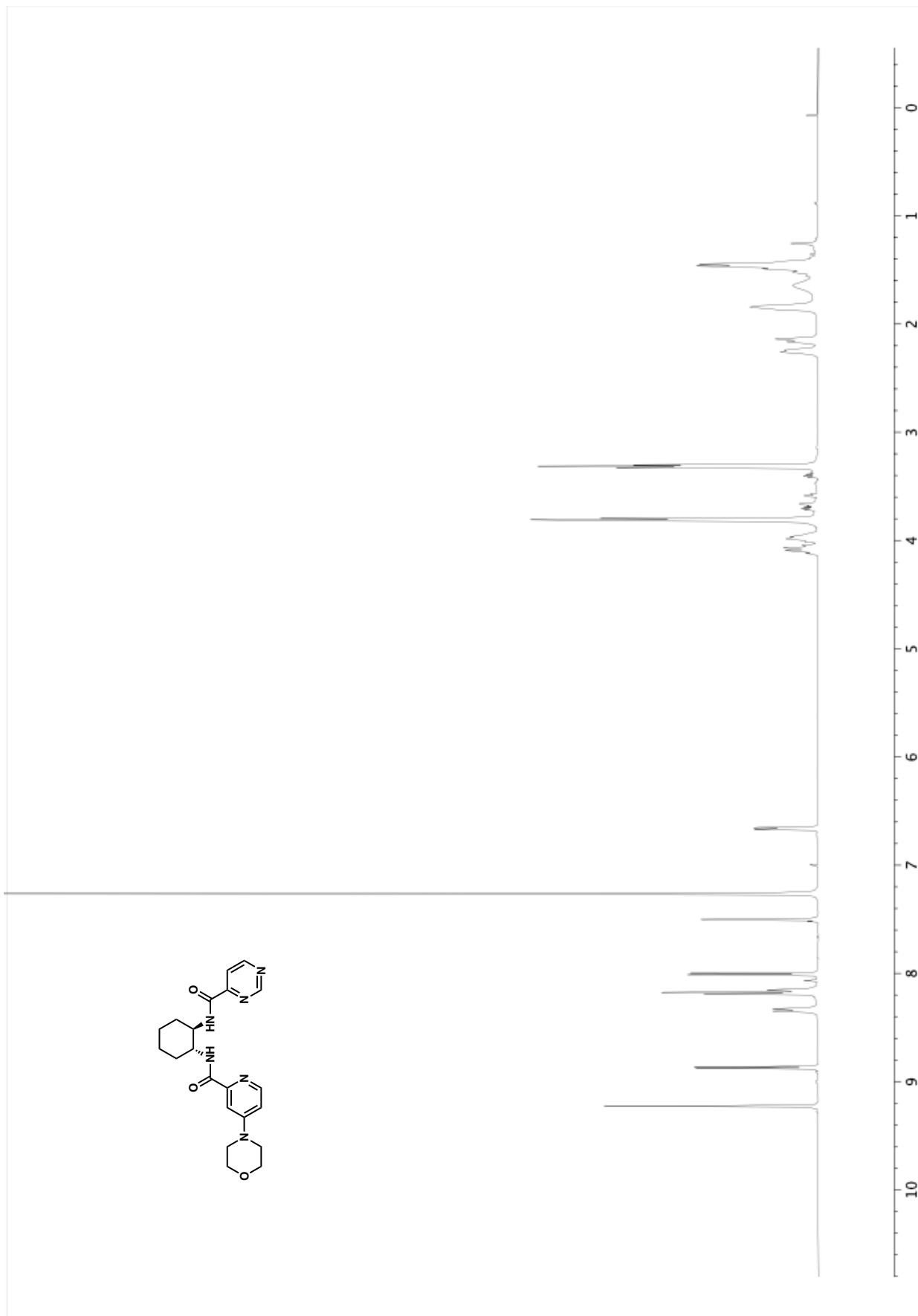
**Figure A3.45.** Infrared spectrum (Thin Film, NaCl) of **L22**.



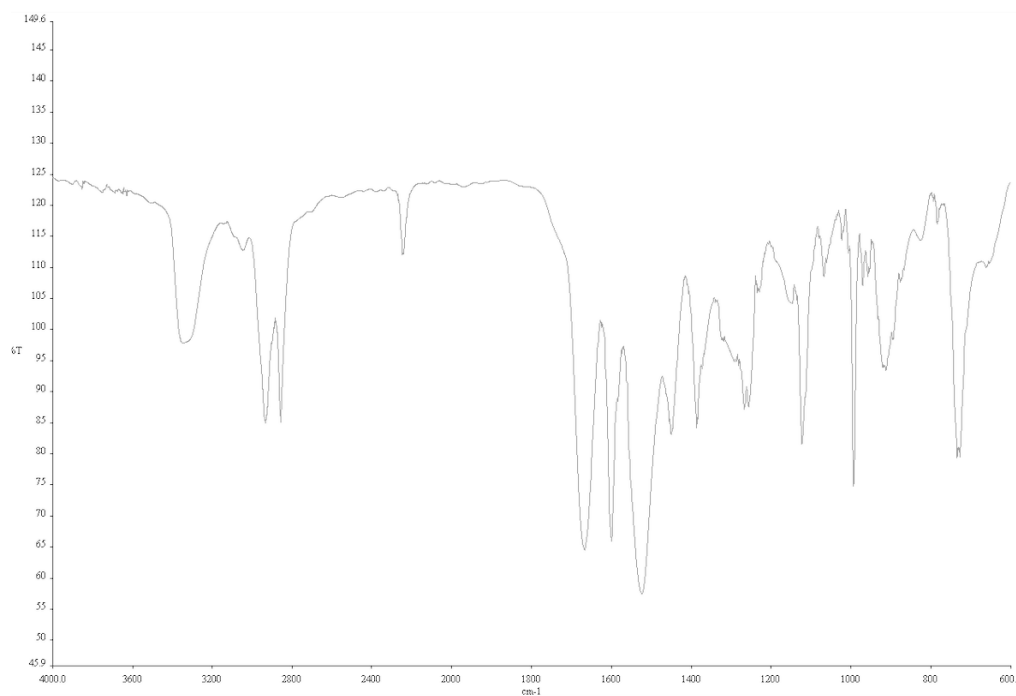
**Figure A3.46.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **L22**.



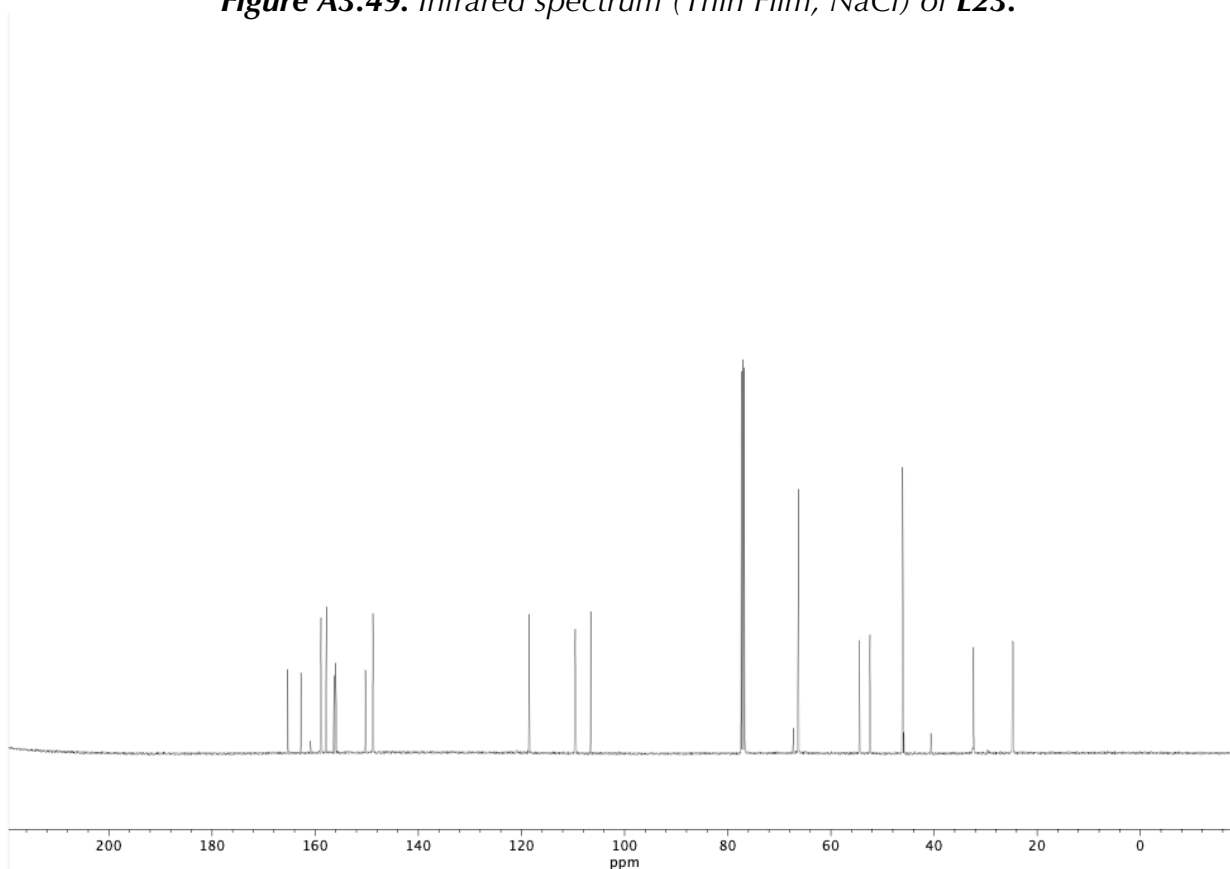
**Figure A3.47.**  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ ) of **L22**.



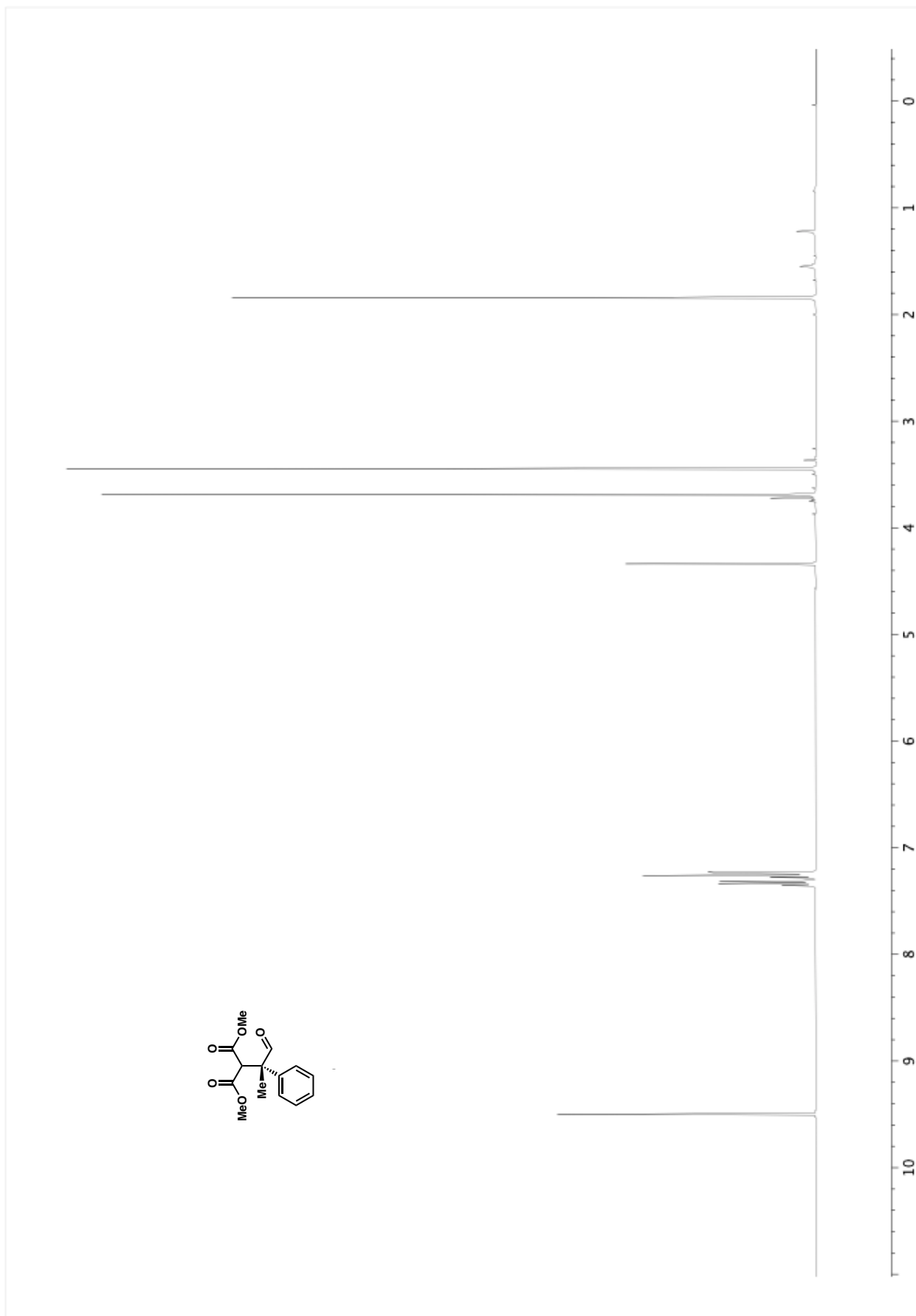
**Figure A3.48.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **L23**.

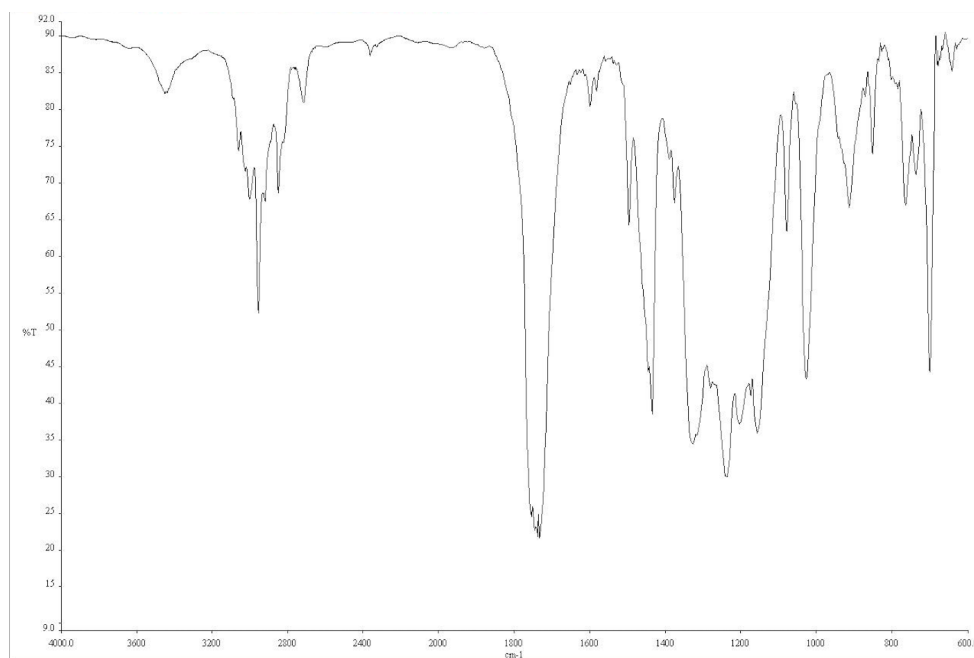


**Figure A3.49.** Infrared spectrum (Thin Film, NaCl) of **L23**.

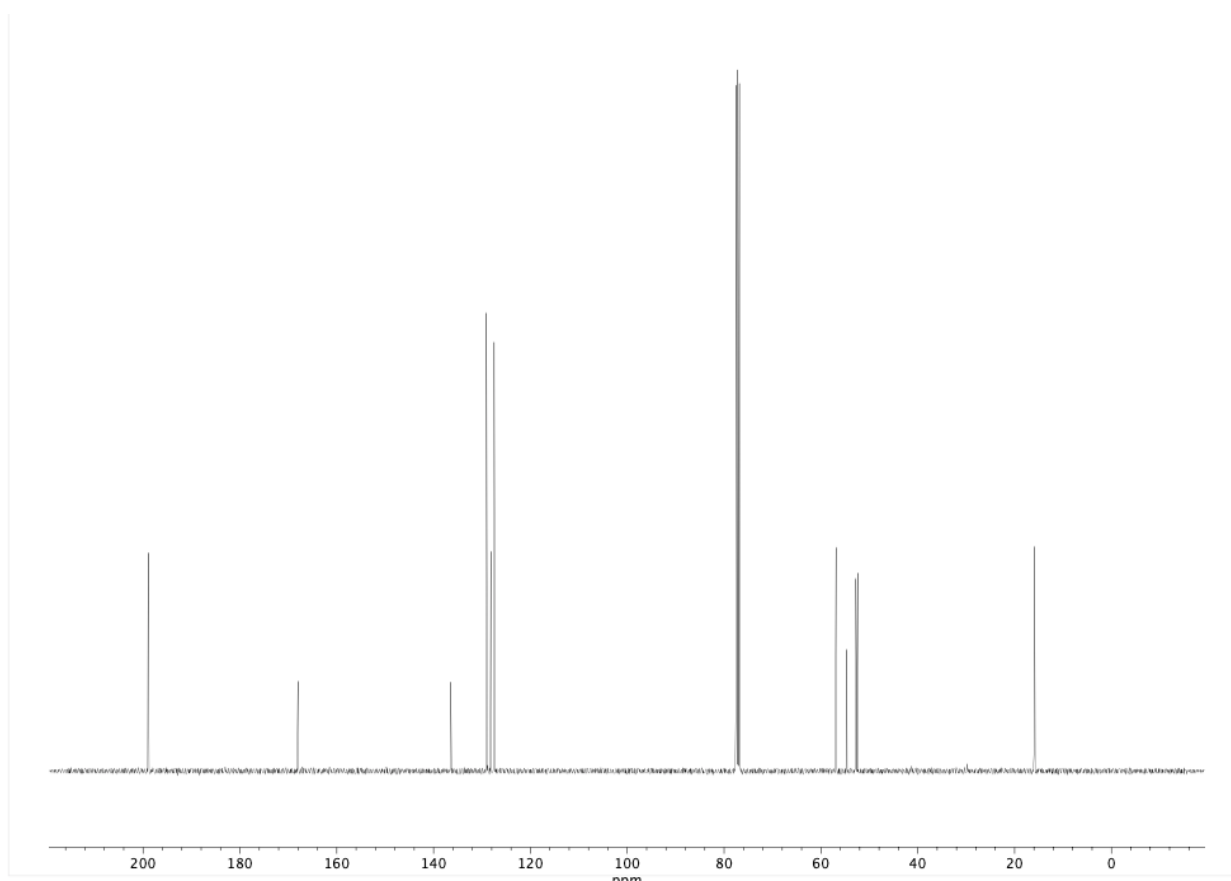


**Figure A3.50.**  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) of **L23**.

**Figure A3.51.** <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) of 55.

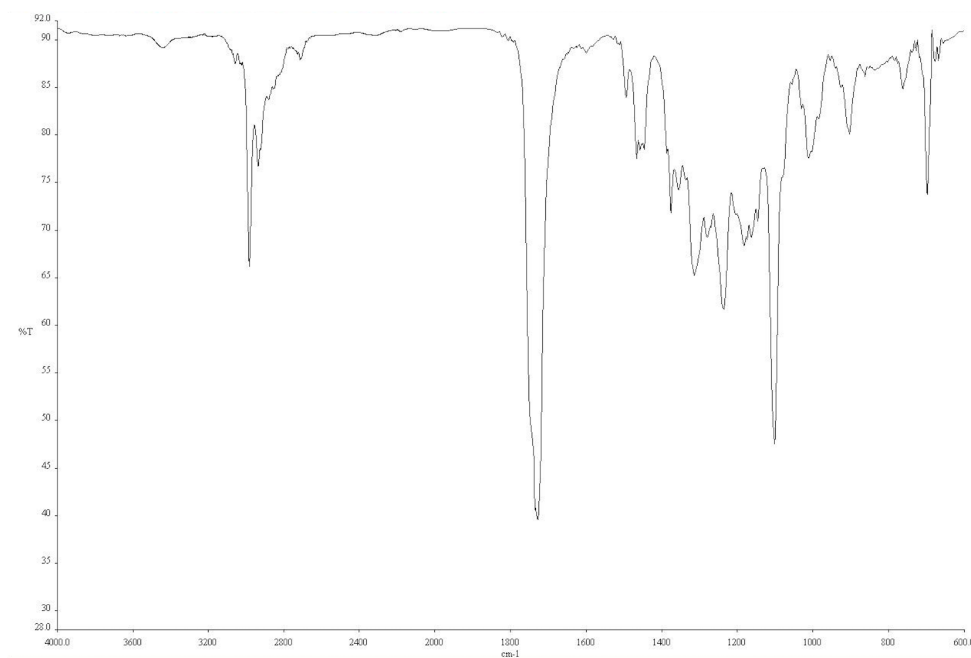


**Figure A3.52.** Infrared spectrum (Thin Film, NaCl) of **55**.

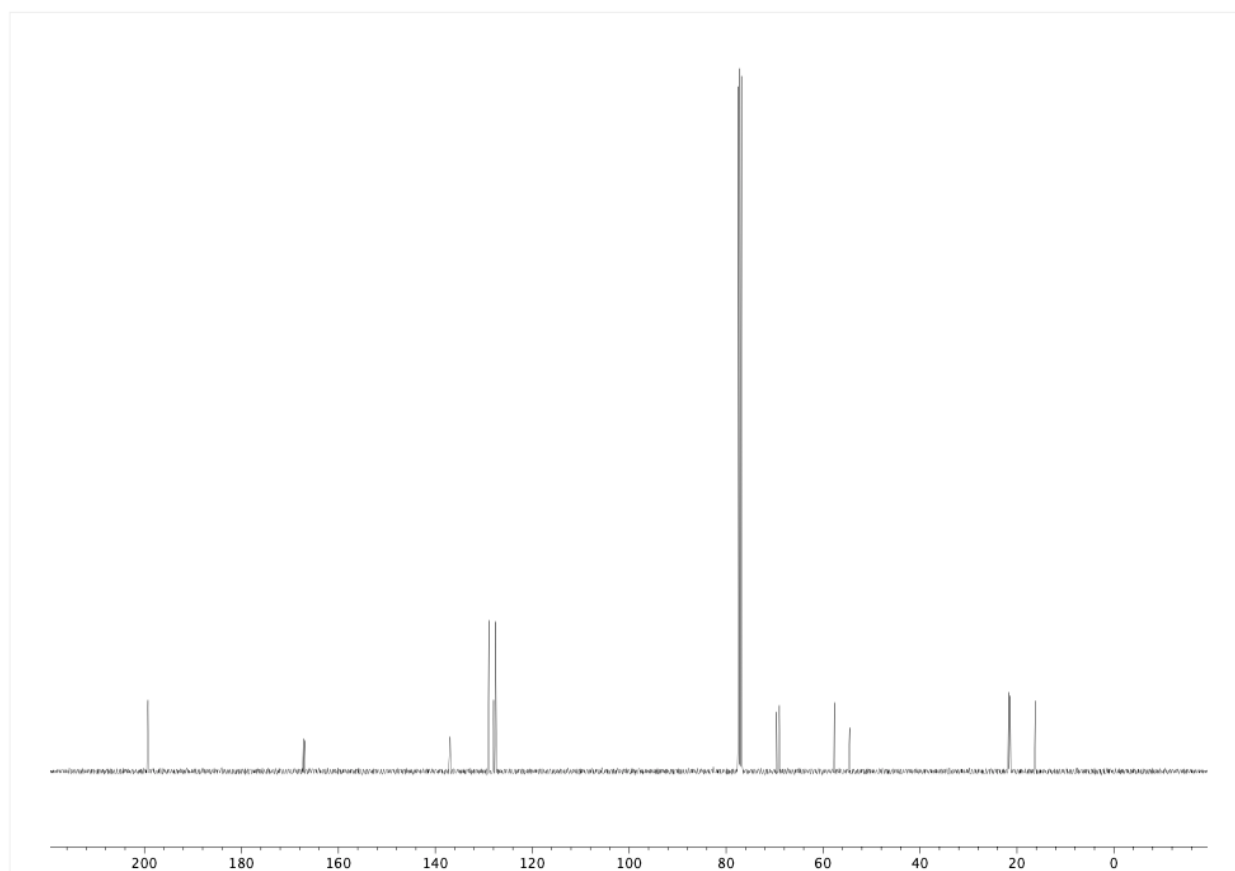


**Figure A3.53.**  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) of **55**.

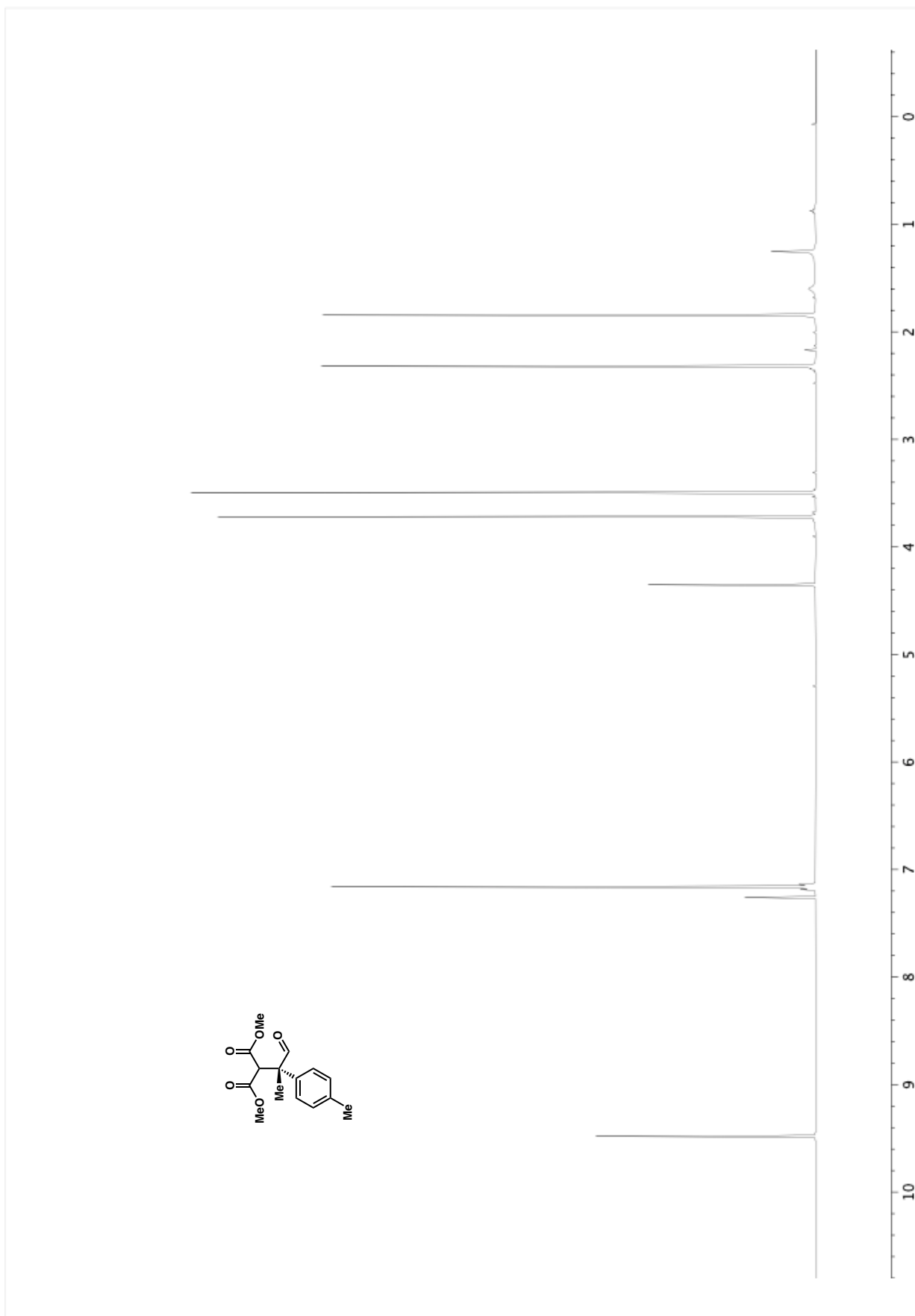
**Figure A3.54.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of 56.



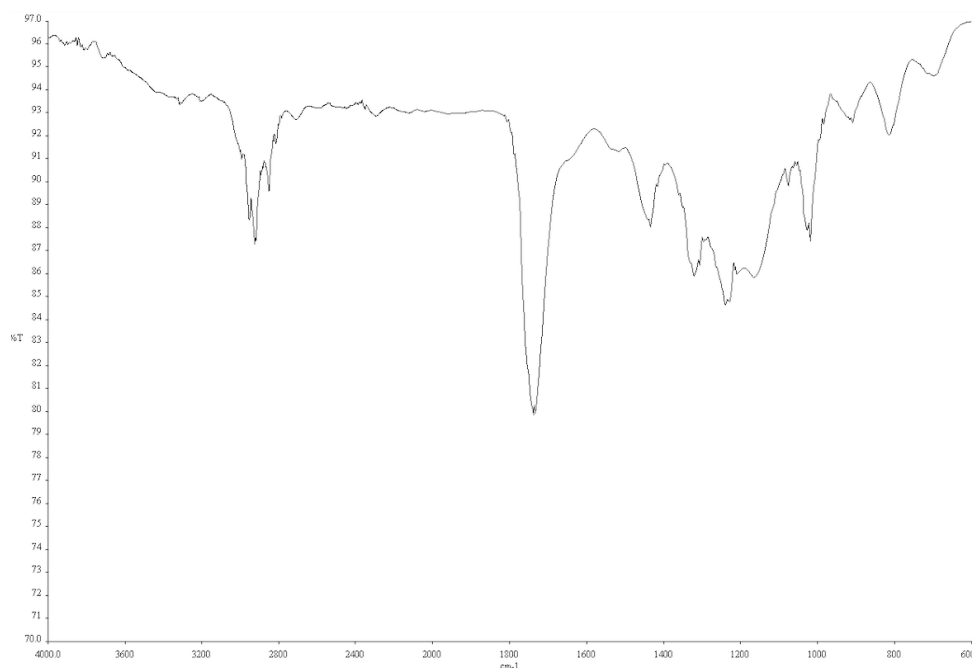
**Figure A3.55.** Infrared spectrum (Thin Film, NaCl) of **56**.



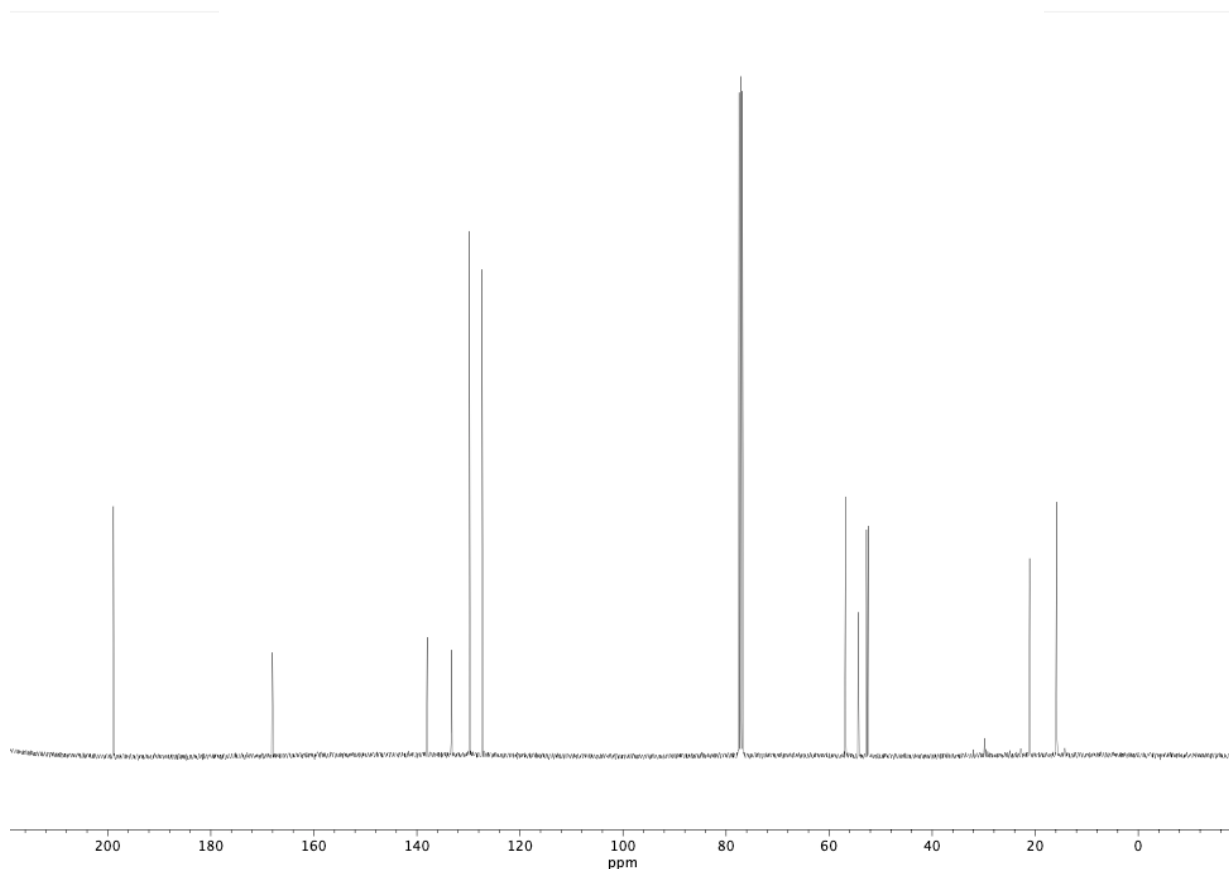
**Figure A3.56.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **56**.



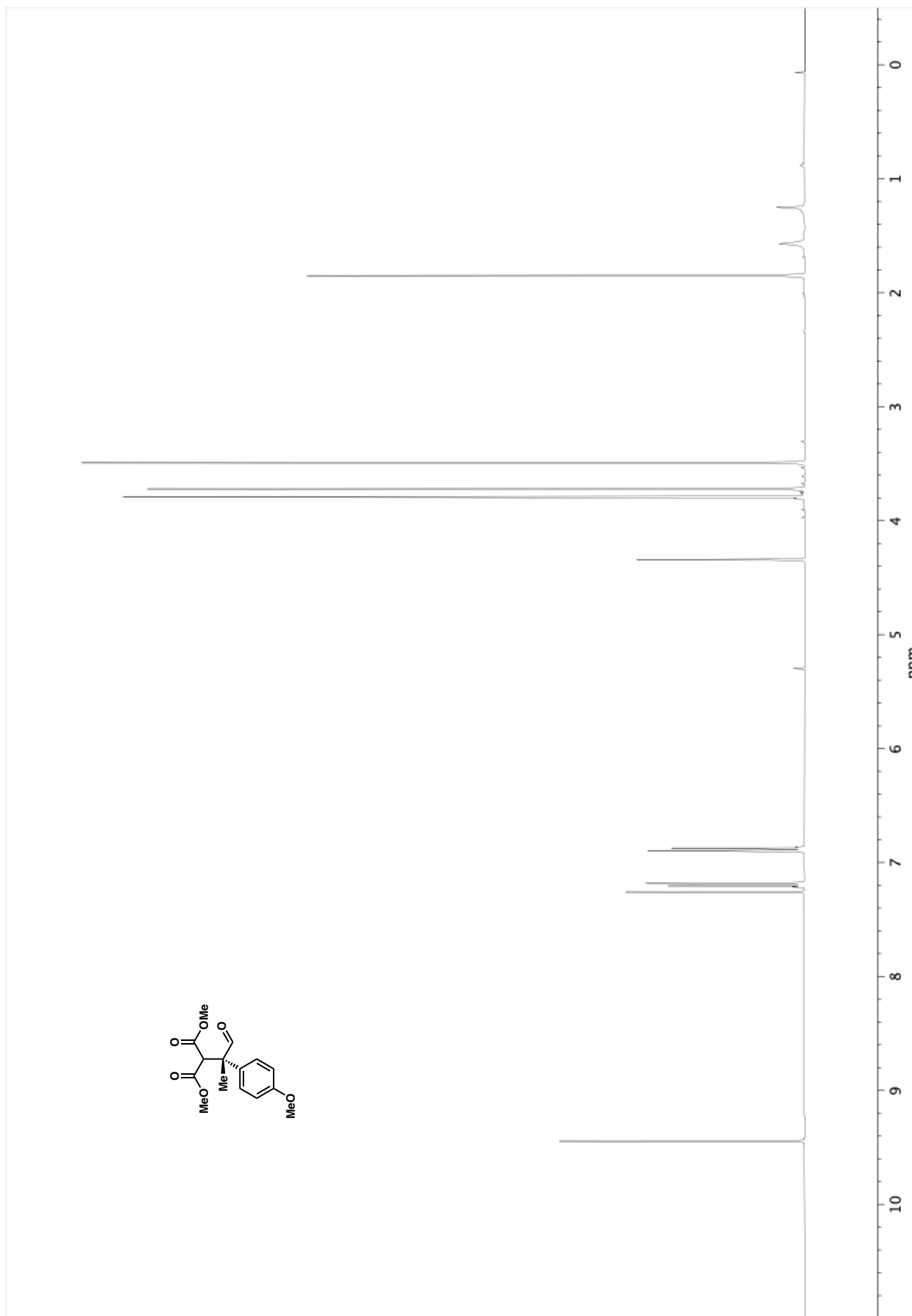
**Figure A3.57.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **58**.

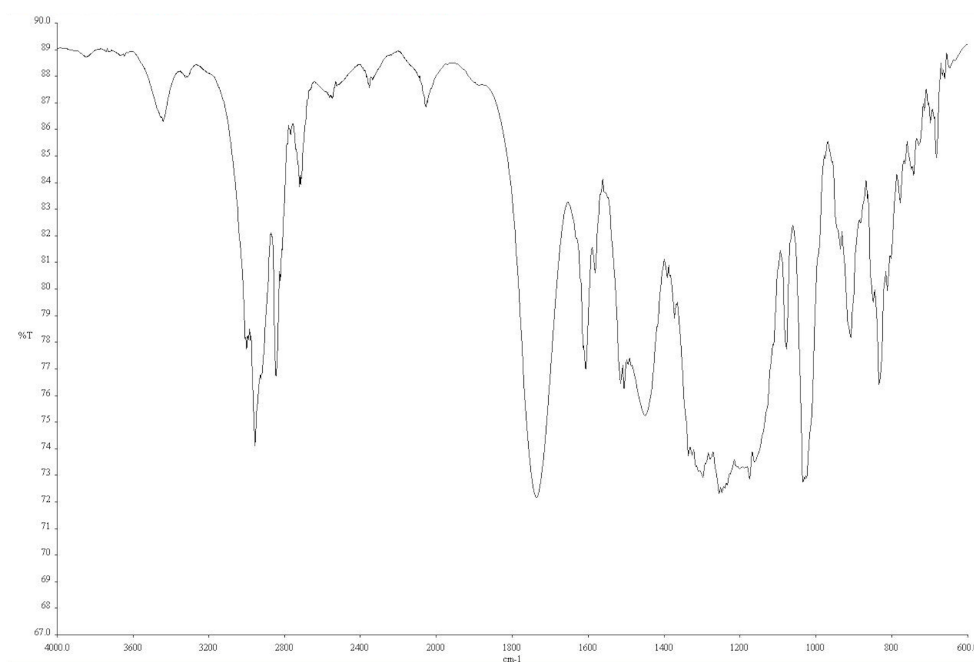


**Figure A3.58.** Infrared spectrum (Thin Film, NaCl) of **58**.

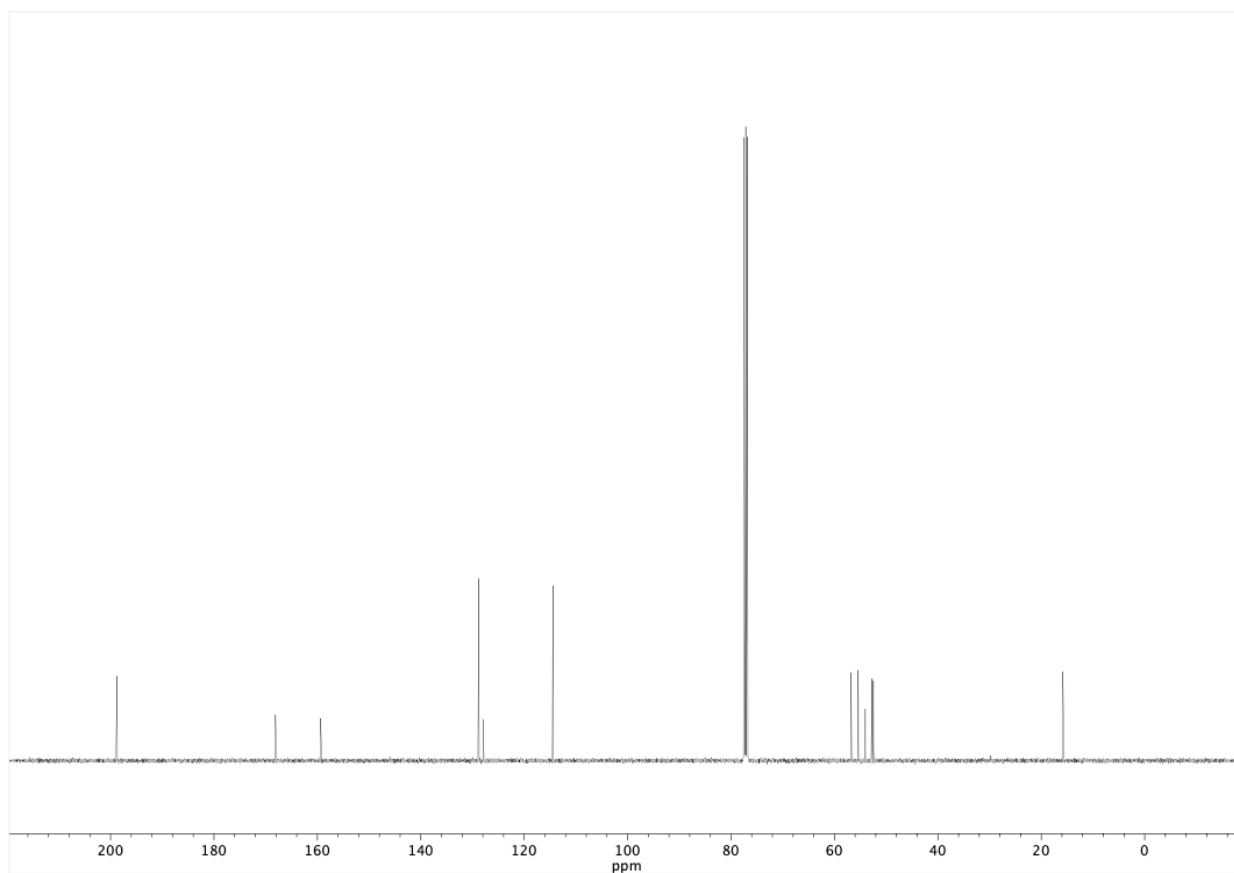


**Figure A3.59.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **58**.

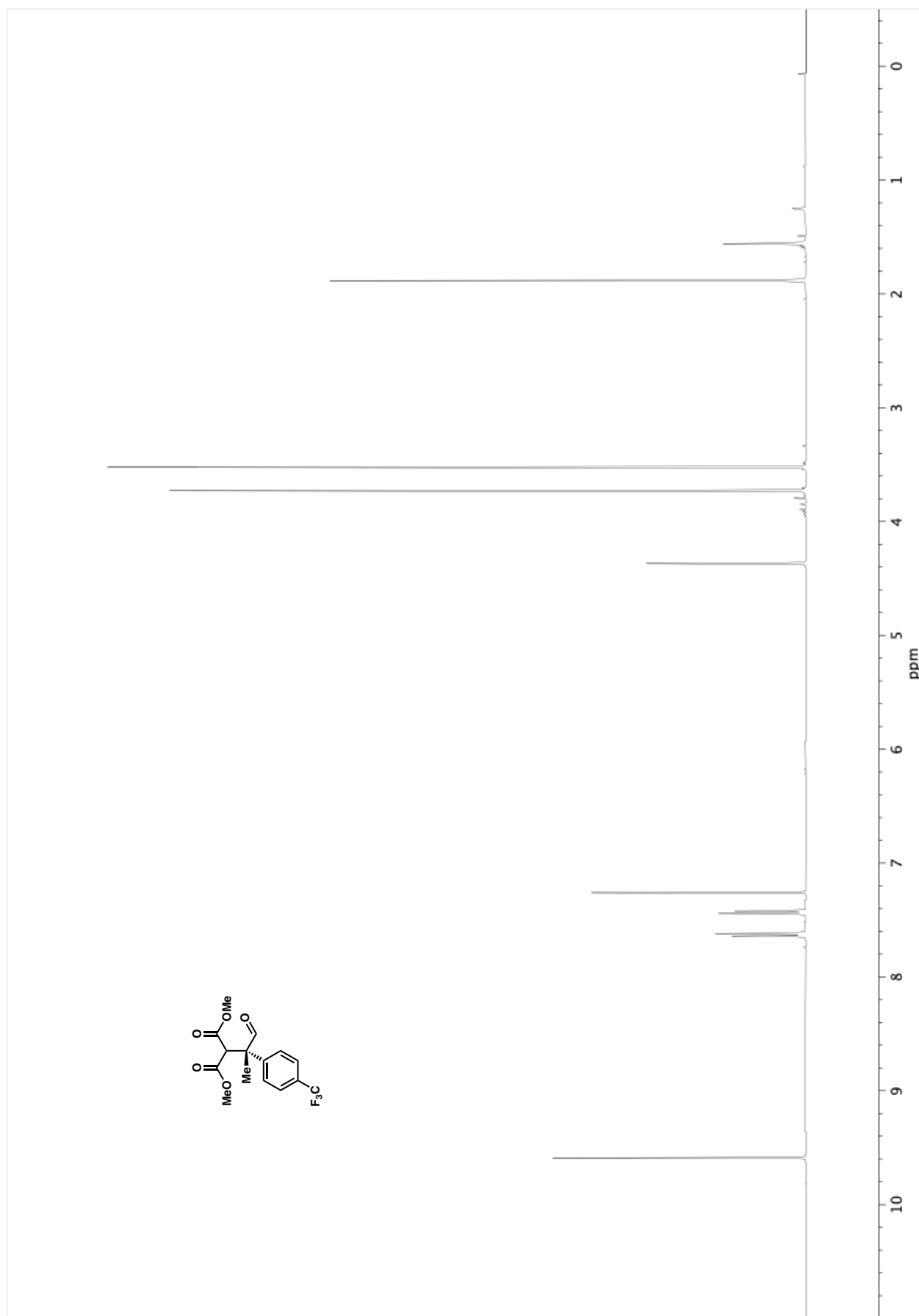
**Figure A3.60.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **59**.



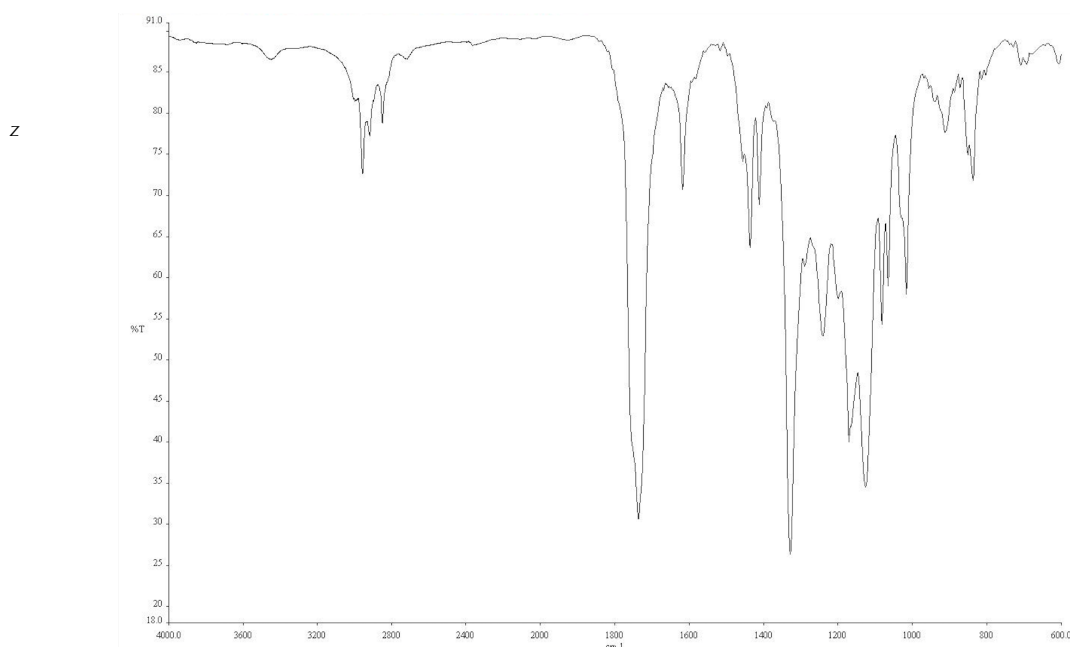
**Figure A3.61.** Infrared spectrum (Thin Film, NaCl) of **59**.



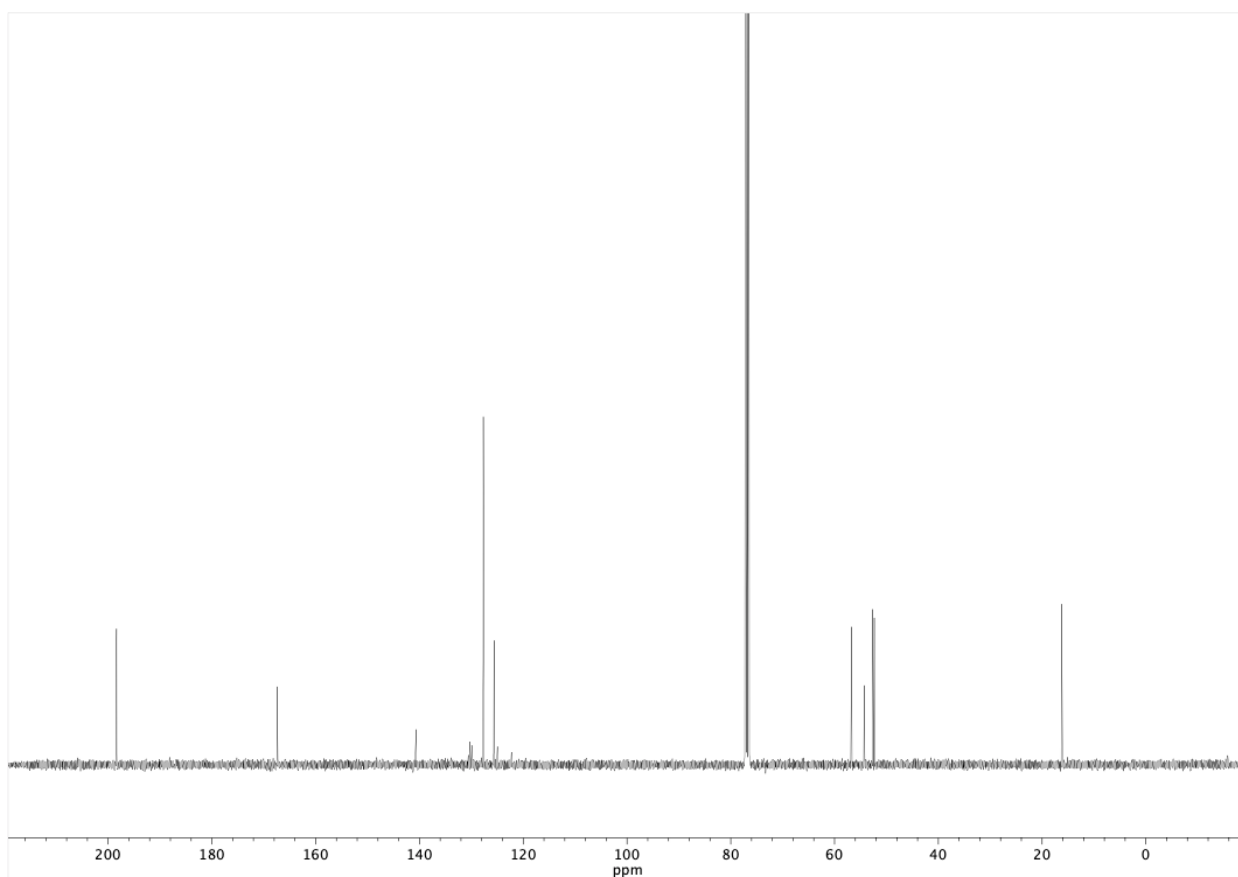
**Figure A3.62.**  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) of **59**.



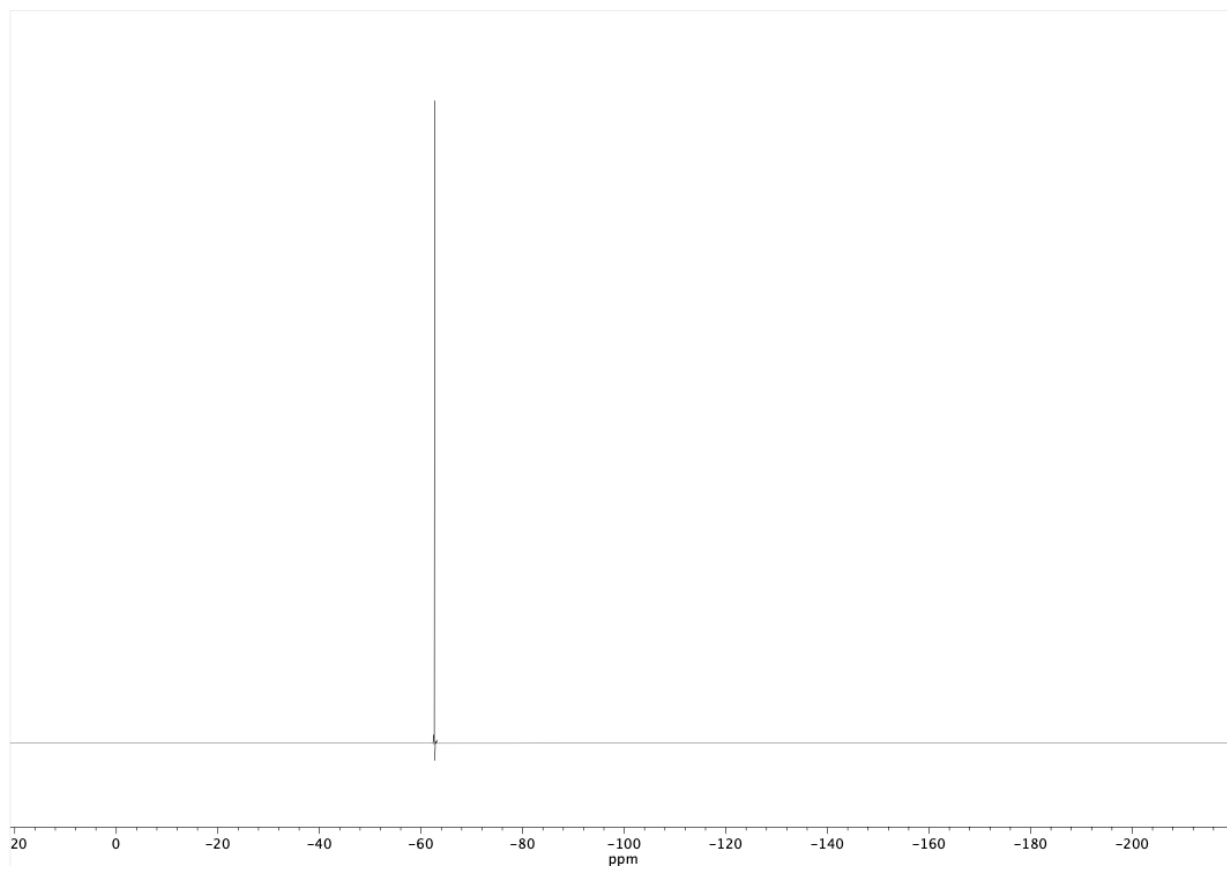
**Figure A3.63.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **60**.



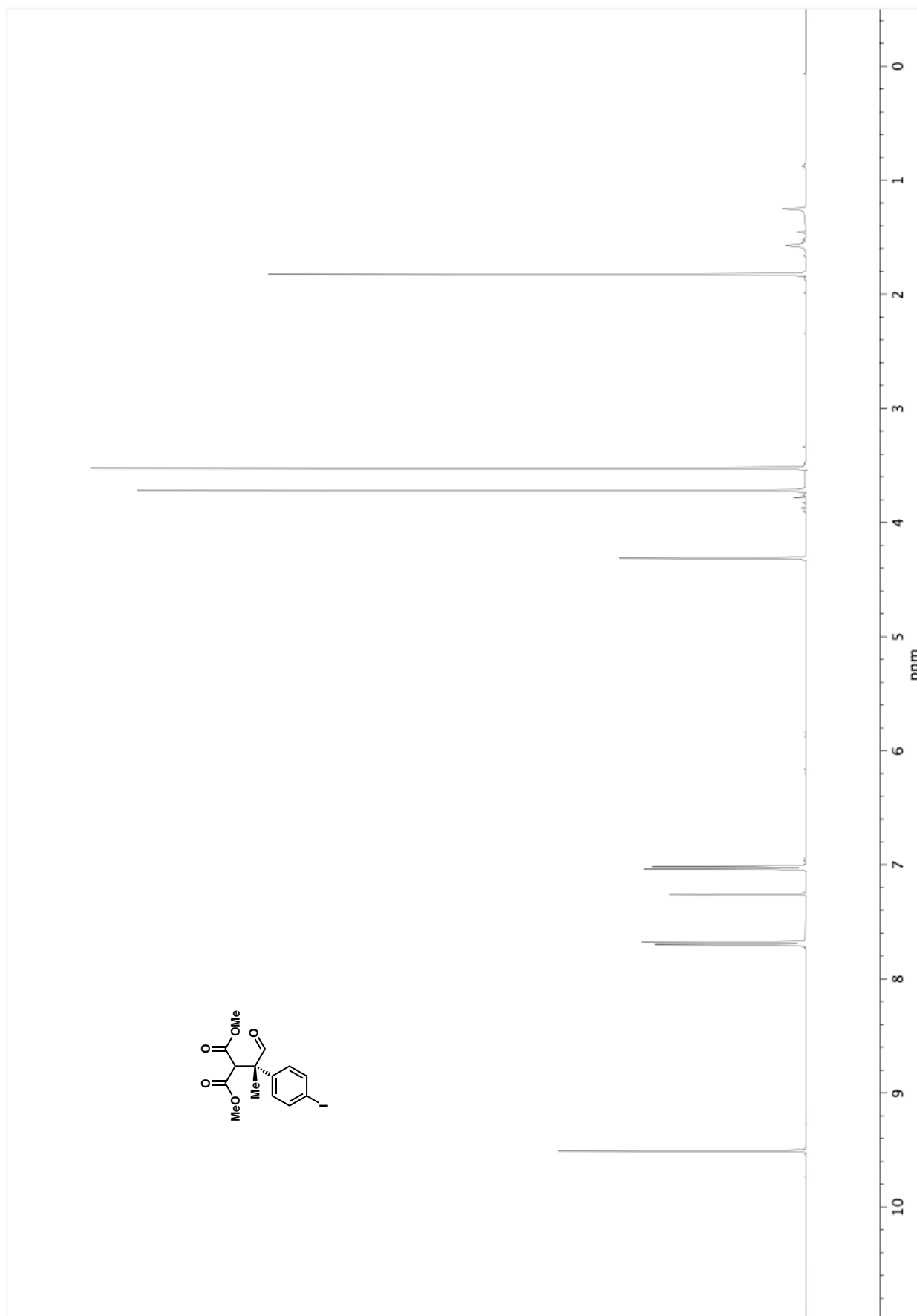
**Figure A3.64.** Infrared spectrum (Thin Film, NaCl) of **60**.



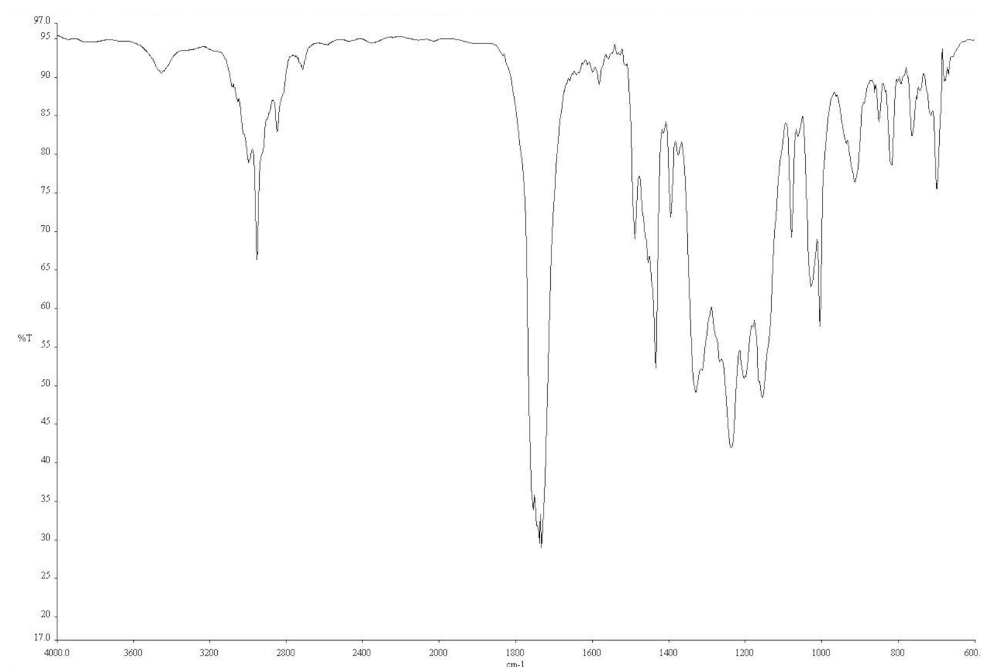
**Figure A3.65.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **60**.



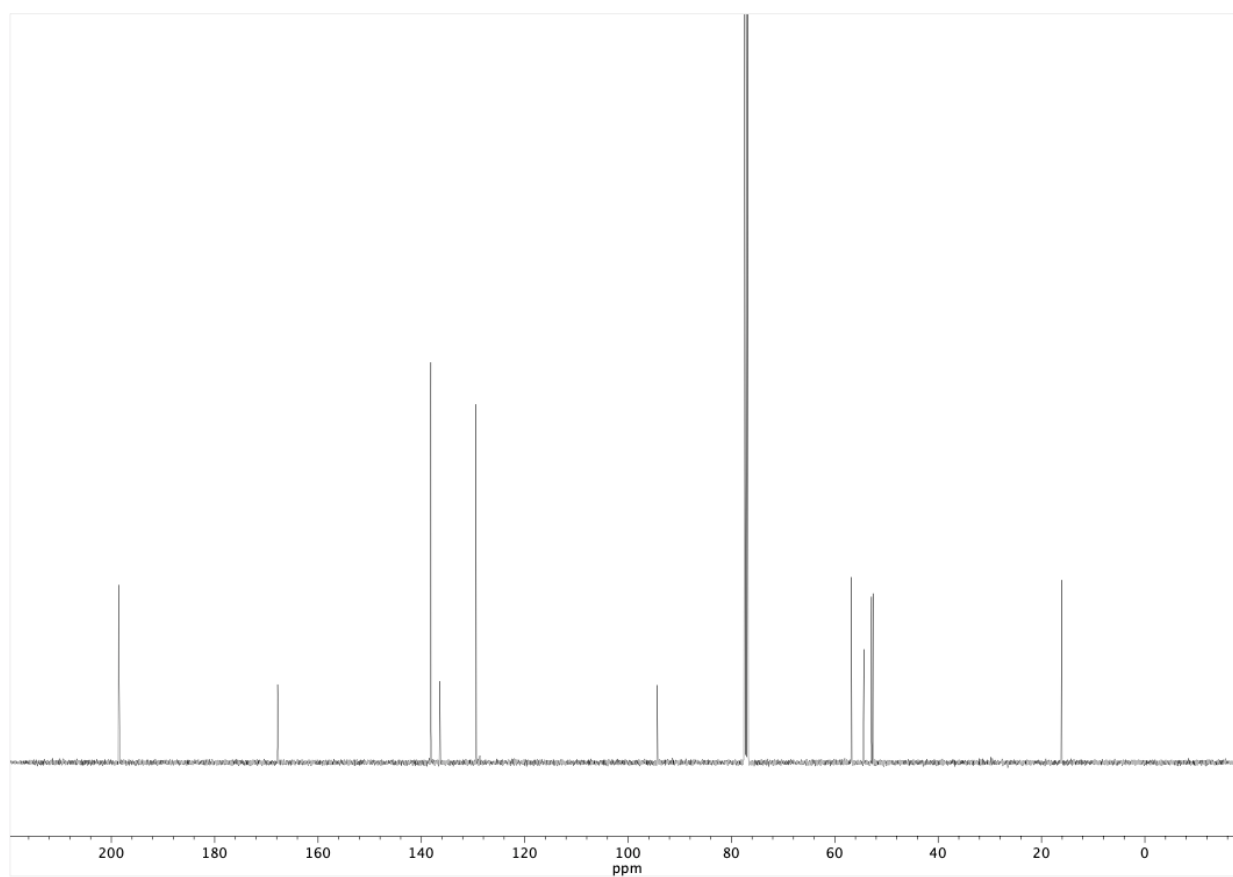
**Figure A3.66.**  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ ) of **60**.



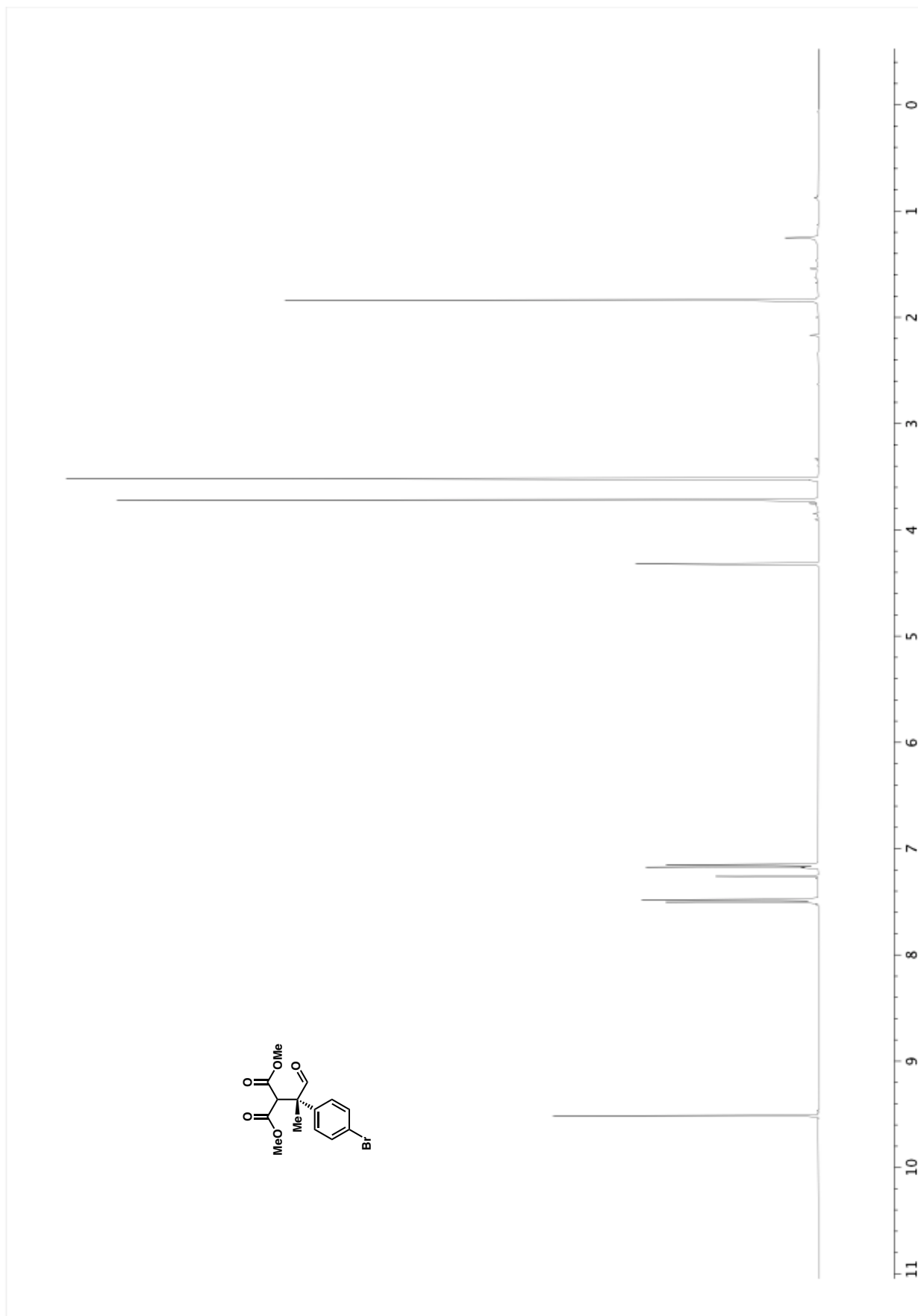
**Figure A3.67.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **62**.



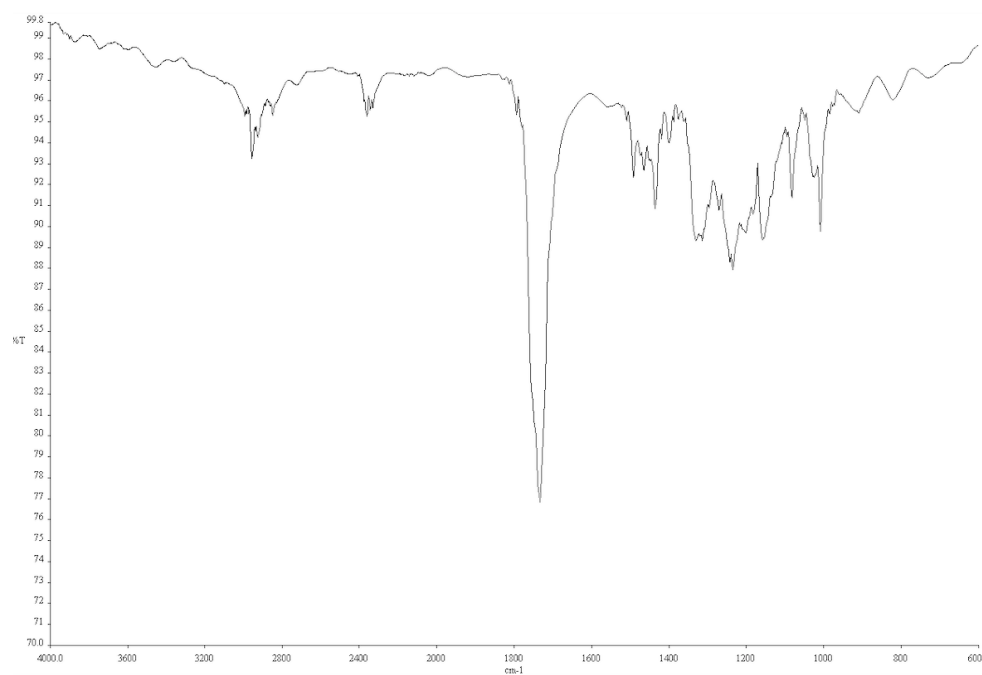
**Figure A3.68.** Infrared spectrum (Thin Film, NaCl) of **62**.



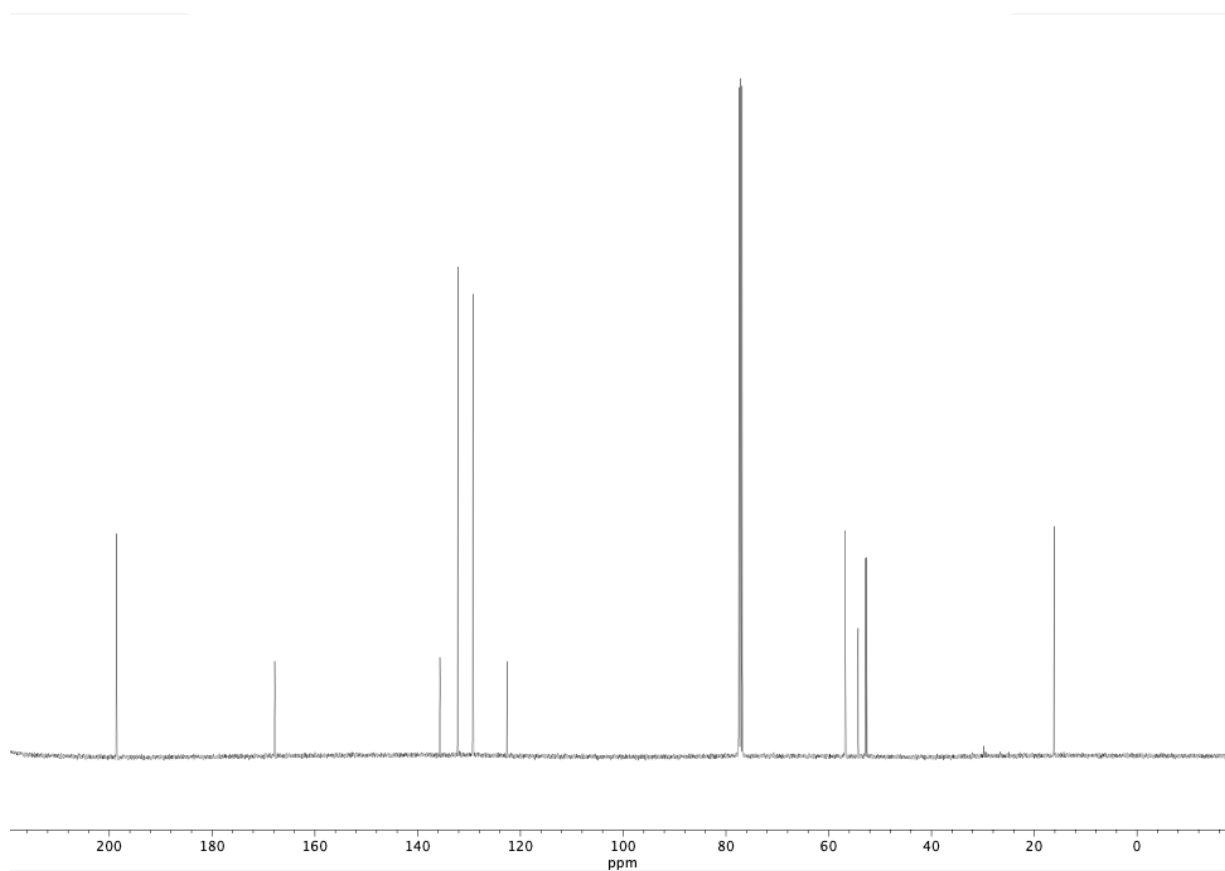
**Figure A3.69.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **62**.



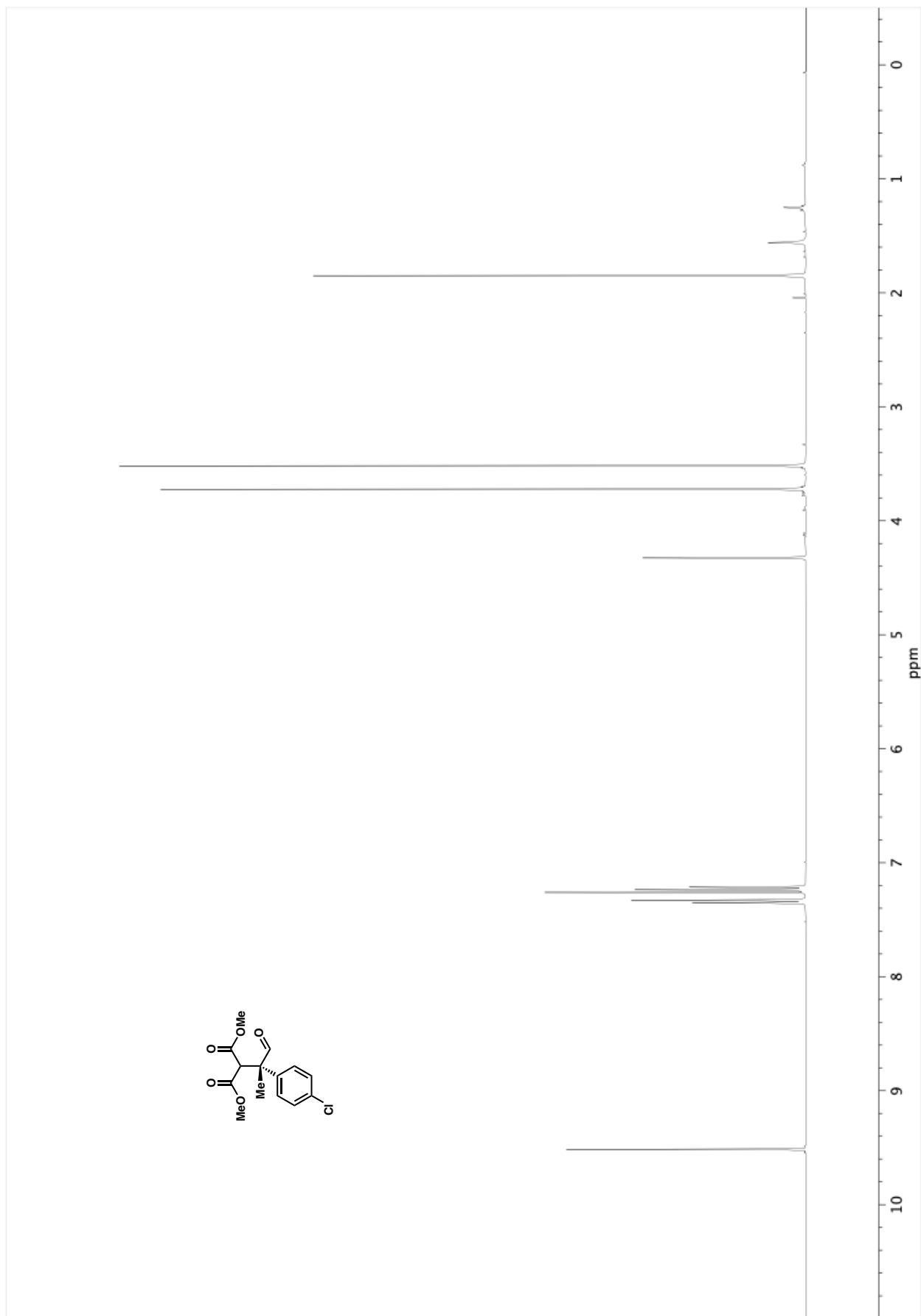
**Figure A3.70.** <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) of **63**.

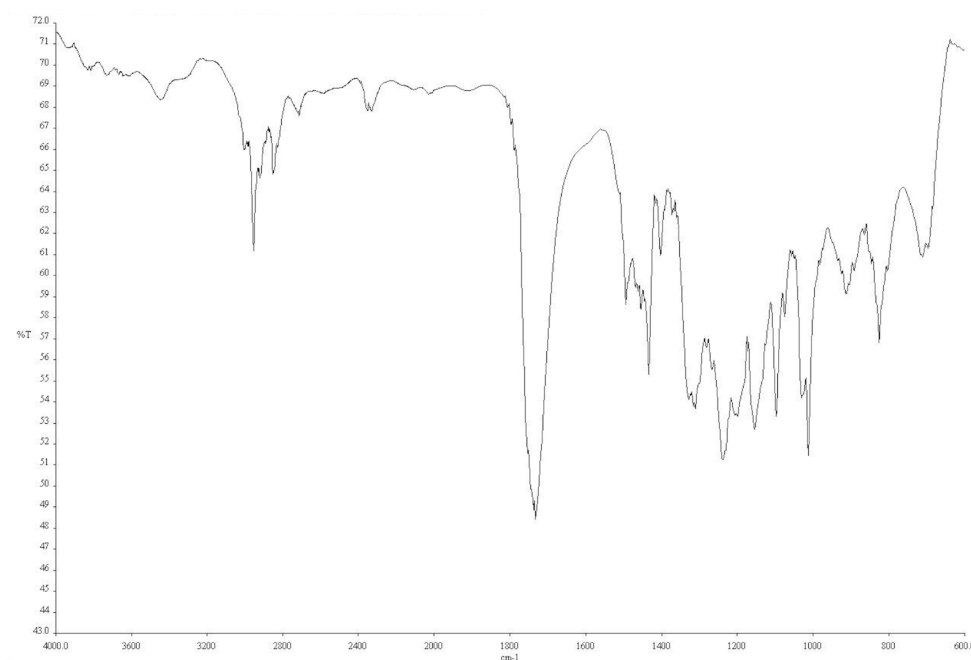


**Figure A3.71.** Infrared spectrum (Thin Film, NaCl) of **63**.

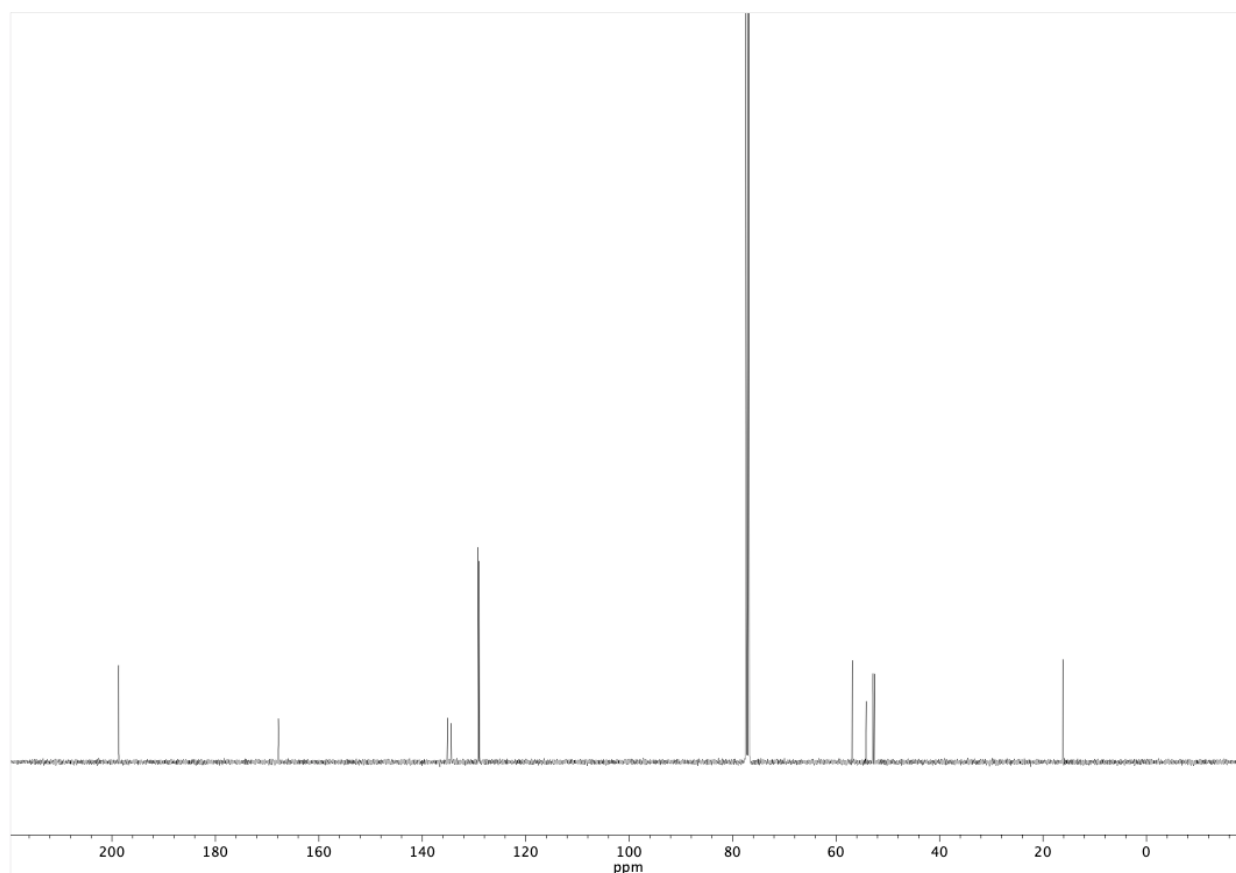


**Figure A3.72.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **63**.

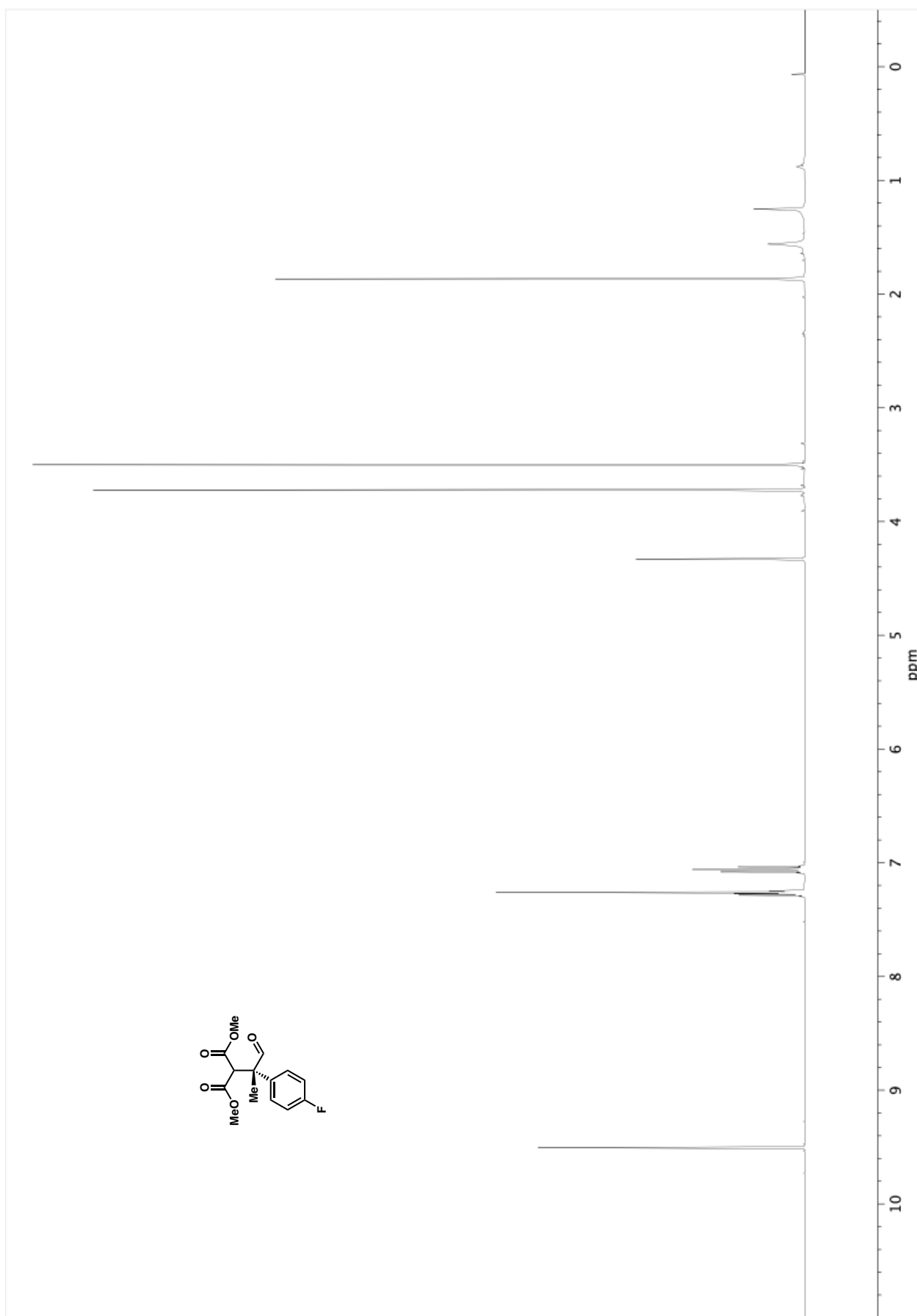
**Figure A3.73.** <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) of **64**.



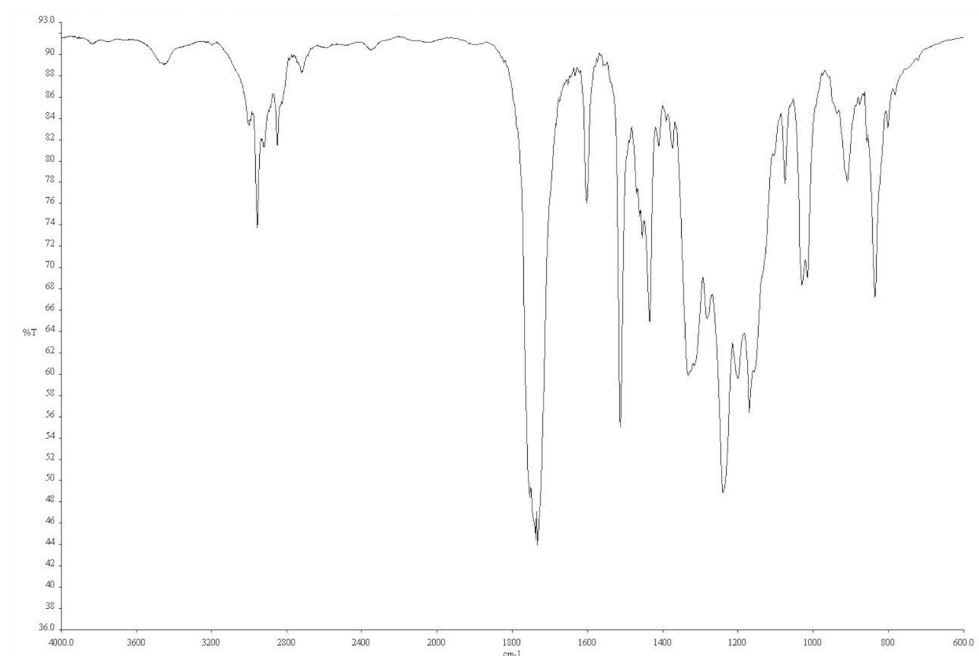
**Figure A3.74.** Infrared spectrum (Thin Film, NaCl) of **64**.



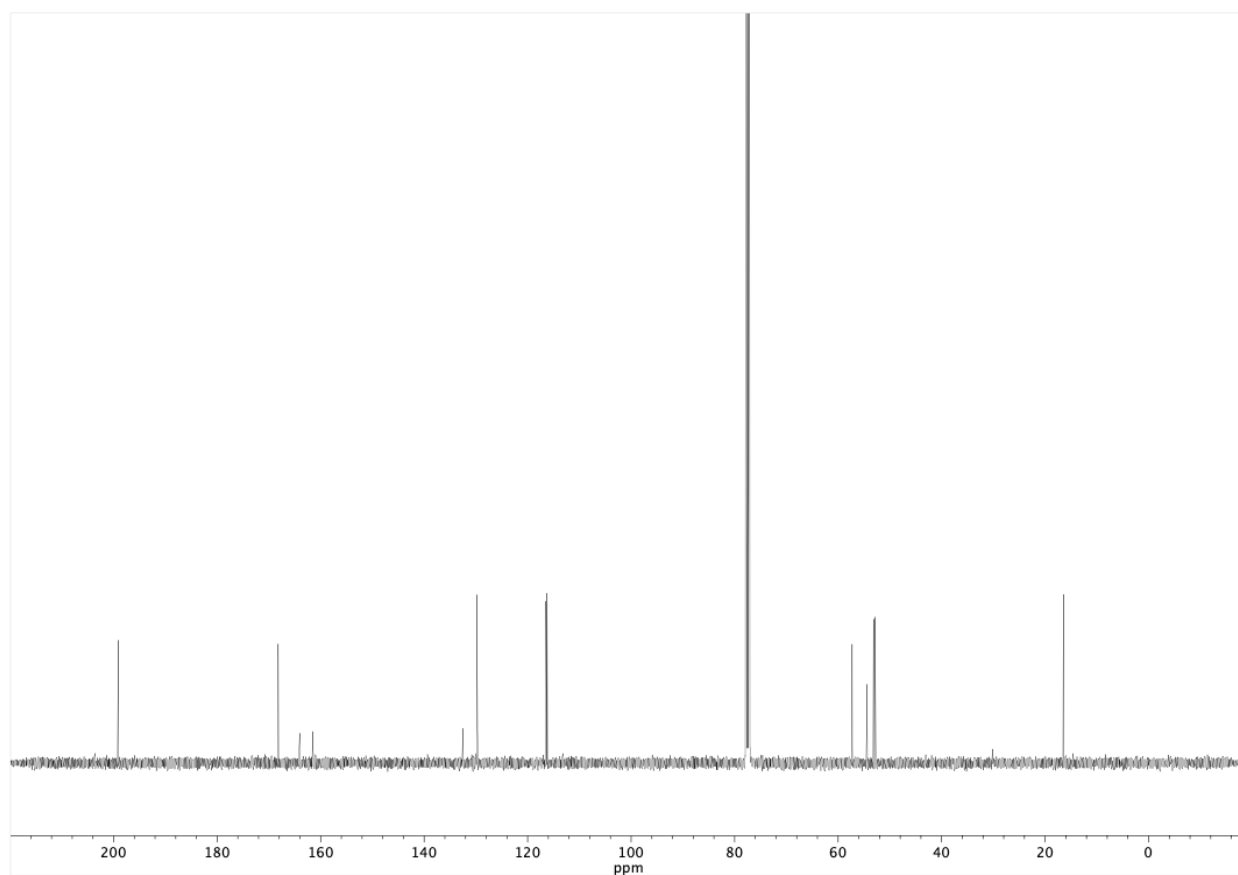
**Figure A3.75.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **64**.



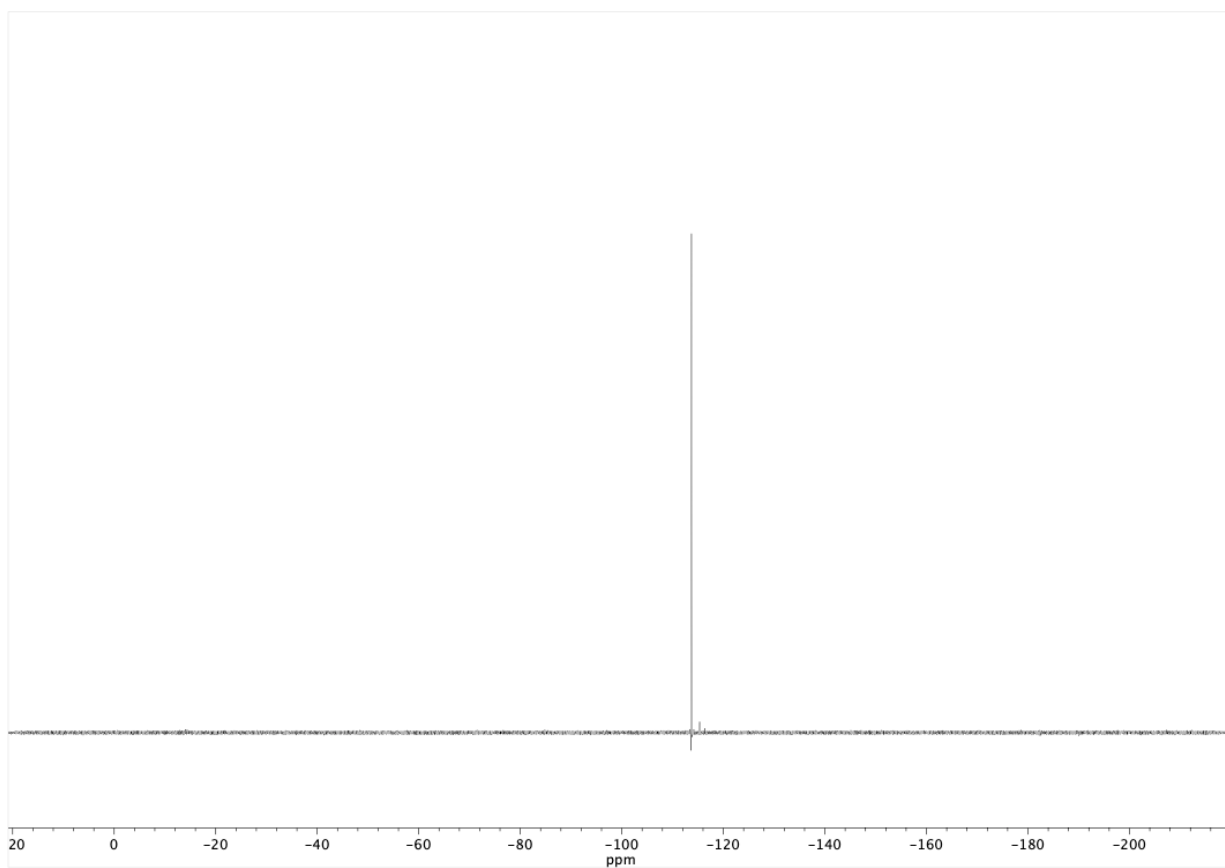
**Figure A3.76.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **65**.



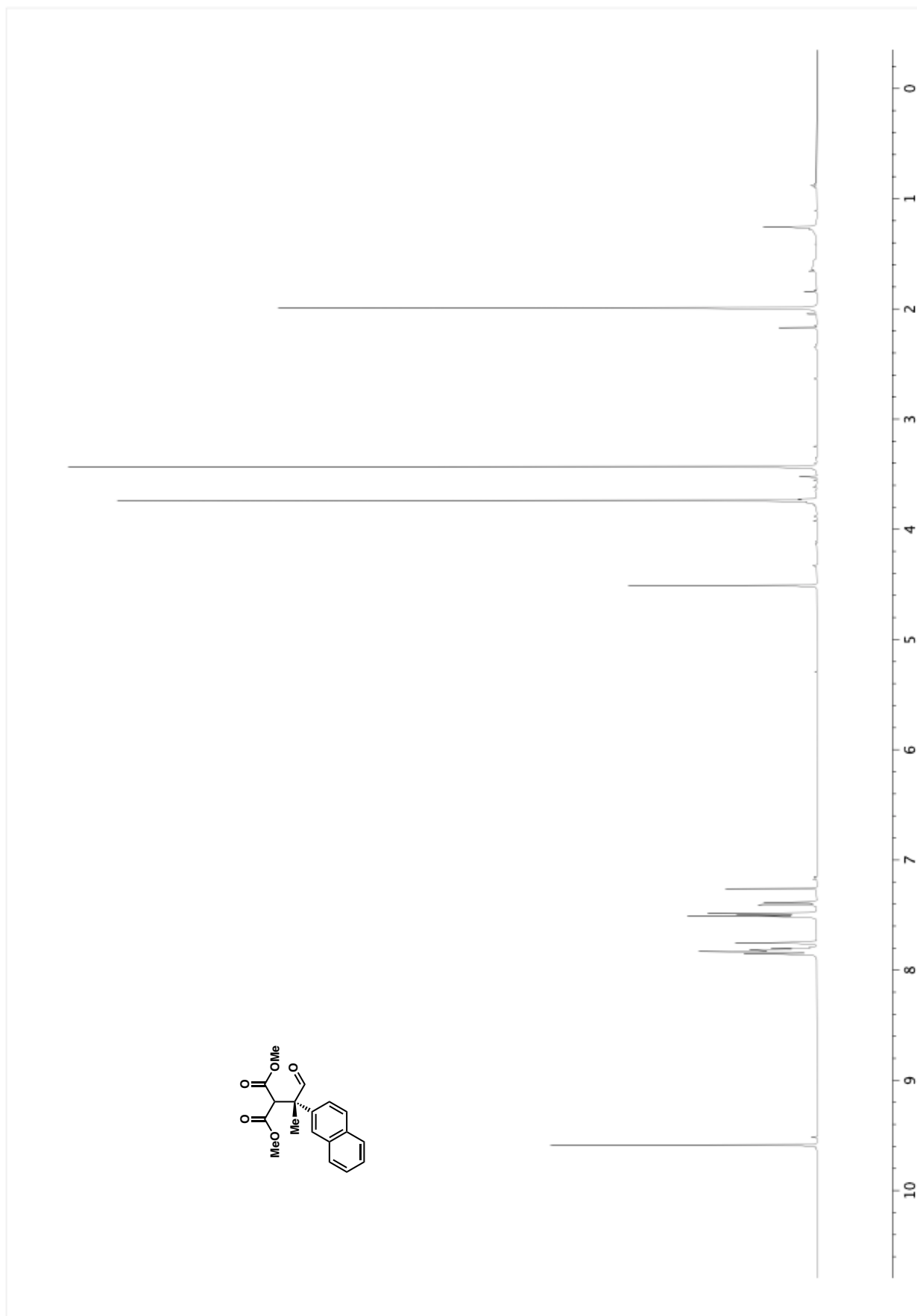
**Figure A3.77.** Infrared spectrum (Thin Film, NaCl) of **65**.

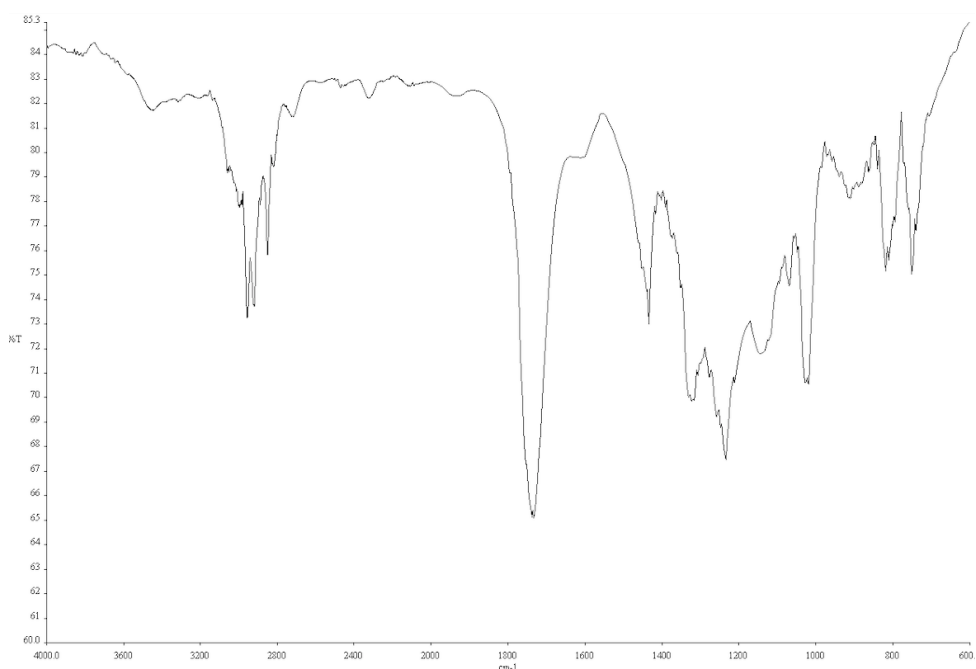


**Figure A3.78.**  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) of **65**.

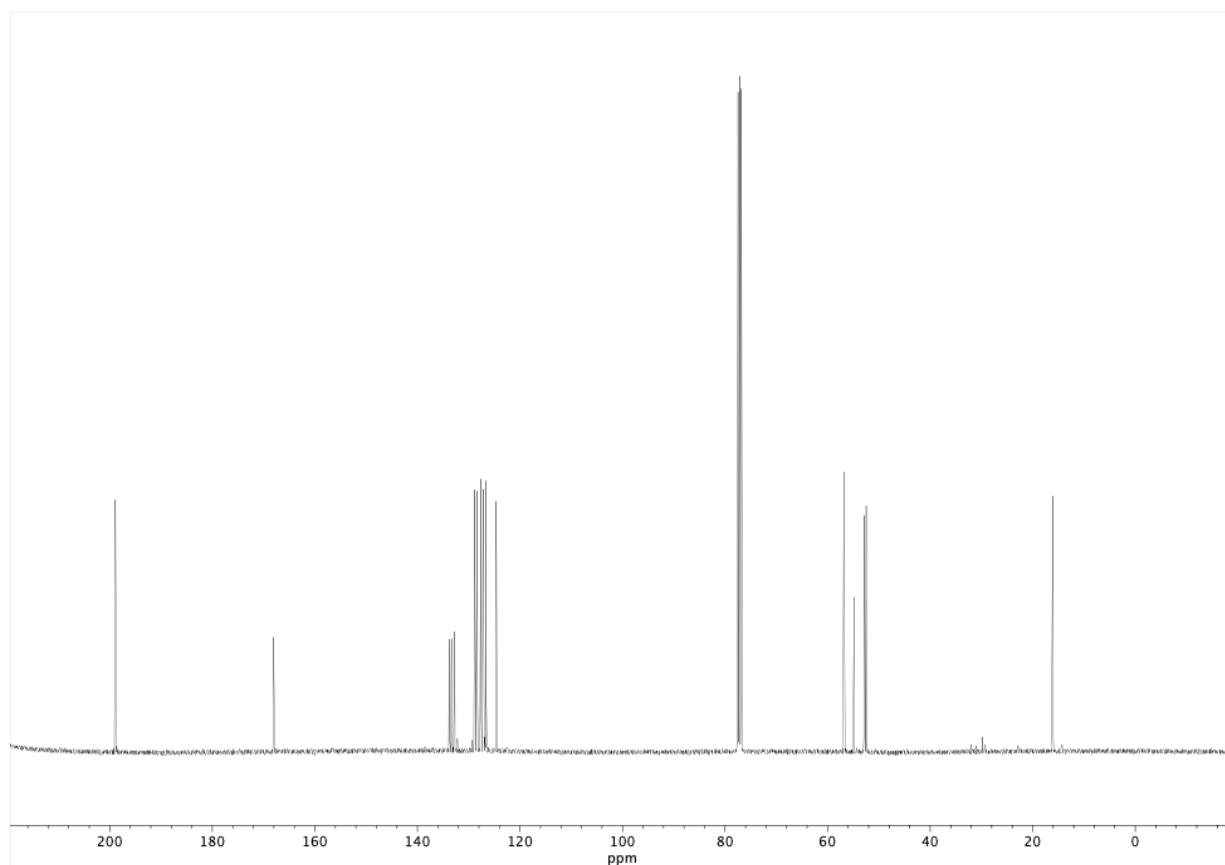


**Figure A3.79.**  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ ) of **65**.

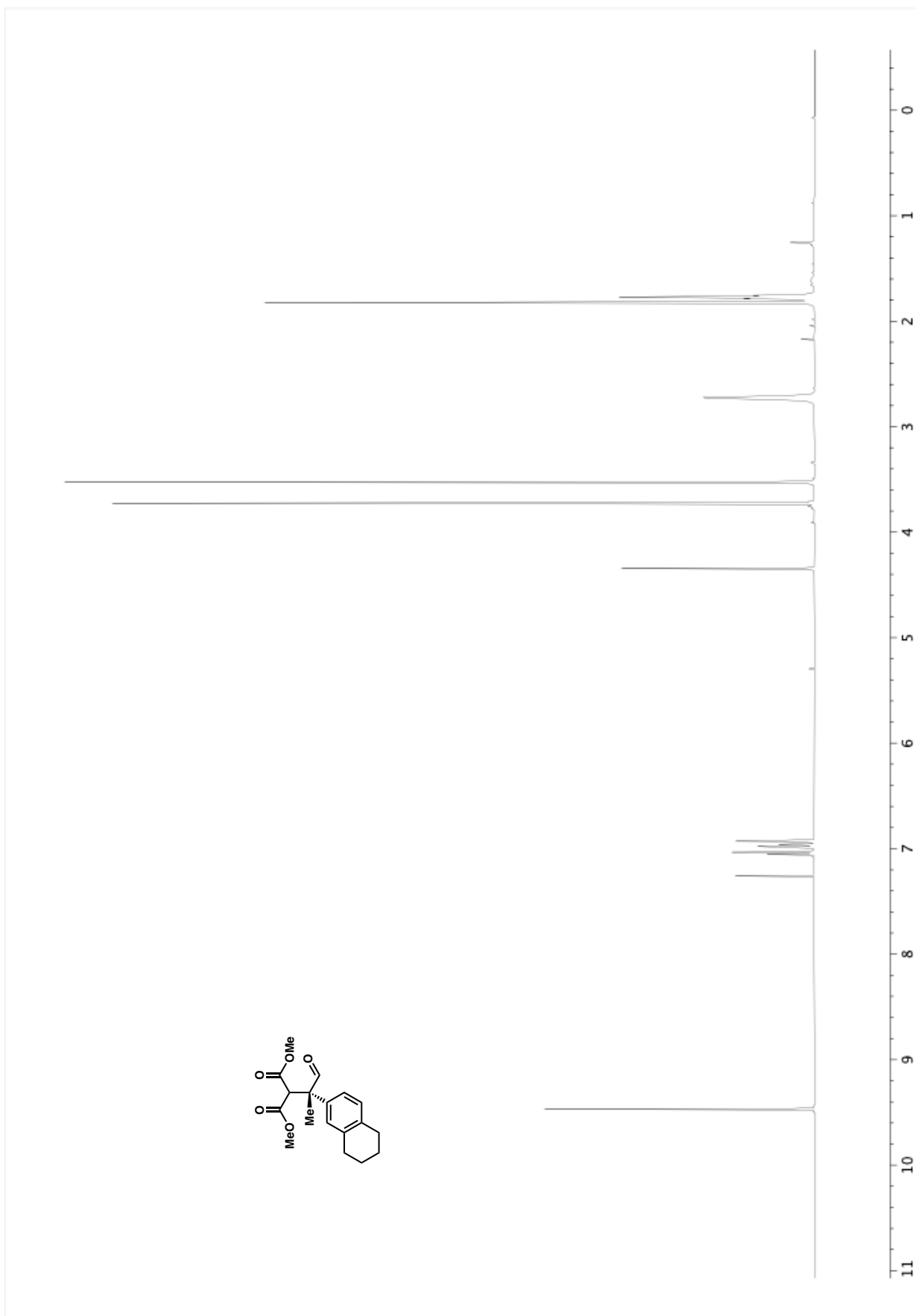
**Figure A3.80.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **66**.



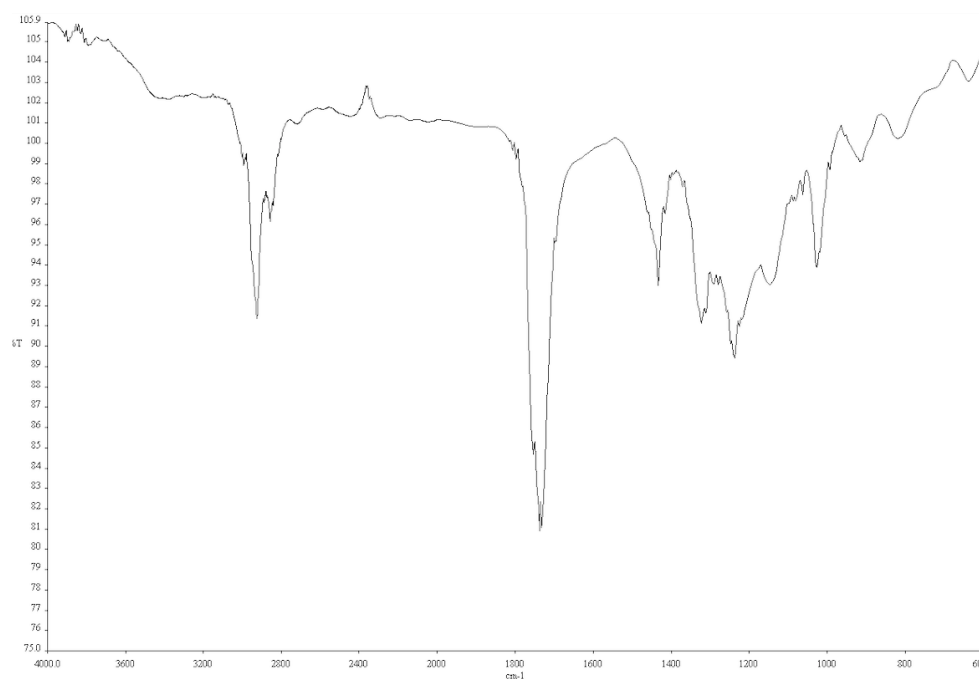
**Figure A3.81.** Infrared spectrum (Thin Film, NaCl) of **66**.



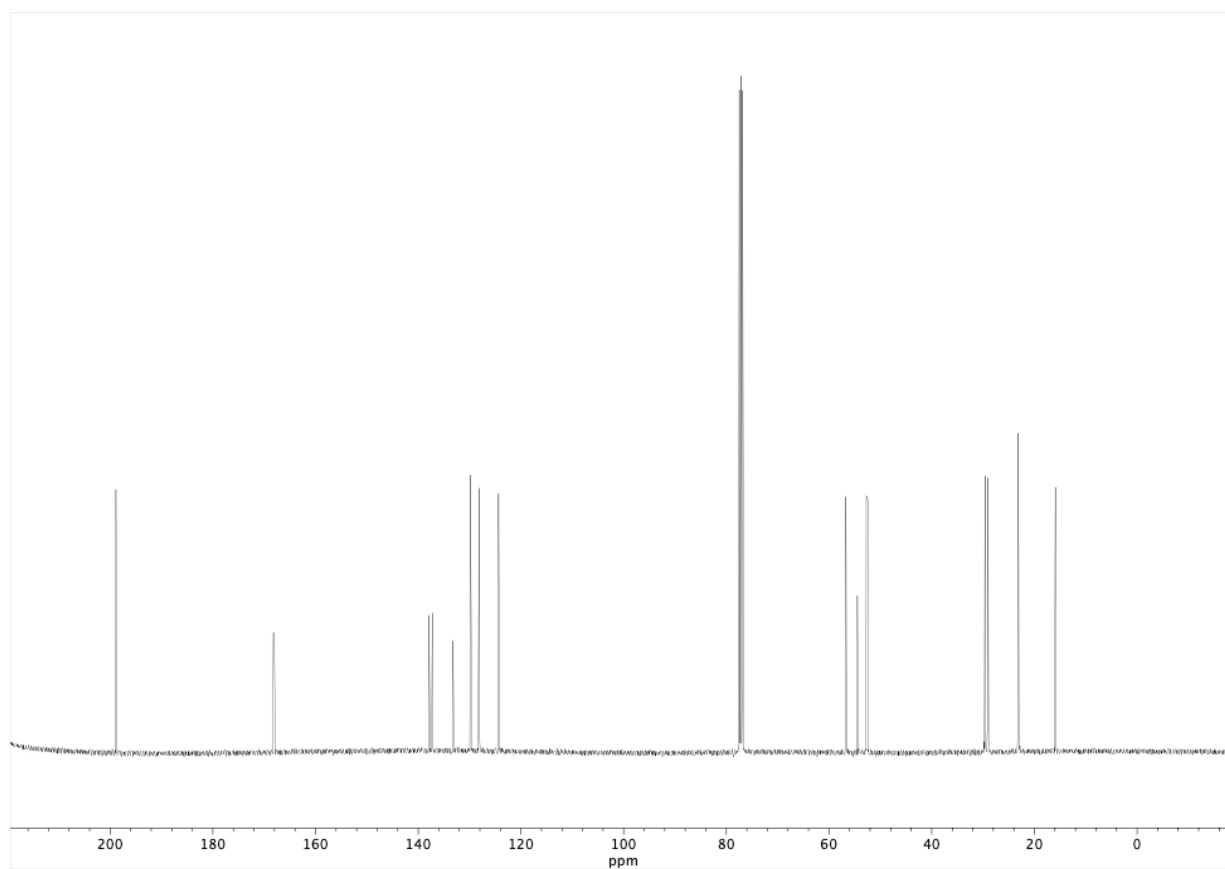
**Figure A3.82.**  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) of **66**.



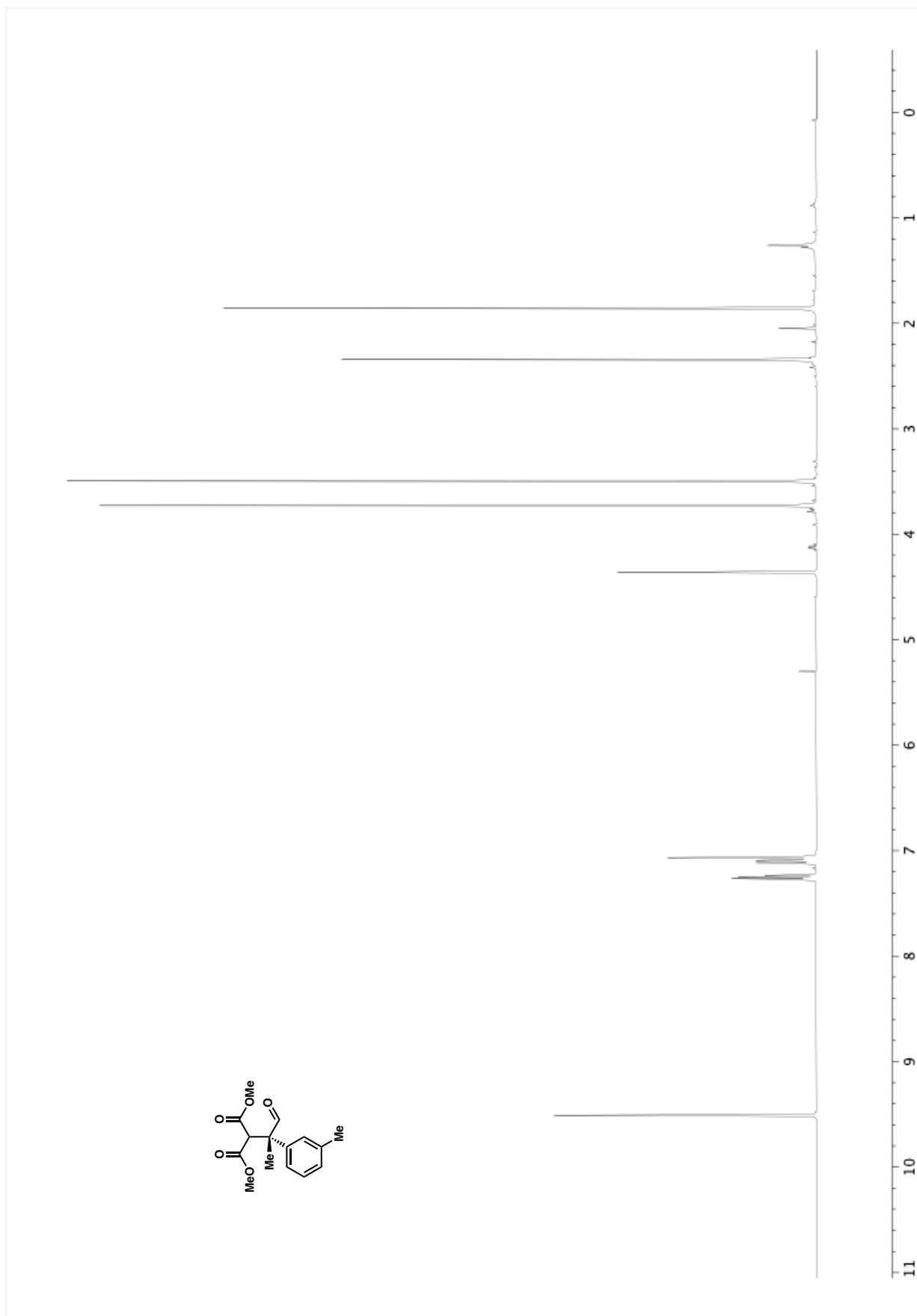
**Figure A3.83.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **67**.



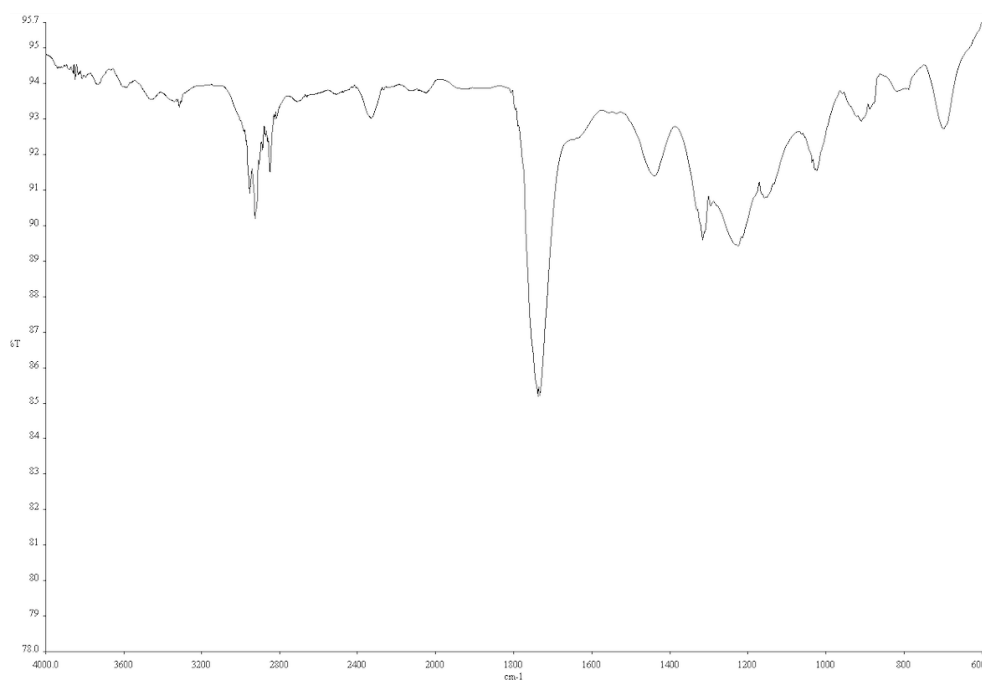
**Figure A3.84.** Infrared spectrum (Thin Film, NaCl) of **67**.



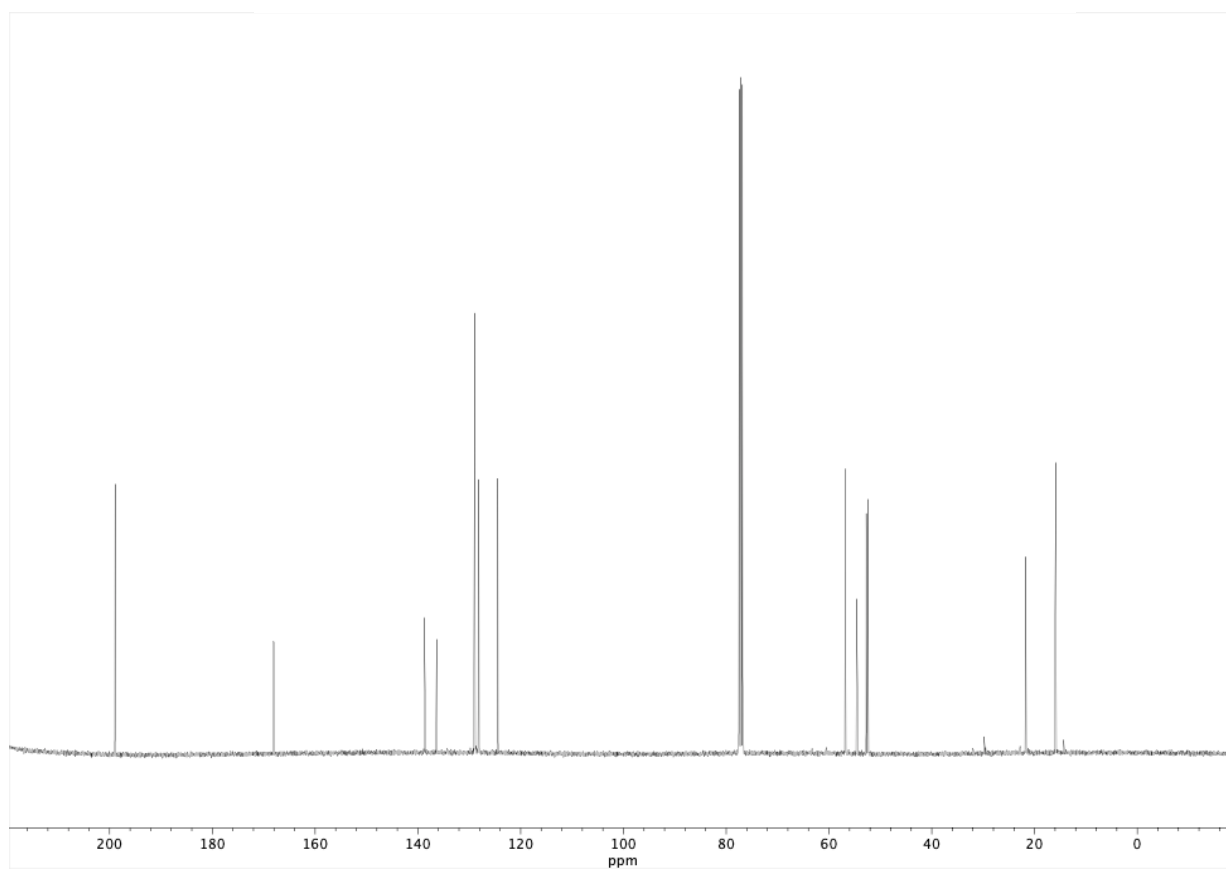
**Figure A3.85.**  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) of **67**.



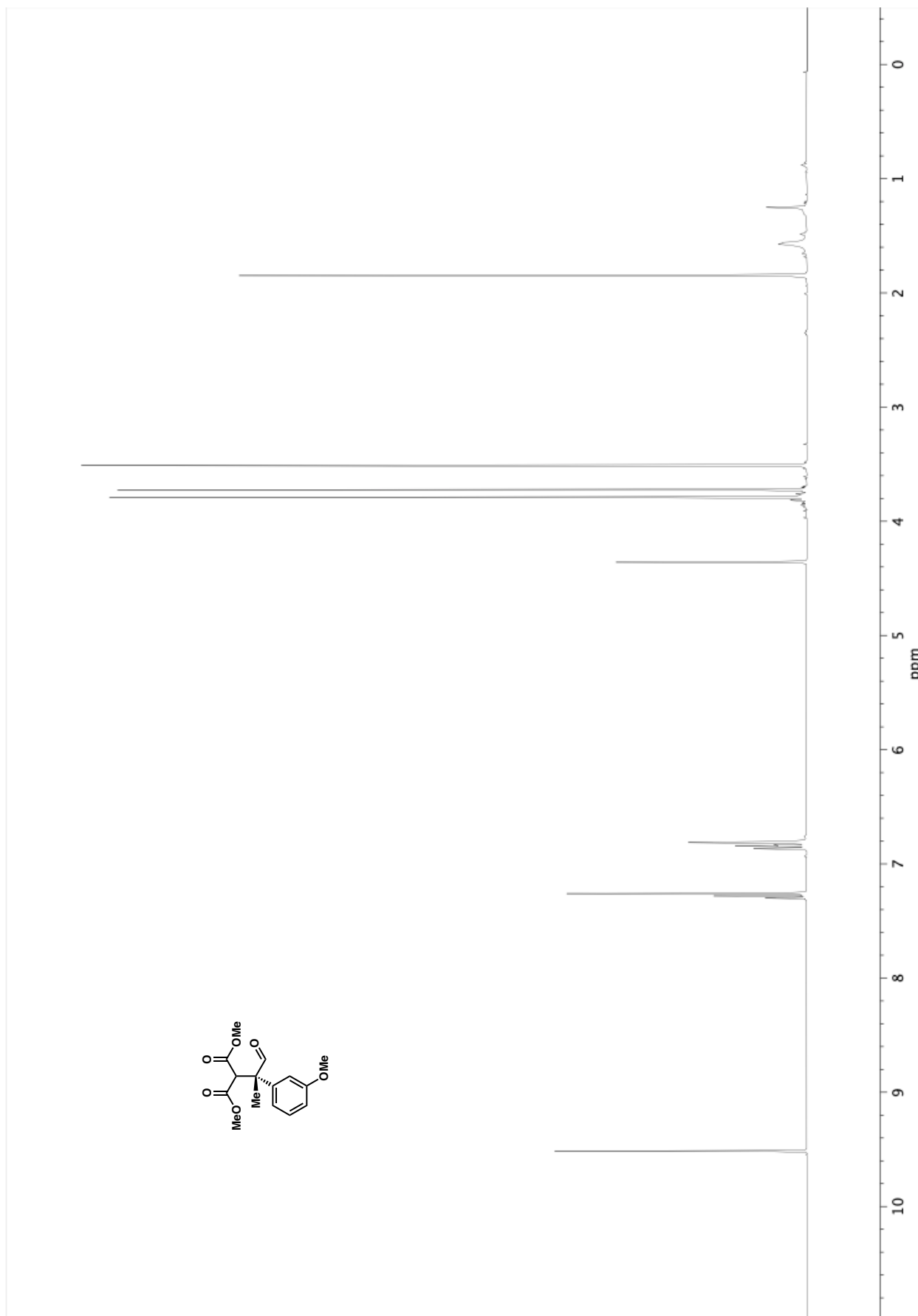
**Figure A3.86.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **68**.



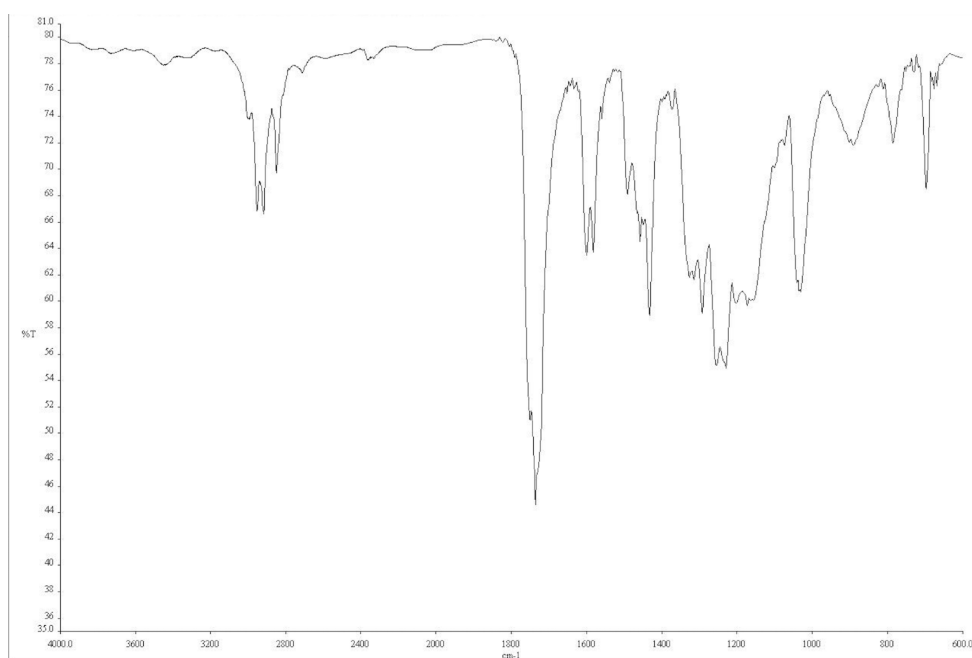
**Figure A3.87.** Infrared spectrum (Thin Film, NaCl) of **68**.



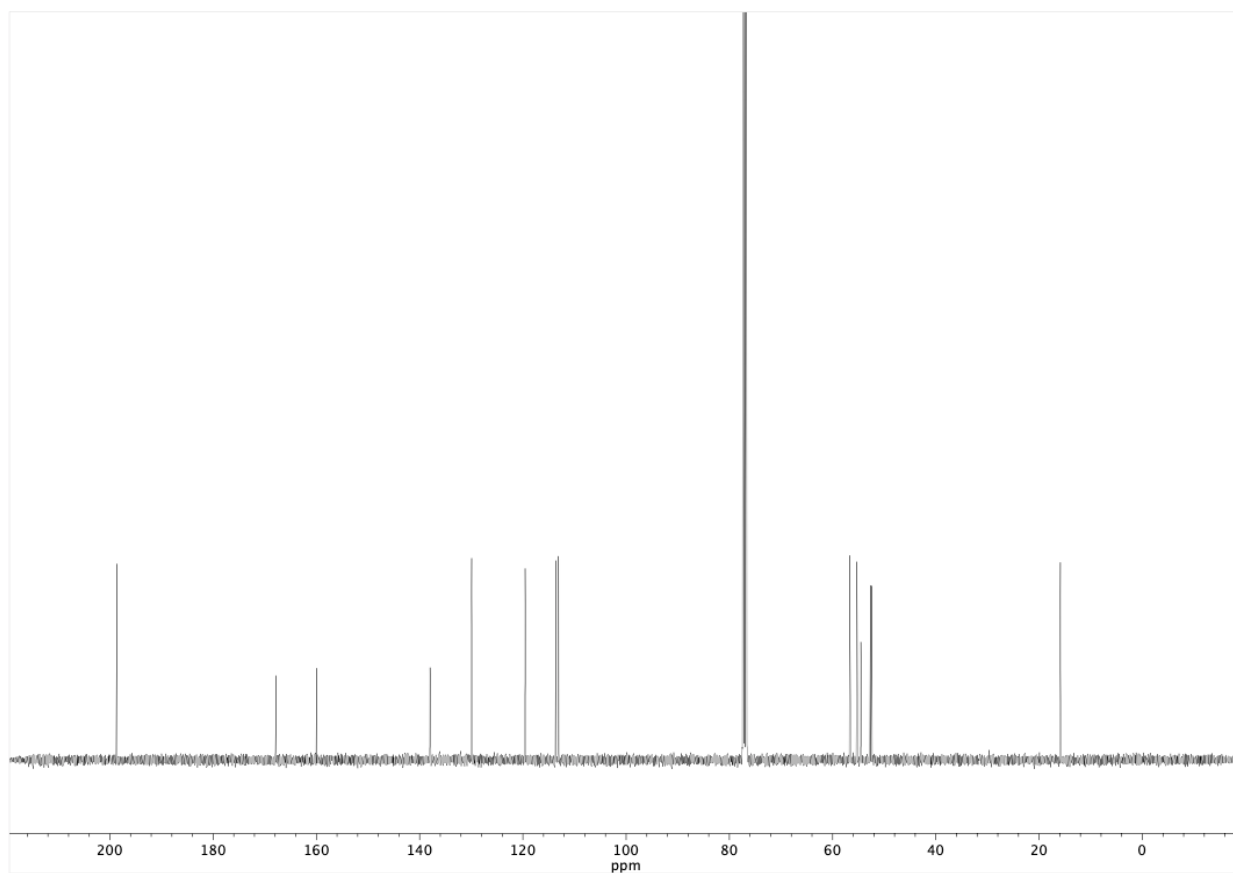
**Figure A3.88.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **68**.



**Figure A3.89.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **69**.

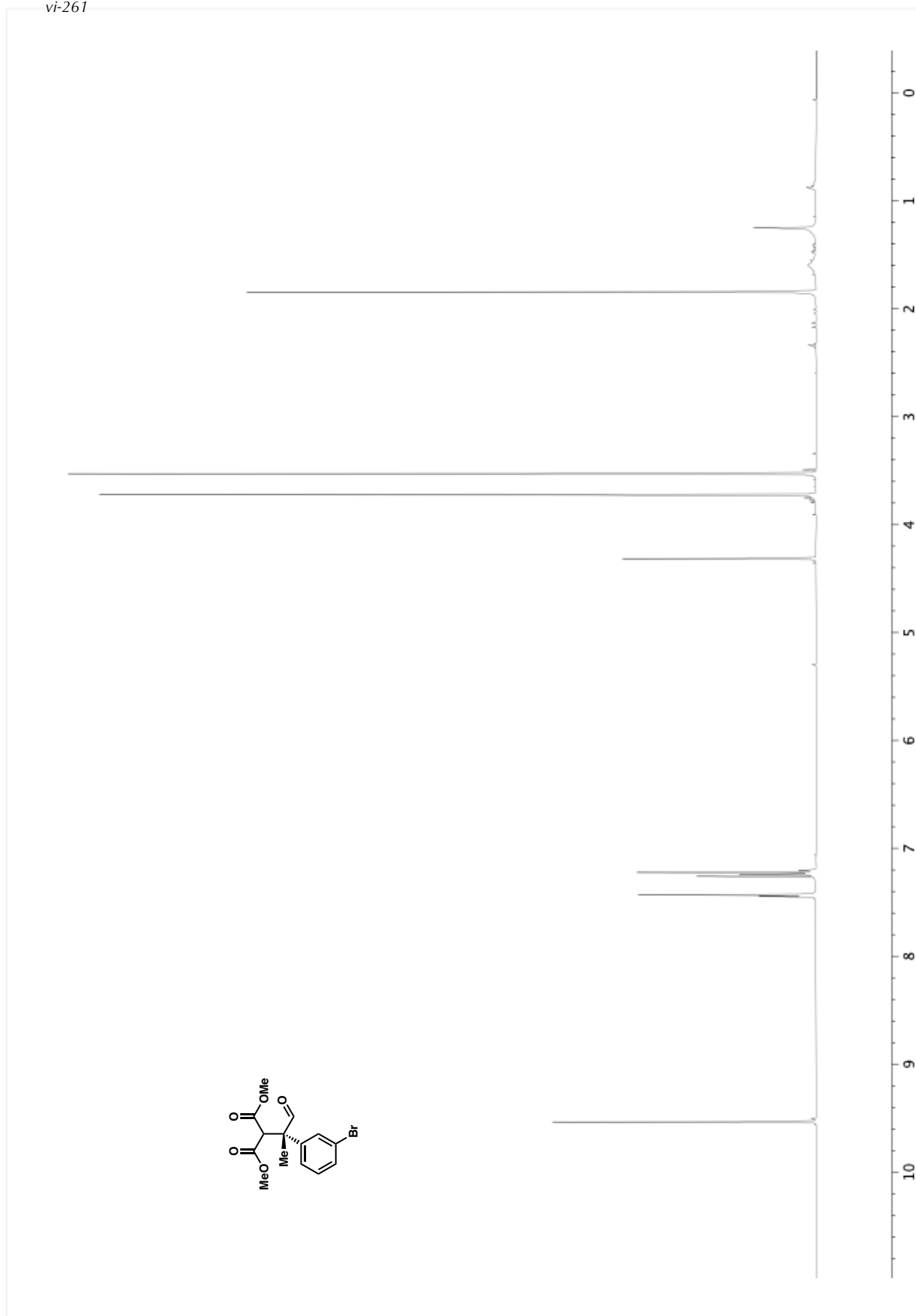


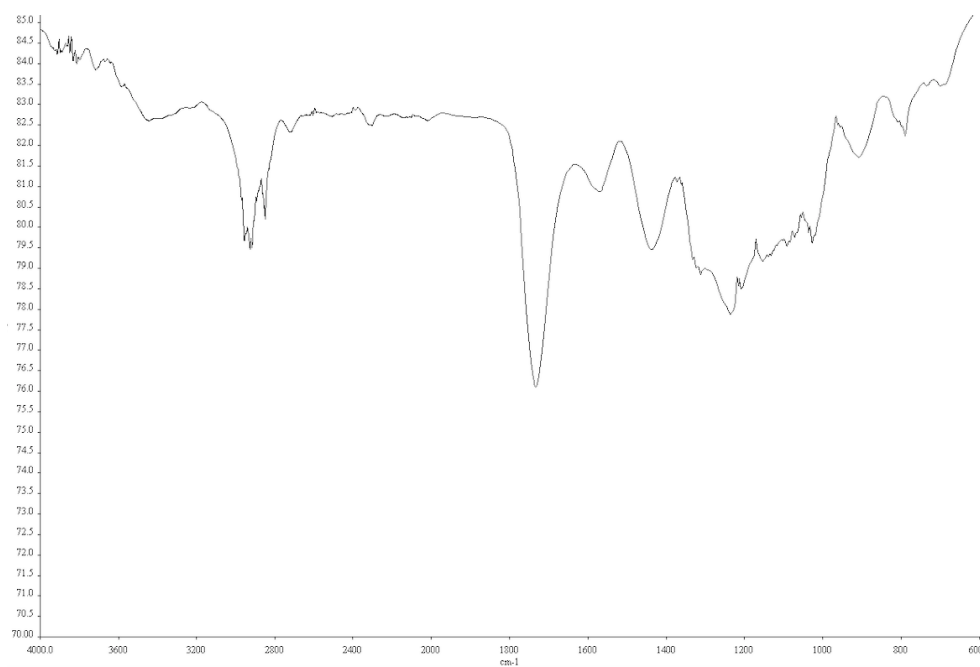
**Figure A3.90.** Infrared spectrum (Thin Film, NaCl) of **69**.



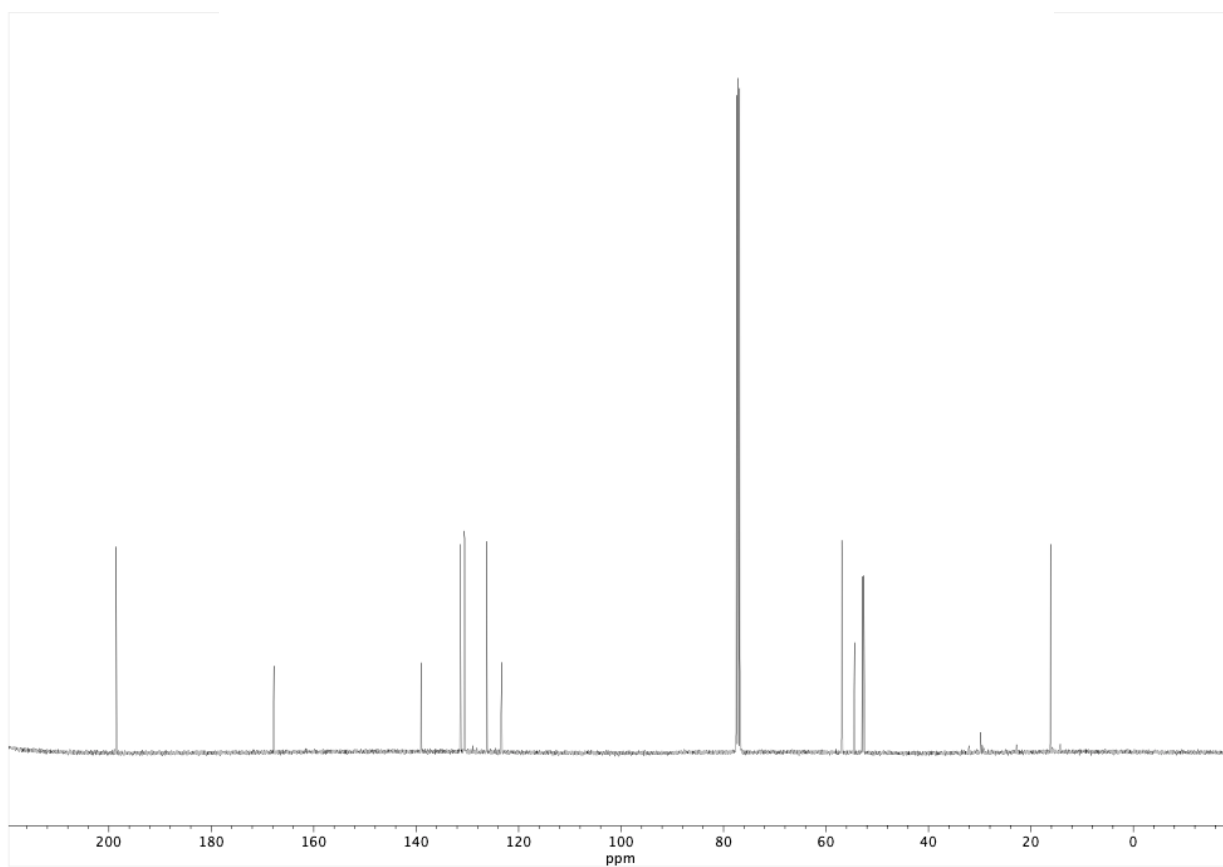
**Figure A3.91.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **69**.

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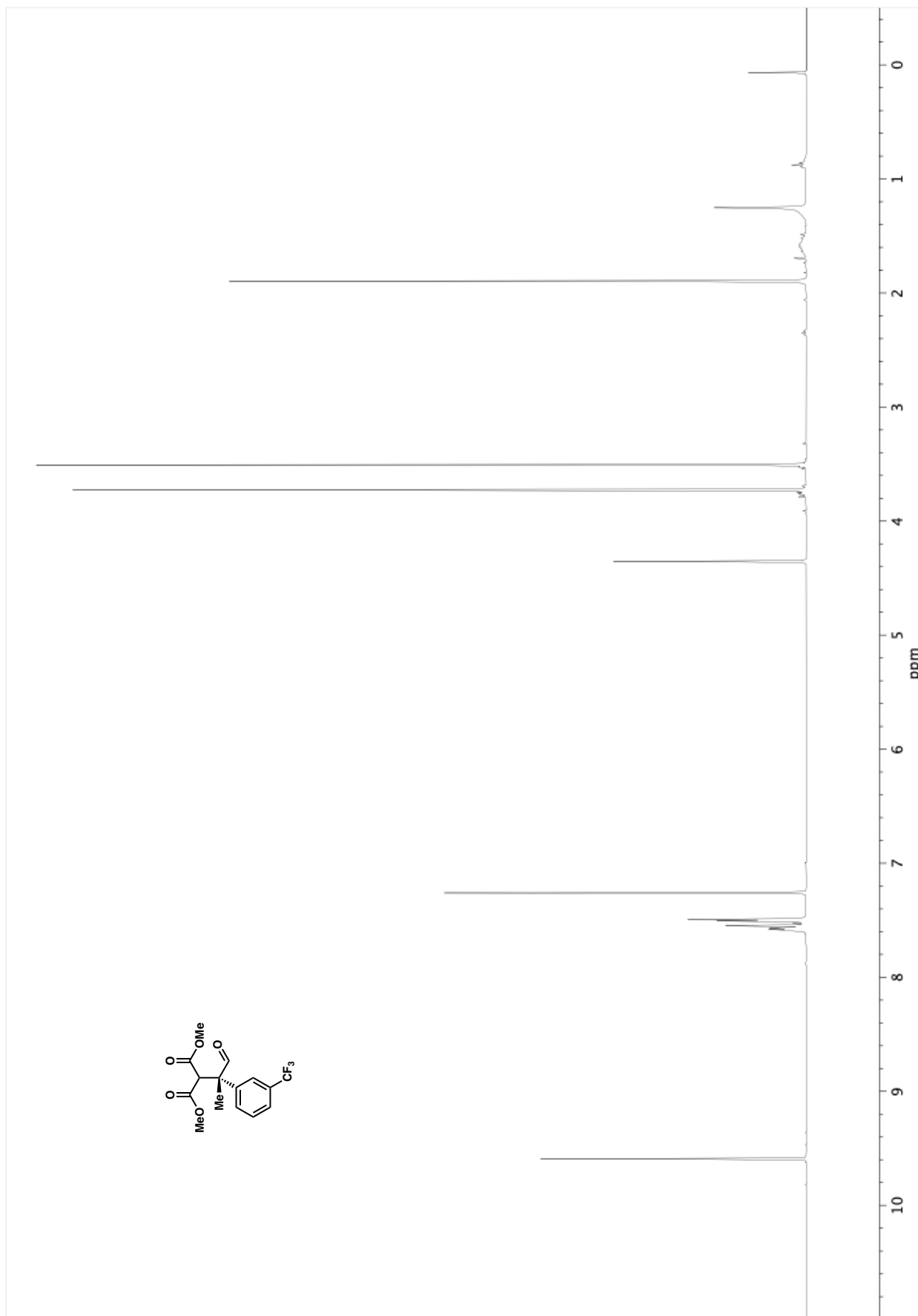
**Figure A3.92.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **70**.



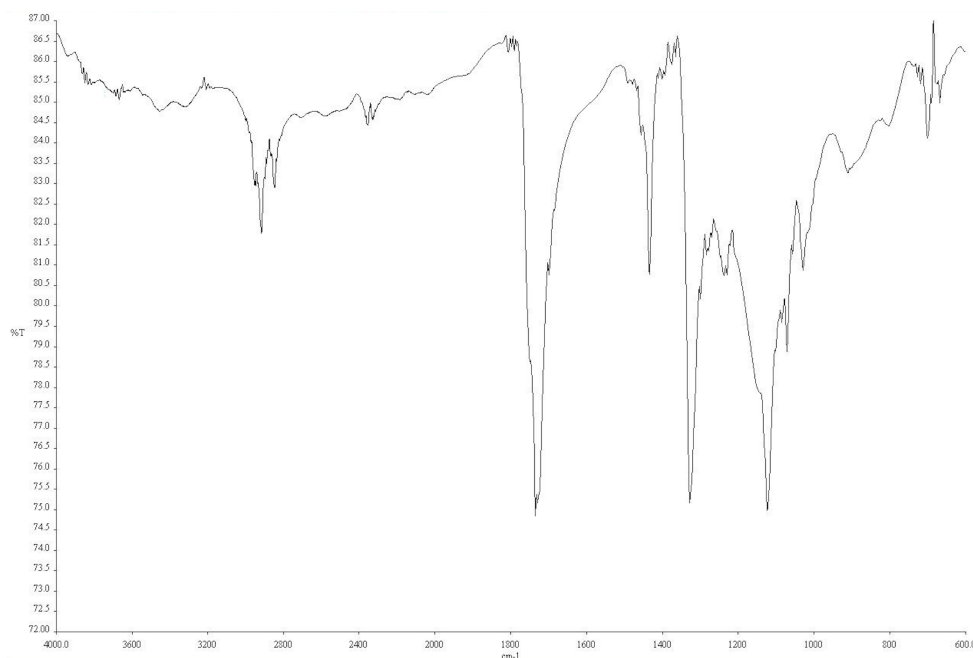
**Figure A3.93.** Infrared spectrum (Thin Film, NaCl) of **70**.



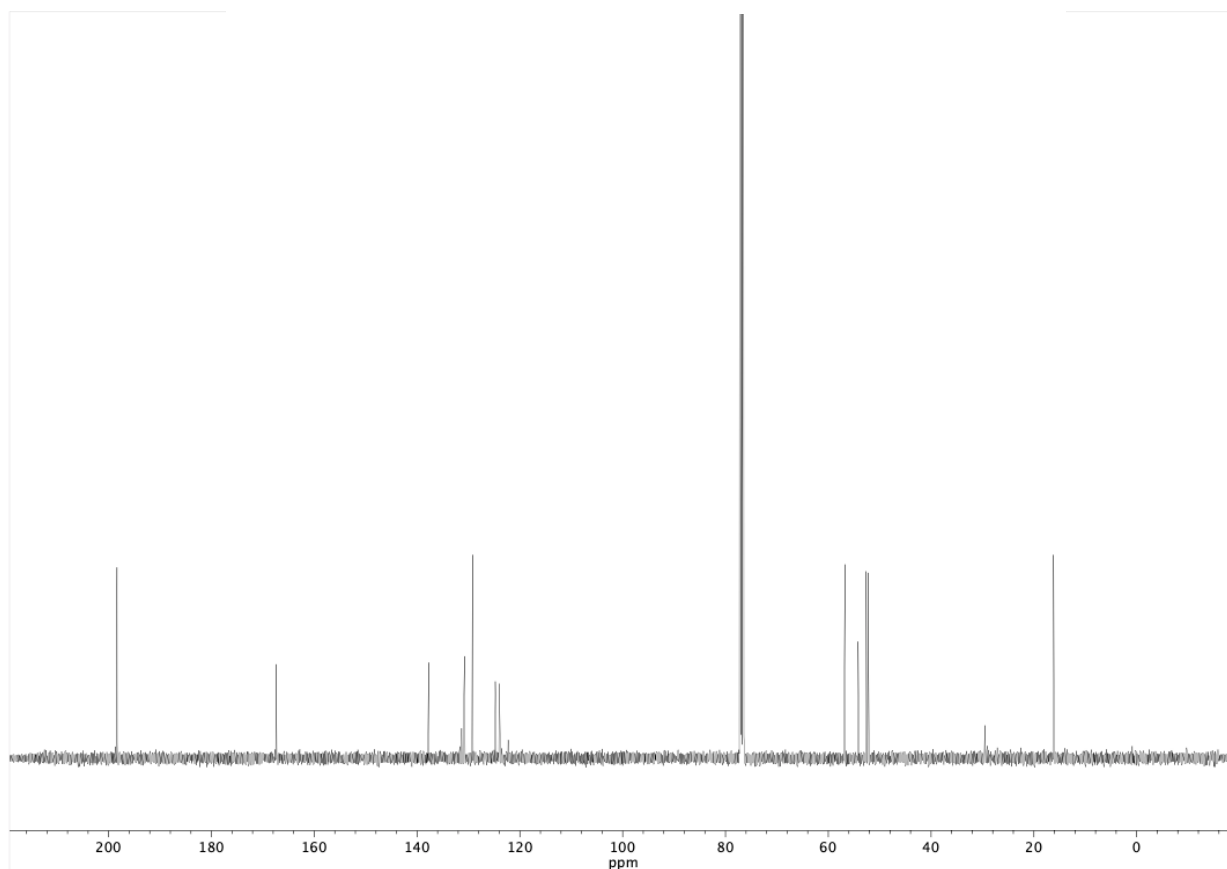
**Figure A3.94.**  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) of **70**.



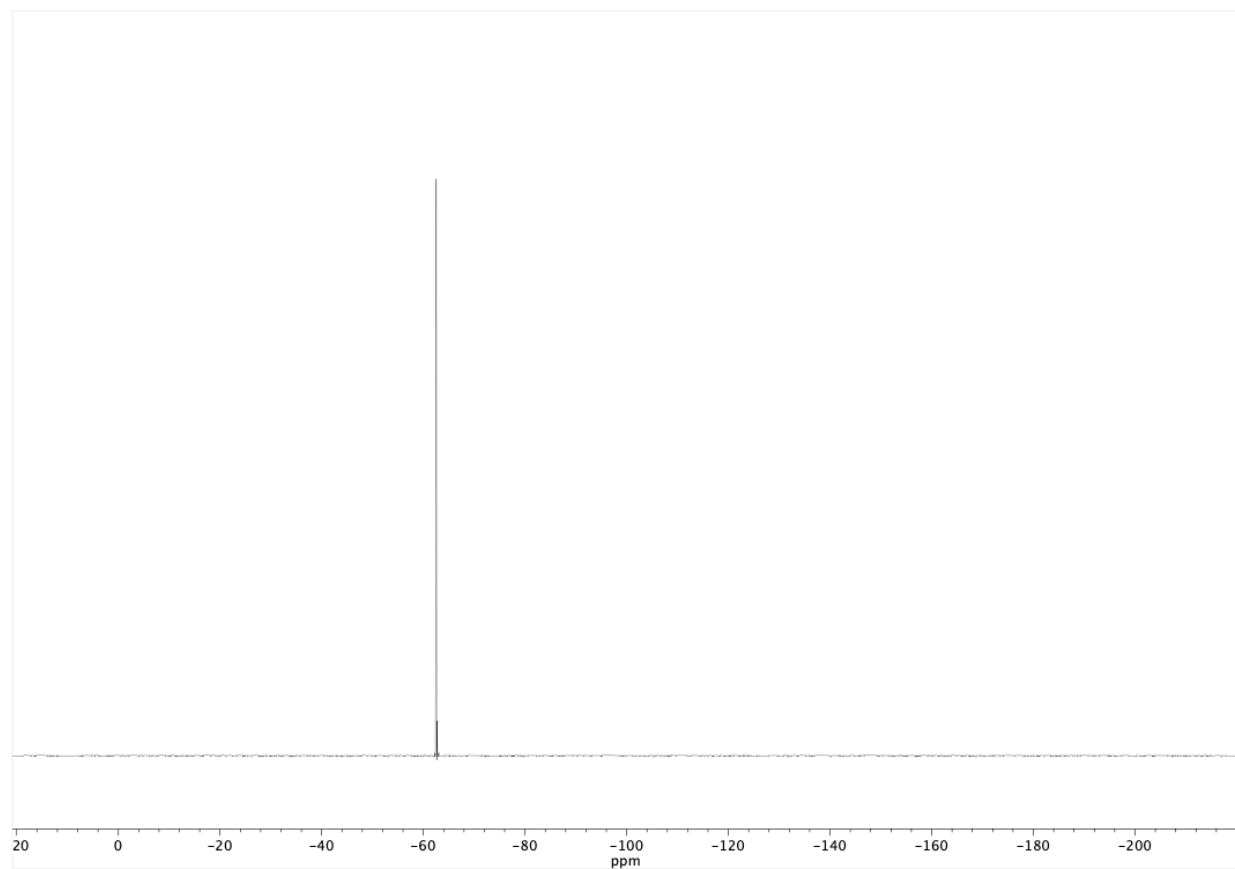
**Figure A3.95.** <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) of **71**.



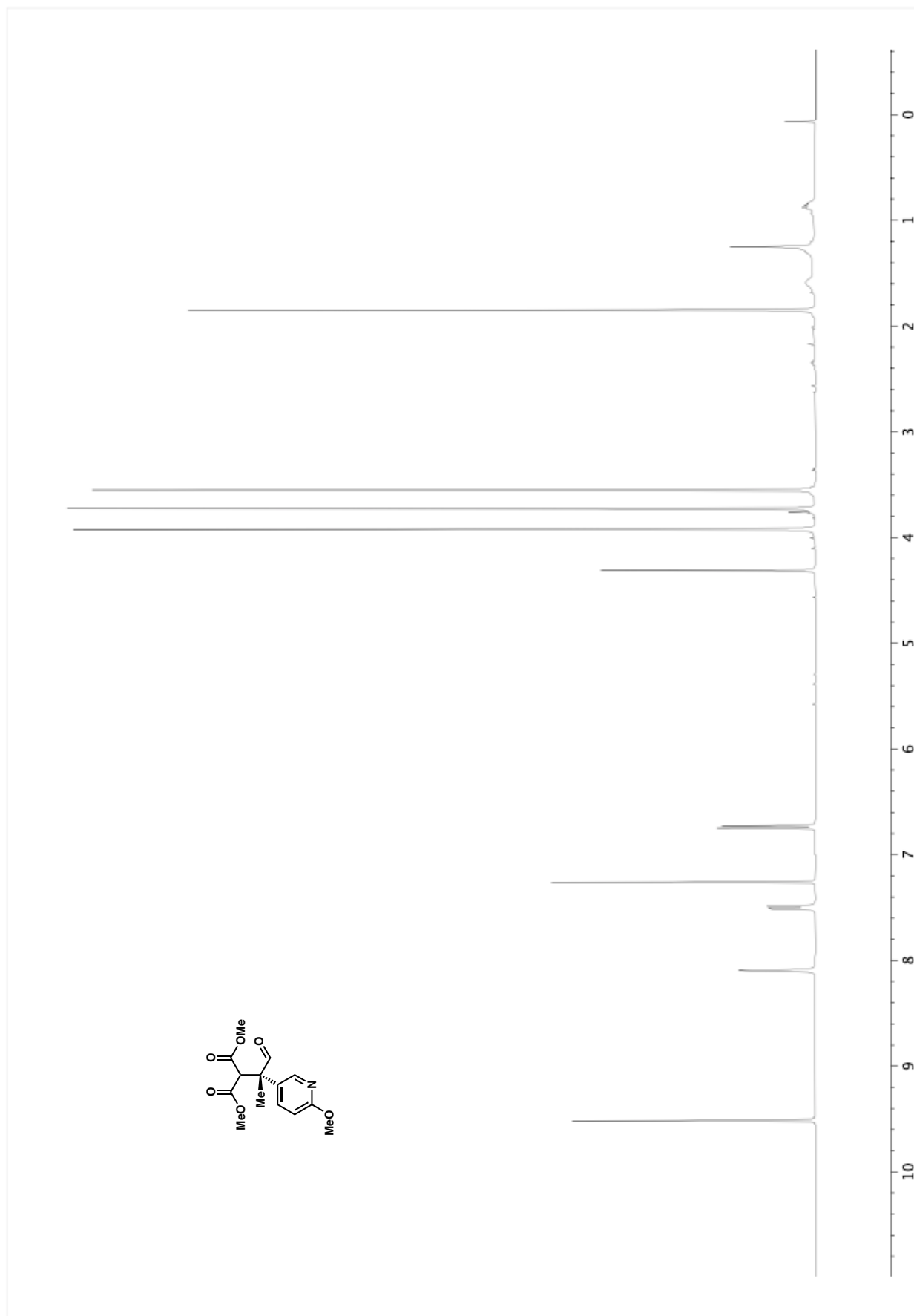
**Figure A3.96.** Infrared spectrum (Thin Film, NaCl) of **71**.



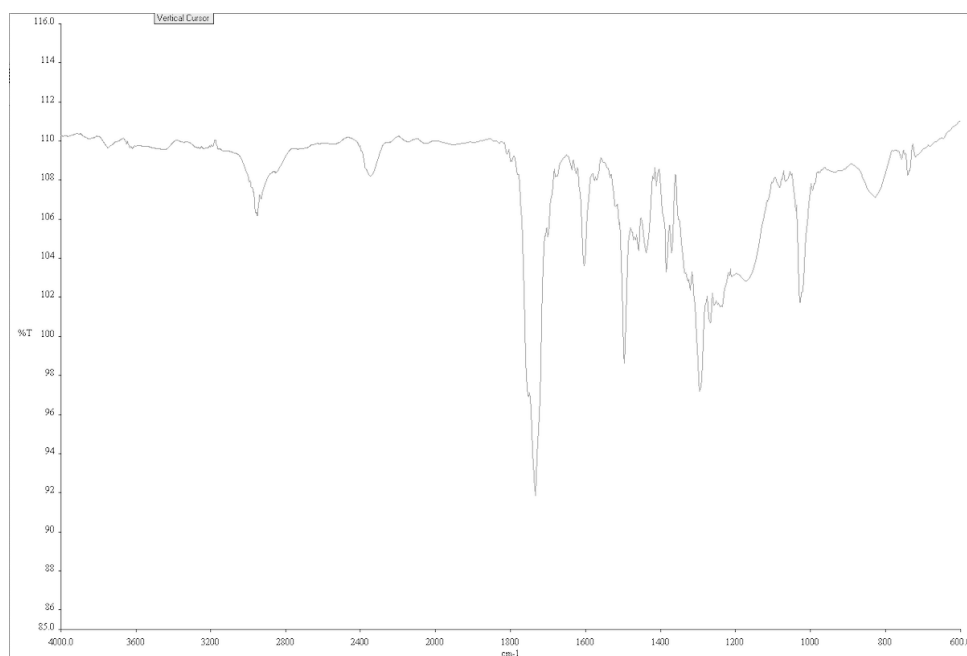
**Figure A3.97.**  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) of **71**.



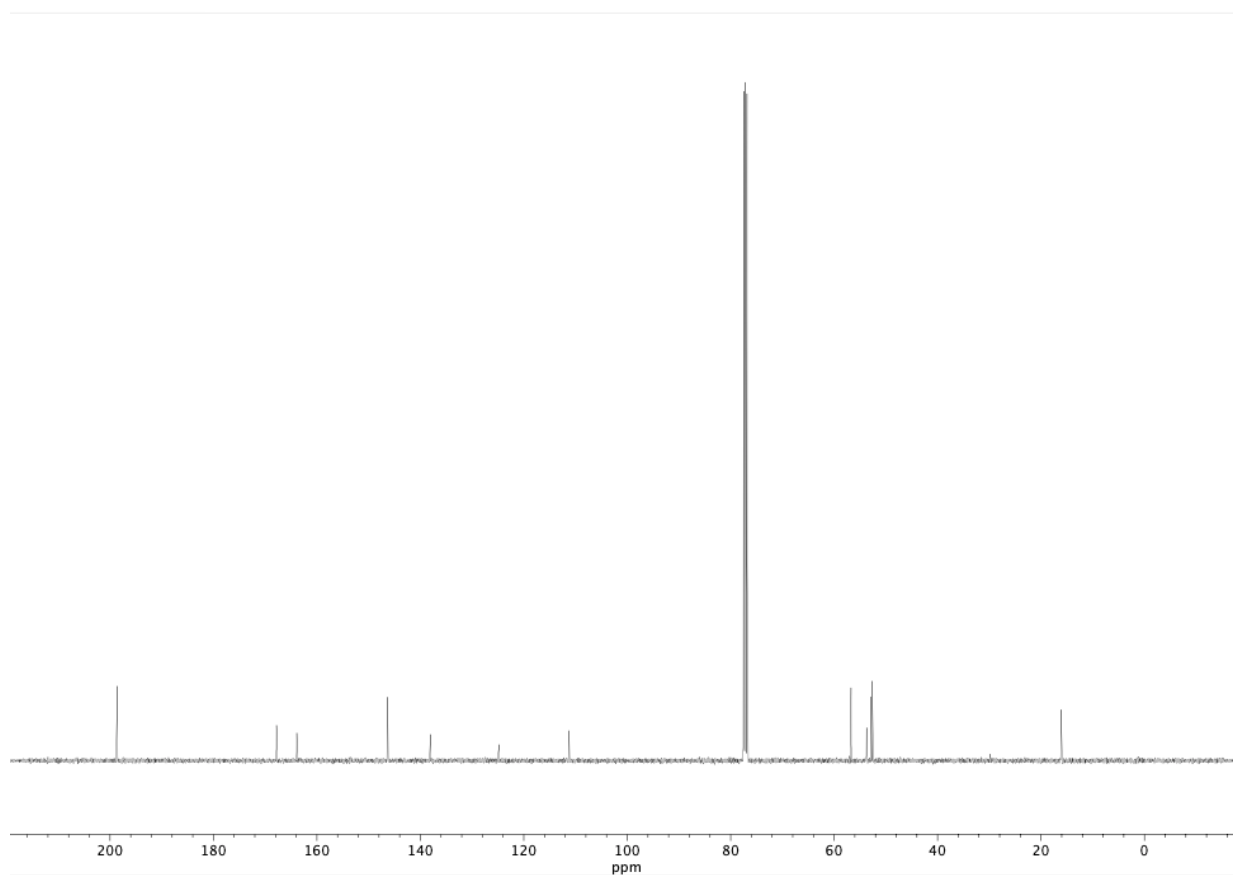
**Figure A3.98.**  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ ) of **71**.



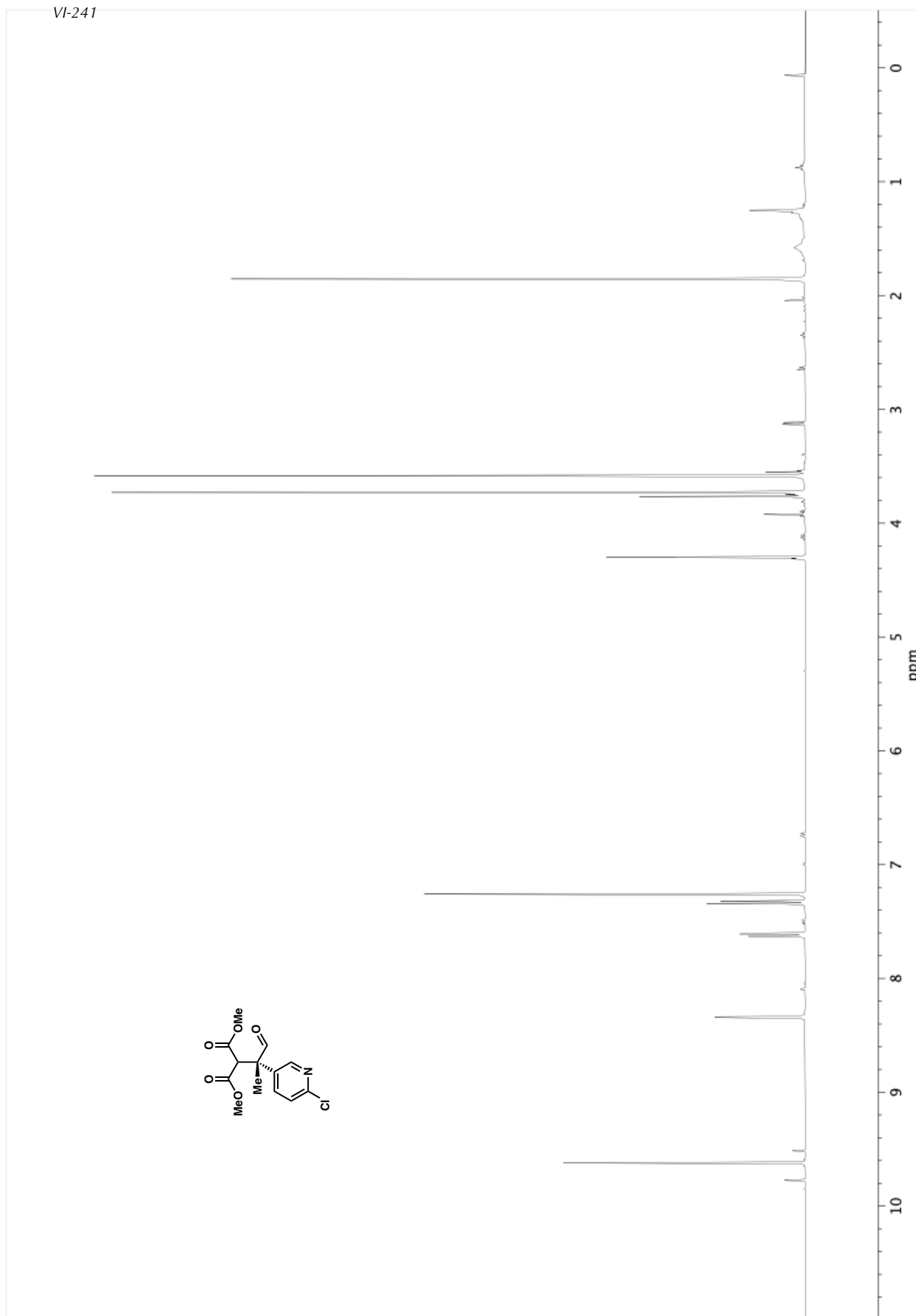
**Figure A3.99.** <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) of **72**.

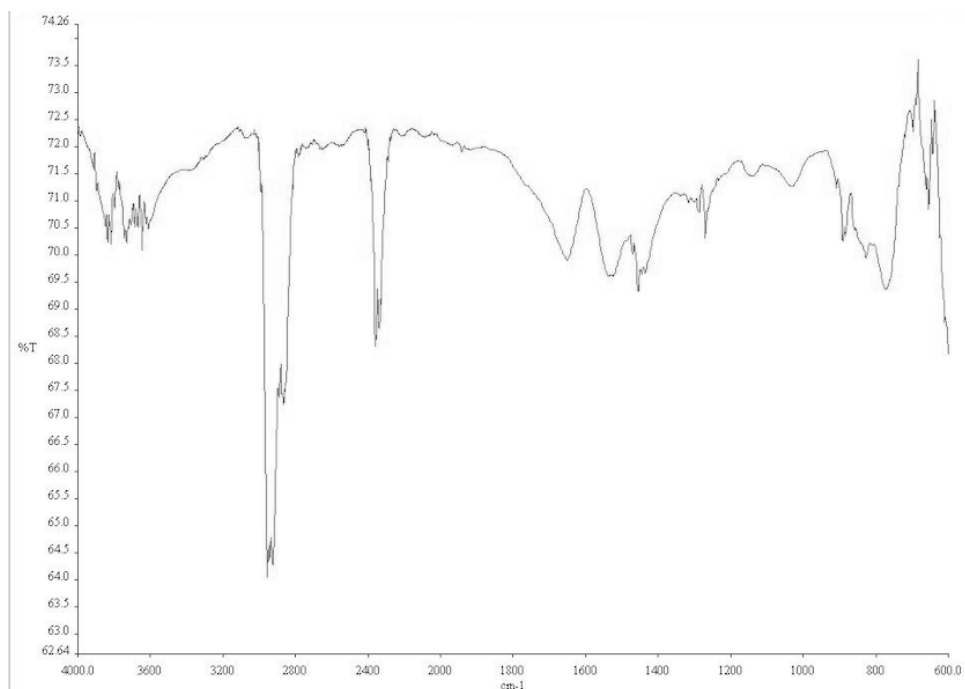


**Figure A3.100.** Infrared spectrum (Thin Film, NaCl) of **72**

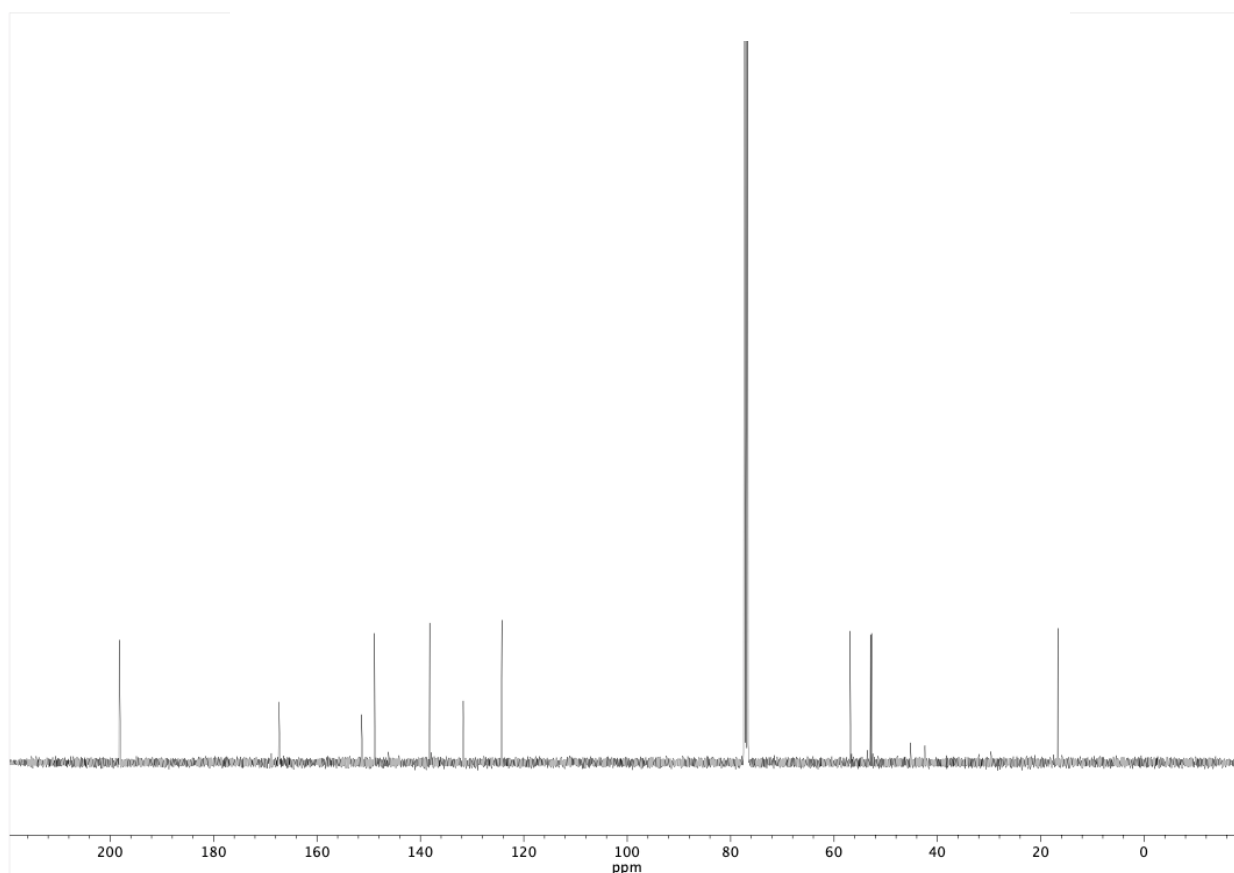


**Figure A3.101.**  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) of **72**

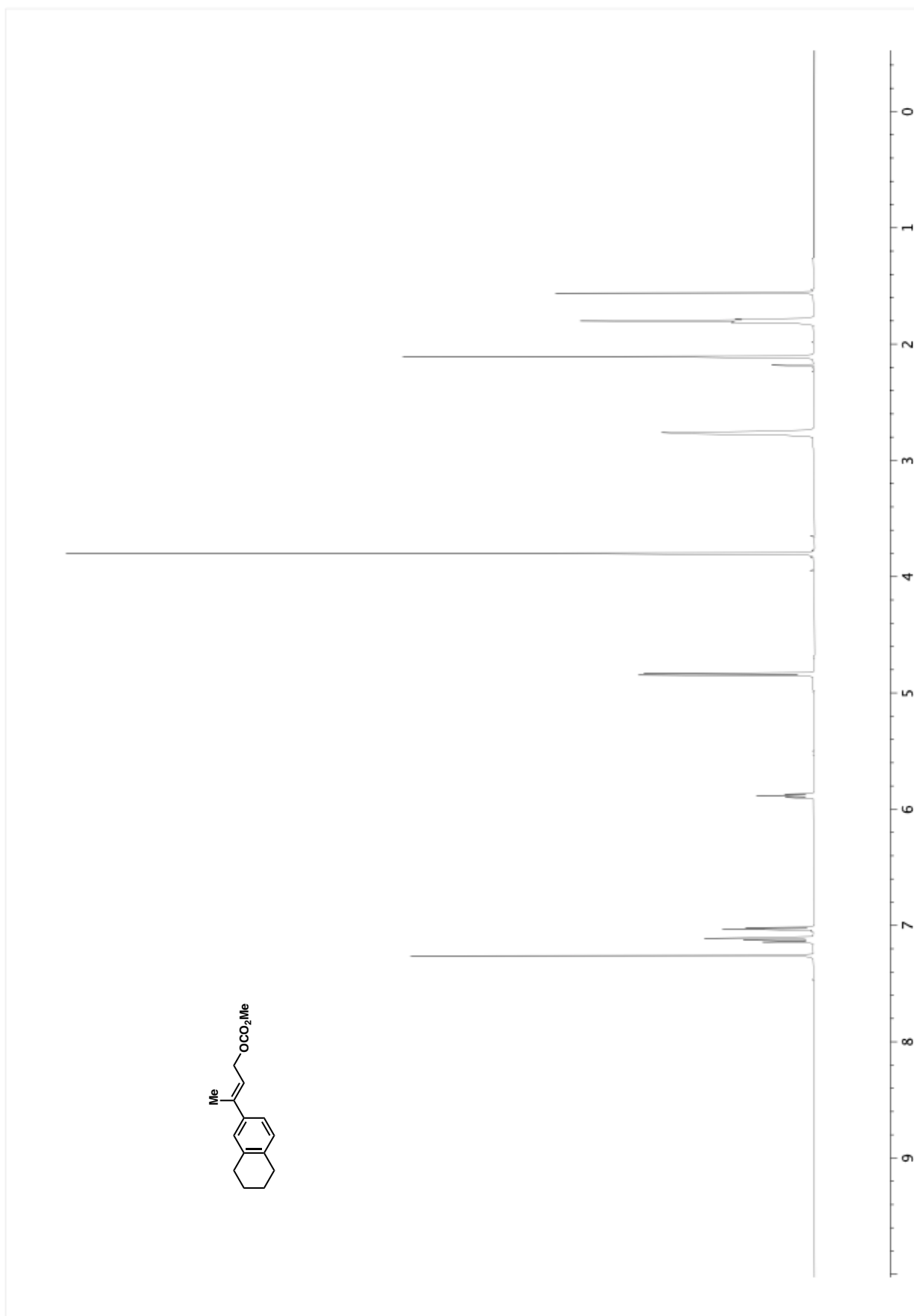
**Figure A3.102.** <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) of 73.



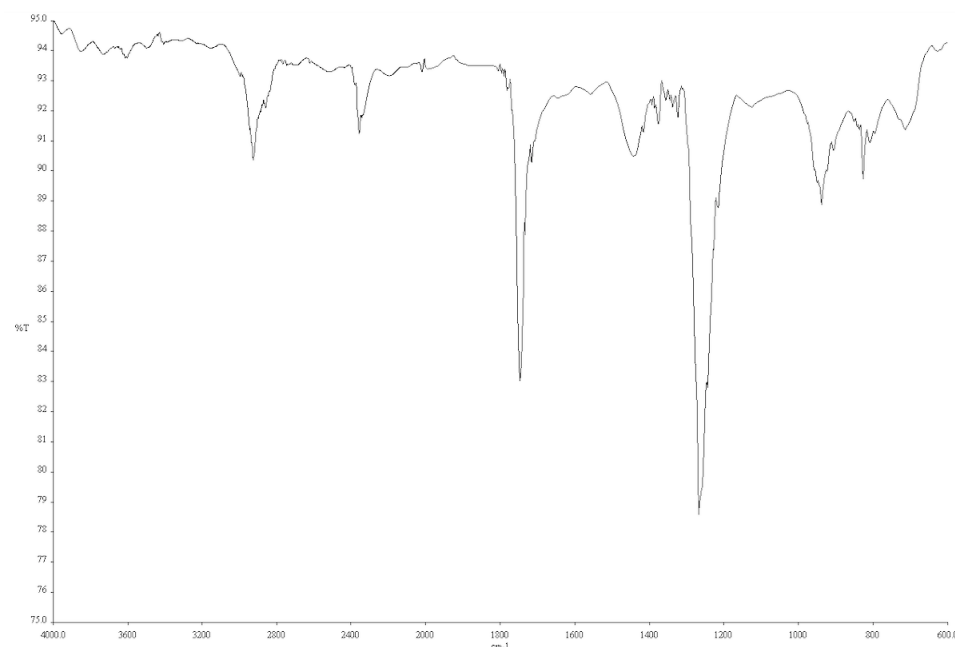
**Figure A3.103.** Infrared spectrum (Thin Film, NaCl) of **73**.



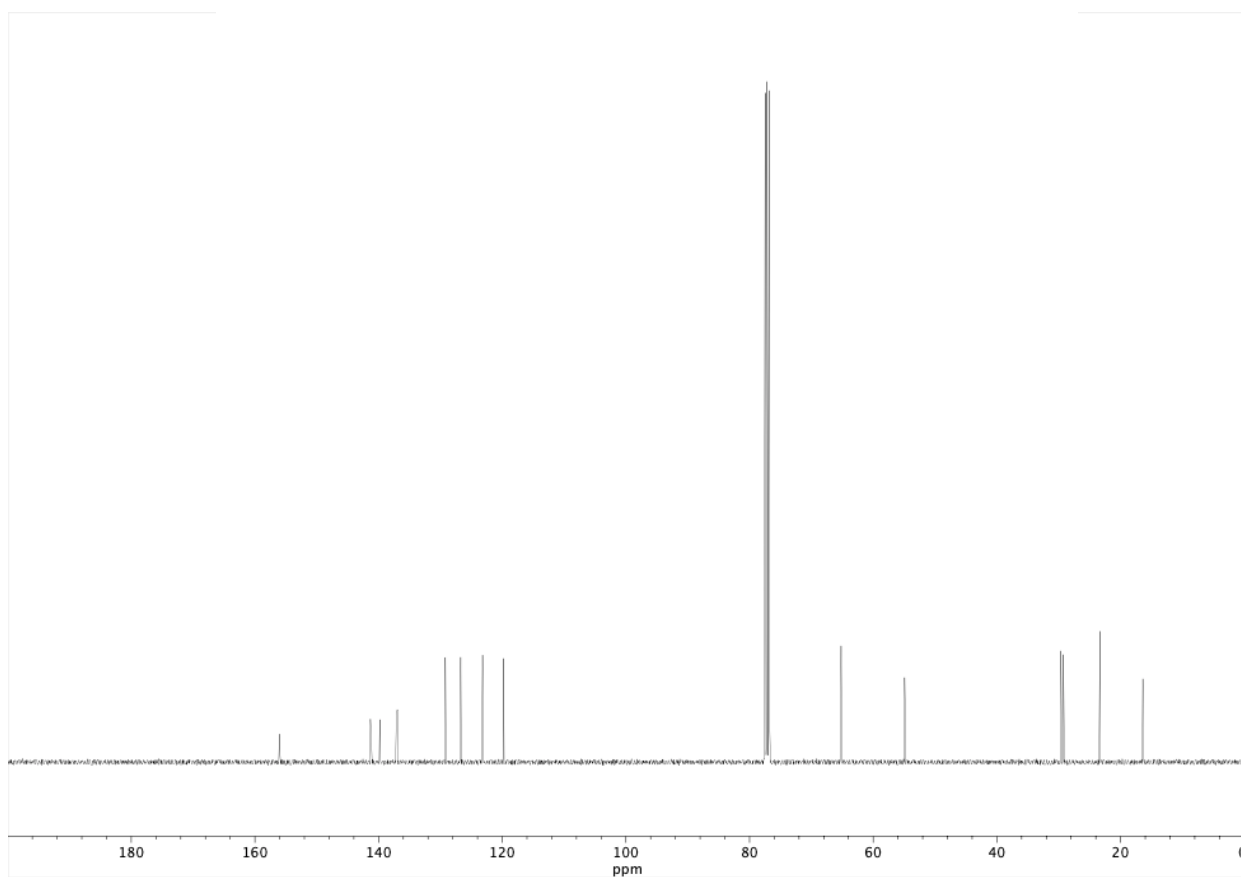
**Figure A3.104.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **73**.



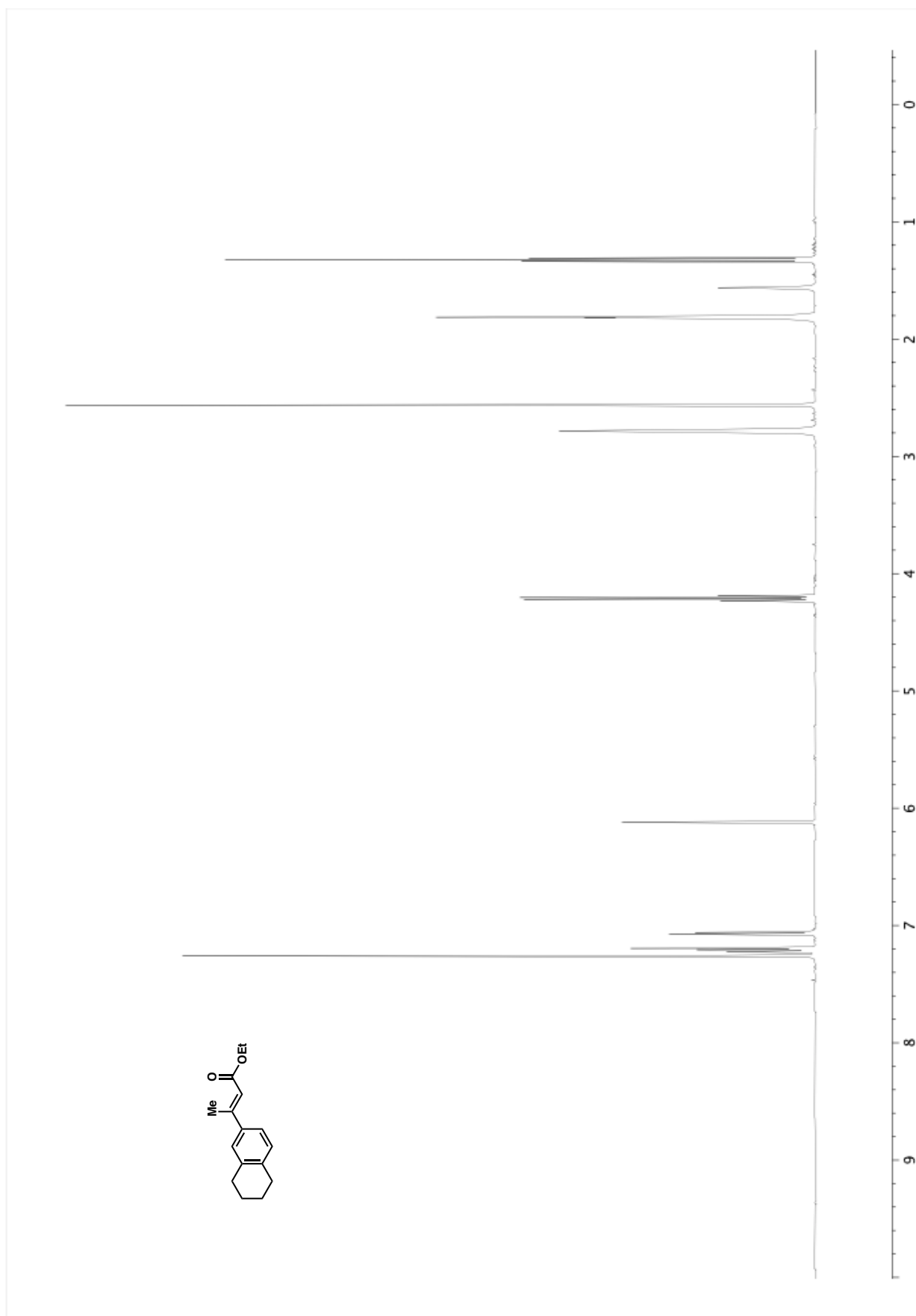
**Figure A3.105.** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of **67a**.



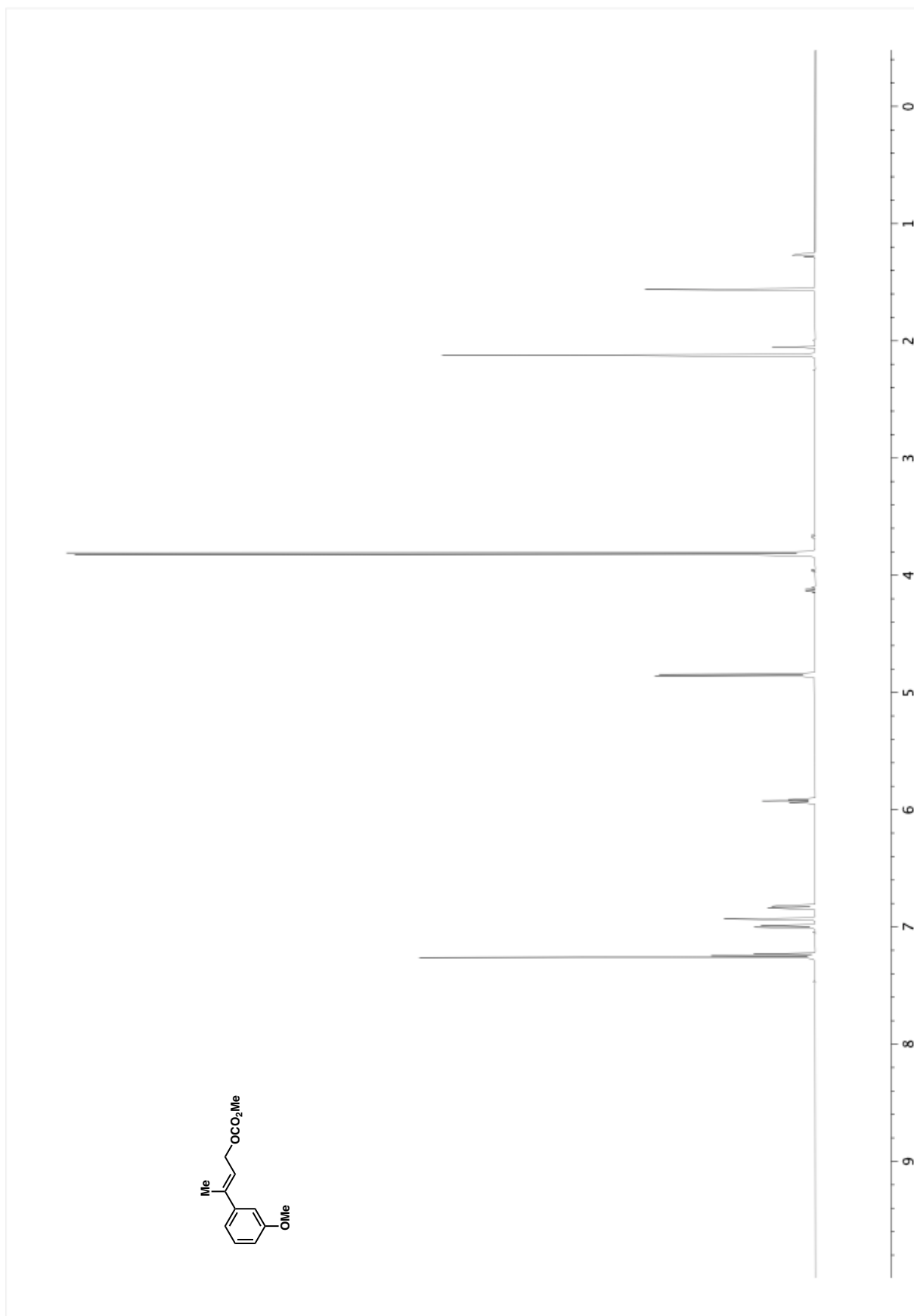
**Figure A3.106.** Infrared spectrum (Thin Film, NaCl) of **67a**.



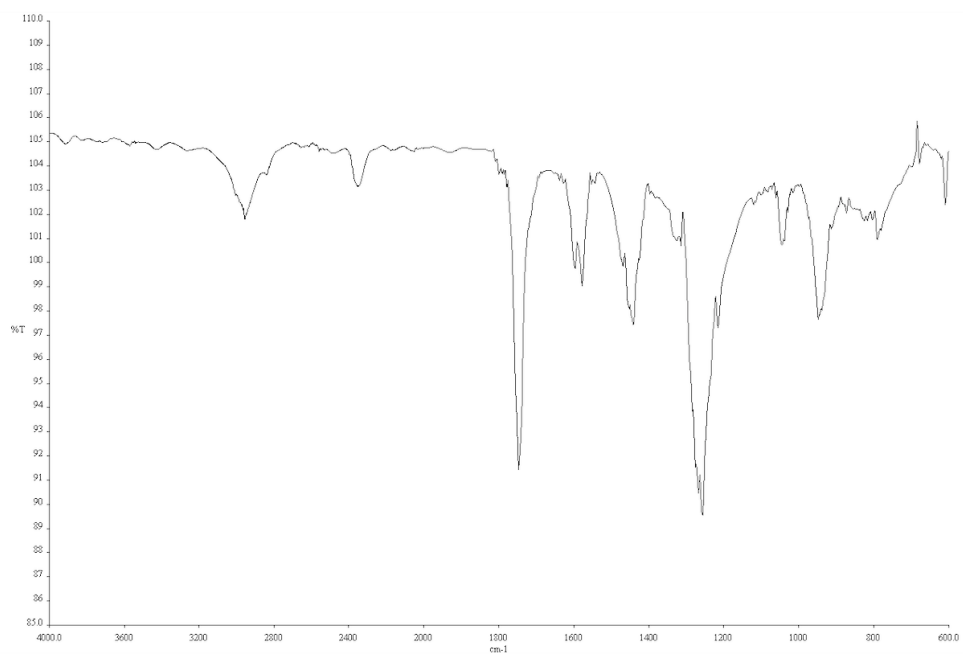
**Figure A3.107.**  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) of **67a**.



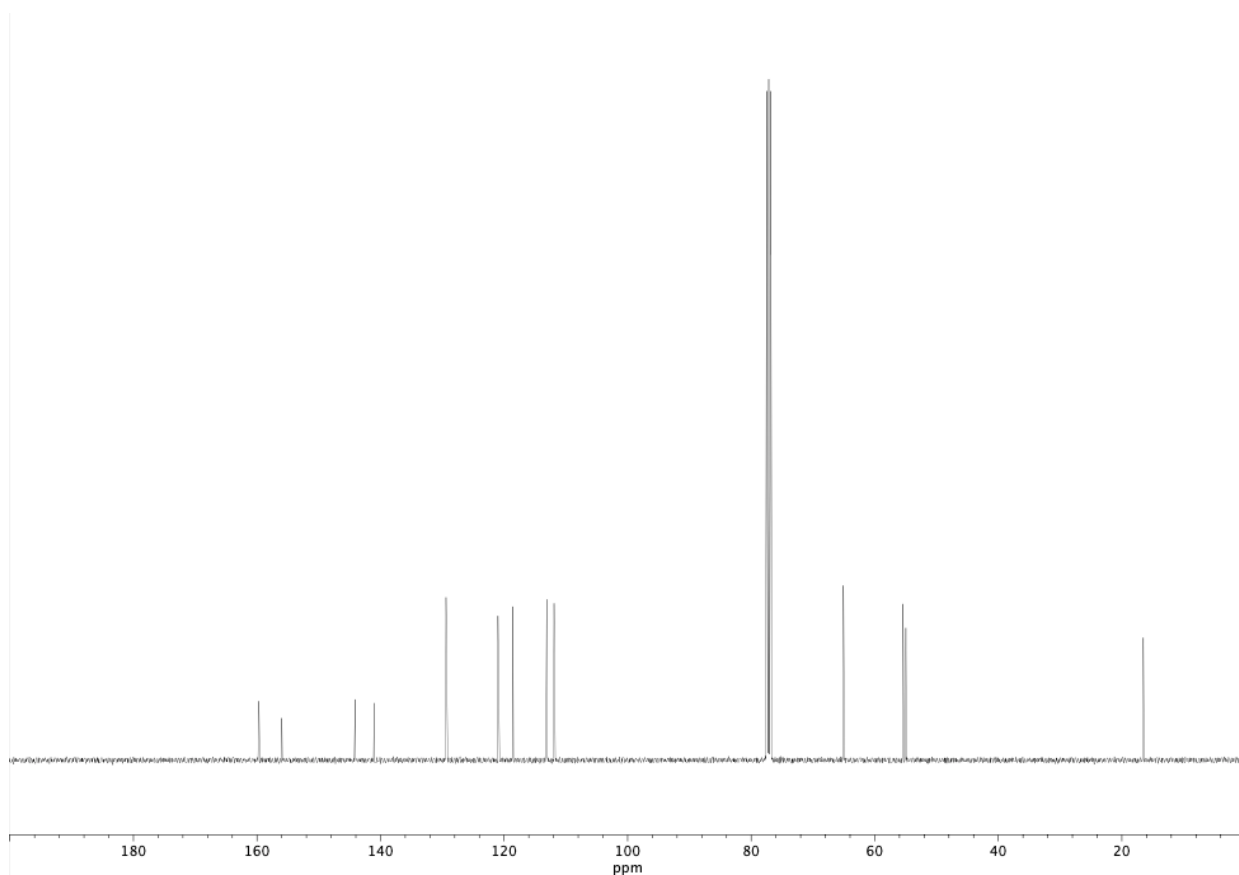
**Figure A3.108.**  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ ) of **67b**.



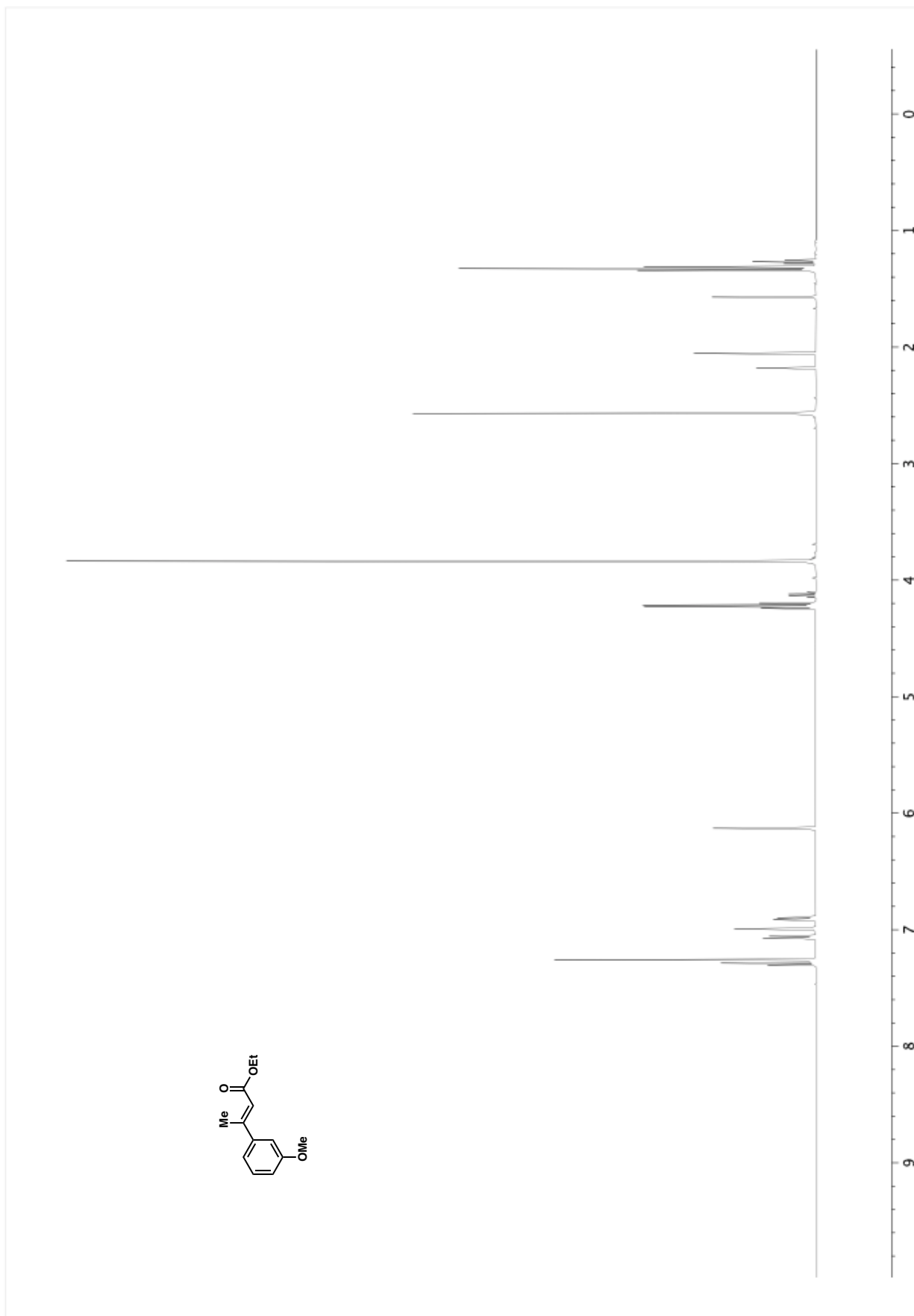
**Figure A3.109.** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of **69a**.



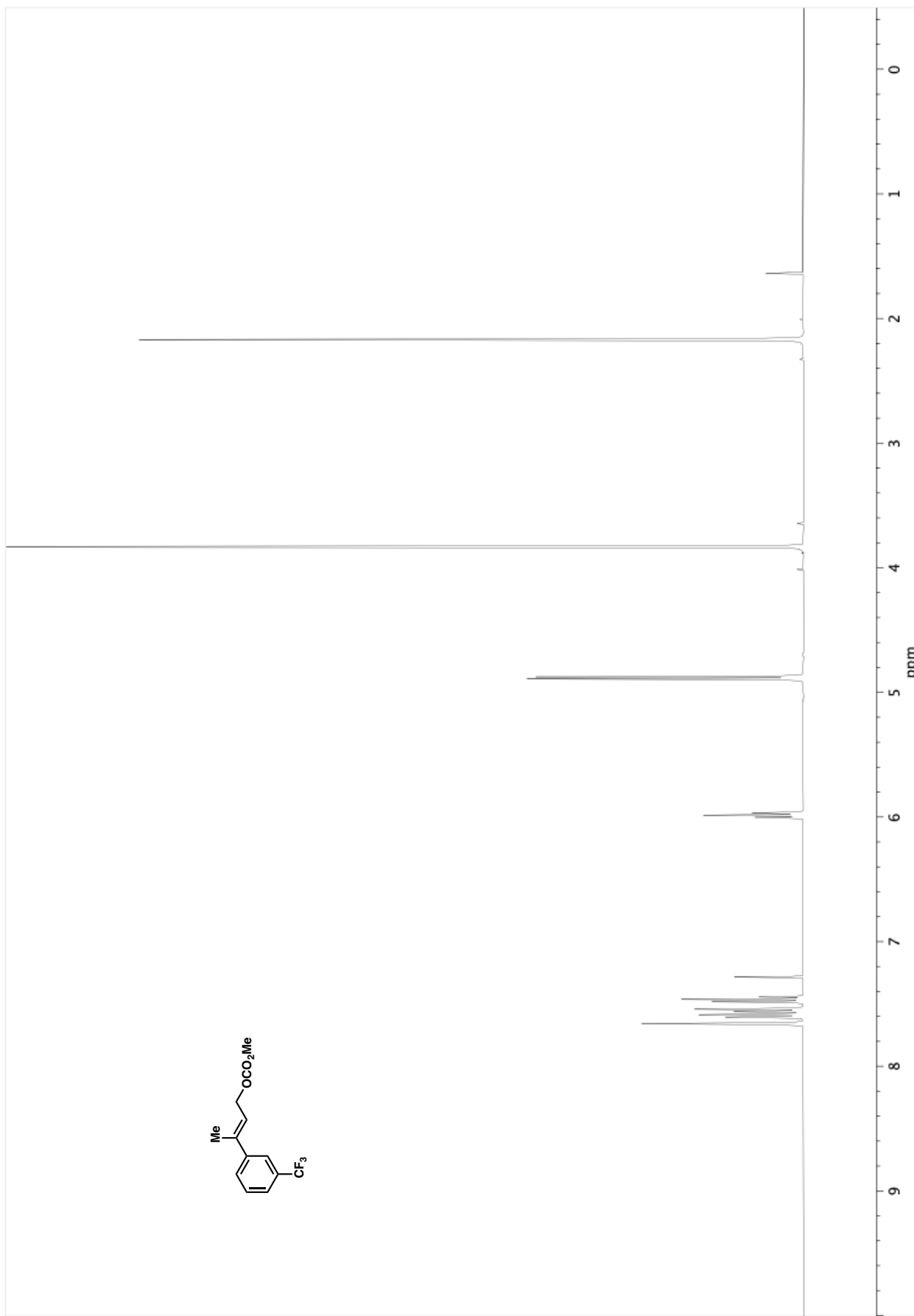
**Figure A3.110.** Infrared spectrum (Thin Film, NaCl) of **69a**.

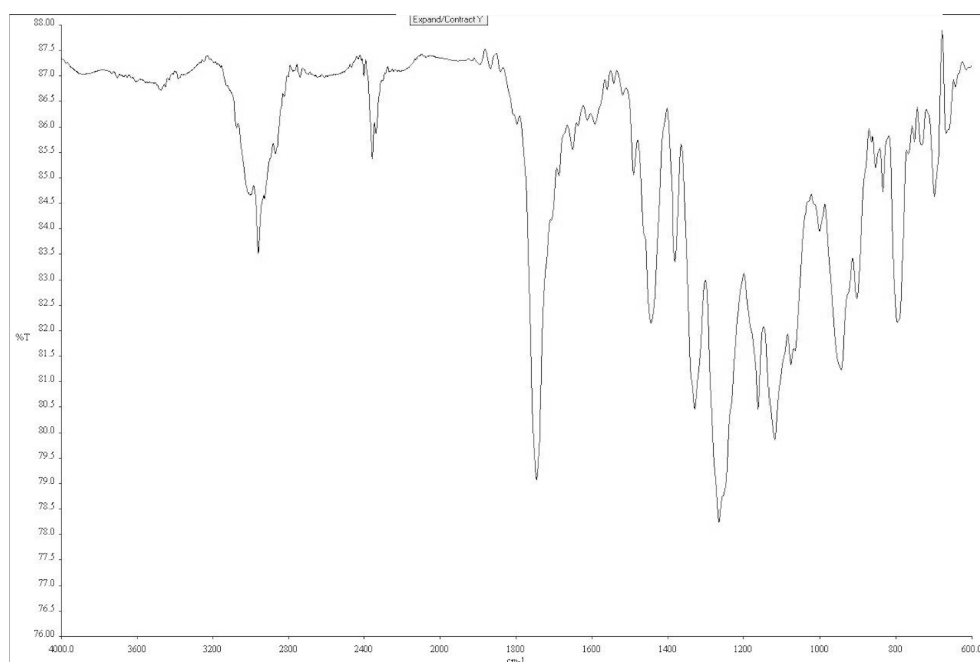


**Figure A3.111.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **69a**.

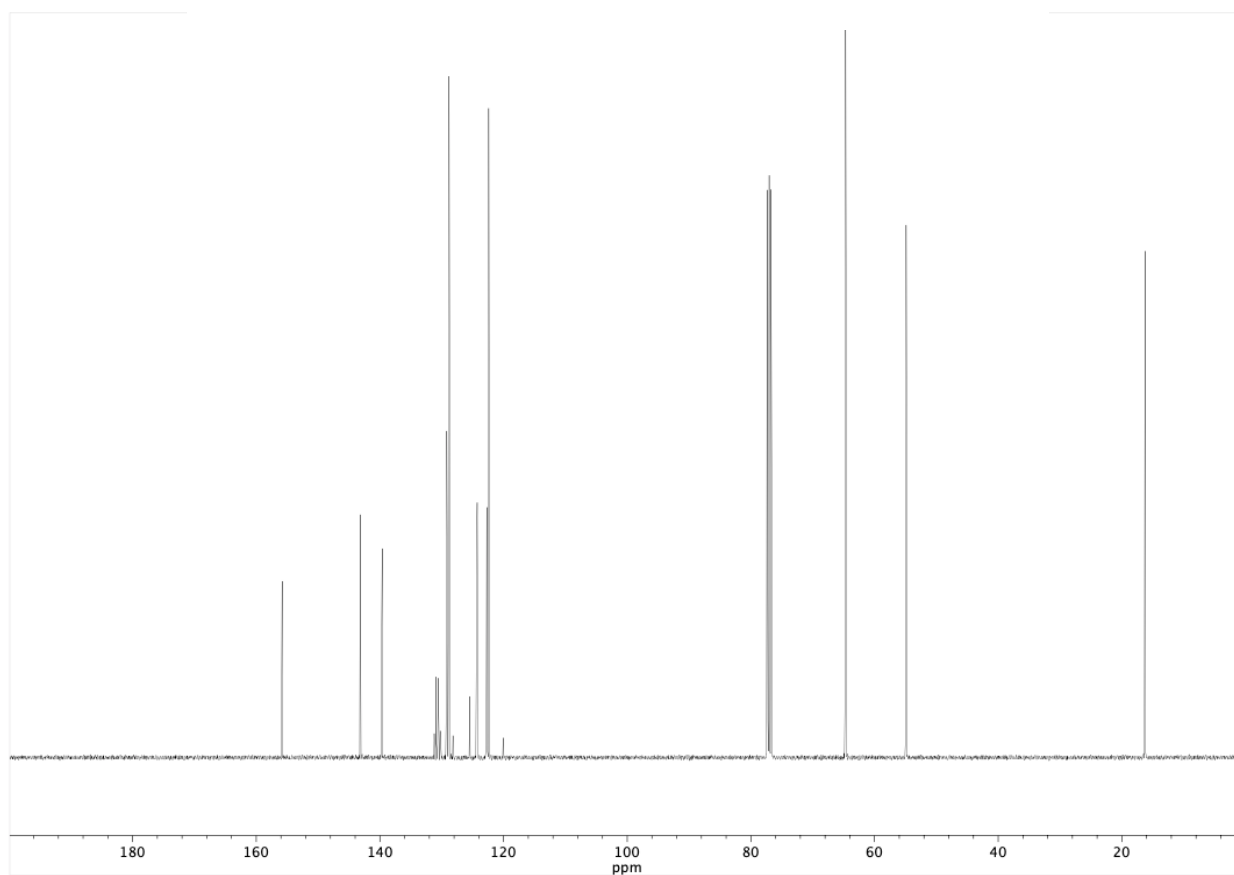


**Figure A3.112.** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of **69b**.

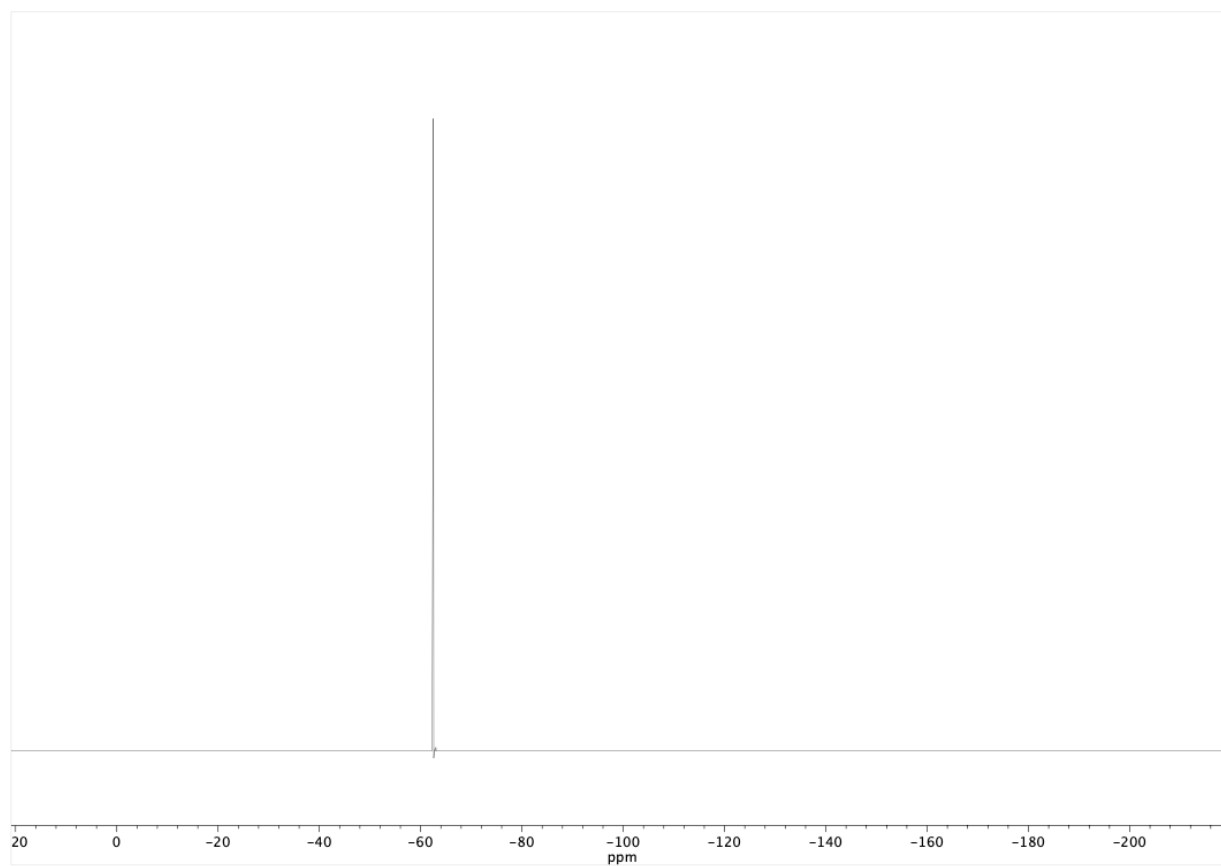
**Figure A3.113.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **71a**.



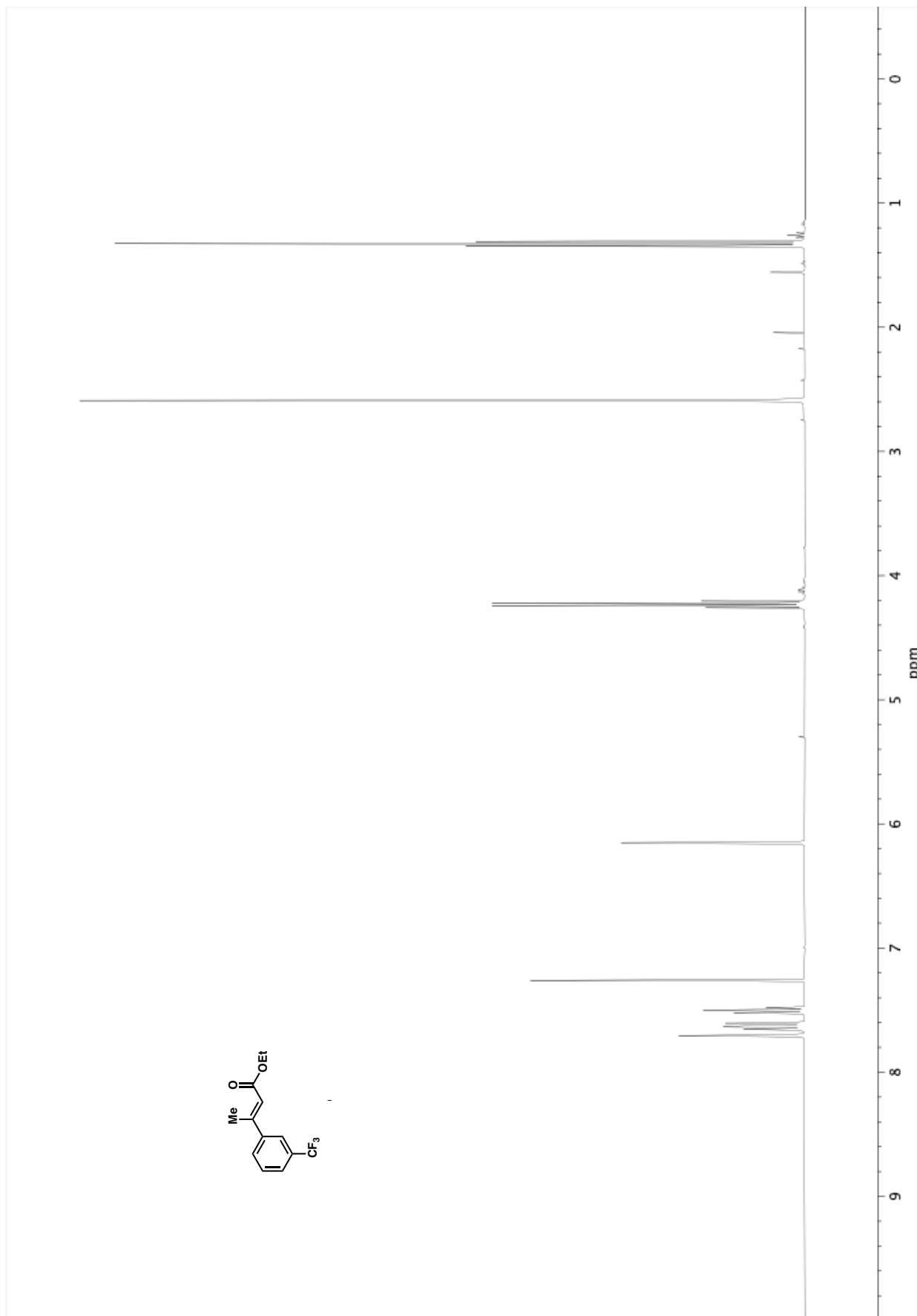
**Figure A3.114.** Infrared spectrum (Thin Film, NaCl) of **71a**.



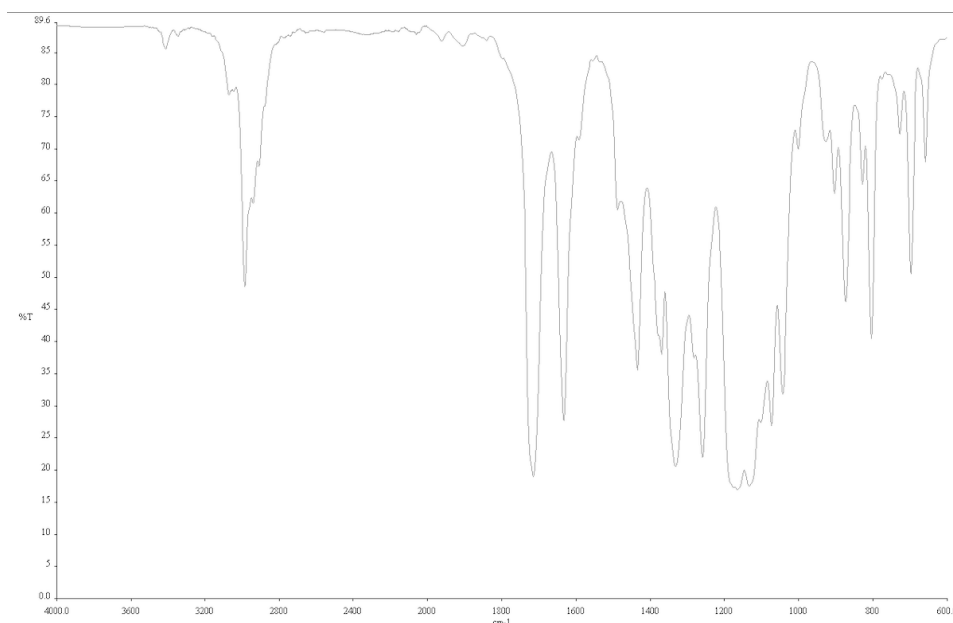
**Figure A3.115.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **71a**.



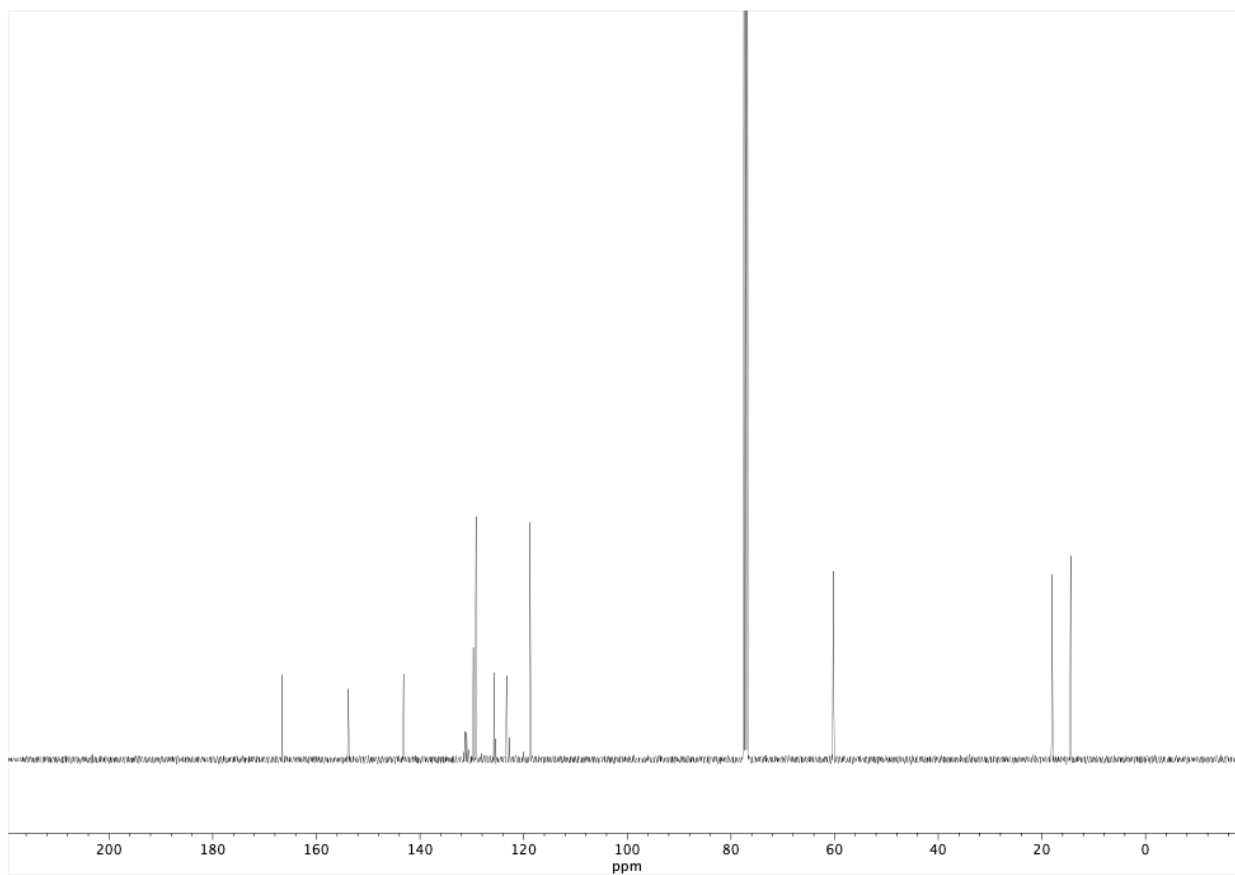
**Figure A3.116.**  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ ) of **71a**.



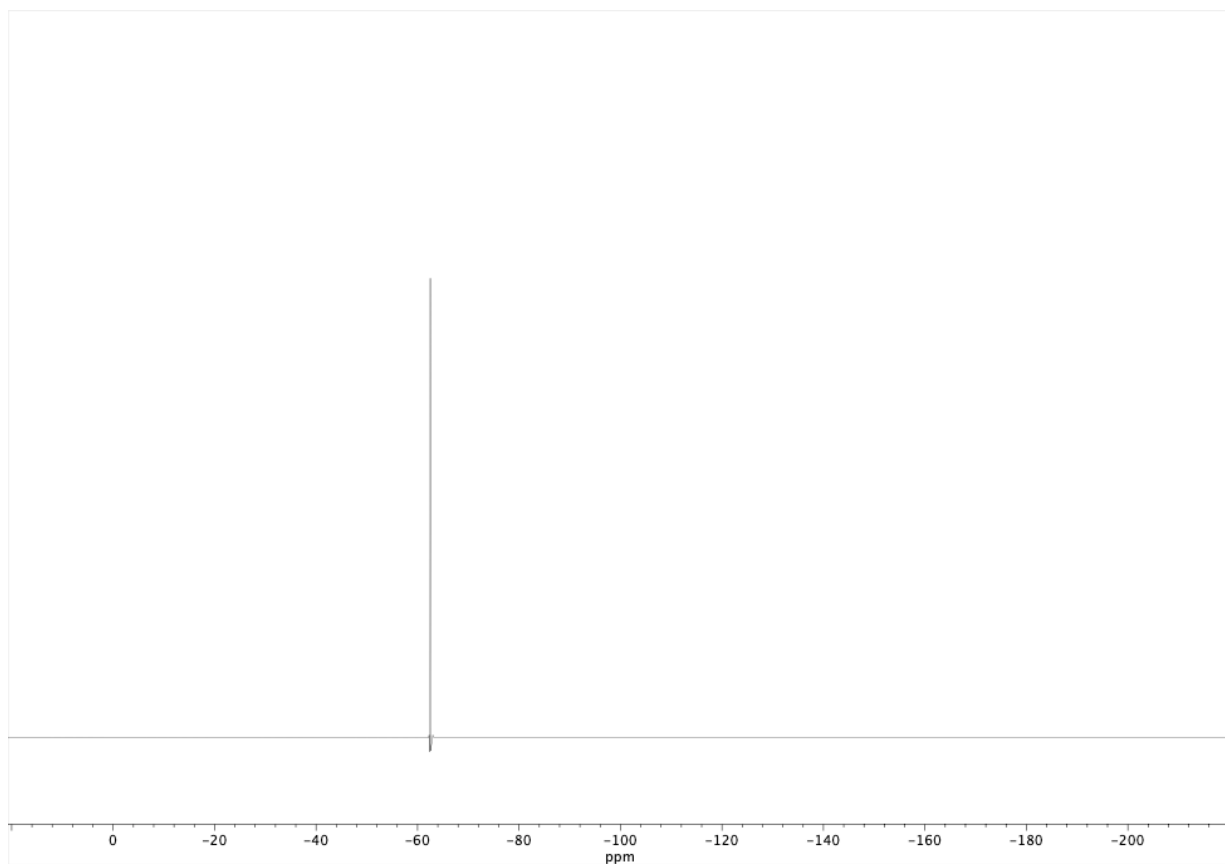
**Figure A3.117.**  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ ) of **71b**.



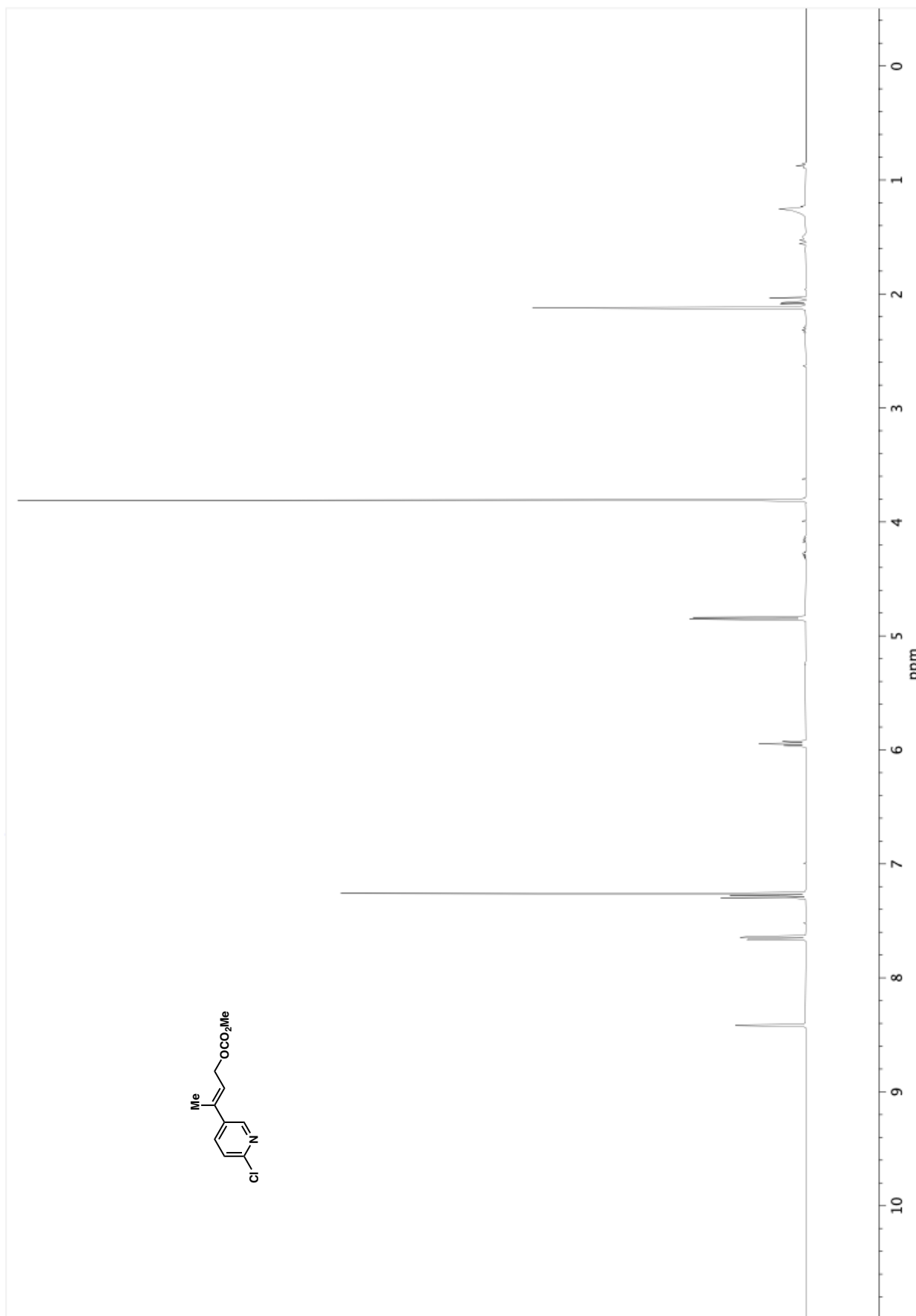
**Figure A3.118.** Infrared spectrum (Thin Film, NaCl) of **71b**.



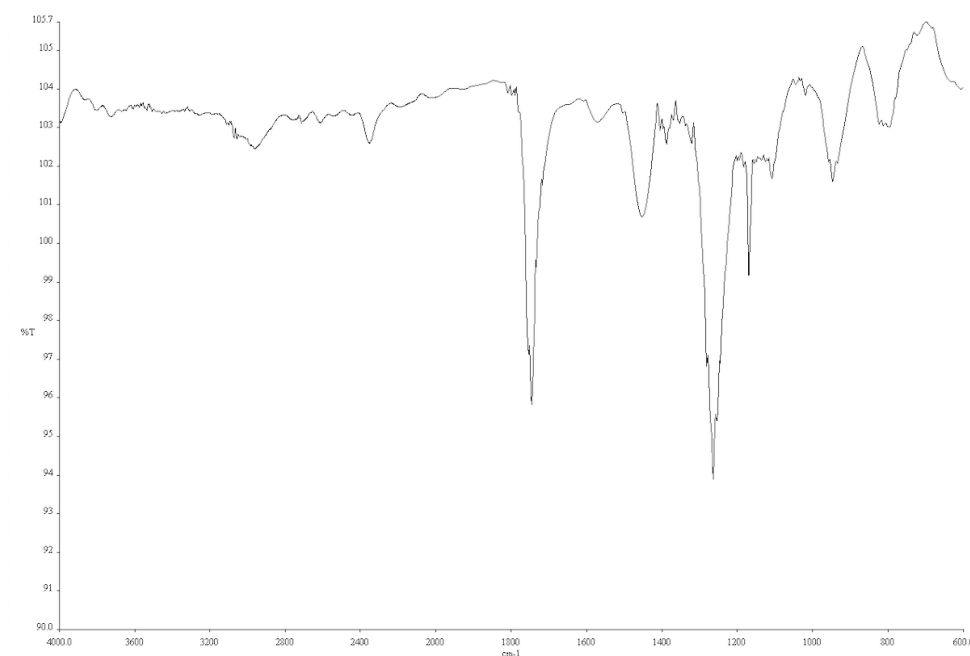
**Figure A3.119.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **71b**.



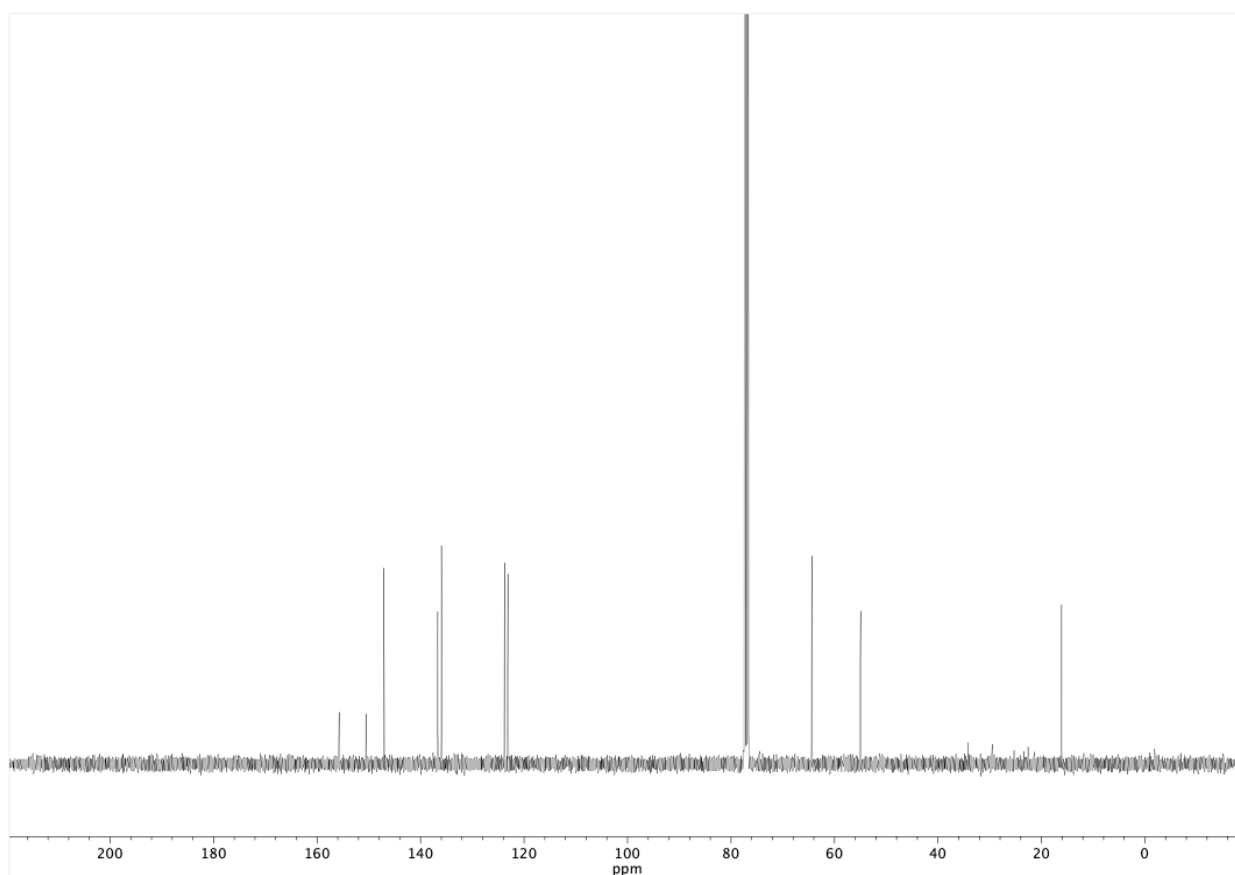
**Figure A3.120.**  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ ) of **71b**.



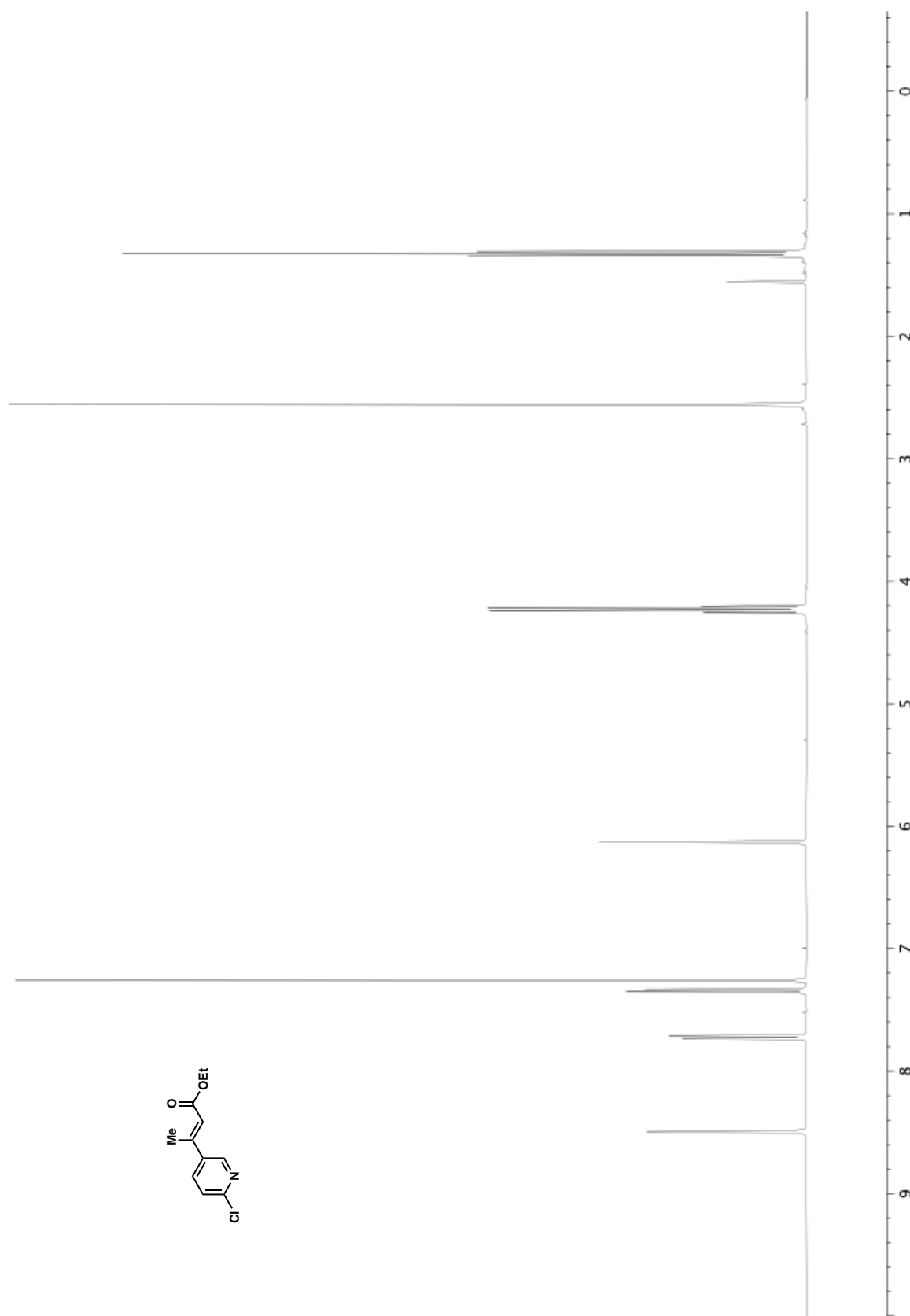
**Figure A3.121.** <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) of 73a.



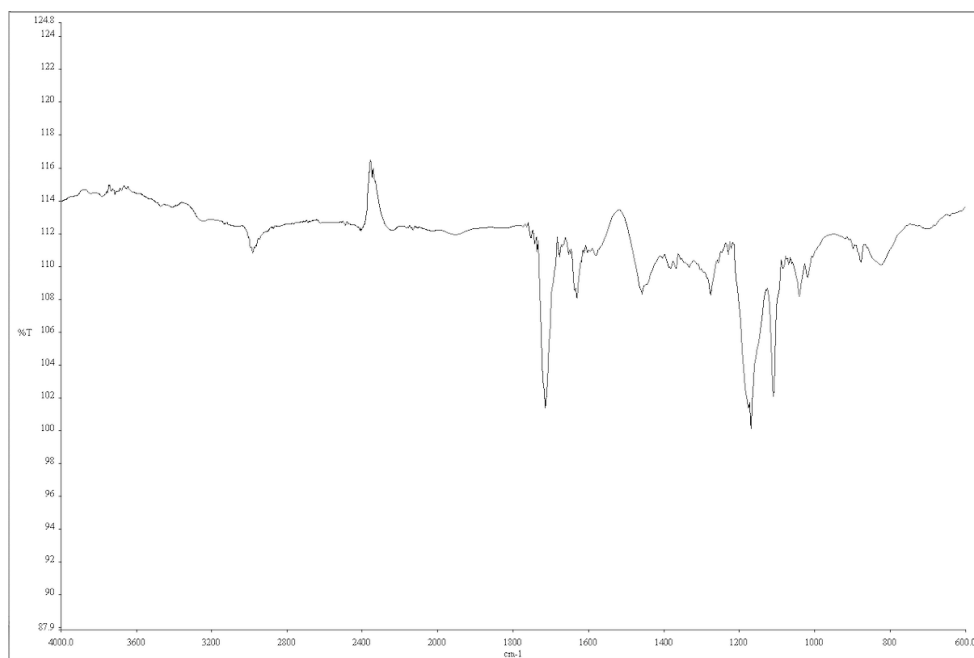
**Figure A3.122.** Infrared spectrum (Thin Film, NaCl) of **73a**



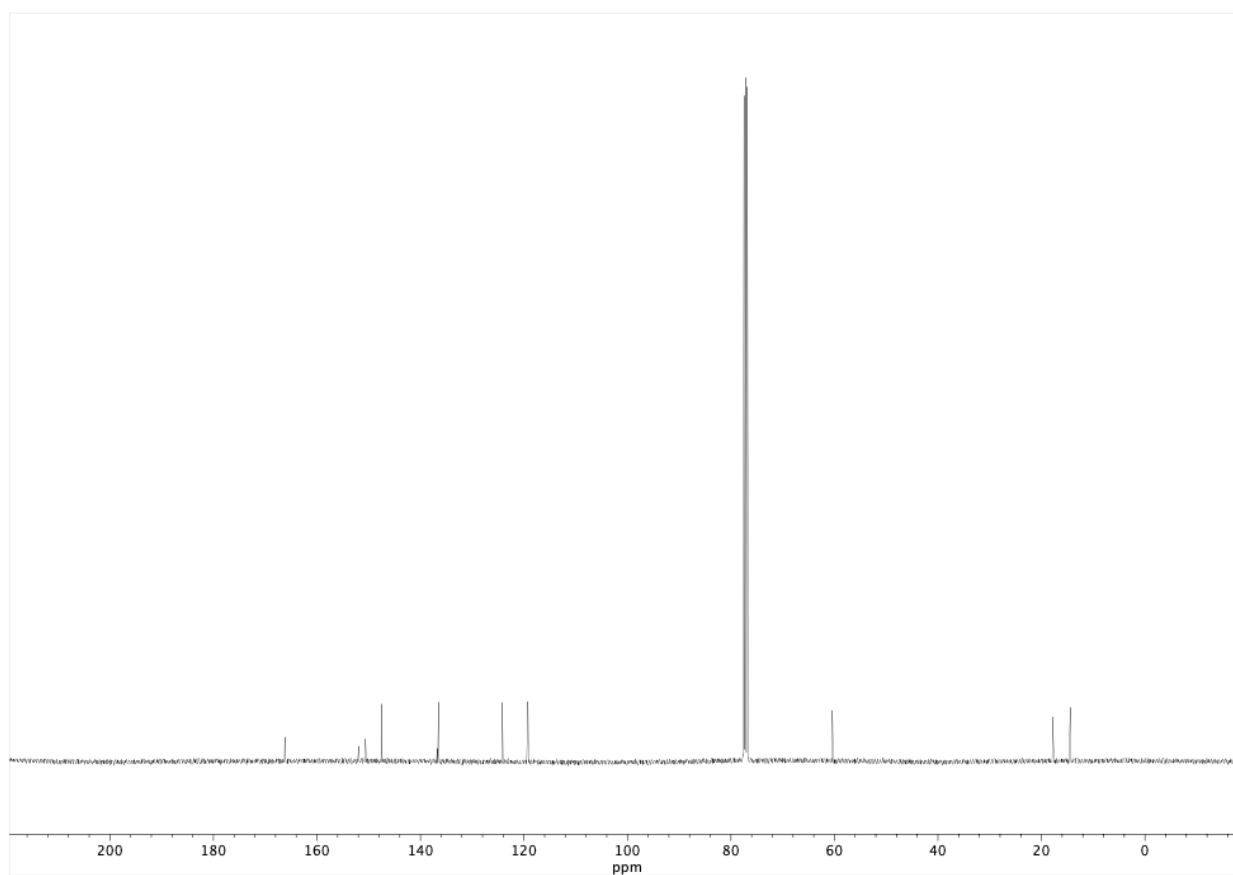
**Figure A3.123.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **73a**



**Figure A3.124.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of 73b.



**Figure A3.125.** Infrared spectrum (Thin Film, NaCl) of **73b**.



**Figure A3.126.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **73b**.

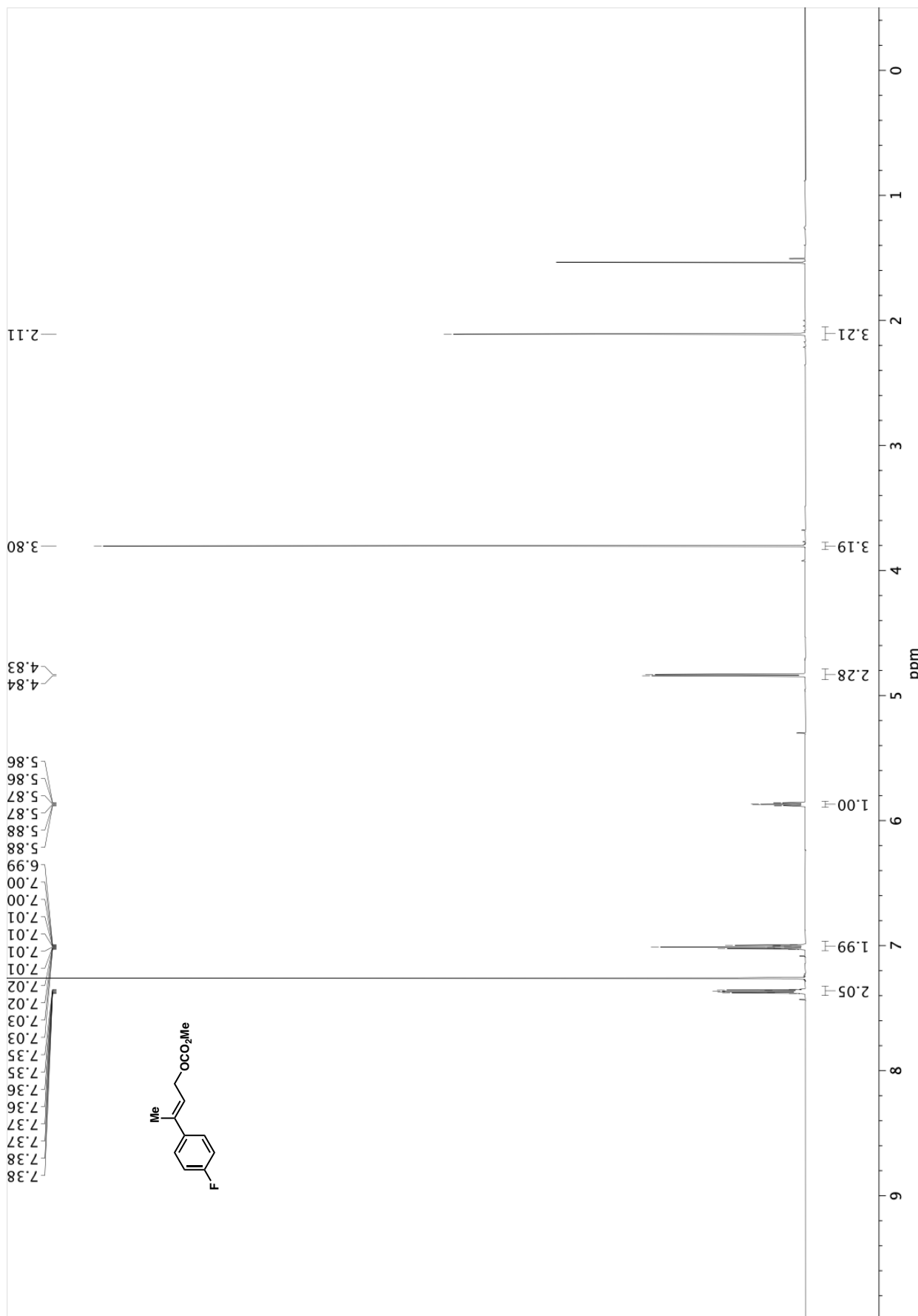
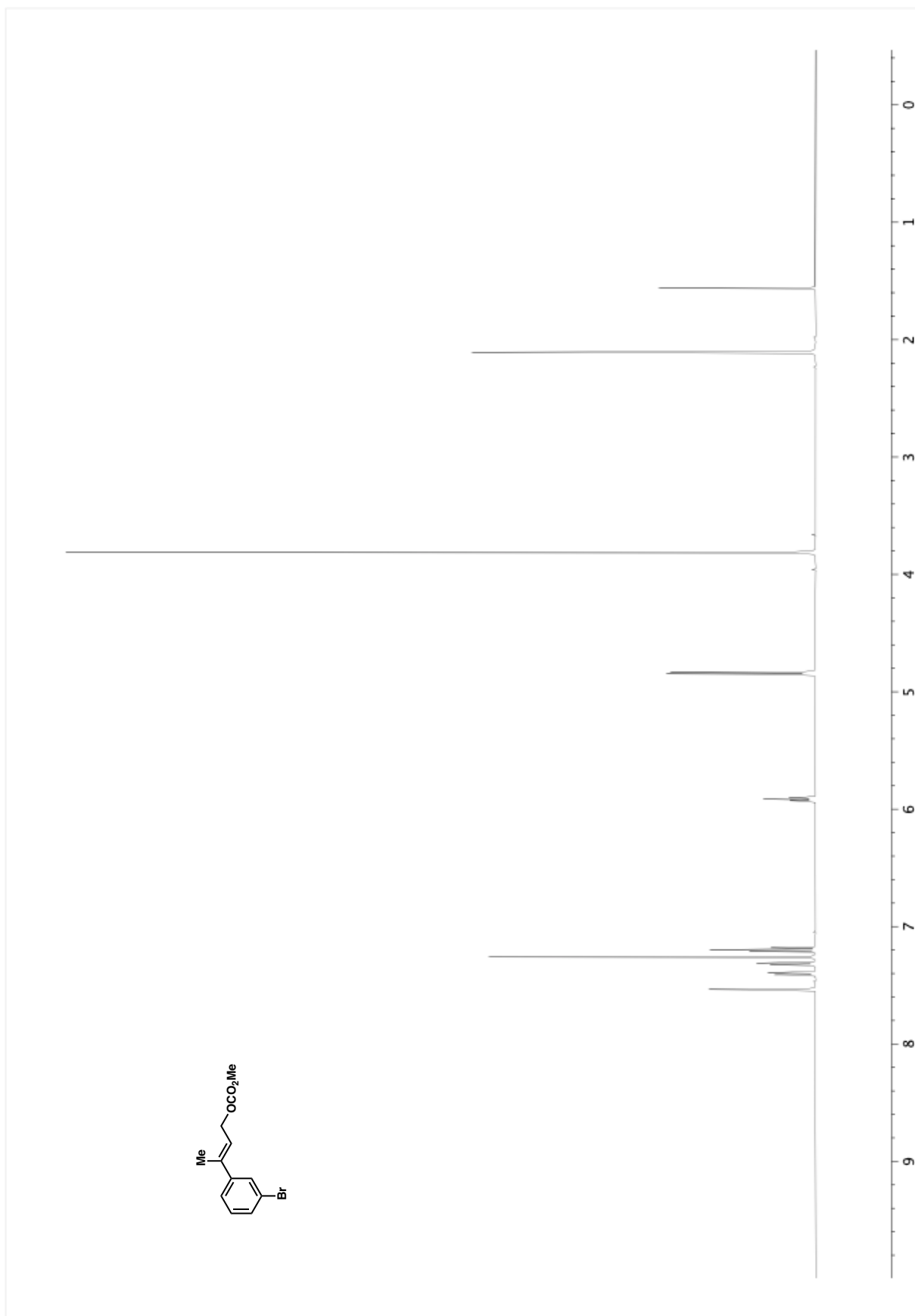
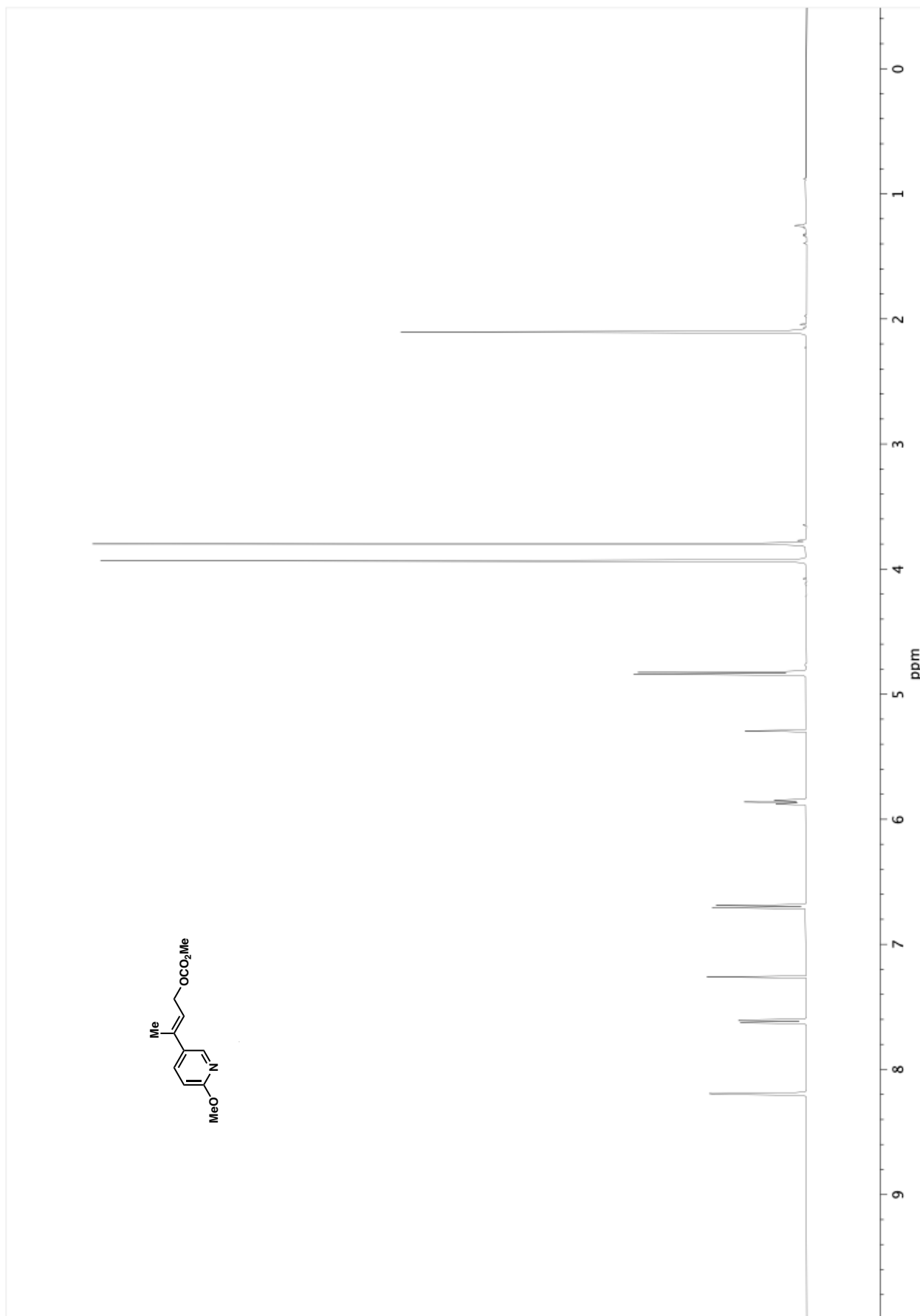


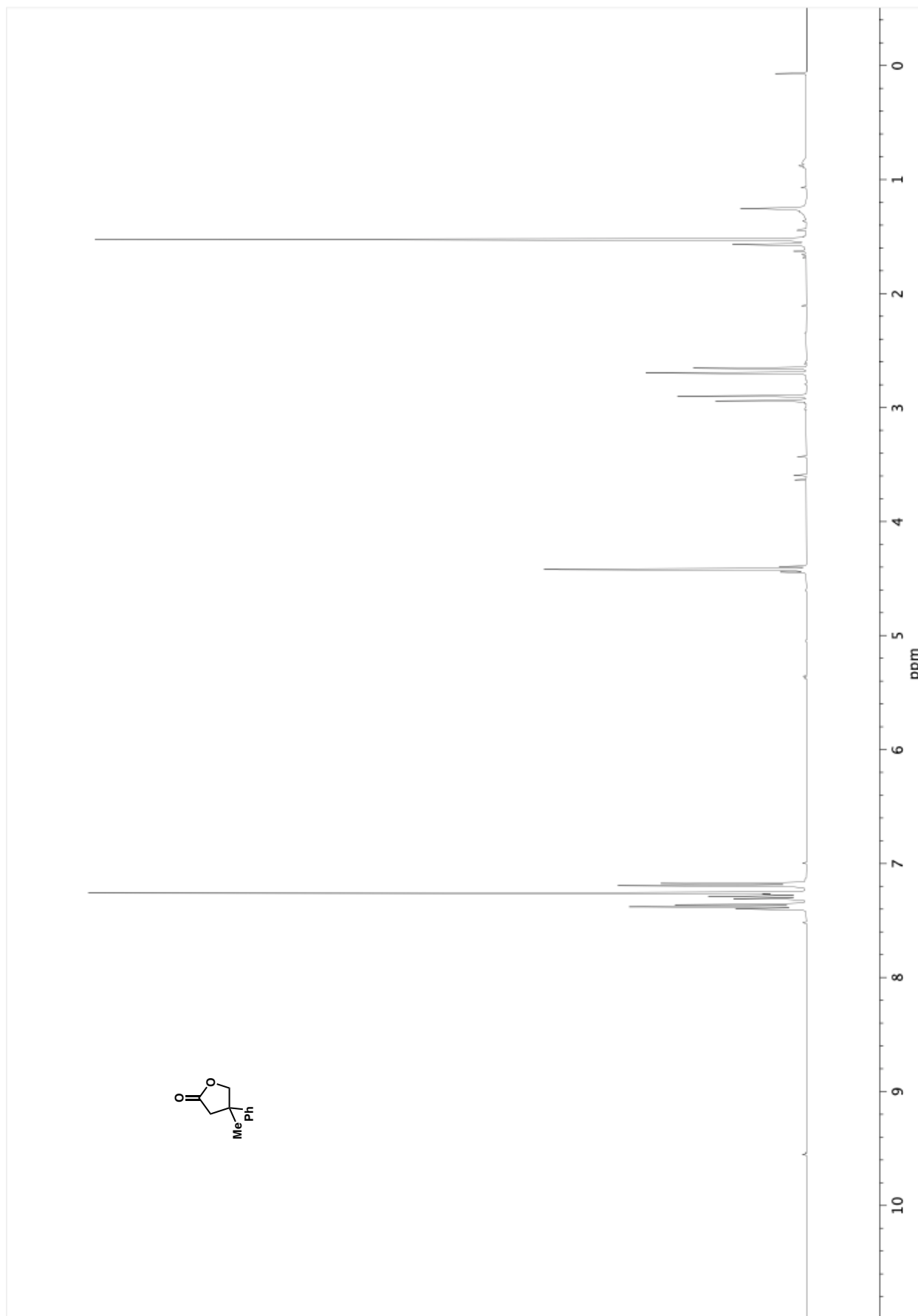
Figure A3.127.  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ ) of **65a**.



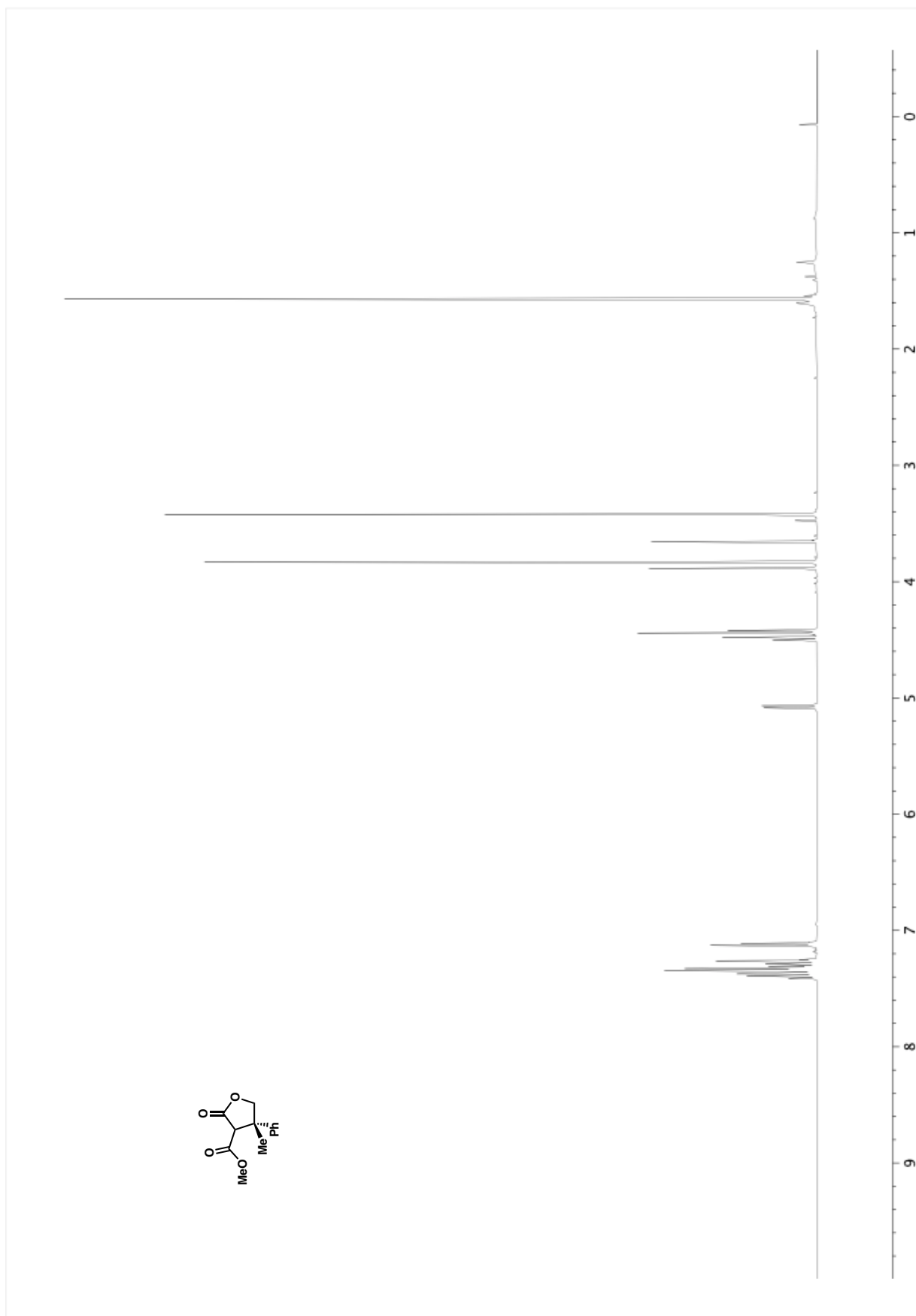
**Figure A3.128.** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of **70a**.



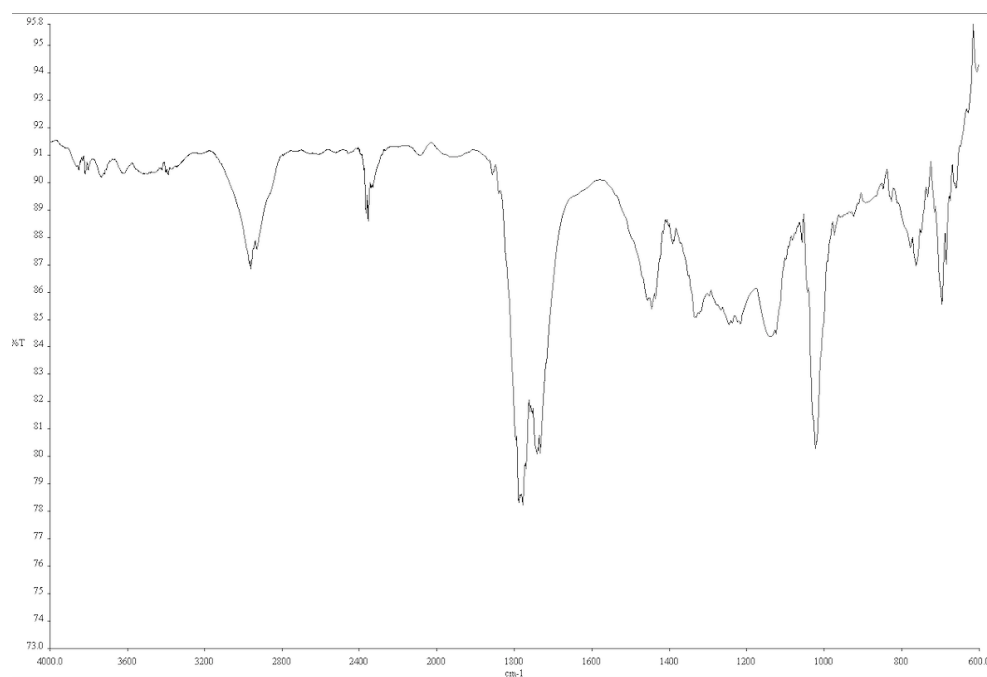
**Figure A3.129.** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of 72a.



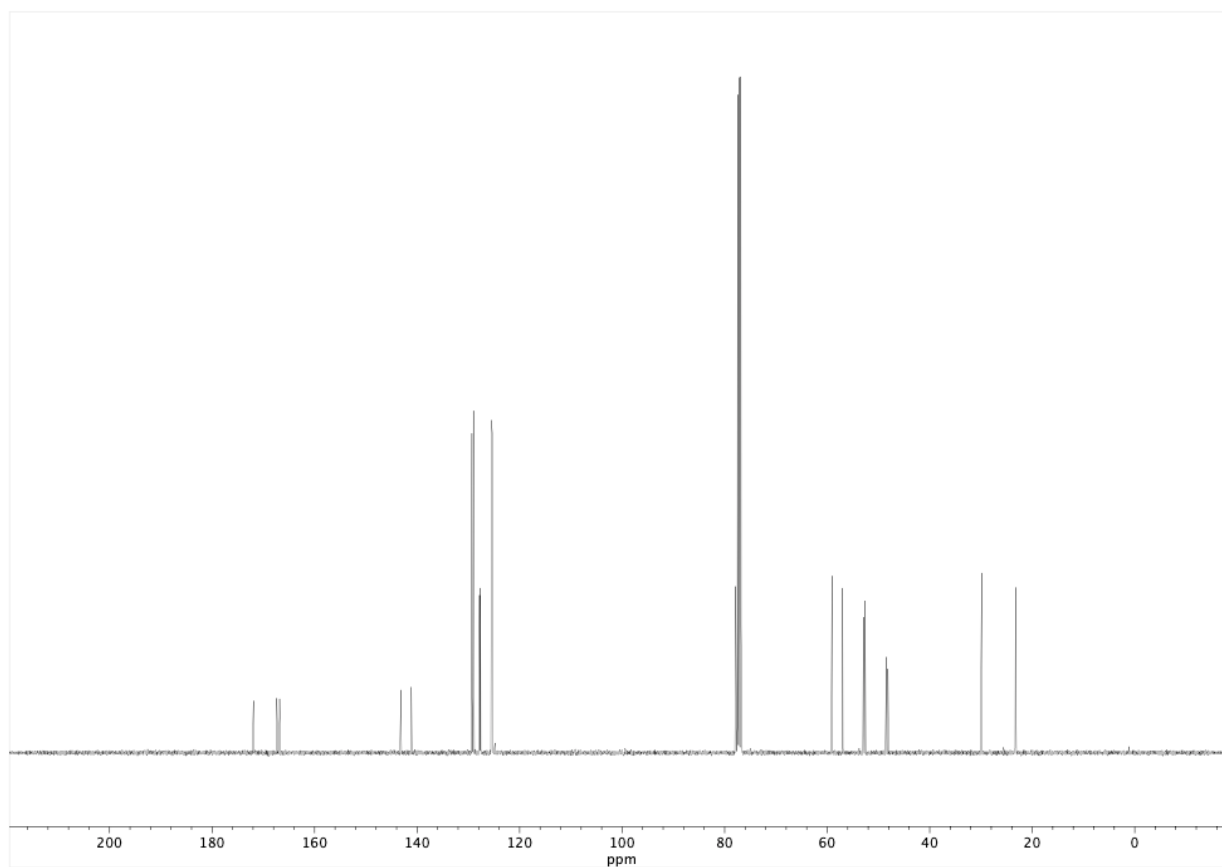
**Figure A3.130.** <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) of 77.



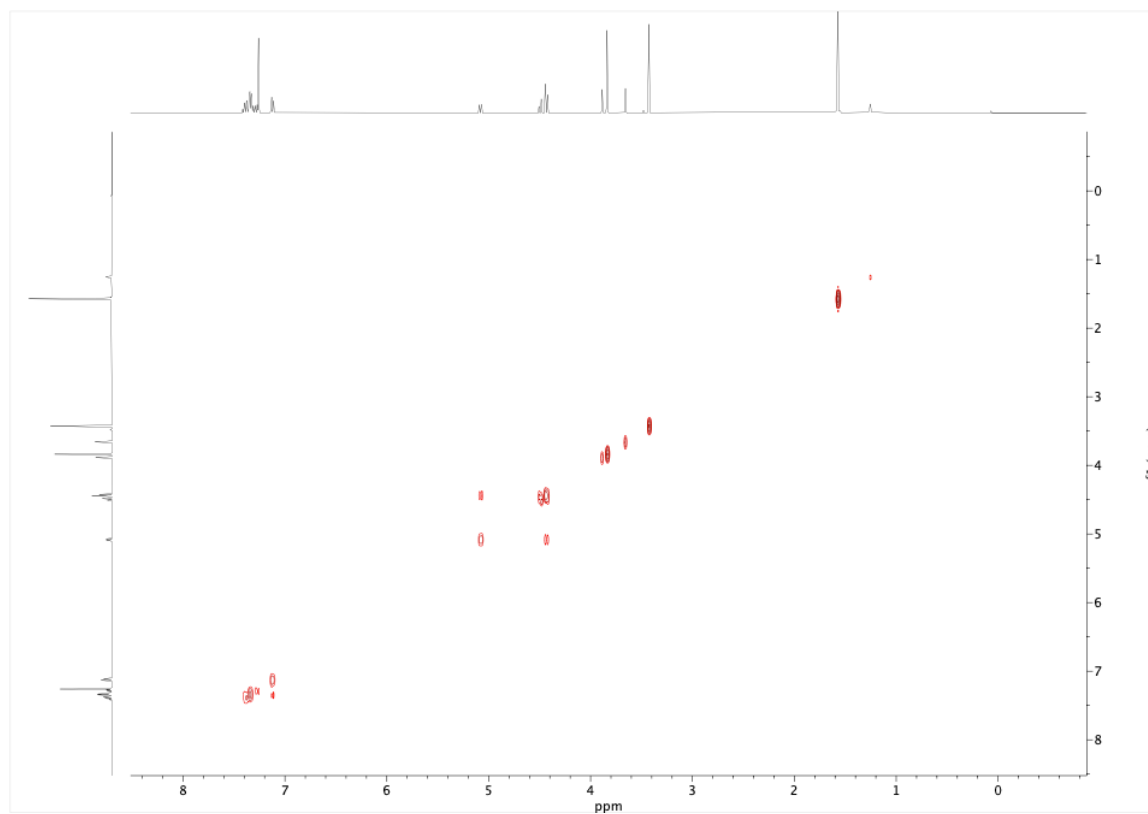
**Figure A3.131.** <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) of **78**.



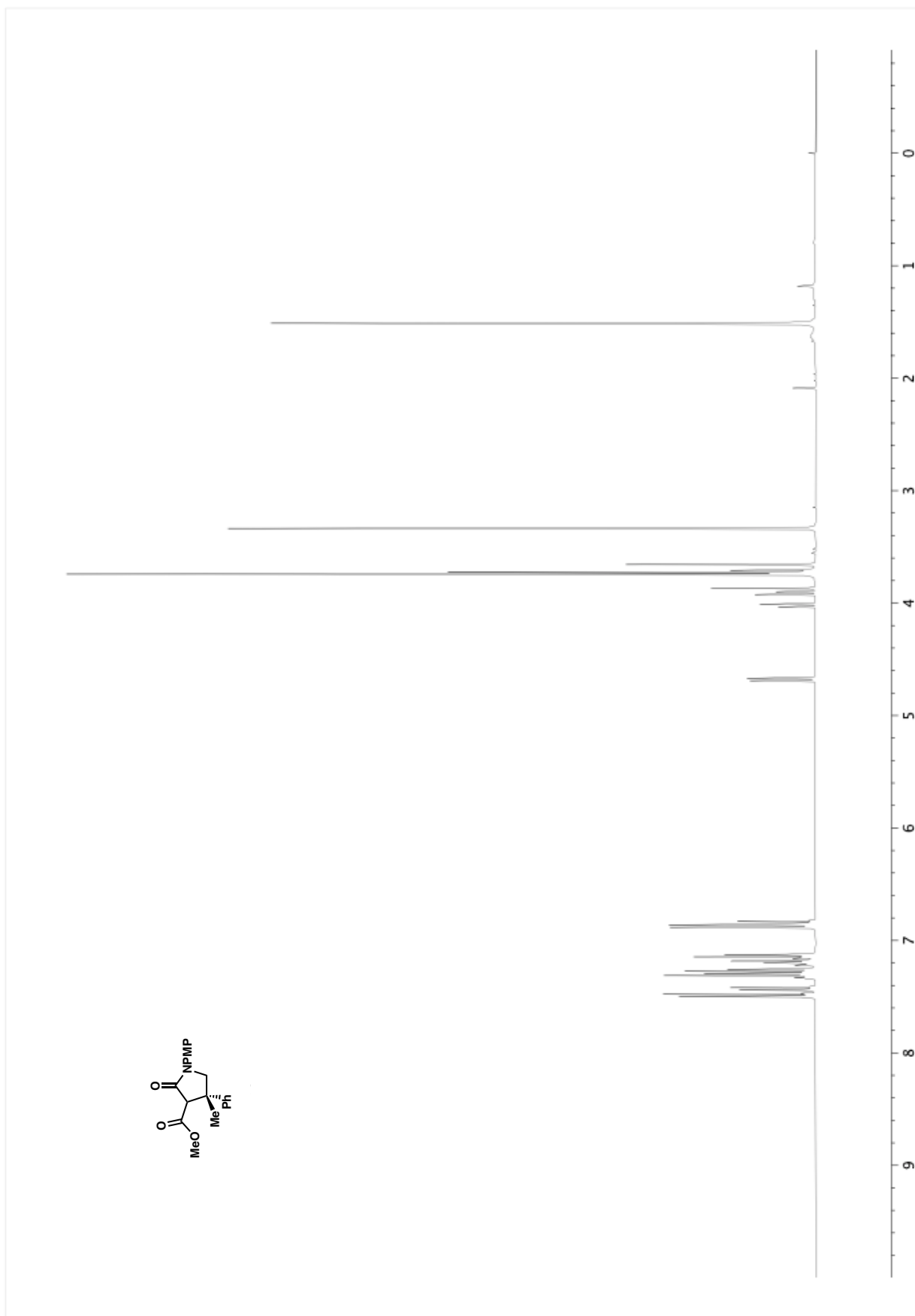
**Figure A3.132.** Infrared spectrum (Thin Film, NaCl) of **78**.



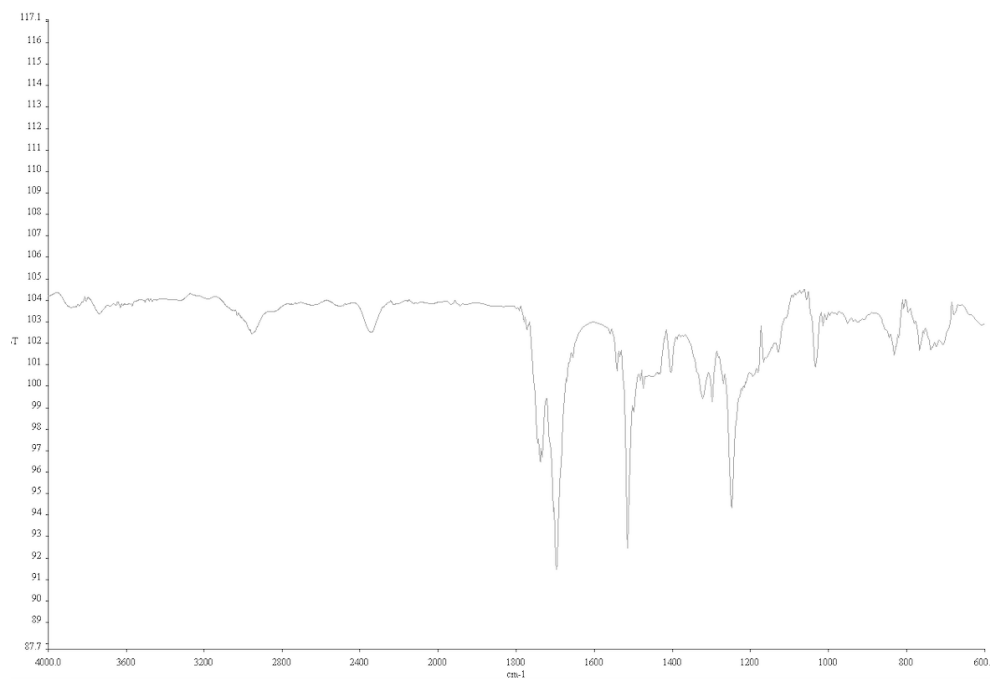
**Figure A3.133.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **78**.



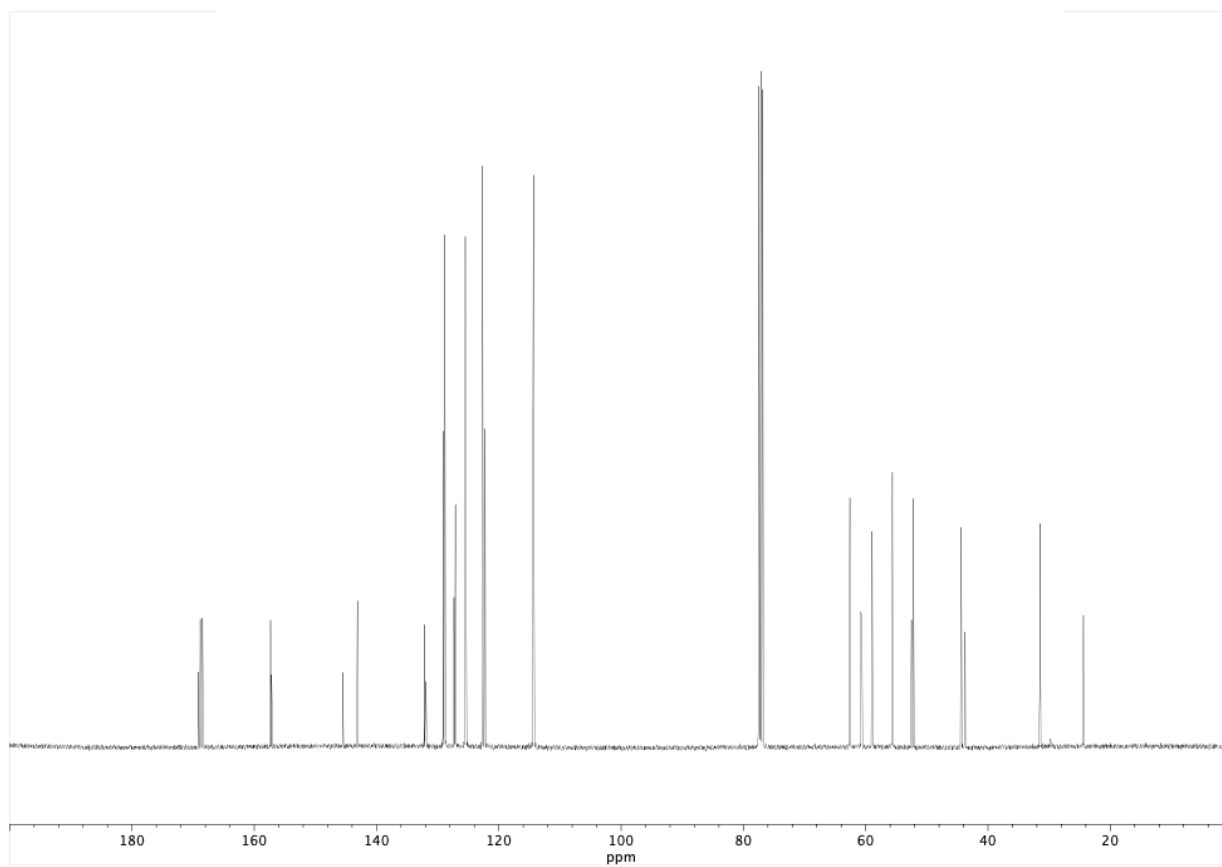
**Figure A3.134.**  $^1\text{H}$ - $^{13}\text{C}$  HSQC ( $\text{CDCl}_3$ ) of compound **78**.



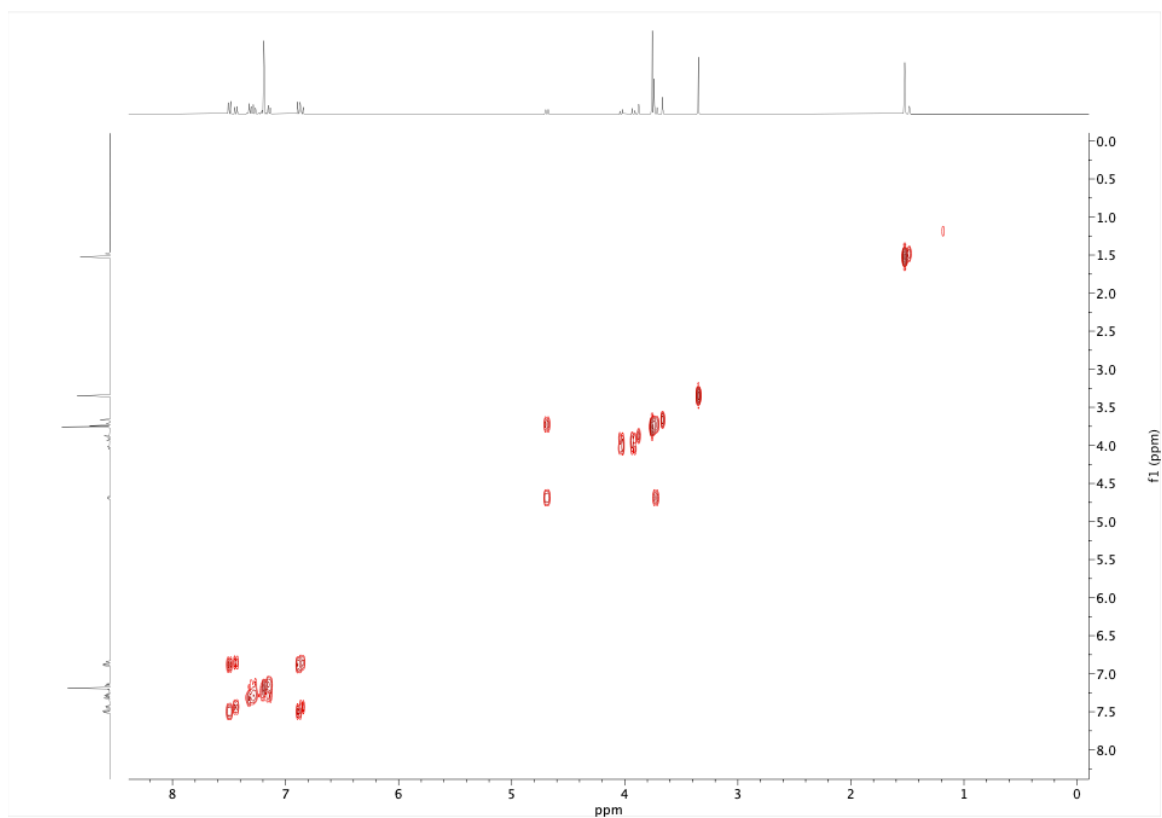
**Figure A3.135.** <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) of **79**.



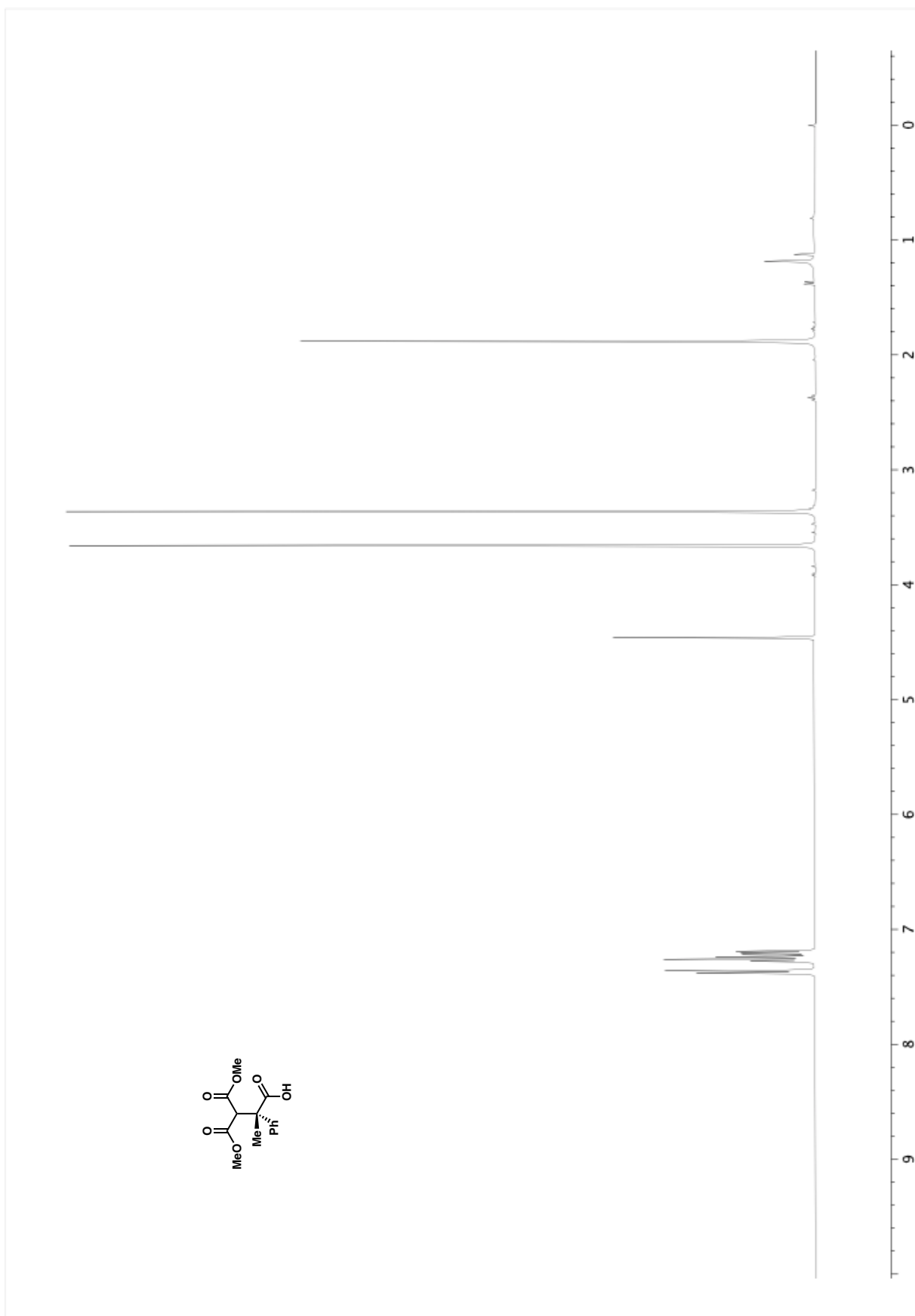
**Figure A3.136.** Infrared spectrum (Thin Film, NaCl) of **79**.



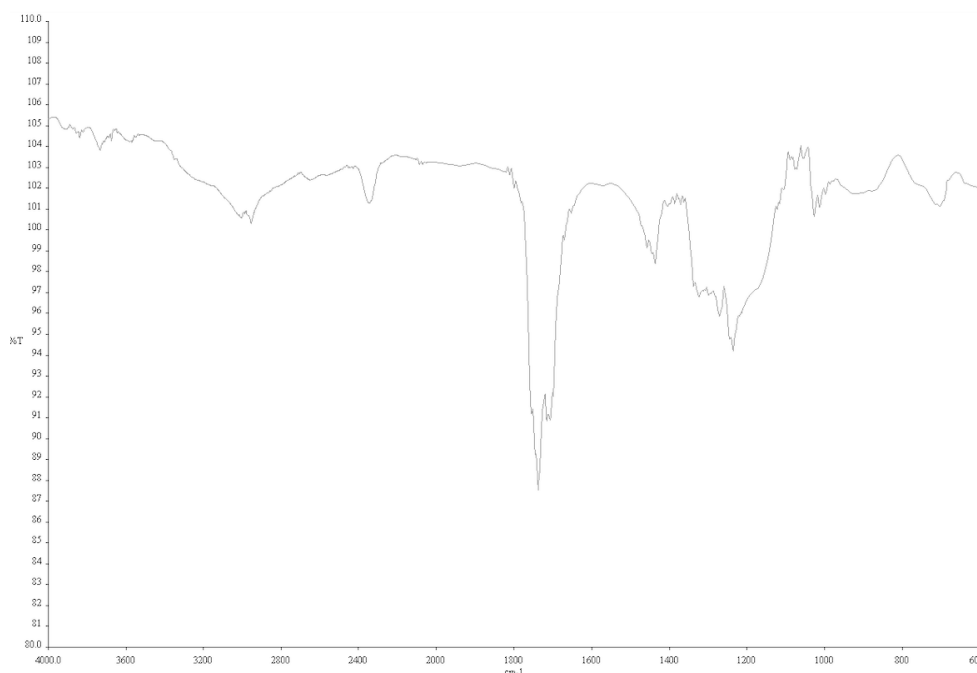
**Figure A3.137.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **79**.



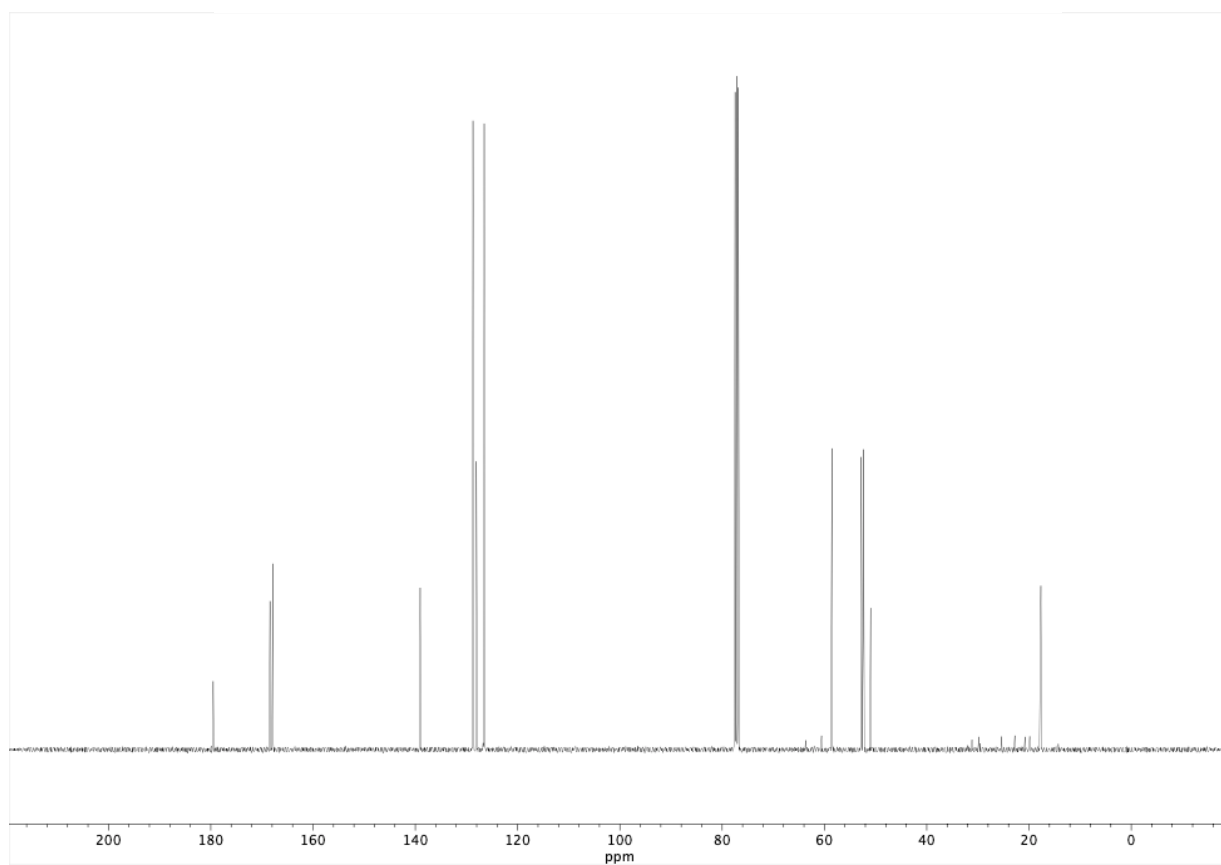
**Figure A3.138.**  $^1\text{H}$ - $^{13}\text{C}$  HSQC ( $\text{CDCl}_3$ ) of compound **79**.



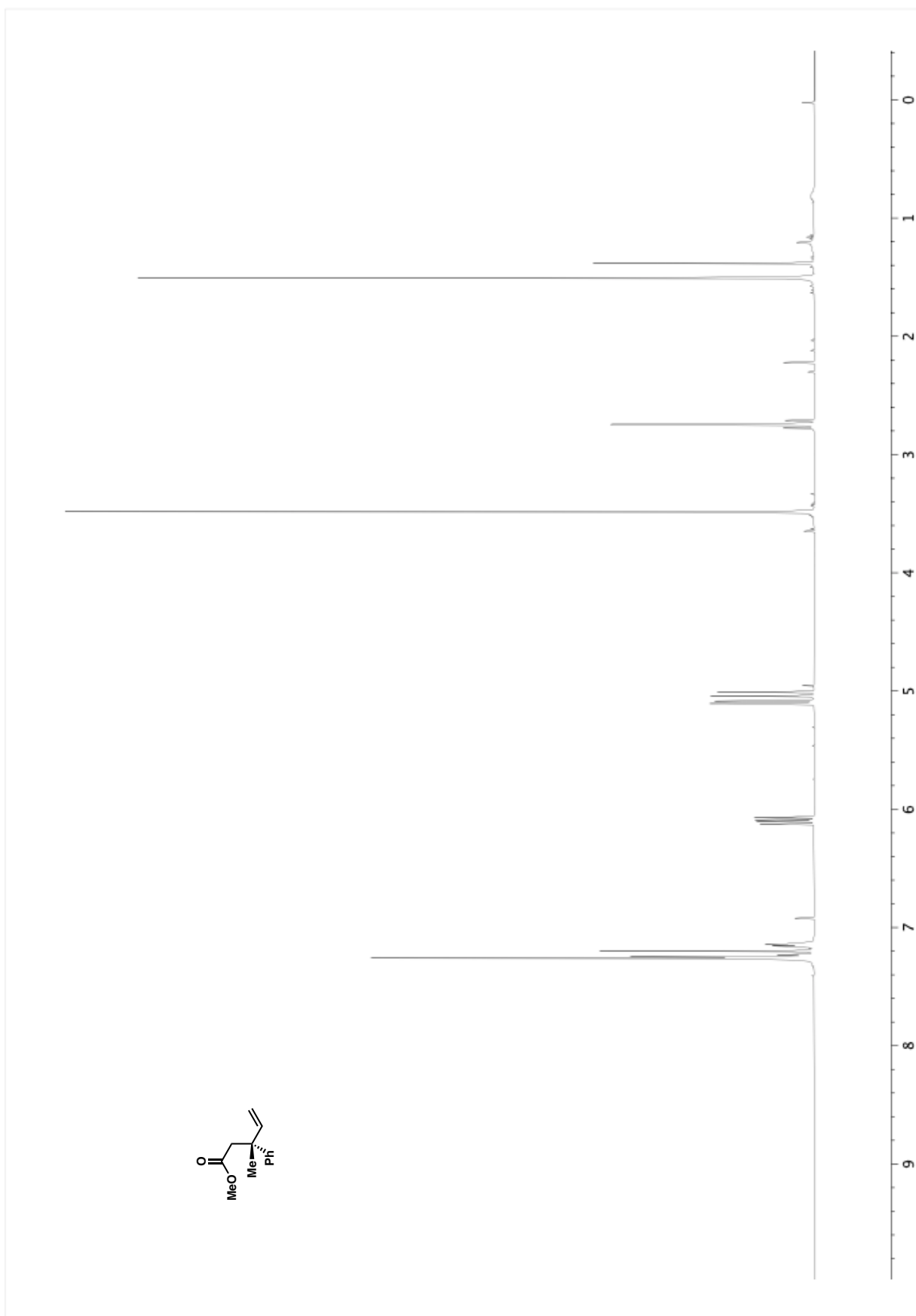
**Figure A3.139.**  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) of **80**.



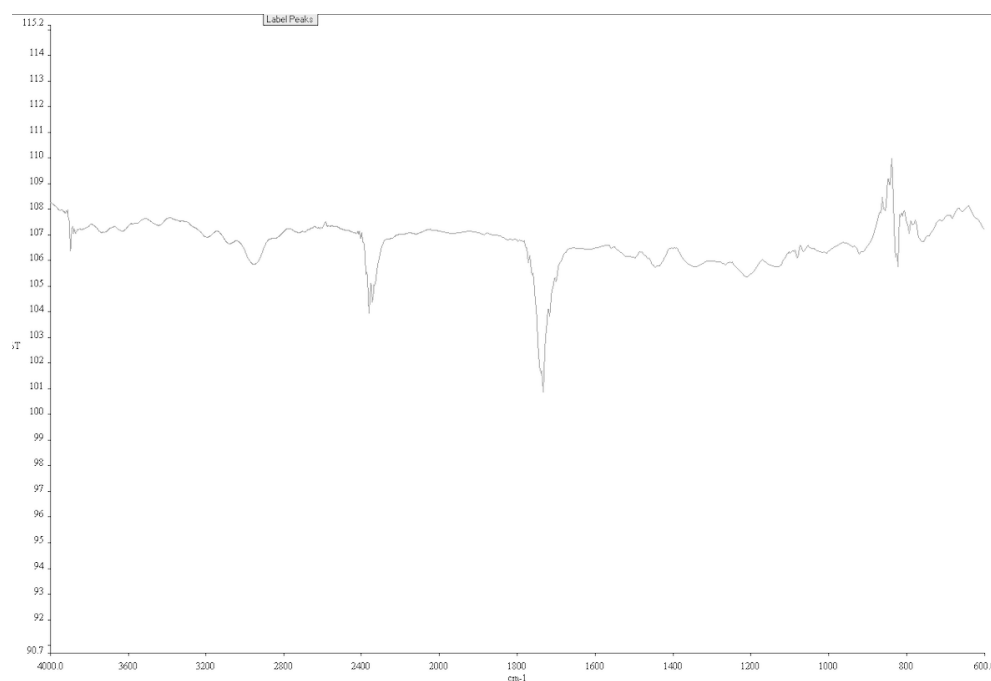
**Figure A3.140.** Infrared spectrum (Thin Film, NaCl) of **80**.



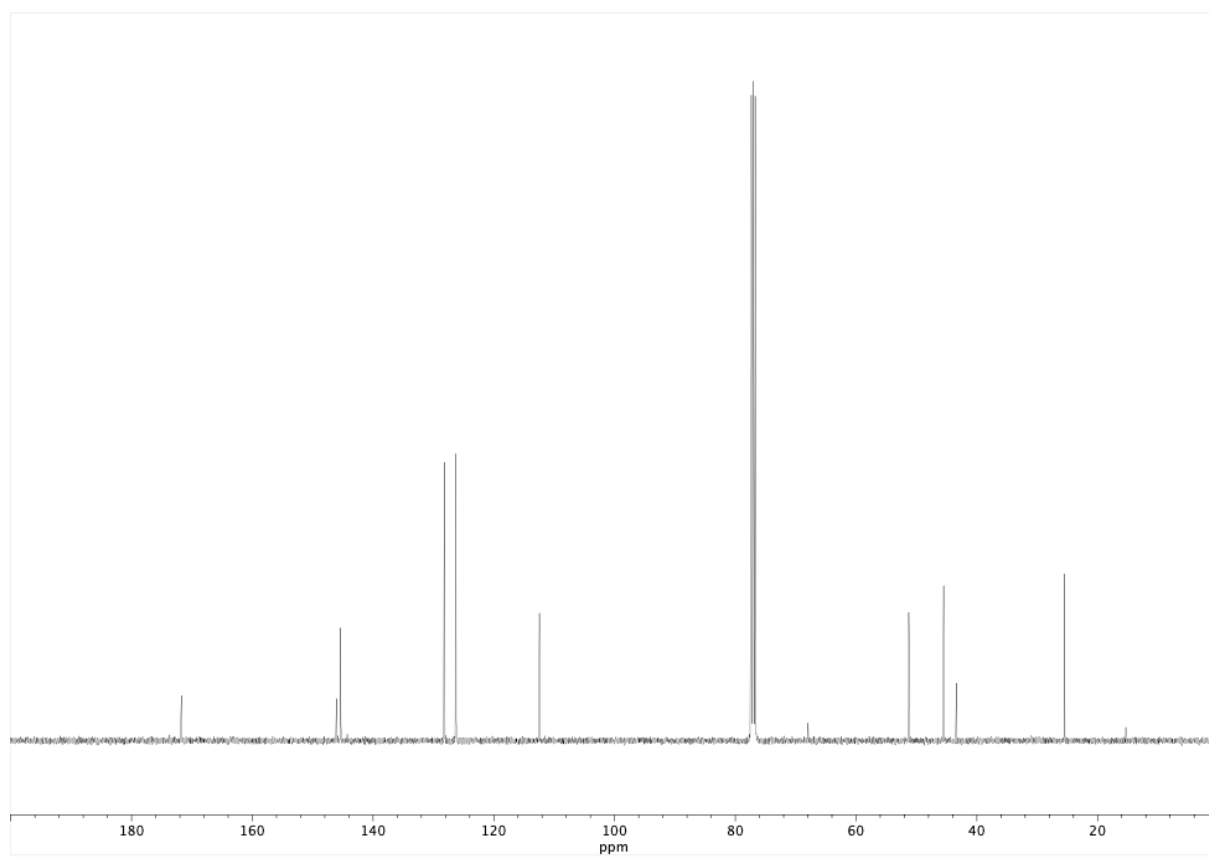
**Figure A3.141.**  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ ) of **80**.



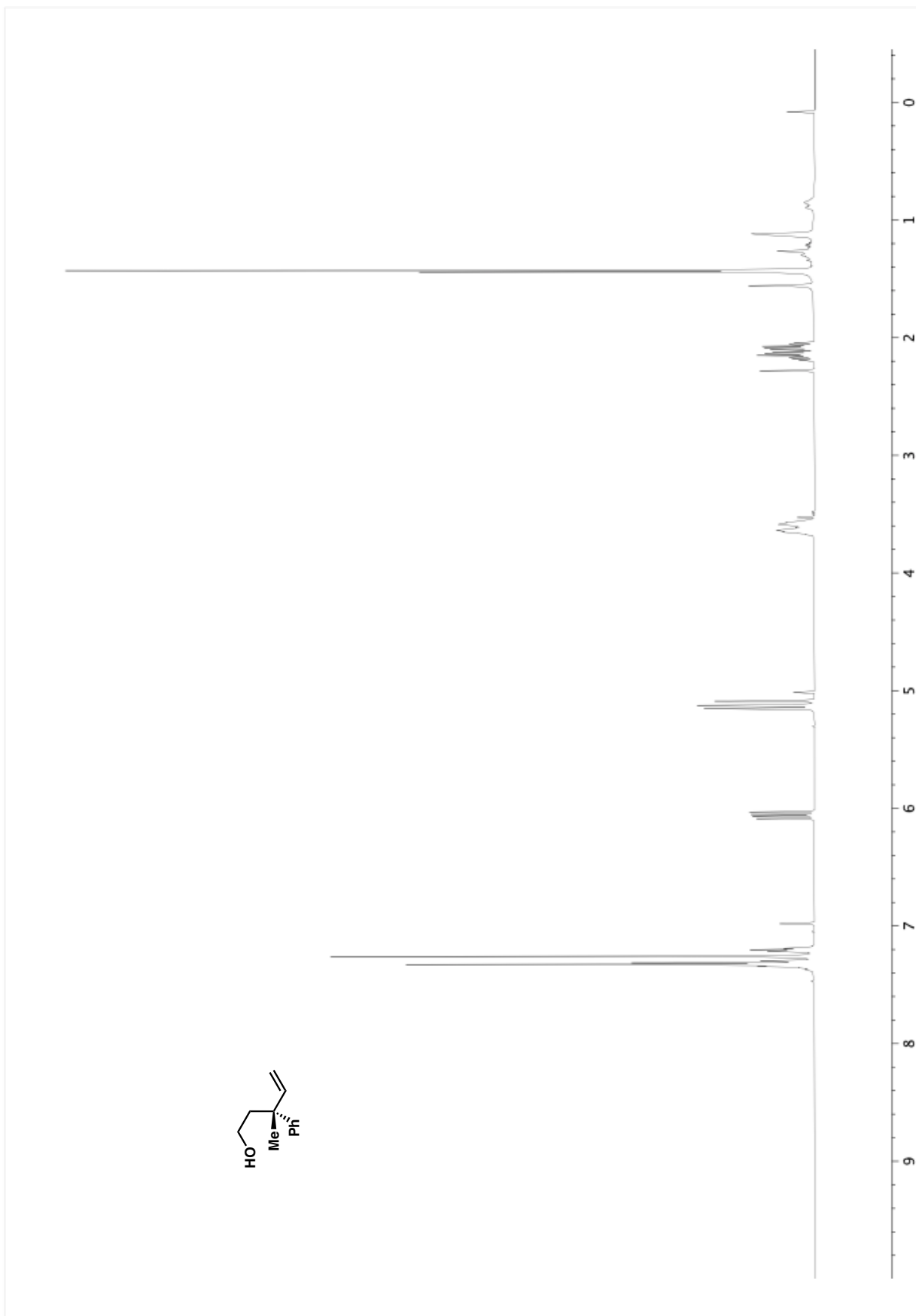
**Figure A3.142.**  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ ) of **81**.



**Figure A3.143.** Infrared spectrum (Thin Film, NaCl) of **81**.



**Figure A3.144.** <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) of **81**.



**Figure A3.145.** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) of **82**.