Supporting Information

Application of 2-Aryl Indenylphosphine Ligand in the Buchwald-Hartwig Cross-Coupling Reactions of Aryl and Heteroaryl Chlorides under the Solvent-Free and Aqueous Conditions

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1. General experimental information

1.1 General methods

Unless otherwise noted, all reagents were purchased from commercial suppliers and used without purification. (2,6-dimethoxyphenyl)boronic acid,[1] Dicyclohexyl (2-(2,6-dimethoxyphenyl) -1H-inden-3-yl) phosphine[2] were prepared according to the reported procedures. All of the (hetero) aryl chloride was dried over anhydrous magnesium sulfate. All arylamine compounds were dried over anhydrous potassium carbonate. All reactions were performed in a reaction bulb (approx. 4 mL volume) in the presence of a Teflon coated magnetic stirrer bar. Silica gel (200–300 mesh) was used for column chromatography. ^{1}H and ^{13}C spectra were recorded on a Mercury-Plus (400 MHz) and (300 MHz) spectrometer. HRMS were obtained on an IonSpec FT-ICR mass spectrometer with ESI resource. All yields reported refer to isolated yields of compounds estimated to be greater than 95% purity as determined ^{1}H NMR.

1.2 General Procedures for Reaction Condition Screenings.

Chlorobenzene (2.5 mmol), aniline (3.0 mmol), ^{t}BuONa (3.5 mmol), Pd source and phosphine ligand (as indicated in Table 1) was loaded into a Schlenk tube equipped with a Teflon-coated magnetic stir bar. The mixture was pumped and refilled with nitrogen three times. The tube was then placed into a preheated oil bath and stirred for the time period as indicated in Table 1. After completion of reaction, the tube was allowed to cool to room temperature. The mixture was purified by column chromatography to afford the desired product.

1.3 General procedure for the Buchwald-Hartwig cross-coupling reaction under solvent-free conditions.

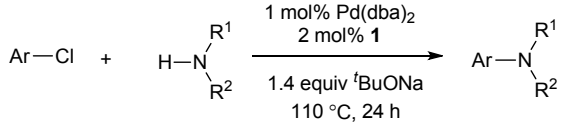
A disposable tube with a screw cap, Teflon septum and stir bar was charged with $Pd(dba)_2$ (0.0125 mmol), ligand **1** (0.0250 mmol), aryl halide (1.25 mmol), amine (1.50 mmol), ^{t}BuONa (1.75 mmol). The tube was evacuated and flushed with nitrogen three times, and then placed in a preheated oil bath (110 °C) for 24 h. After completion of reaction, the tube was allowed to cool to room temperature. The mixture was purified by silica gel column chromatography to provide desired compounds.

1.4 General procedure for the Buchwald-Hartwig cross-coupling reaction under aqueous conditions.

A disposable tube with a screw cap, Teflon septum and stir bar was charged with $Pd(dba)_2$ (0.0125 mmol), ligand **1** (0.0250 mmol), aryl halide (1.25 mmol), amine (1.50 mmol), ^{t}BuONa (1.75 mmol) and water (0.05 mL). The tube was evacuated and flushed with nitrogen three times, and then placed in a preheated oil bath (110 °C) for 24 h. After completion of reaction, the tube was allowed to cool to room temperature. Water was draw with dropper and the mixture was purified by silica gel column chromatography to provide desired compounds.

2. Table

Table 1. Buchwald-Hartwig cross-coupling reactions of aryl chlorides with amines under solvent-free conditions[a]



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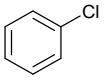
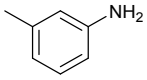
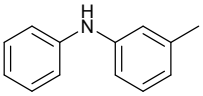
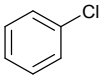
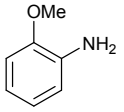
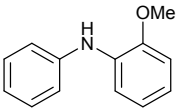
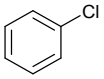
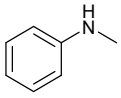
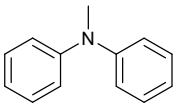
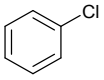
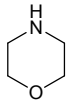
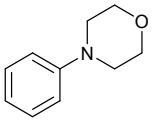
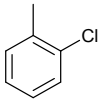
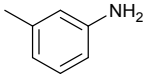
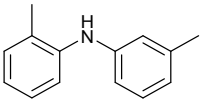
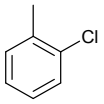
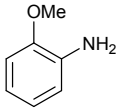
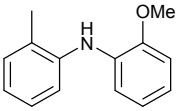
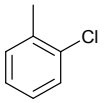
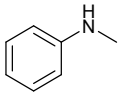
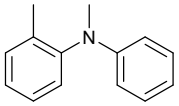
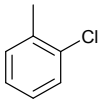
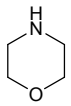
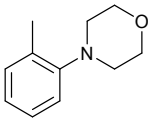
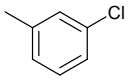
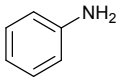
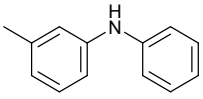
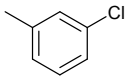
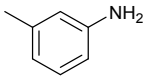
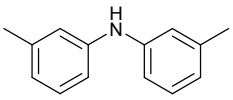
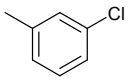
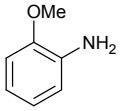
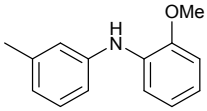
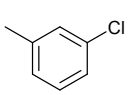
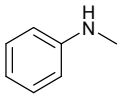
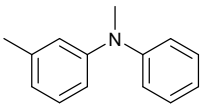
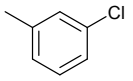
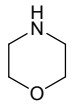
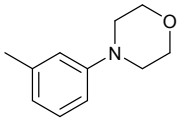
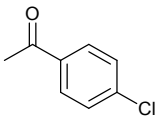
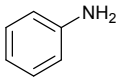
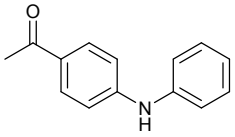
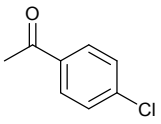
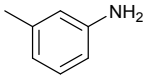
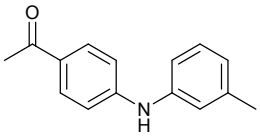
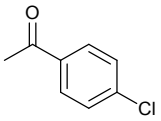
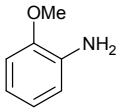
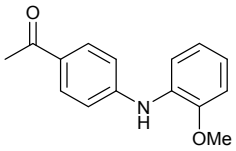
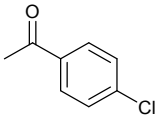
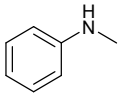
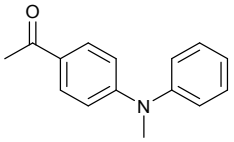
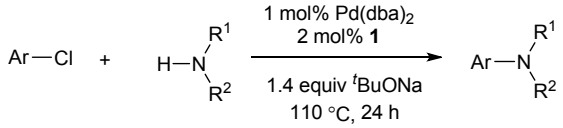
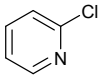
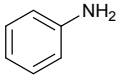
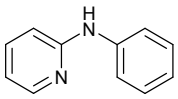
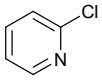
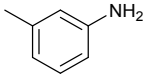
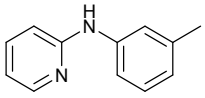
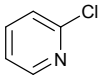
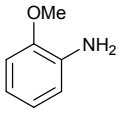
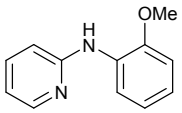
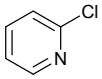
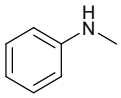
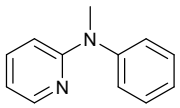
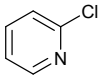
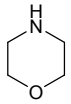
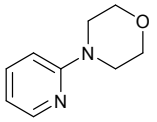
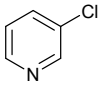
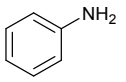
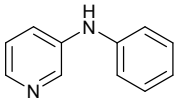
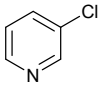
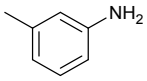
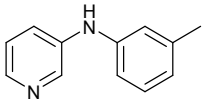
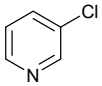
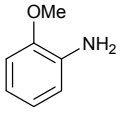
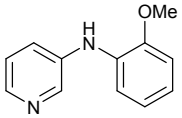
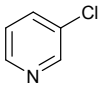
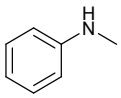
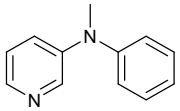
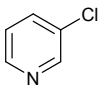
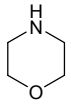
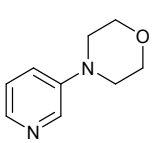
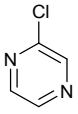
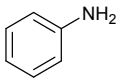
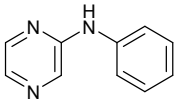
1				62
2				52
3				75
4				29
5				73
6				64
7				58
8				62
9				57
10				63
11				62

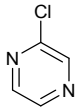
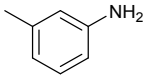
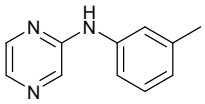
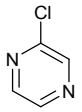
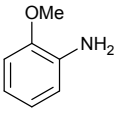
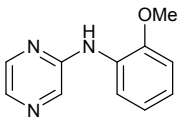
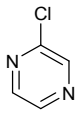
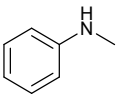
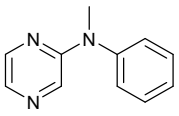
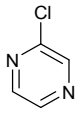
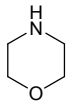
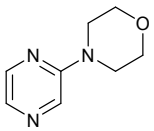
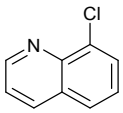
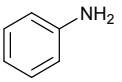
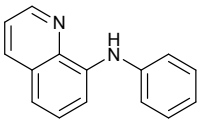
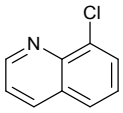
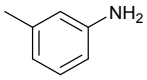
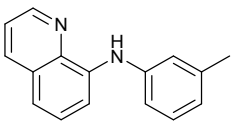
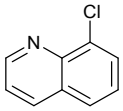
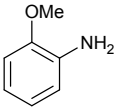
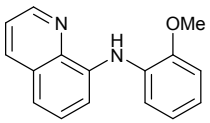
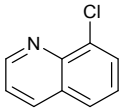
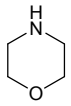
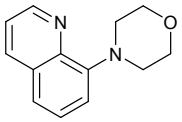
12				64
13				39
14				59
15				28
16				40
17				28

[a]Reaction conditions: ArCl (1.25 mmol), Amines (1.5 mmol), $Pd(dba)_2$ (1 mol%, 0.0125 mmol), ligand **1** (2 mol%, 0.025 mmol) and ^{t}BuONa (1.4 equiv, 1.75 mmol) at 110 ºC for 24 h. [b]Isolated yield.

Table 2. Buchwald-Hartwig cross-coupling reactions of heteroaryl chlorides with amines under solvent-free conditions[a]

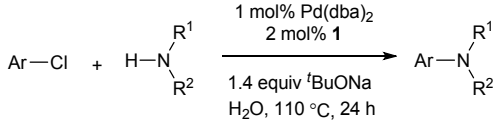


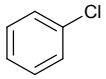
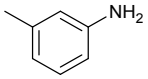
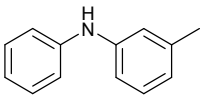
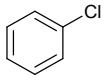
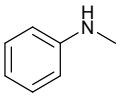
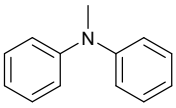
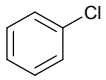
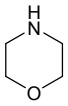
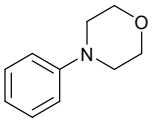
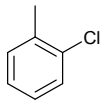
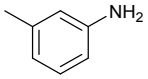
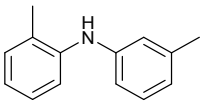
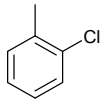
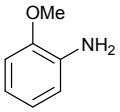
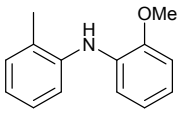
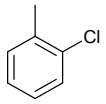
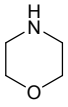
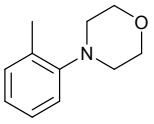
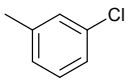
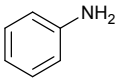
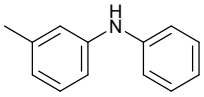
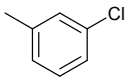
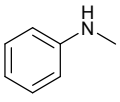
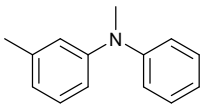
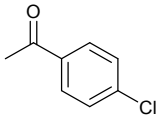
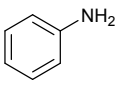
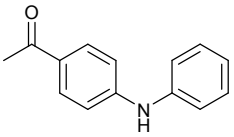
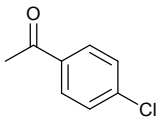
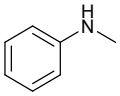
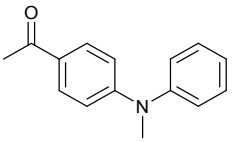
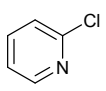
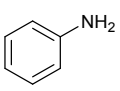
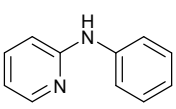
Entry	ArCl	Amine	Product	Yield (%)[b]
1				64
2				59
3				70
4				46
5				58
6				51
7				55
8				49
9				52
10				30
11				78

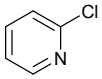
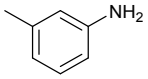
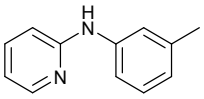
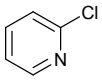
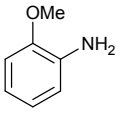
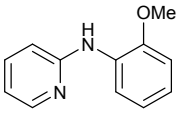
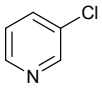
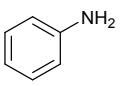
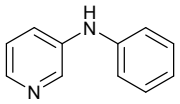
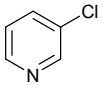
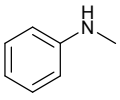
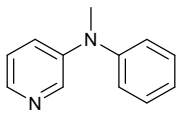
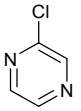
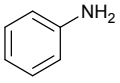
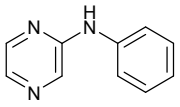
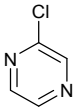
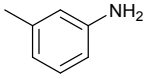
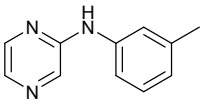
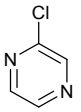
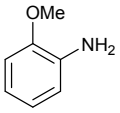
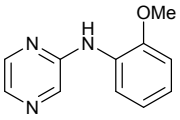
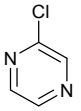
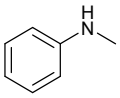
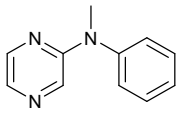
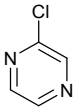
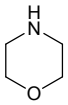
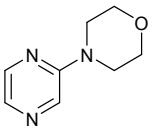
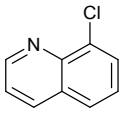
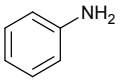
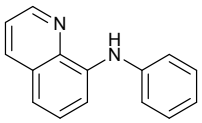
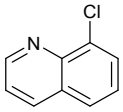
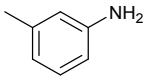
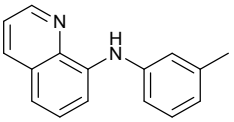
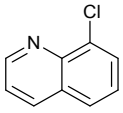
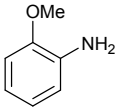
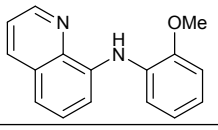
12				82
13				64
14				48
15				75
16				44
17				67
18				65
19				26

[a]Reaction conditions: heteroaryl chlorides (1.25 mmol), Amines (1.5 mmol), $Pd(dba)_2$ (1 mol%, 0.0125 mmol), ligand **1** (2 mol%, 0.025 mmol) and ^{t}BuONa (1.4 equiv, 1.75 mmol) at 110 ºC for 24 h. [b]Isolated yield.

Table 3. Buchwald-Hartwig cross-coupling reactions of amines with aryl and heteroaryl chlorides under aqueous conditions[a]

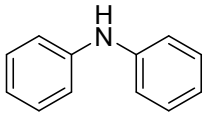


Entry	ArCl	Amine	Product	Yield (%)[c]
1				50
2				79
3				51
4				71
5				61
6				53
7				73
8				73
9				74
10				60
11				65

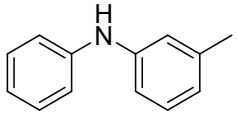
12				66
13				70
14				77
15				71
16				88
17				87
18				80
19				69
20				73
21				55
22				55
23				58

[a]Reaction conditions: H_2O (0.05 mL), ArCl (1.25 mmol), Amines (1.5 mmol), $Pd(dba)_2$ (1 mol%, 0.0125 mmol), ligand **1** (2 mol%, 0.025 mmol) and ^{t}BuONa (1.4 equiv, 1.75 mmol) at 110 ºC for 24 h. [b]Isolated yield.

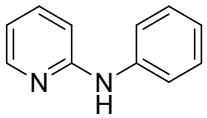
3. ^{1}H NMR and ^{13} C NMR spectrum for all isolated products



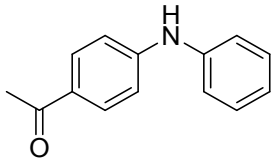
Diphenylamine.[3] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 20 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.26 - 7.21 (m, 4H, Ar-H), 7.06 - 7.03 (m, 4H, Ar-H), 6.92 - 6.88 (m, 2H, Ar-H), 5.68 (s, 1H, NH) ppm.



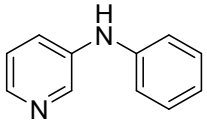
3-methyl-*N*-phenylaniline.[6] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 20 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.25 - 7.20 (m, 2H, Ar-H), 7.12 (t, *J* = 8 Hz, 1H, Ar-H), 7.03 (d, *J* = 8 Hz, 2H, Ar-H), 6.90 - 6.84 (m, 3H, Ar-H), 6.72 (d, *J* = 8 Hz, 1H, Ar-H), 5.62 (s, 1H, NH), 2.29 (s, 3H, CH_3) ppm.



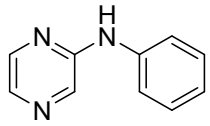
N-phenylpyridin-2-amine.[5] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.16 (d, *J* = 4 Hz, 1H, NH), 7.48 - 7.44 (m, 1H, Ar-H), 7.30 - 7.28 (m, 4H, Ar-H), 7.03 - 7.01 (m, 1H, Ar-H), 6.86 (d, *J* = 8 Hz, 1H, Ar-H), 6.72 - 6.69 (m, 2H, Ar-H) ppm.



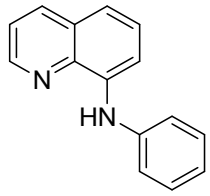
1-(4-(phenylamino)phenyl)ethanone.[7] The product was purified with silica gel column chromatography (Petroleum ether : Ethyl acetate = 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.84 (d, *J* = 8 Hz, 2H, Ar-H), 7.32 (t, *J* = 8 Hz, 2H, Ar-H), 7.16 (d, *J* = 8 Hz, 2H, Ar-H), 7.06 (t, *J* = 8 Hz, 1H, Ar-H), 6.97 (d, *J* = 8 Hz, 2H, Ar-H), 6.10 (s, 1H, NH), 2.52 (s, 1H, CO-CH_3) ppm.



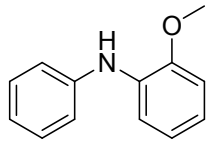
N-phenylpyridin-3-amine.[5] The product was purified with silica gel column chromatography (Petroleum ether : Ethyl acetate = 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.34 (s, 1H, Ar-H), 8.13 (d, *J* = 8 Hz, 1H, Ar-H), 7.38(d, *J* = 8 Hz, 1H, Ar-H), 7.27 (t, *J* = 8 Hz, 2H, Ar-H), 7.16 - 7.13 (m, 1H, Ar-H), 7.06 (d, *J* = 8 Hz, 2H, Ar-H), 6.97 (t, *J* = 8 Hz, 1H, Ar-H), 5.70 (s, 1H, NH) ppm.



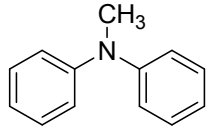
N-phenylpyrazin-2-amine.[8] The product was purified with silica gel column chromatography (Petroleum ether : Ethyl acetate = 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.21 (s, 1H, Ar-H), 8.08 (s, 1H, Ar-H), 7.95 (d, *J* = 4 Hz, 1H, Ar-H), 7.40 (d, *J* = 8 Hz, 2H, Ar-H), 7.34 (t, *J* = 8 Hz, 2H, Ar-H), 7.08 (d, *J* = 8 Hz, 1H, Ar-H), 6.59 (s, 1H, NH) ppm.



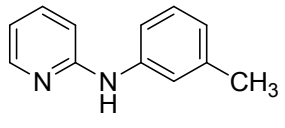
N-phenylquinolin-8-amine.[9] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.72 - 8.71 (dd, *J* = 4 Hz, 1H, NH), 8.22 (s, 1H, Ar-H), 8.04 - 8.02 (dd, *J* = 8 Hz, 1H, Ar-H), 7.45 (d, *J* = 8 Hz, 1H, Ar-H), 7.36 - 7.30 (m, 6H, Ar-H), 7.15 (d, *J* = 8 Hz, 1H, Ar-H), 7.09 (t, *J* = 8 Hz, 1H, Ar-H) ppm.



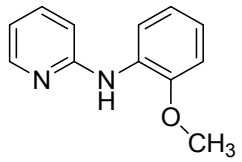
2-methoxy-*N*-phenylaniline.[7] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 20 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.28 - 7.22 (m, 3H, Ar-H), 7.11 (d, *J* = 8 Hz, 2H, Ar-H), 6.90 (t, *J* = 8 Hz, 1H, Ar-H), 6.86 - 6.81 (m, 3H, Ar-H), 6.11 (s, 1H, NH), 3.85 (s, 3H, OCH_3) ppm.



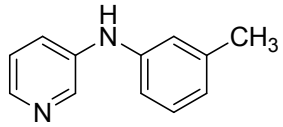
N-methyl-*N*-phenylaniline.[3] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 20 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.24 - 7.20 (m, 4H, Ar-H), 6.99 - 6.97 (m, 4H, Ar-H), 6.93 - 6.89 (m, 2H, Ar-H), 3.27 (s, 3H, CH_3) ppm.



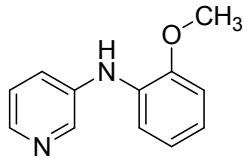
N-(*m*-tolyl)pyridin-2-amine.[10] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.14 (d, *J* = 4 Hz, 1H, NH), 7.45 - 7.41 (m, 1H, Ar-H), 7.20 - 7.16 (m, 1H, Ar-H), 7.09 - 7.08 (m, 3H, Ar-H), 6.87 - 6.82 (m, 2H, Ar-H), 6.68 - 6.65 (m, 1H, Ar-H), 2.32 (s, 3H, CH_3) ppm.



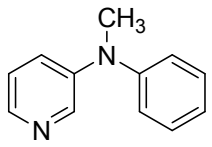
N-(2-methoxyphenyl)pyridin-2-amine.[8] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.19 (d, *J* = 4 Hz, 1H, NH), 8.02 - 8.00 (m, 1H, Ar-H), 7.47 - 7.43 (m, 1H, Ar-H), 6.94 - 6.91 (m, 3H, Ar-H), 6.88 - 6.85 (m, 1H, Ar-H), 6.82 (d, *J* = 8 Hz, 1H, Ar-H), 6.71 - 6.68 (m, 1H, Ar-H), 3.86 (s, 3H, OCH_3) ppm.



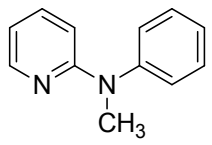
N-(*m*-tolyl)pyridin-3-amine.[11] The product was purified with silica gel column chromatography (Petroleum ether : Ethyl acetate = 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.34 (s, 1H, Ar-H), 8.12 (d, *J* = 8 Hz, 1H, Ar-H), 7.39 - 7.35 (m, 1H, Ar-H), 7.18 - 7.12 (m, 2H, Ar-H), 6.87 (d, *J* = 8 Hz, 2H, Ar-H), 6.79 (d, *J* = 8 Hz, 1H, Ar-H), 5.70 (s, 1H, NH), 2.31 (s, 3H, CH_3) ppm.



N-(2-methoxyphenyl)pyridin-3-amine.[12] The product was purified with silica gel column chromatography (Petroleum ether : Ethyl acetate = 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.40 (d, *J* = 4 Hz, 1H, Ar-H), 8.13 (d, *J* = 4 Hz, 1H, Ar-H), 7.45 (d, *J* = 12 Hz, 1H, Ar-H), 7.22 (s, 1H, Ar-H), 7.17 - 7.14 (m, 1H, Ar-H), 6.89 - 6.86 (m, 3H, Ar-H), 6.11 (s, 1H, NH), 3.89 (s, 3H, OCH_3) ppm.

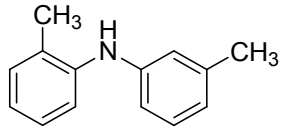


N-methyl-*N*-phenylpyridin-3-amine.[3] The product was purified with silica gel column chromatography (Petroleum ether : Ethyl acetate = 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.27 (d, *J* = 4 Hz, 1H, Ar-H), 8.10 - 8.09 (m, 1H, Ar-H), 7.30 (t, *J* = 8 Hz, 2H, Ar-H), 7.20 - 7.17 (m, 1H, Ar-H), 7.11 (d, *J* = 8 Hz, 1H, Ar-H), 7.08 - 7.02 (m, 3H, Ar-H), 3.31 (s, 3H, CH_3) ppm.

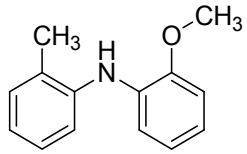


N-methyl-*N*-phenylpyridin-2-amine.[13] The product was purified with silica gel column

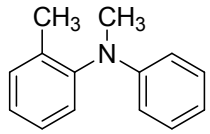
chromatography (Petroleum ether : CH_2Cl_2 = 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.19 (d, *J* = 4 Hz, 1H, Ar-H), 7.36 (t, *J* = 8 Hz, 2H, Ar-H), 7.29 - 7.22 (m, 3H, Ar-H), 7.18 (d, *J* = 8 Hz, 1H, Ar-H), 6.59 - 6.56 (m, 1H, Ar-H), 6.50 (d, *J* = 8 Hz, 1H, Ar-H), 3.46 (s, 3H, CH_3) ppm.



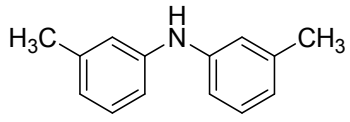
2-methyl-*N*-(*m*-tolyl)aniline.[14] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 20 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.19 (d, *J* = 8 Hz, 1H, Ar-H), 7.14 (d, *J* = 4 Hz, 1H, Ar-H), 7.09 (t, *J* = 8 Hz, 2H, Ar-H), 6.88 (t, *J* = 8 Hz, 1H, Ar-H), 6.73 (d, *J* = 8 Hz, 2H, Ar-H), 6.68 (d, *J* = 8 Hz, 1H, Ar-H), 5.28 (s, 1H, NH), 2.28 (s, 3H, CH_3) , 2.22 (s, 3H, CH_3) ppm.



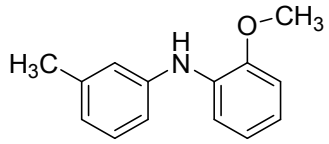
2-methoxy-*N*-(*o*-tolyl)aniline.[15] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 20 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.28 (d, *J* = 8 Hz, 1H, Ar-H), 7.17 (d, *J* = 8 Hz, 1H, Ar-H), 7.13 (t, *J* = 8 Hz, 1H, Ar-H), 7.01 - 6.99 (m, 1H, Ar-H), 6.91 (t, *J* = 8 Hz, 1H, Ar-H), 6.87 - 6.76 (m, 3H, Ar-H), 5.84 (s, 1H, NH), 3.88 (s, 3H, OCH_3) , 2.26 (s, 3H, CH_3) ppm.



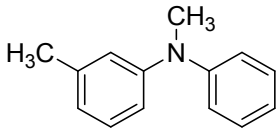
N,2-dimethyl-*N*-phenylaniline.[3] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 20 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.24 (d, *J* = 8 Hz, 1H, Ar-H), 7.19 (d, *J* = 8 Hz, 1H, Ar-H), 7.16 - 7.09 (m, 4H, Ar-H), 6.67 (t, *J* = 8 Hz, 1H, Ar-H), 6.50 (d, *J* = 8 Hz, 2H, Ar-H), 3.19 (s, 3H, CH_3) , 2.13 (s, 3H, CH_3) ppm.



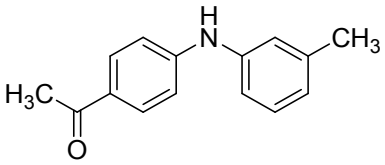
di-*m*-tolylamine.[16] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 20 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.11 (t, *J* = 8 Hz, 2H, Ar-H), 6.84 (d, *J* = 8 Hz, 4H, Ar-H), 6.71 (d, *J* = 8 Hz, 2H, Ar-H), 5.55 (s, 1H, NH) , 2.29 (s, 6H, CH_3) ppm.



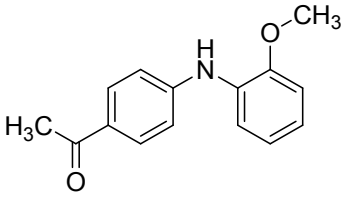
2-methoxy-*N*-(m-tolyl)aniline.[14] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 20 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.28 - 7.25 (m, 1H, Ar-H), 7.13 (t, *J* = 8 Hz, 1H, Ar-H), 6.94 (s, 2H, Ar-H), 6.86 - 6.80 (m, 3H, Ar-H), 6.73 (d, *J* = 8 Hz, 1H, Ar-H), 6.08 (s, 1H, NH) , 3.85 (s, 3H, OCH_3), 2.30 (s, 3H, CH_3) ppm.



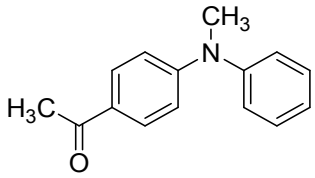
N,3-dimethyl-*N*-phenylaniline.[3] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 20 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.24 - 7.18 (m, 2H, Ar-H), 7.13 (t, *J* = 8 Hz, 1H, Ar-H), 6.94 (d, *J* = 8 Hz, 2H, Ar-H), 6.90 (t, *J* = 8 Hz, 1H, Ar-H), 6.81 (d, *J* = 8 Hz, 2H, Ar-H), 6.75 (d, *J* = 4 Hz, 1H, Ar-H), 3.27 (s, 3H, CH_3), 2.28 (s, 3H, CH_3) ppm.



1-(4-(*m*-tolylamino)phenyl)ethanone.[15] The product was purified with silica gel column chromatography (Petroleum ether : Ethyl acetate = 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.83 (d, *J* = 8 Hz, 2H, Ar-H), 7.23 - 7.18 (m, 1H, Ar-H), 6.97 - 6.93 (m, 4H, Ar-H), 6.87 (d, *J* = 8 Hz, 1H, Ar-H), 6.07 (s, 1H, NH), 2.52 (s, 3H, $COCH_3$), 2.34 (s, 3H, CH_3) ppm.

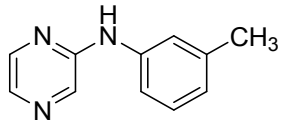


1-(4-((2-methoxyphenyl)amino)phenyl)ethanone. The product was purified with silica gel column chromatography (Petroleum ether : Ethyl acetate = 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.84 (d, *J* = 8 Hz, 2H, Ar-H), 7.37 (d, *J* = 8 Hz, 1H, Ar-H), 7.04 (d, *J* = 8 Hz, 2H, Ar-H), 6.99 - 6.88 (m, 3H, Ar-H), 6.41 (s, 1H, NH), 3.85(s, 3H, OCH_3), 2.52 (s, 3H, $COCH_3$) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ 196.11 (CO), 149.55, 147.72, 130.21, 129.85, 128.59, 122.36, 120.40, 118.02, 114.57, 110.72 (Ar), 55.27 ($COCH_3$), 25.80 (CH_3) ppm. HRMS (ESI): $[M+H]^+$ Calcd for $C_{15}H_{15}NO_2$: 242.1175. found: 242.1167.

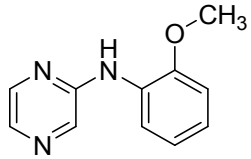


1-(4-(methyl(phenyl)amino)phenyl)ethanone.[17] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.79

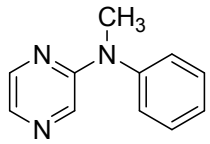
(d, J = 8 Hz, 2H, Ar-H), 7.38 (d, J = 8 Hz, 2H, Ar-H), 7.23 - 7.18 (m, 3H, Ar-H), 6.73 (d, J = 8 Hz, 2H, Ar-H), 3.36(s, 3H, CH_3), 2.50 (s, 3H, CO-CH_3) ppm.



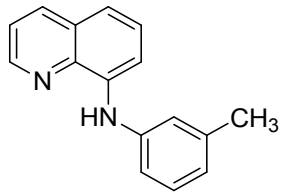
N-(*m*-tolyl)pyrazin-2-amine. The product was purified with silica gel column chromatography (Petroleum ether : Ethyl acetate = 30 : 1 to 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.20 (s, 1H, NH), 8.05 (d, J = 4 Hz, 1H, Ar-H), 7.91 (d, J = 4 Hz, 1H, Ar-H), 7.23 - 7.09 (m, 4H, Ar-H), 6.88 (t, J = 4 Hz, 1H, Ar-H), 2.33 (s, 3H, CH_3) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ 152.52, 141.64, 139.20, 138.92, 133.84, 132.96, 128.88, 124.00, 120.62, 117.11 (Ar), 21.28 (CH_3) ppm. HRMS (ESI): $[M+H]^+$ Calcd for $C_{11}H_{11}N_3$: 186.1025. found: 186.1023.



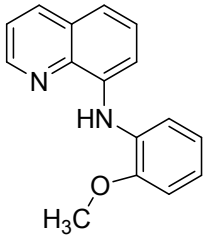
N-(2-methoxyphenyl)pyrazin-2-amine. The product was purified with silica gel column chromatography (Petroleum ether : Ethyl acetate = 30 : 1 to 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.21 - 8.18 (m, 2H, Ar-H), 8.09 (d, J = 4 Hz, 1H, Ar-H), 7.92 (s, 1H, NH), 7.09 (s, 1H, Ar-H), 6.99 - 6.94 (m, 2H, Ar-H), 6.90 - 6.88 (m, 1H, Ar-H), 3.90 (s, 3H, OCH_3) ppm. ^{13}C NMR (75 MHz, $CDCl_3$): δ 151.81, 148.27, 141.19, 134.09, 128.78, 122,08, 120.61, 118.35, 109.93 (Ar), 55.30 (OCH_3) ppm. HRMS (ESI): $[M+H]^+$ Calcd for $C_{11}H_{11}N_3O$: 202.0974. found: 202.0970.



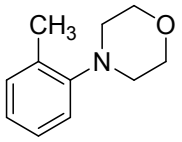
N-methyl-*N*-phenylpyrazin-2-amine.[18] The product was purified with silica gel column chromatography (Petroleum ether : Ethyl acetate = 30 : 1 to 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.05 (d, J = 4 Hz, 1H, Ar-H), 7.91 (s, 1H, Ar-H), 7.79 (s, 1H, Ar-H), 7.41 (t, J = 8 Hz, 2H, Ar-H), 7.27 - 7.23 (m, 3H, Ar-H), 3.44 (s, 3H, CH_3) ppm.



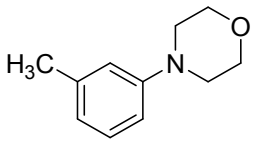
N-(*m*-tolyl)quinolin-8-amine.[9] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 20 : 1 to 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.71 (s, 1H, NH), 8.19 (s, 1H, Ar-H), 8.04 - 8.01 (m, 1H, Ar-H), 7.45 - 7.43 (m, 1H, Ar-H), 7.36 - 7.32 (m, 2H, Ar-H), 7.23 - 7.14 (m, 4H, Ar-H), 6.82 (d, J = 8 Hz, 1H, Ar-H), 2.35 (s, 3H, CH_3) ppm.



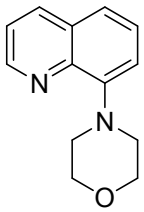
N-(2-methoxyphenyl)quinolin-8-amine. The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 20 : 1 to 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.79 (d, *J* = 8 Hz, 1H, Ar-H), 8.49 (s, 1H, NH), 8.08 - 8.06 (dd, *J* = 8 Hz, 1H, Ar-H), 7.63 (t, *J* = 4 Hz, 1H, Ar-H), 7.52 (d, *J* = 8 Hz, 1H, Ar-H), 7.40 - 7.36 (m, 2H, Ar-H), 7.19 (t, *J* = 8 Hz, 1H, Ar-H), 6.97 - 6.94 (m, 3H, Ar-H), 3.93 (s, 3H, OCH_3). ^{13}C NMR (75 MHz, $CDCl_3$): δ 149.55, 146.93, 139.21, 138.58, 135.51, 130.87, 128.35, 126.69, 120.93, 120.81, 120.08, 116.65, 116.09, 110.22, 107.57 (Ar), 55.10 (OCH_3) ppm. HRMS (ESI): $[M+H]^+$ Calcd for $C_{16}H_{14}N_2O$: 251.1178. found: 251.1177.



4-(*o*-tolyl)morpholine.[19] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 30 : 1 to 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.14 (t, *J* = 4 Hz, 2H, Ar-H), 6.99 - 6.95 (m, 2H, Ar-H), 3.82 (t, *J* = 4 Hz, 4H, CH_2), 2.89 (t, *J* = 4 Hz, 4H, CH_2), 2.30 (s, 3H, CH_3) ppm.

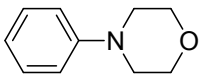


4-(*m*-tolyl)morpholine.[20] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 30 : 1 to 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.13 (t, *J* = 8 Hz, 1H, Ar-H), 6.68 (t, *J* = 8 Hz, 3H, Ar-H), 3.82 (t, *J* = 8 Hz, 4H, CH_2), 3.12 (t, *J* = 8 Hz, 4H, CH_2), 2.31 (s, 3H, CH_3) ppm.

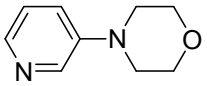


4-(quinolin-8-yl)morpholine.[22] The product was purified with silica gel column chromatography (Petroleum ether : Ethyl acetate = 20 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.85 - 8.84 (dd, *J* = 4 Hz, 1H, Ar-H), 8.10 - 8.08 (dd, *J* = 8 Hz, 1H, Ar-H), 7.43 - 7.40 (m, 2H, Ar-H),

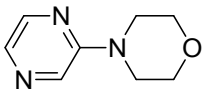
7.37 - 7.33 (m, 1H, Ar-H), 7.11 (t, J = 4 Hz, 1H, Ar-H), 4.04 (t, J = 4 Hz, 4H, CH_2), 3.41 (t, J = 4 Hz, 4H, CH_2), 1.81 (s, 3H, CH_3) ppm.



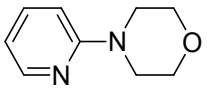
4-phenylmorpholine.[3] The product was purified with silica gel column chromatography (Petroleum ether : Ethyl acetate = 50 : 1 to 30 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.27 - 7.22 (m, 2H, Ar-H), 6.90 - 6.84 (m, 3H, Ar-H), 3.85 (t, J = 4 Hz, 4H, CH_2), 3.14 (t, J = 4 Hz, 4H, CH_2) ppm.



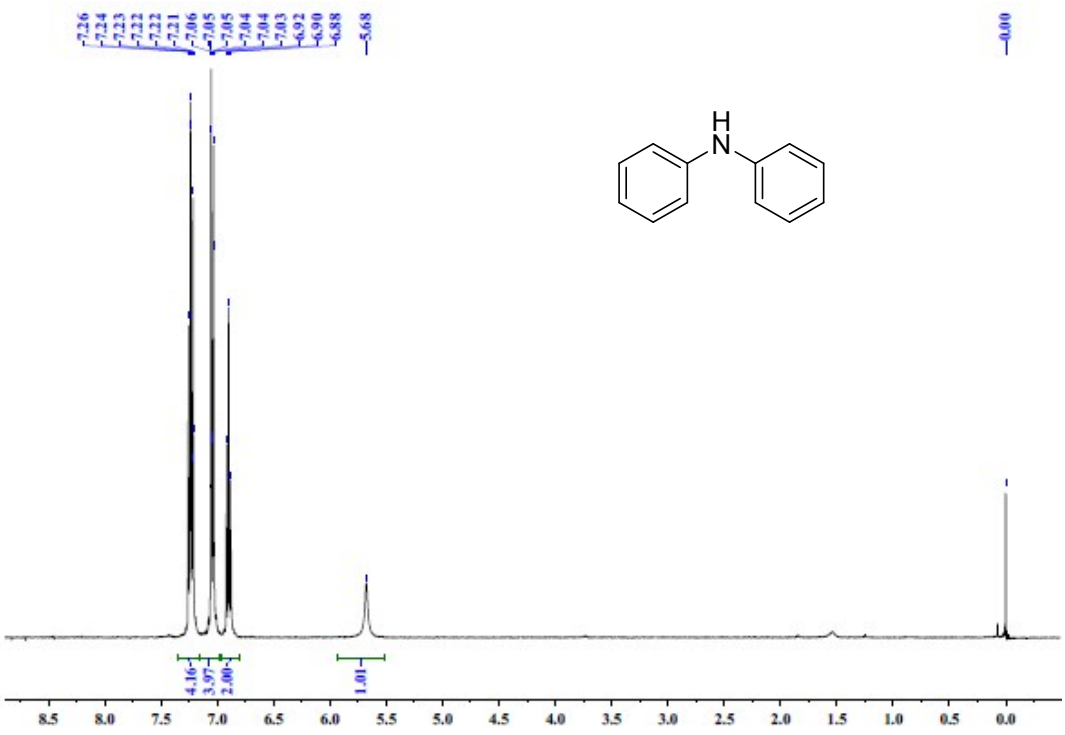
4-(pyridin-3-yl)morpholine.[23] The product was purified with silica gel column chromatography (Petroleum ether : Ethyl acetate = 5 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.26 (s, 1H, Ar-H), 8.09 (t, J = 4 Hz, 1H, Ar-H), 7.14 (d, J = 4 Hz, 2H, Ar-H), 3.85 (t, J = 4 Hz, 4H, CH_2), 3.17 (t, J = 4 Hz, 4H, CH_2) ppm.



4-(pyrazin-2-yl)morpholine.[18] The product was purified with silica gel column chromatography (Petroleum ether : Ethyl acetate = 10 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.10 (d, J = 0.8 Hz, 1H, Ar-H), 8.06 - 8.05 (m, 1H, Ar-H), 7.86 (d, J = 0.8 Hz, 1H, Ar-H), 3.82 (t, J = 4 Hz, 4H, O-CH_2), 3.55 (t, J = 4 Hz, 4H, N-CH_2) ppm.



4-(pyridin-2-yl)morpholine.[3] The product was purified with silica gel column chromatography (Petroleum ether : CH_2Cl_2 = 20 : 1). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.16 (d, J = 4 Hz, 1H, Ar-H), 7.48 - 7.44 (m, 1H, Ar-H), 6.64 - 6.59 (m, 2H, Ar-H), 3.80 (t, J = 8 Hz, 4H, CH_2), 3.48 (t, J = 8 Hz, 4H, CH_2) ppm.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6.88
5.68
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N
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2.00
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7.5
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6.0
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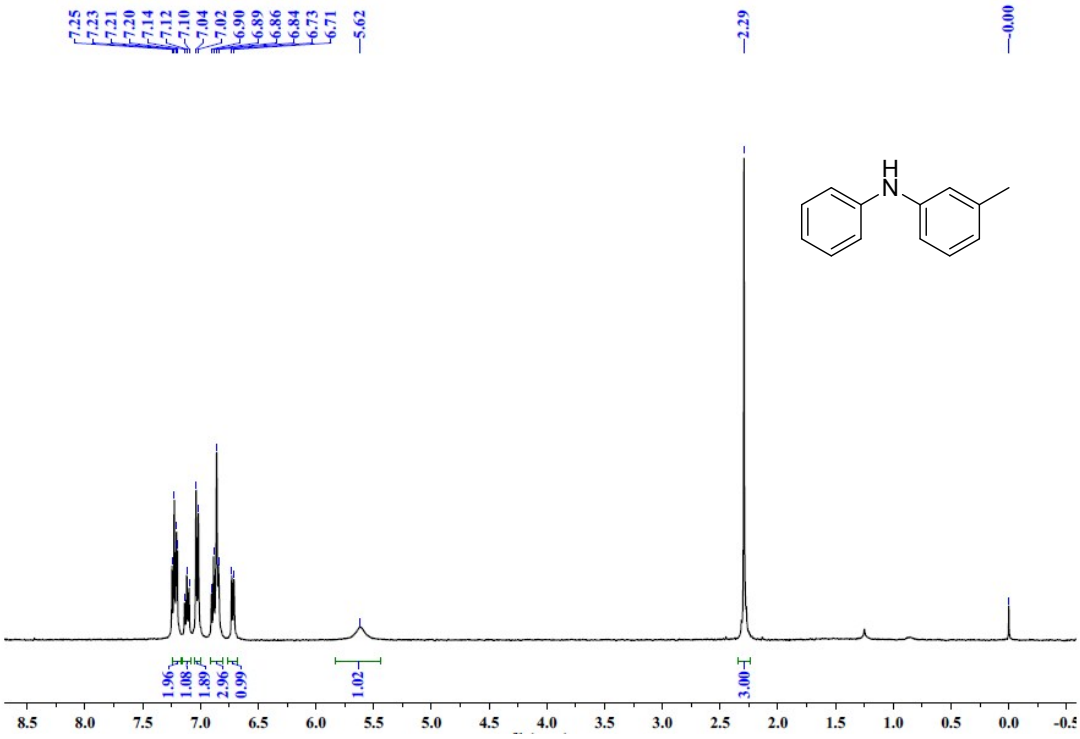
^{1}H NMR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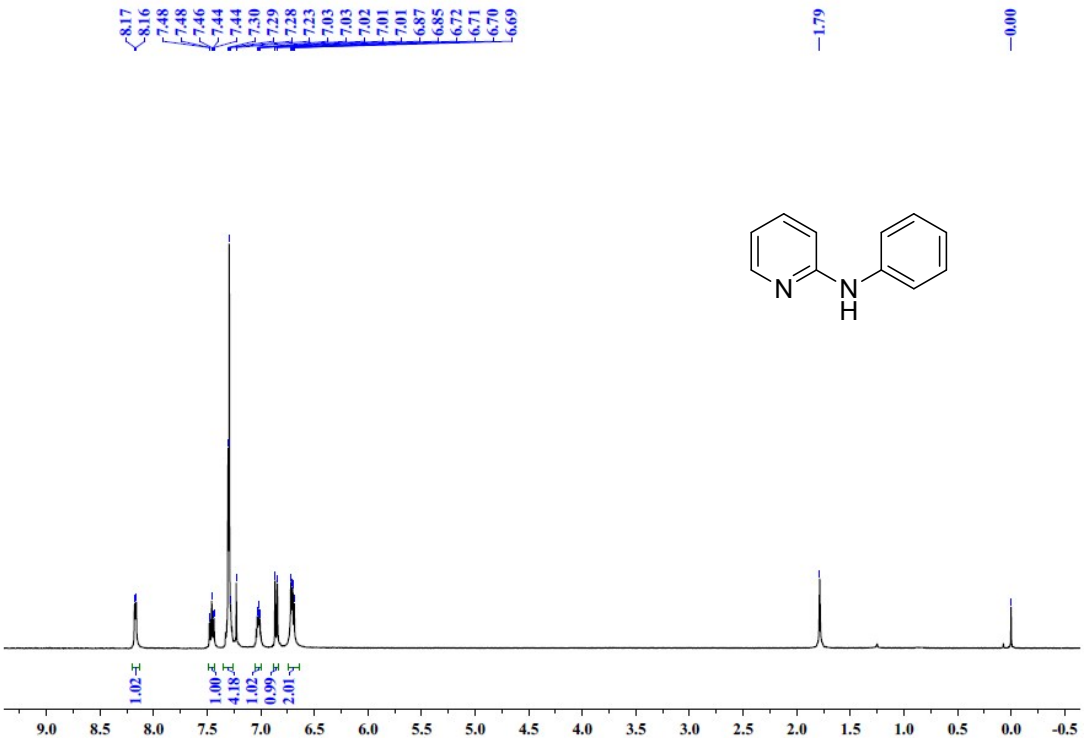
^{1}H NMR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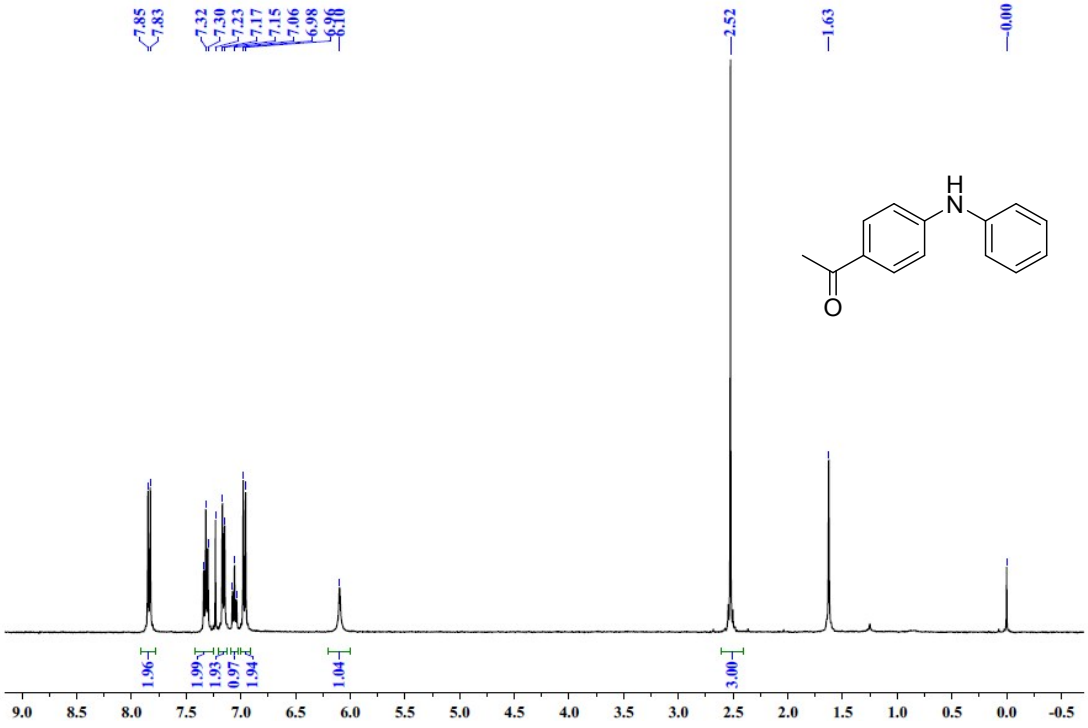
^{1}H NMR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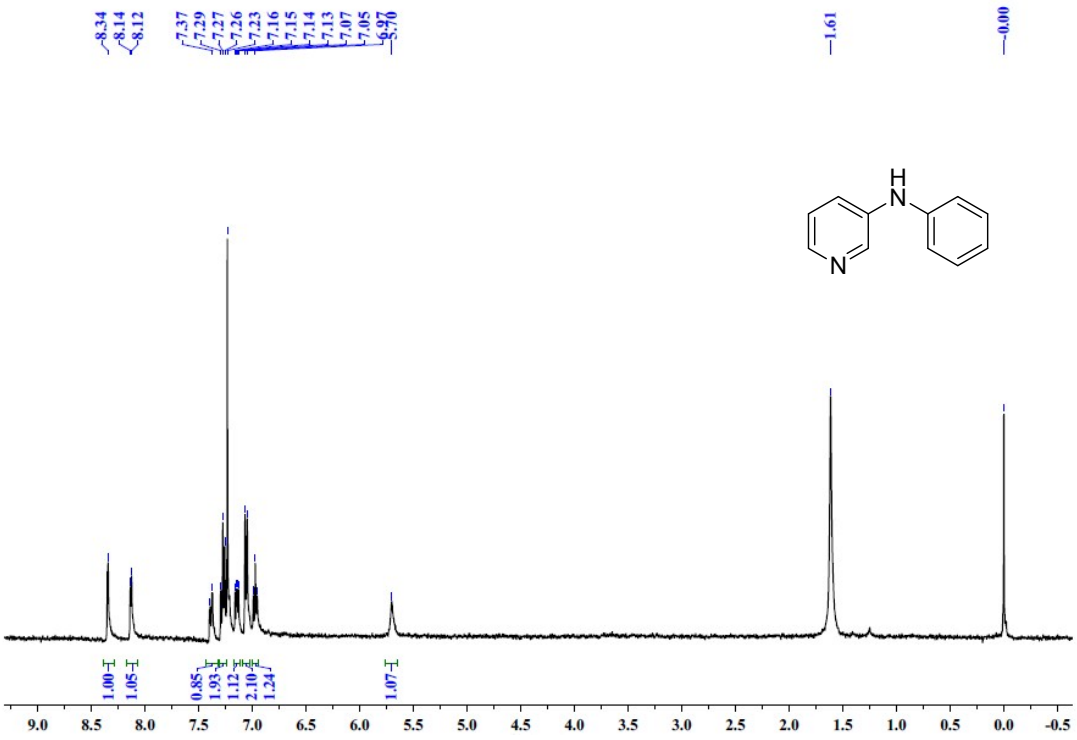
^{1}H NMR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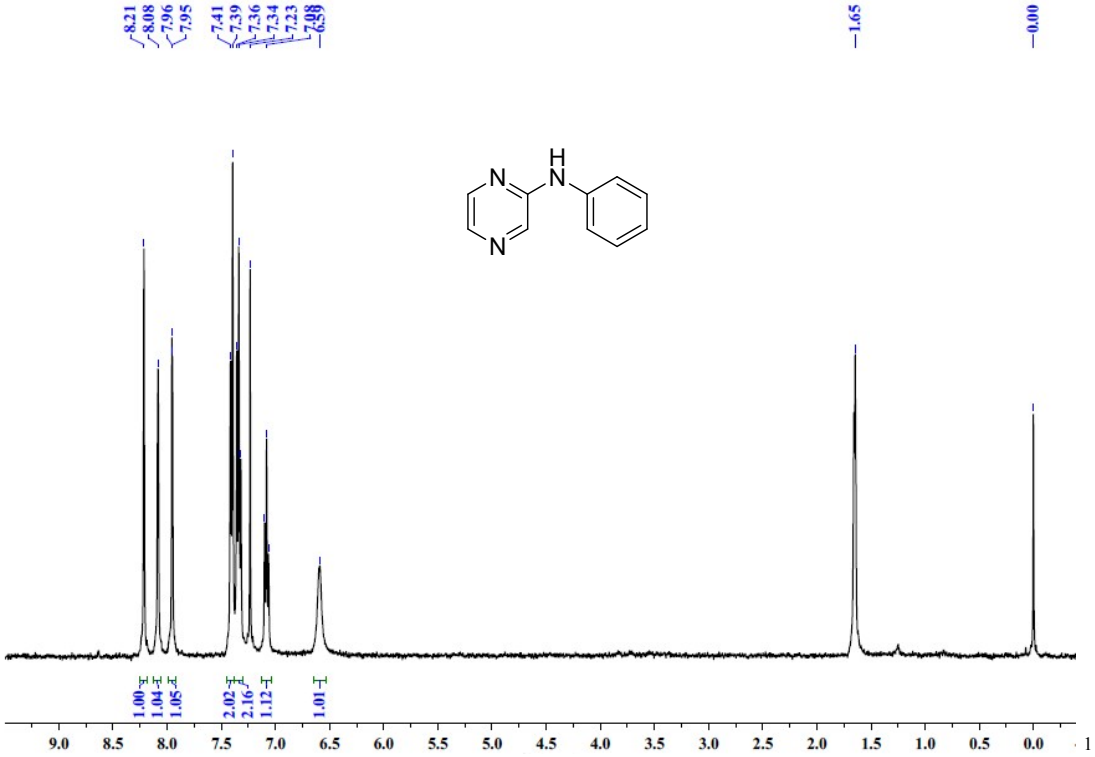
^{1}H NMR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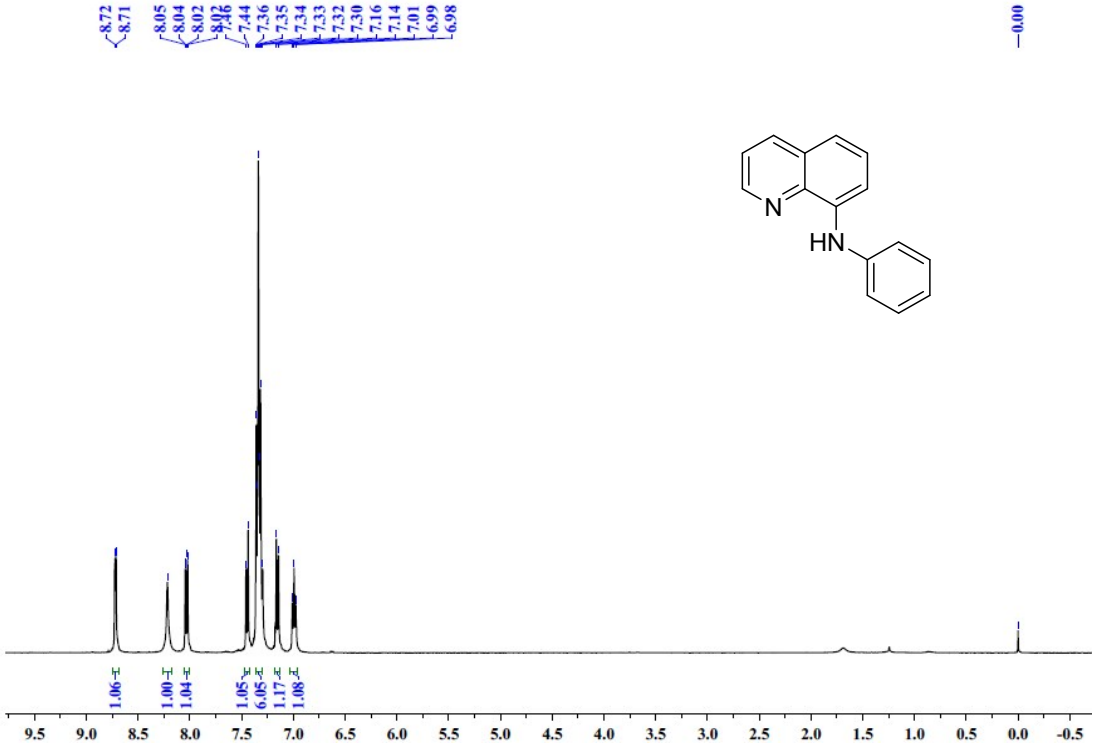
H NMR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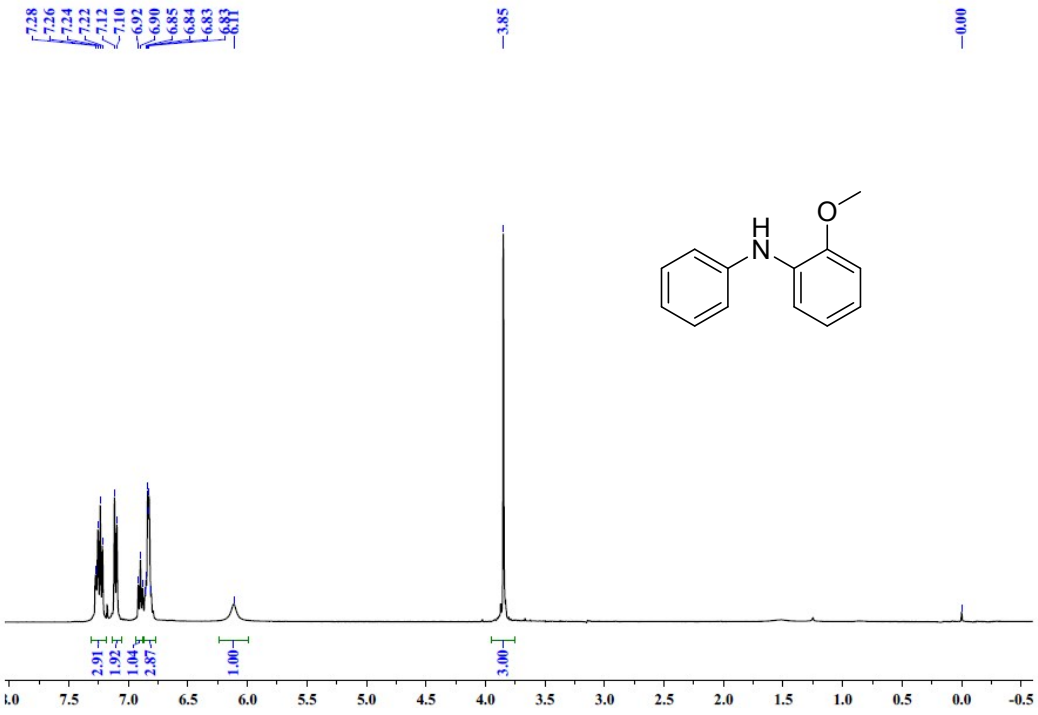
^{1}H NMR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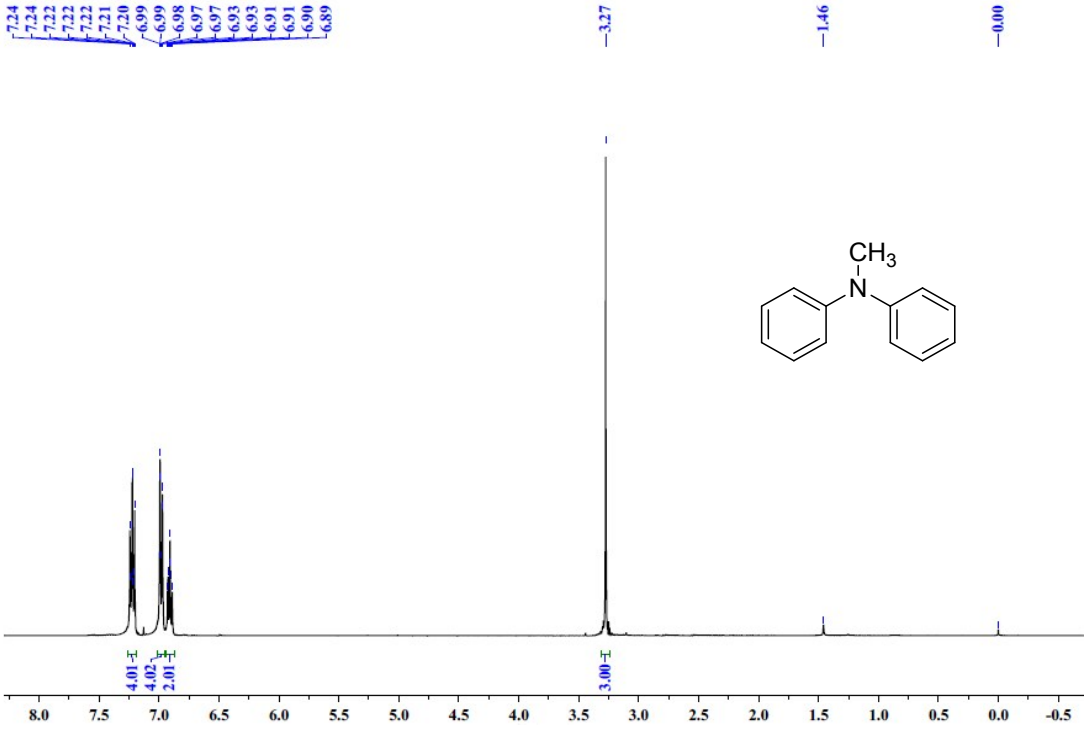
^{1}H NMR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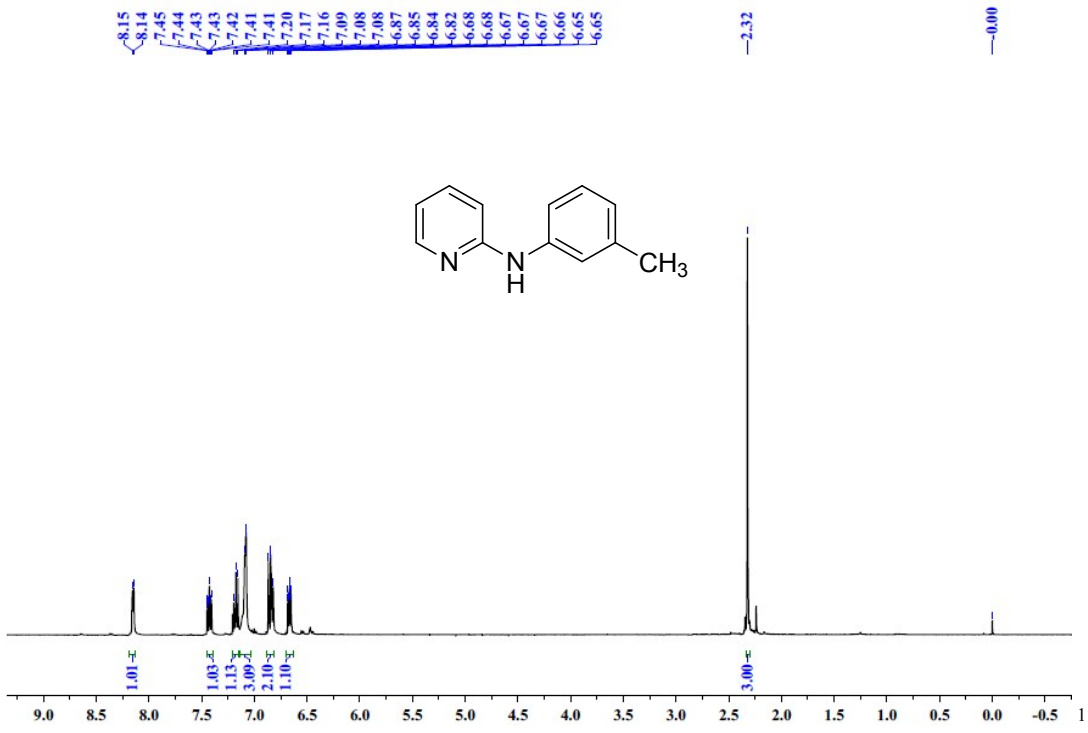
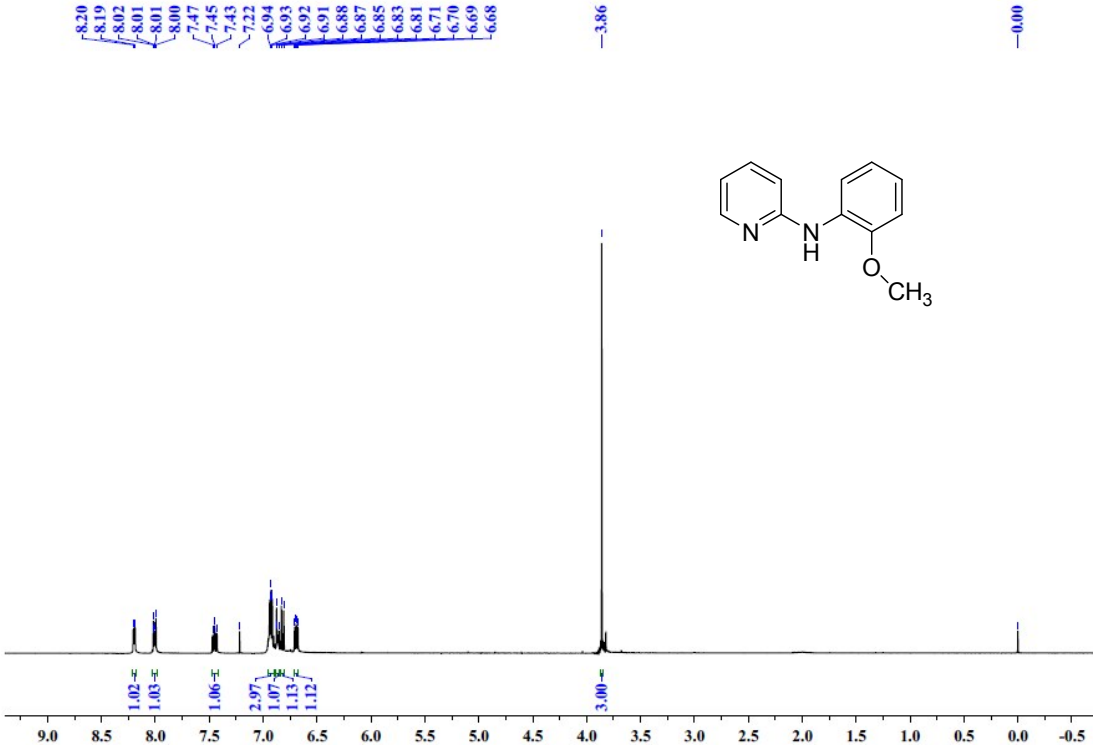
1.46
0.00
CH3
N
4.01
4.02
2.01
3.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

^{1}H NMR


8.15
8.14
7.45
7.44
7.43
7.43
7.42
7.41
7.41
7.20
7.17
7.16
7.09
7.08
7.08
6.87
6.85
6.84
6.82
6.68
6.68
6.67
6.67
6.67
6.66
6.65
6.65
2.32
0.00
N
N
H
CH3
1.01
1.03
1.13
3.09
2.10
1.10
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

H NMR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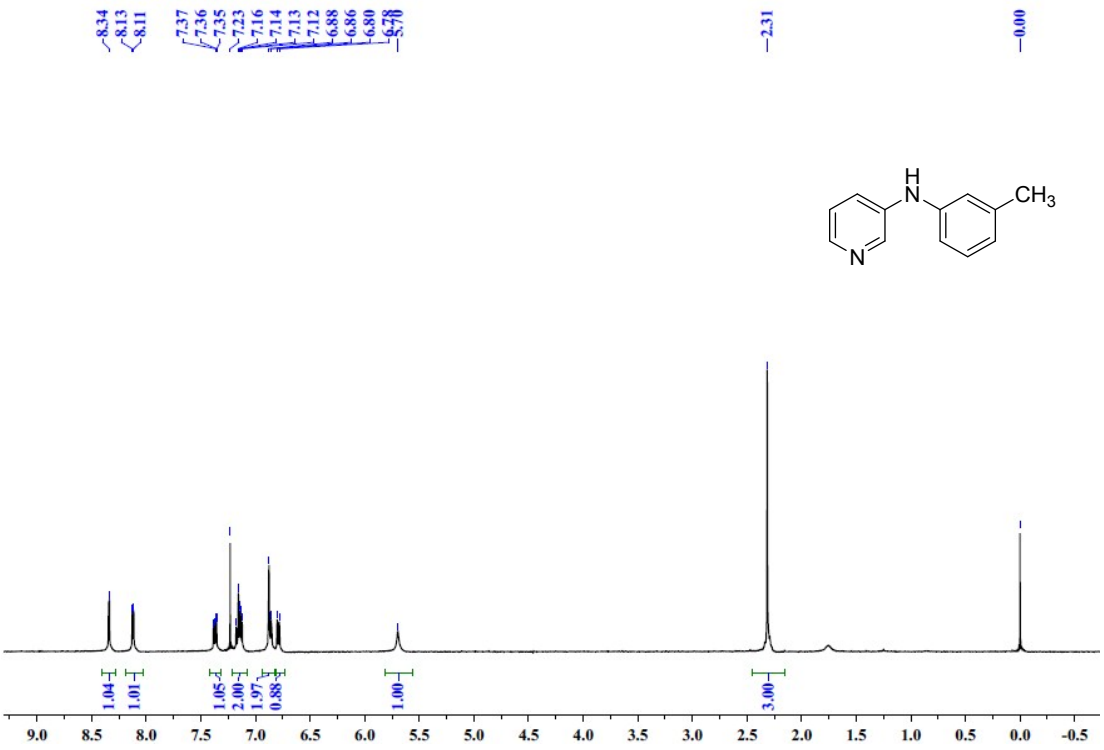
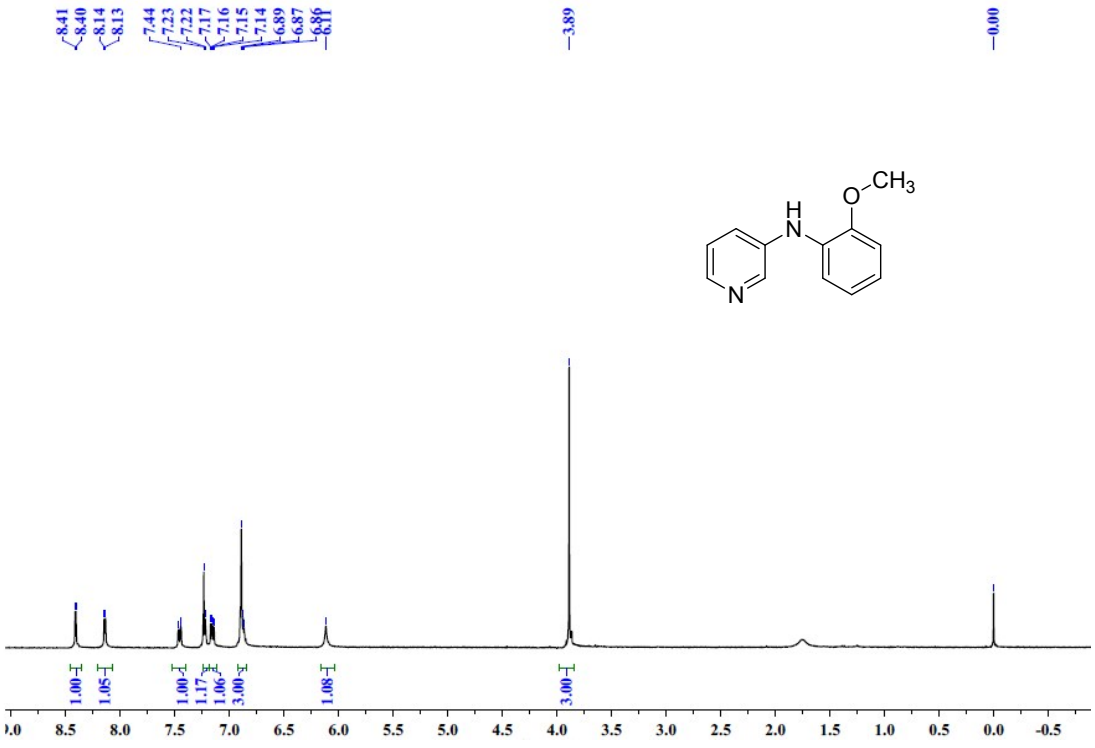
8.02
8.01
8.01
8.00
7.47
7.45
7.43
7.22
6.94
6.93
6.92
6.91
6.88
6.87
6.85
6.83
6.81
6.71
6.70
6.69
6.68
3.86
0.00
N
N
H
O
CH3
1.02
1.03
1.06
2.97
1.07
1.13
1.12
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

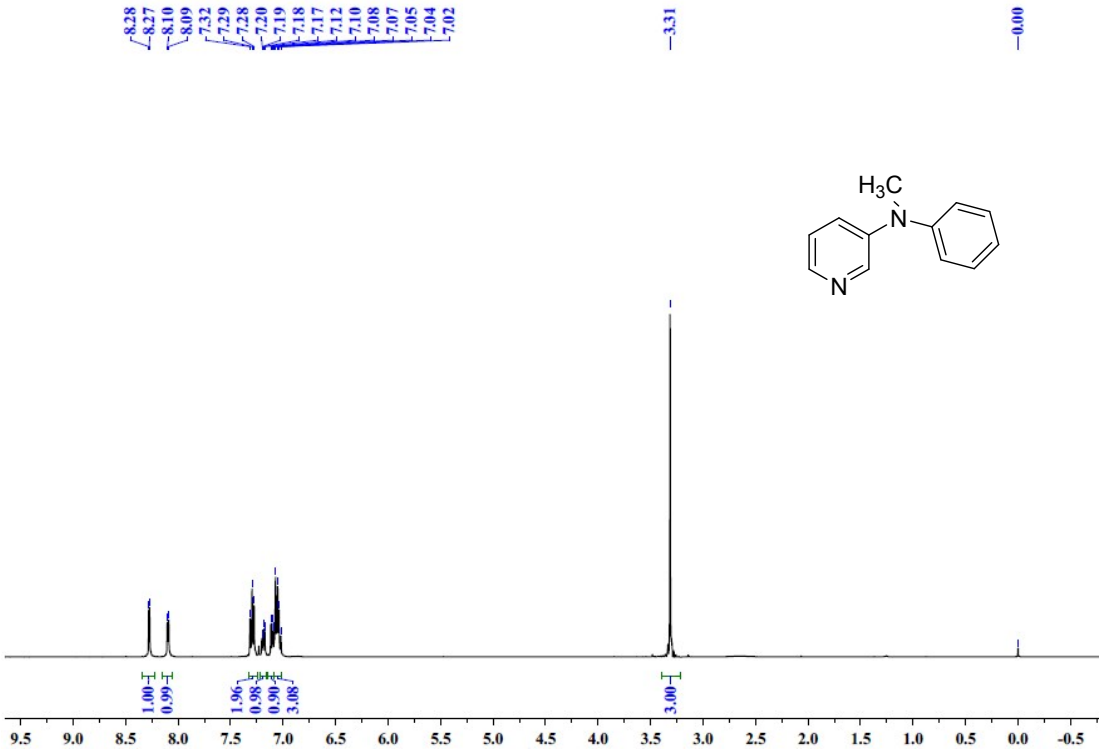
^{1}H NMR


8.34
8.13
8.11
7.37
7.36
7.35
7.23
7.16
7.14
7.13
7.12
6.88
6.86
6.80
6.78
6.76
2.31
0.00
H
N
CH3
N
1.04
1.01
1.05
2.00
1.97
0.88
1.00
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

^{1}H NMR


8.41
8.40
8.14
8.13
7.44
7.23
7.22
7.17
7.16
7.15
7.14
6.89
6.87
6.86
6.11
3.89
0.00
O
CH3
H
N
N
1.00
1.05
1.00
1.17
1.06
3.00
1.08
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

^{1}H NMR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8.27
8.10
8.09
7.32
7.29
7.28
7.20
7.19
7.18
7.17
7.12
7.10
7.08
7.07
7.05
7.04
7.02
3.31
0.00
H3C
N
N
1.00
0.99
1.96
0.98
0.90
3.08
3.00
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
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3.0
2.5
2.0
1.5
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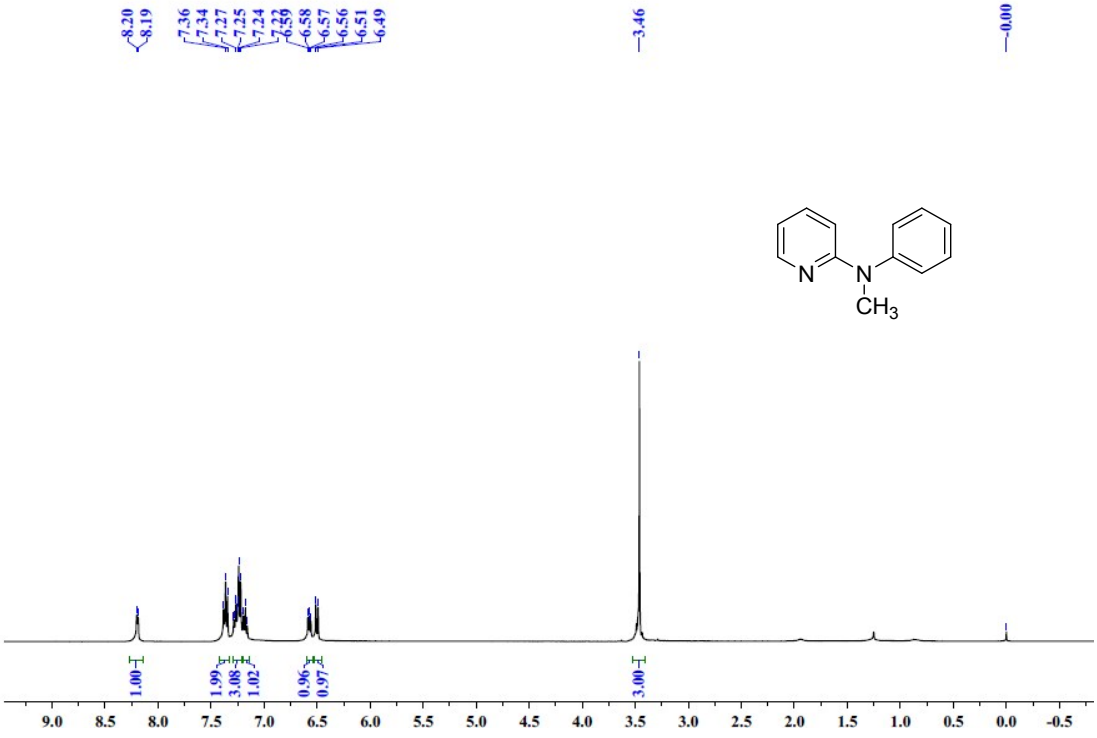
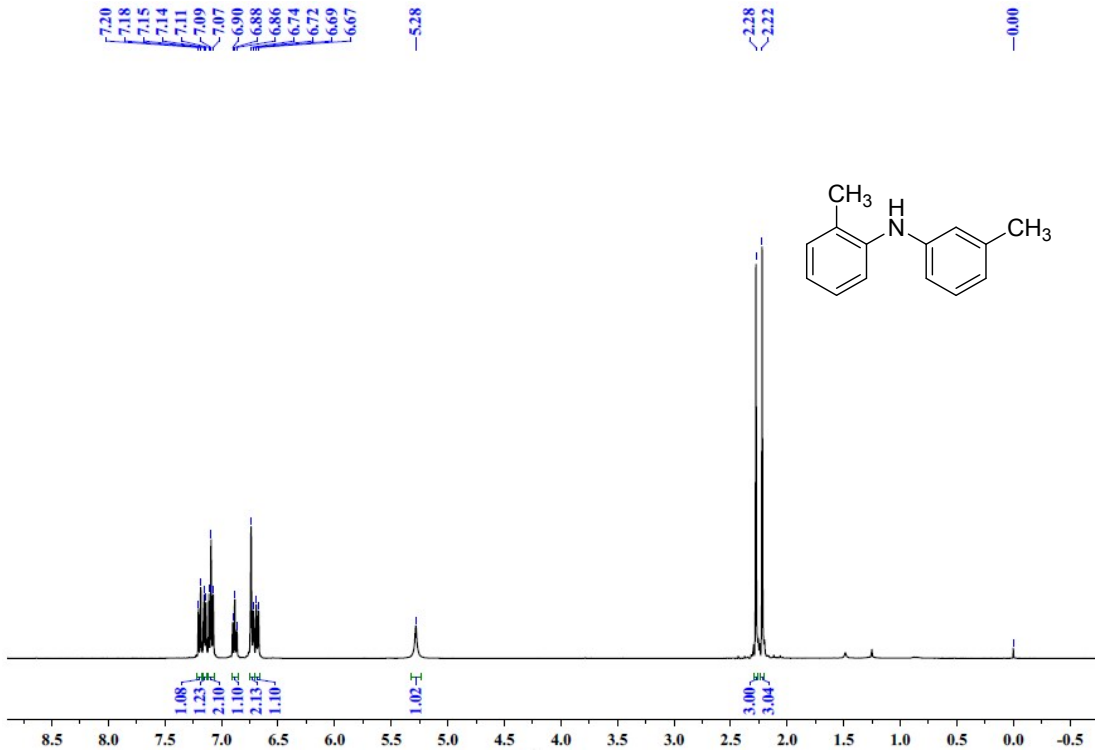
0.5
0.0
-0.5

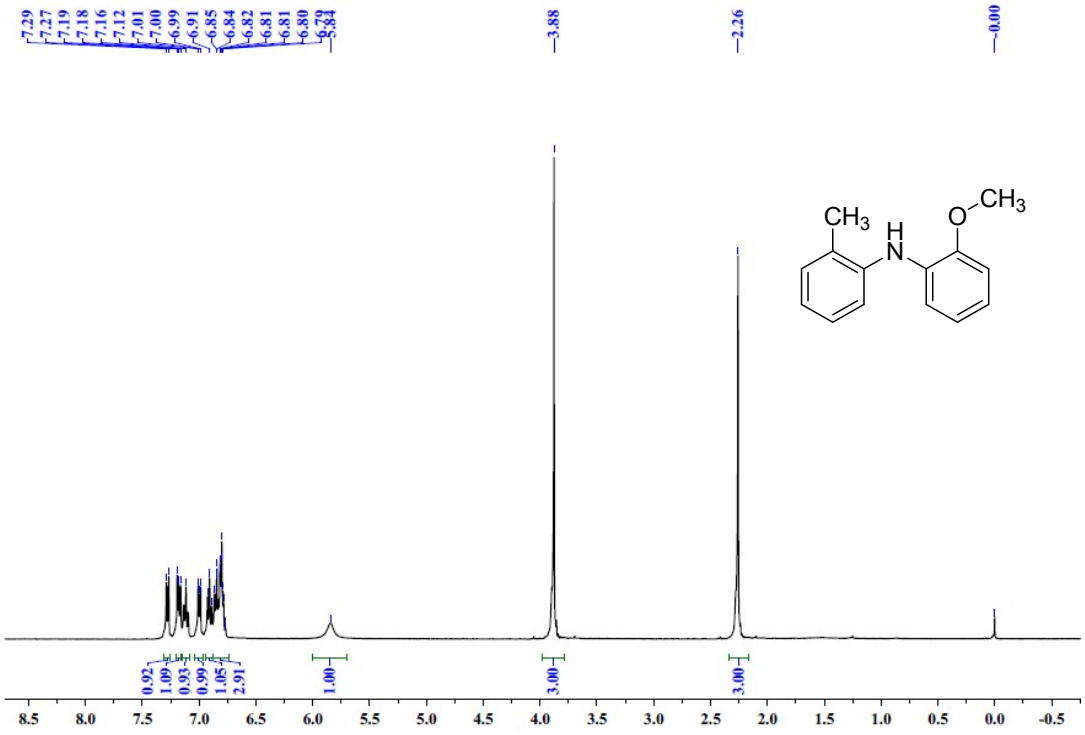
^{1}H NMR


8.20
8.19
7.36
7.34
7.27
7.25
7.24
6.59
6.58
6.57
6.56
6.51
6.49
3.46
0.00
N
N
CH3
1.00
1.99
3.08
1.02
0.96
0.97
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

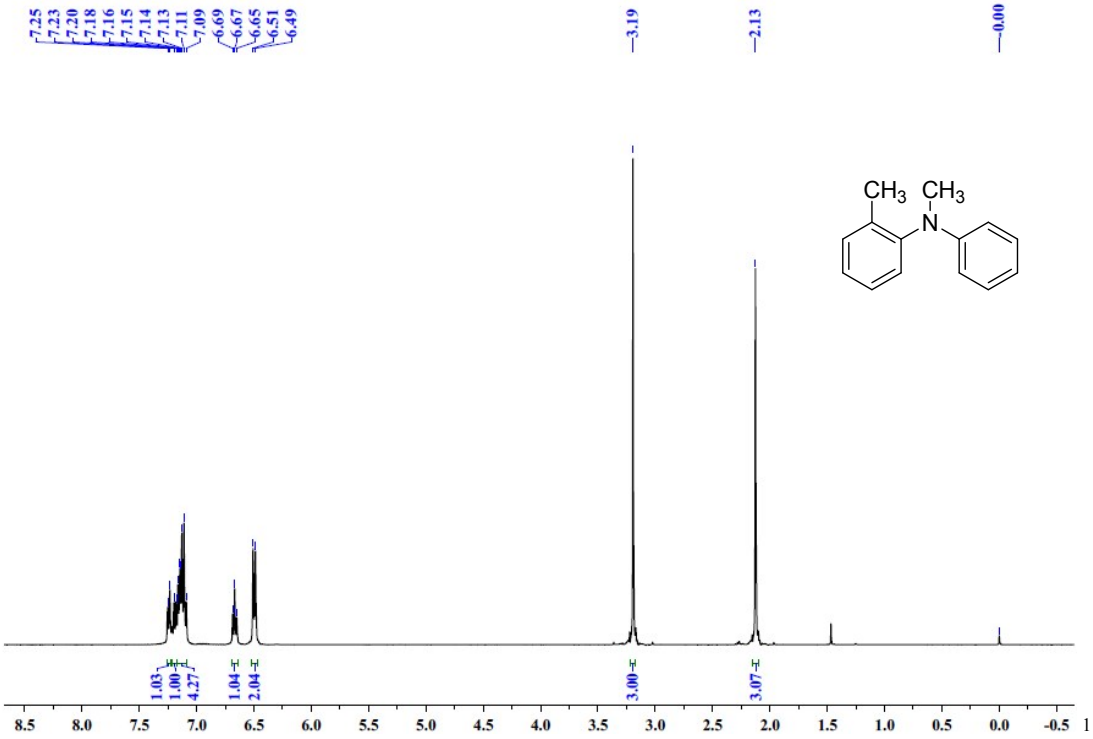
^{1}H NMR


7.20
7.18
7.15
7.14
7.11
7.09
7.07
6.90
6.88
6.86
6.74
6.72
6.69
6.67
5.28
2.28
2.22
0.00
CH3
H
N
CH3
1.08
1.23
2.10
1.10
2.13
1.10
1.02
3.00
3.04
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

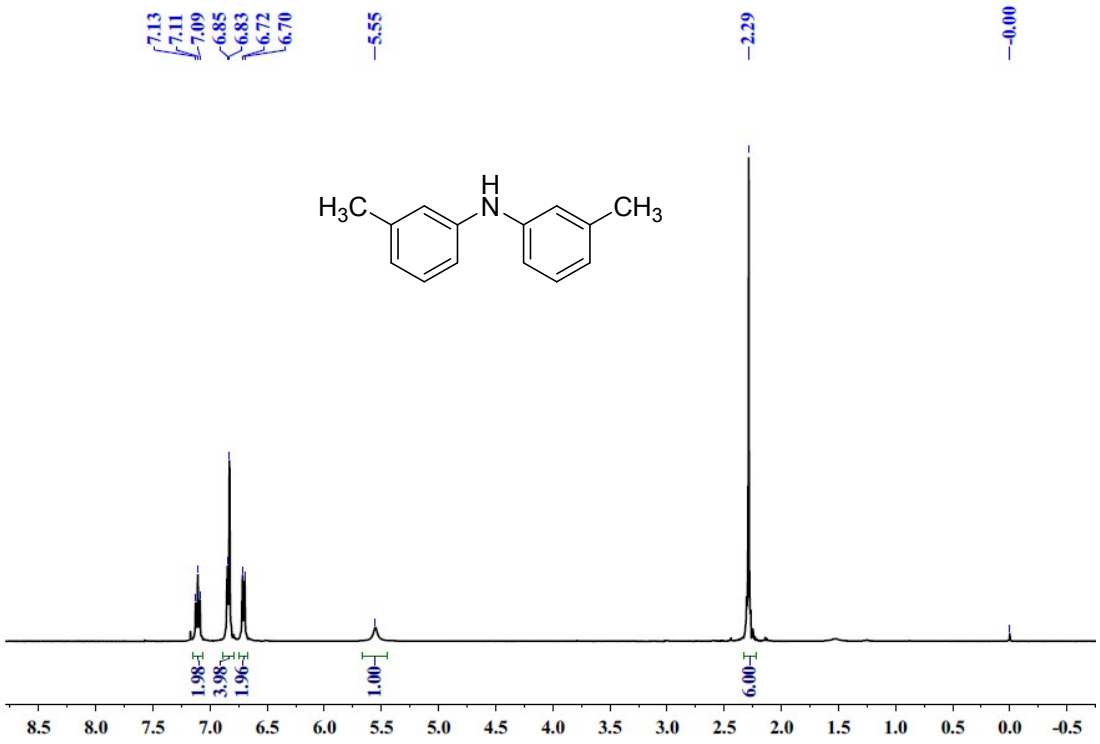
^{1}H NMR


7.29
7.27
7.19
7.18
7.16
7.12
7.01
7.00
6.99
6.91
6.85
6.84
6.82
6.81
6.81
6.80
6.79
3.84
3.88
2.26
0.00
CH3
H
N
O
CH3
0.92
1.09
0.93
0.99
1.05
2.91
1.00
3.00
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

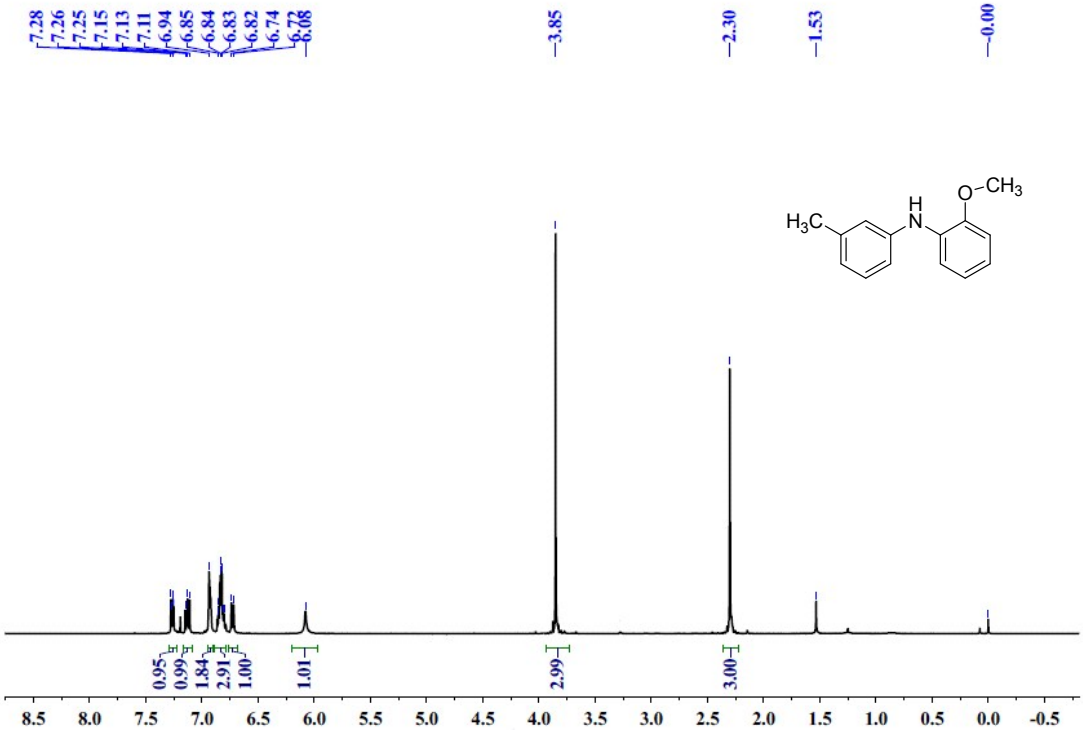
^{1}H NMR


7.25
7.23
7.20
7.18
7.16
7.15
7.14
7.13
7.11
7.09
6.69
6.67
6.65
6.51
6.49
3.19
2.13
0.00
CH3
CH3
N
1.03
1.00
4.27
1.04
2.04
3.00
3.07
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

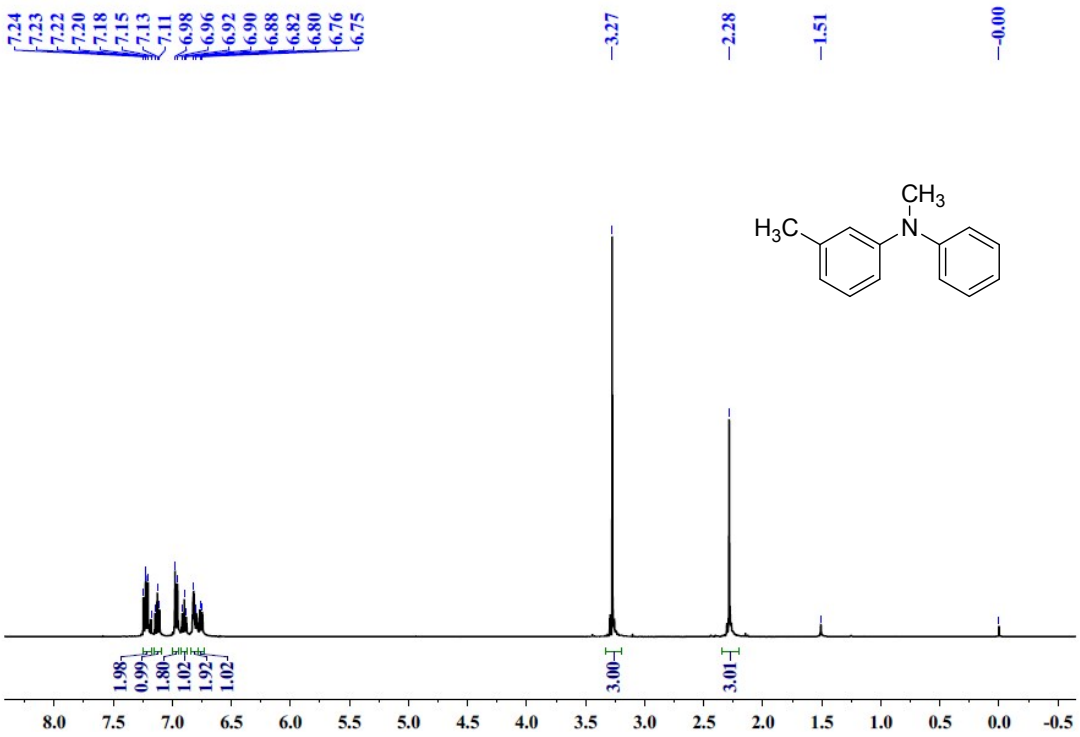
H NMR


7.13
7.11
7.09
6.85
6.83
6.72
6.70
5.55
2.29
0.00
H
N
H3C
CH3
1.98
3.98
1.96
1.00
6.00
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

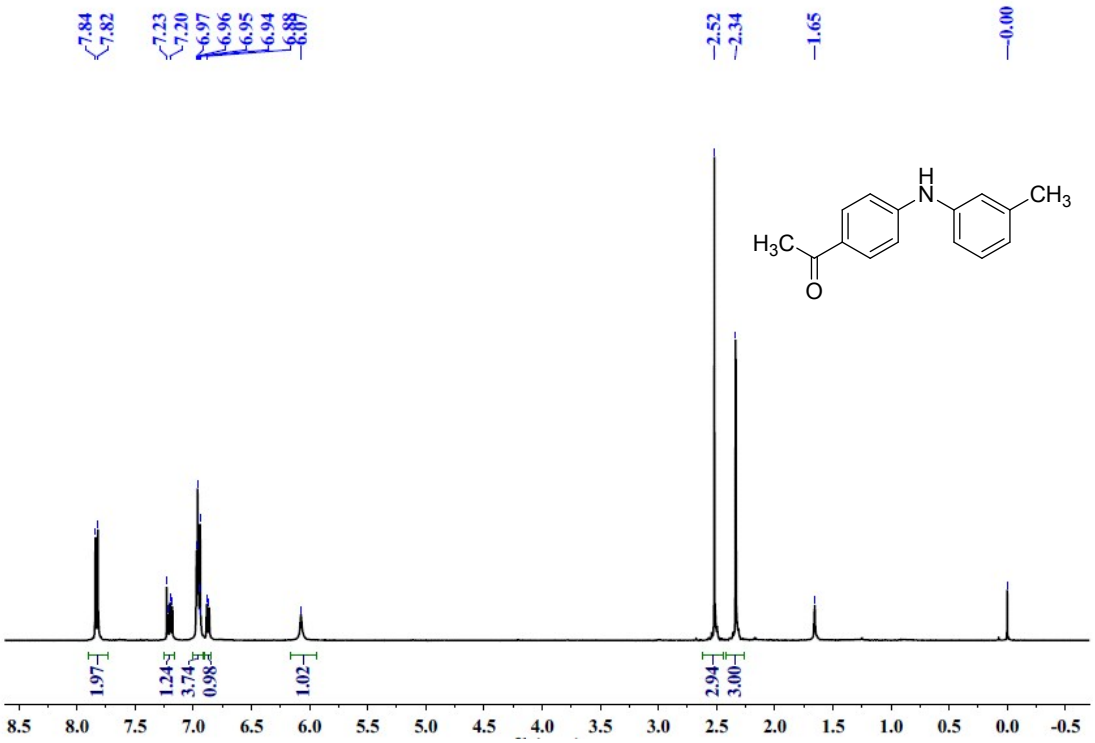
^{1}H NMR


7.28
7.26
7.25
7.15
7.13
7.11
6.94
6.85
6.84
6.83
6.82
6.74
6.72
6.08
3.85
2.30
1.53
0.00
H
N
H3C
O
CH3
0.95
0.99
1.84
2.91
1.00
1.01
2.99
3.00
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

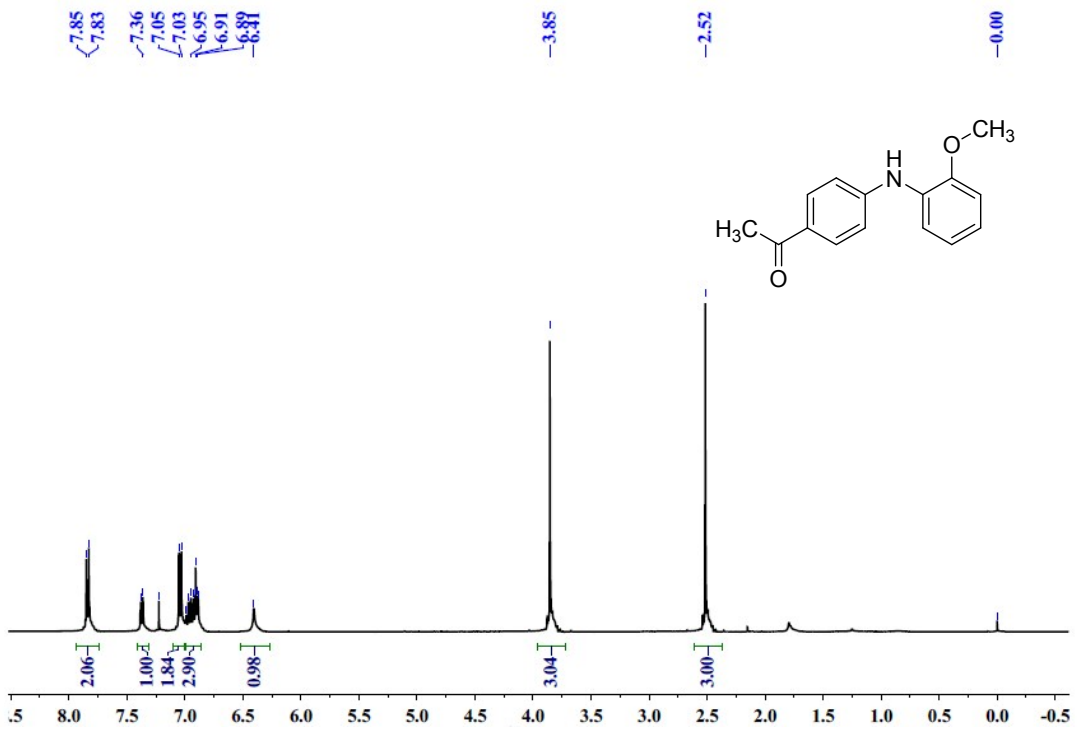
^{1}H NMR


7.24
7.23
7.22
7.20
7.18
7.15
7.13
7.11
6.98
6.96
6.92
6.90
6.88
6.82
6.80
6.76
6.75
3.27
2.28
1.51
0.00
CH3
H3C
N
1.98
0.99
1.80
1.02
1.92
1.02
3.00
3.01
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

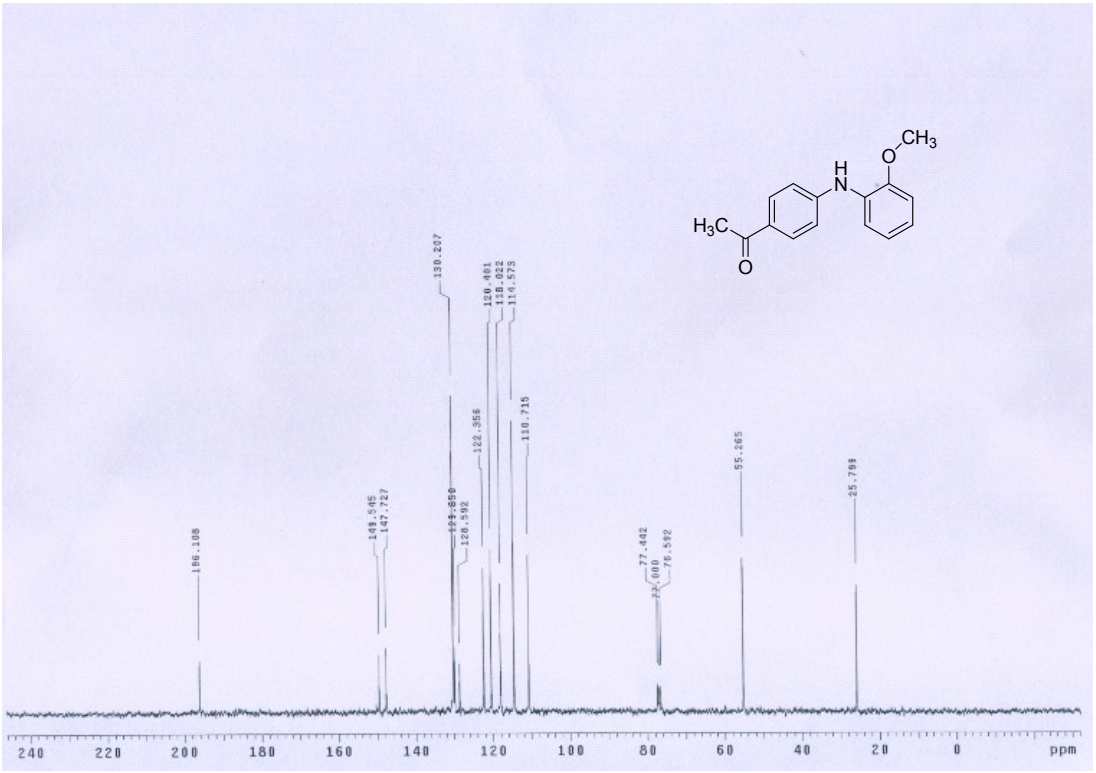
^{1}H NMR


7.84
7.82
7.23
7.20
6.97
6.96
6.95
6.94
6.88
6.87
2.52
2.34
1.65
0.00
H
N
CH3
H3C
O
1.97
1.24
3.74
0.98
1.02
2.94
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

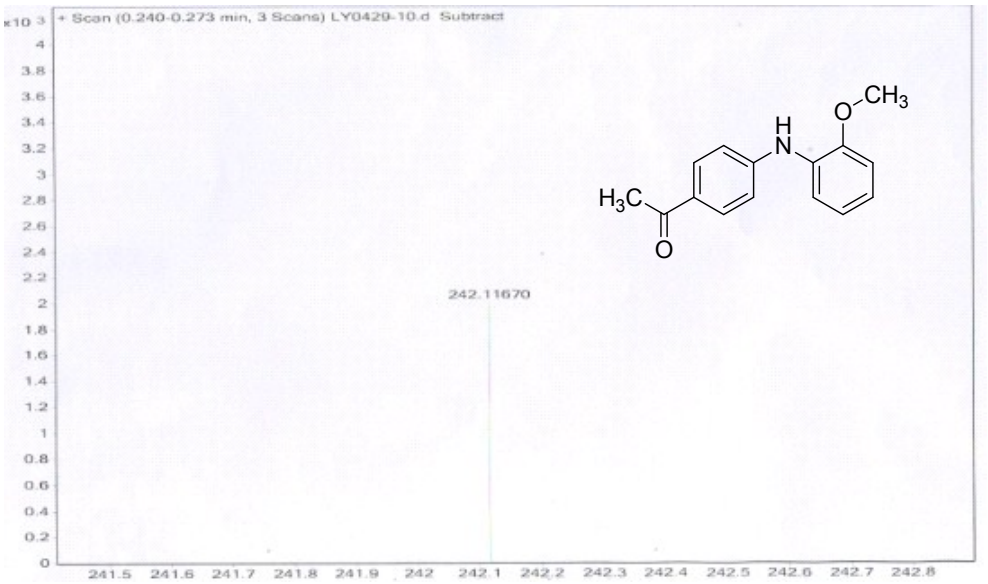
^{1}H NMR



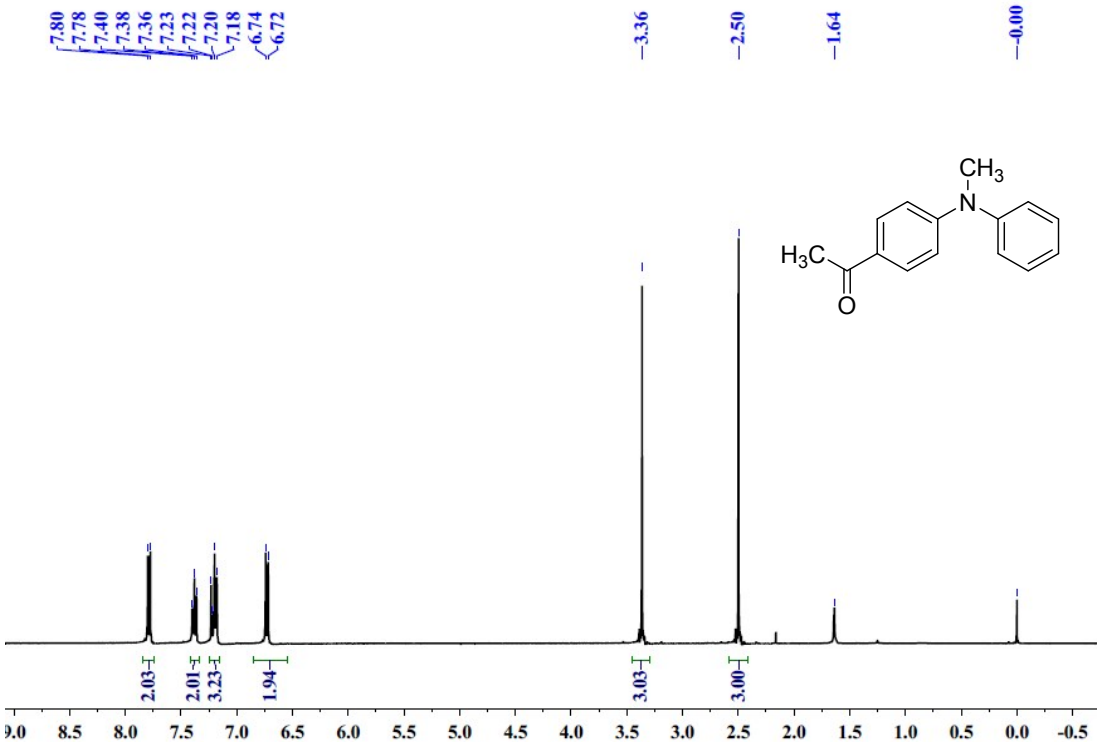
^{1}H NMR



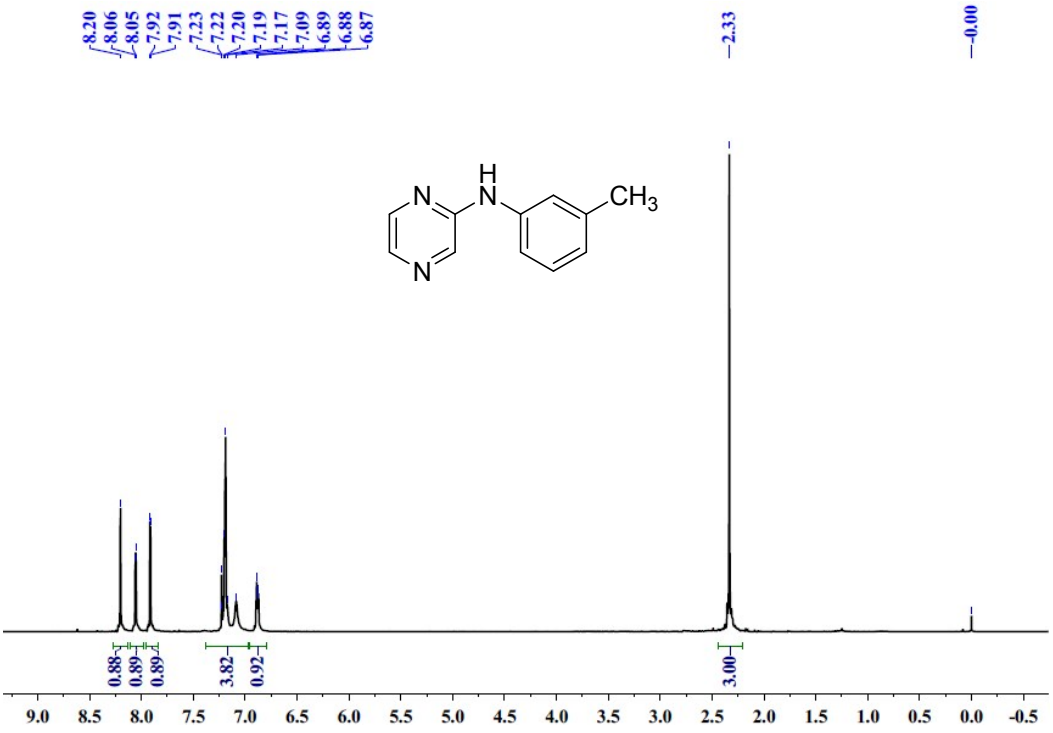
^{13}C NMR


+ Scan (0.240-0.273 min, 3 Scans) LY0429-10.d Subtract
242.11670
241.5 241.6 241.7 241.8 241.9 242 242.1 242.2 242.3 242.4 242.5 242.6 242.7 242.8

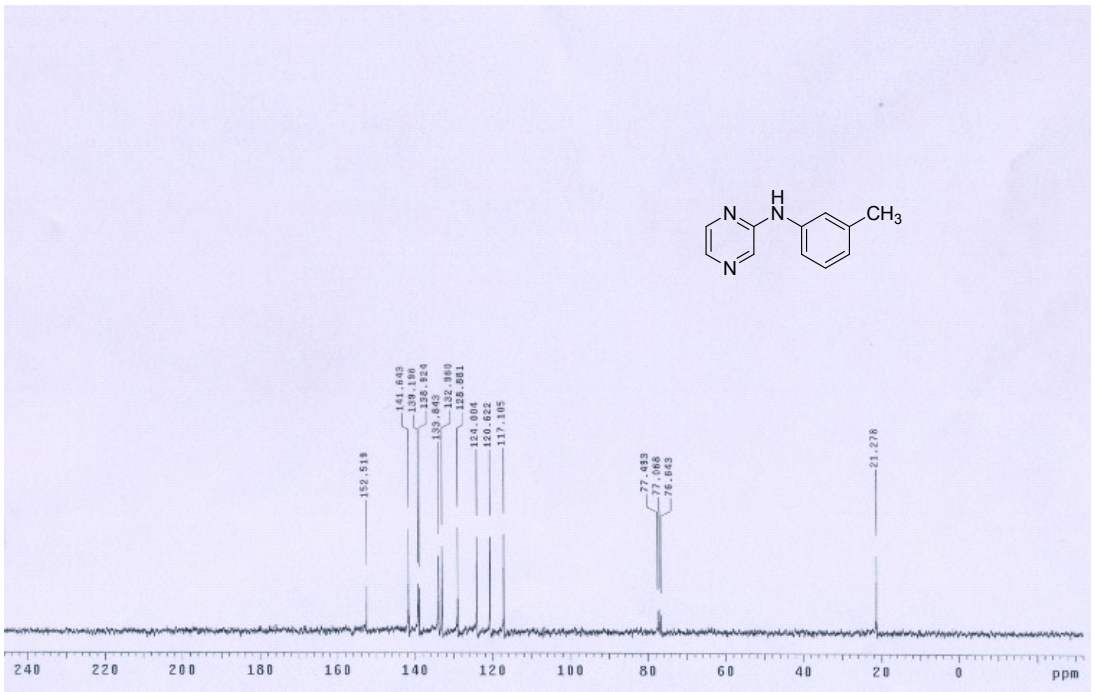
HRMS


7.80
7.78
7.40
7.38
7.36
7.23
7.22
7.20
7.18
6.74
6.72
3.36
2.50
1.64
0.00
2.03
2.01
3.23
1.94
3.03
3.00

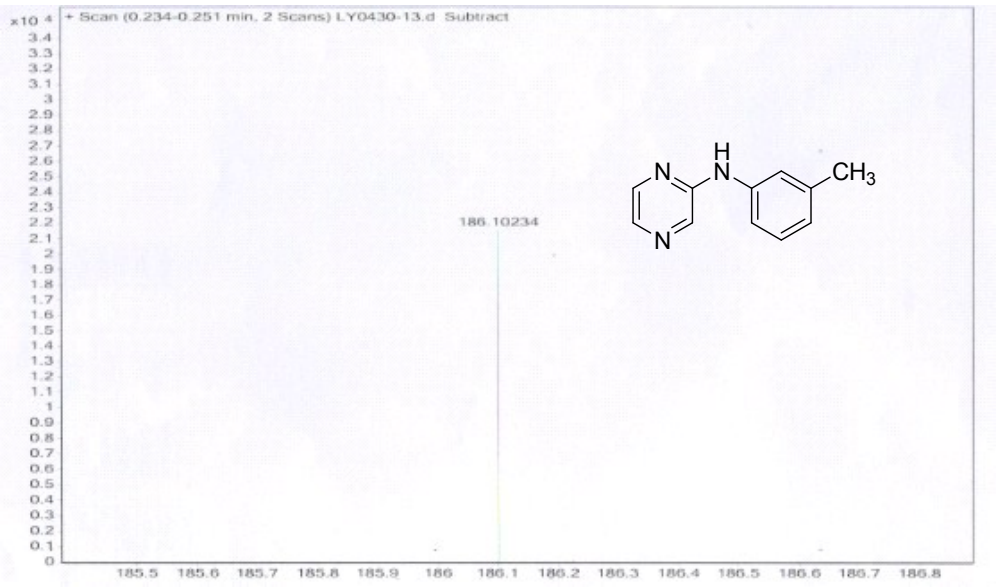
^{1}H NMR


8.20
8.06
8.05
7.92
7.91
7.23
7.22
7.20
7.19
7.17
7.09
6.89
6.88
6.87
2.33
0.00
0.88
0.89
0.89
3.82
0.92
3.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

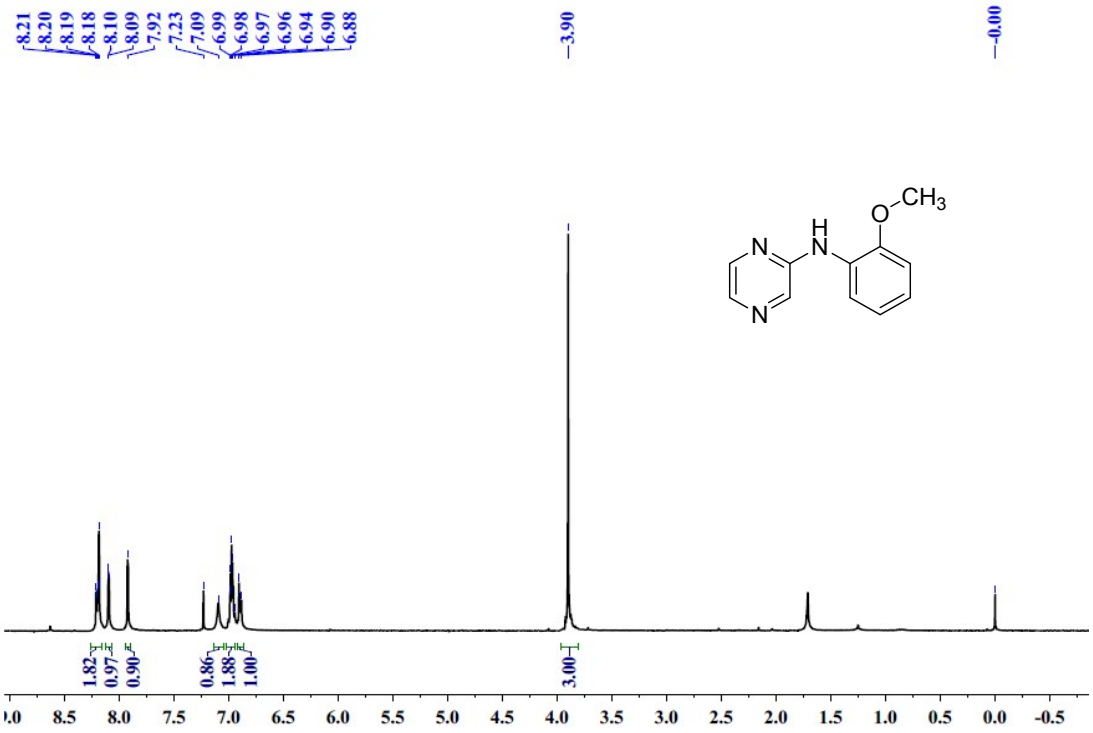
^{1}H NMR


152.519
141.643
139.196
136.924
133.843
132.980
128.881
124.004
120.622
117.105
77.493
77.068
76.643
21.276
240 220 200 180 160 140 120 100 80 60 40 20 0 ppm

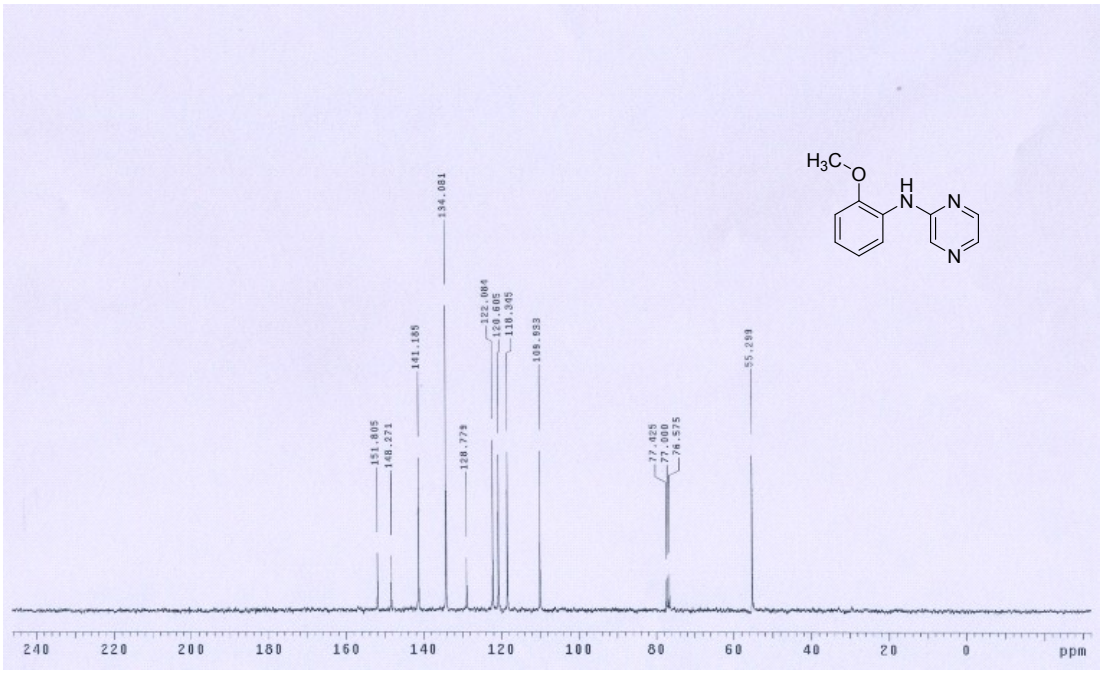
^{3}C NMR


+ Scan (0.234-0.251 min, 2 Scans) LY0430-13.d Subtract
186.10234
H
N
N
N
CH3

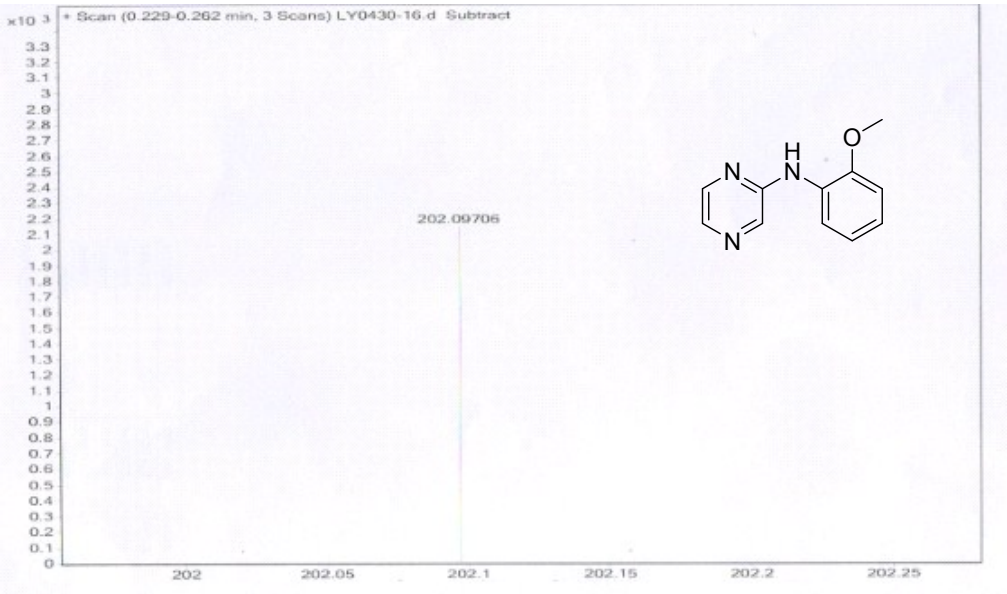
HRMS


8.21
8.20
8.19
8.18
8.10
8.09
7.92
7.23
7.09
6.99
6.98
6.97
6.96
6.94
6.90
6.88
3.90
0.00
O
CH3
H
N
N
N
1.82
0.97
0.90
0.86
1.88
1.00
3.00

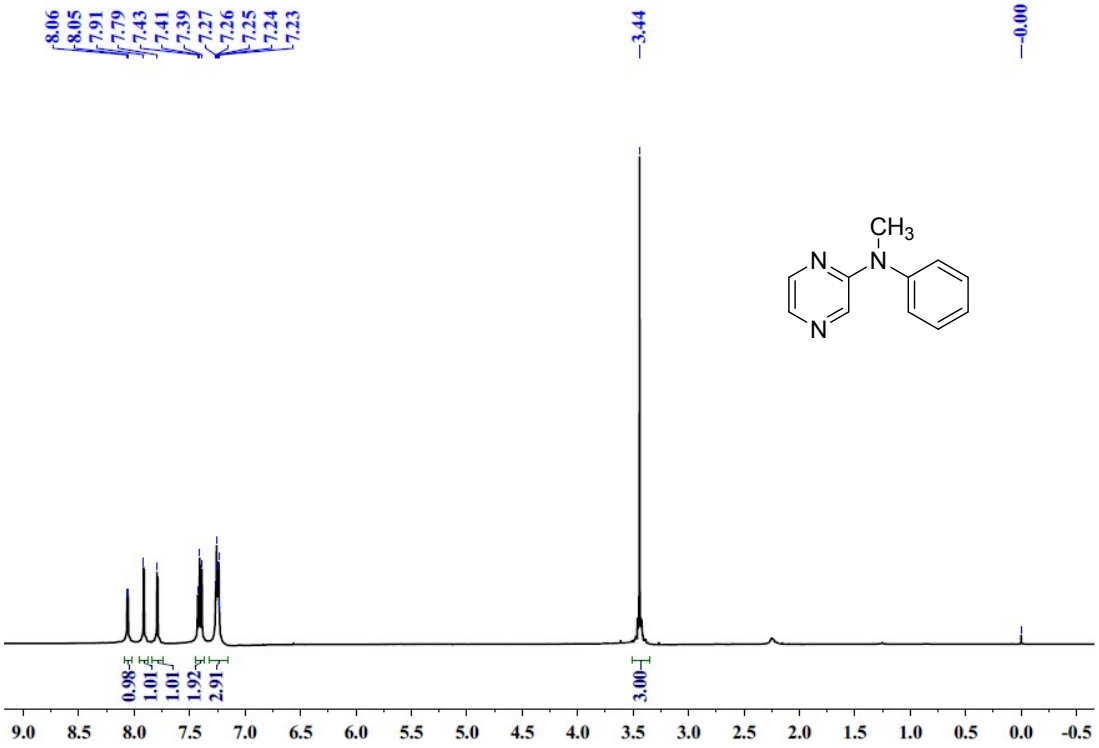
^{1}H NMR


151.805
148.271
141.165
134.081
130.779
122.004
120.605
110.345
109.693
77.425
77.000
76.575
55.259
240
220
200
180
160
140
120
100
80
60
40
20
0
ppm

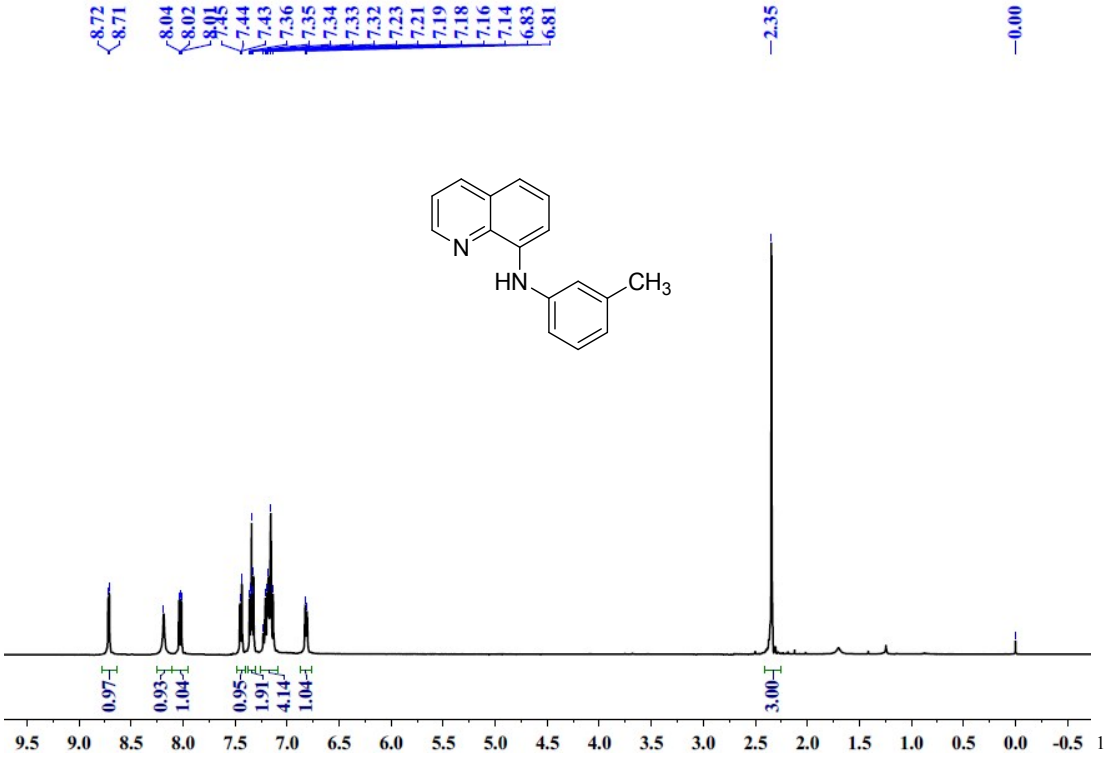
^{13}C NMR


x10 3
+ Scan (0.229-0.262 min, 3 Scans) LY0430-16.d Subtract
202.09706
202
202.05
202.1
202.15
202.2
202.25

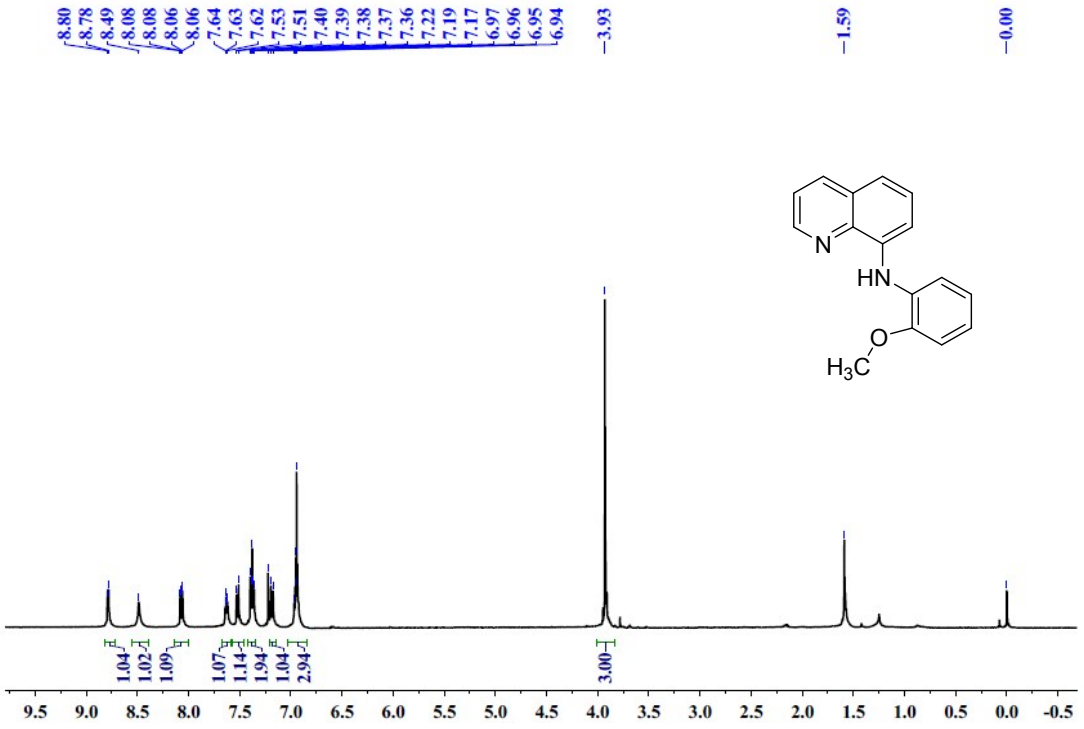
HRMS


8.06
8.05
7.91
7.79
7.43
7.41
7.39
7.27
7.26
7.25
7.24
7.23
3.44
0.00
CH3
N
N
N
0.98
1.01
1.01
1.92
2.91
3.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

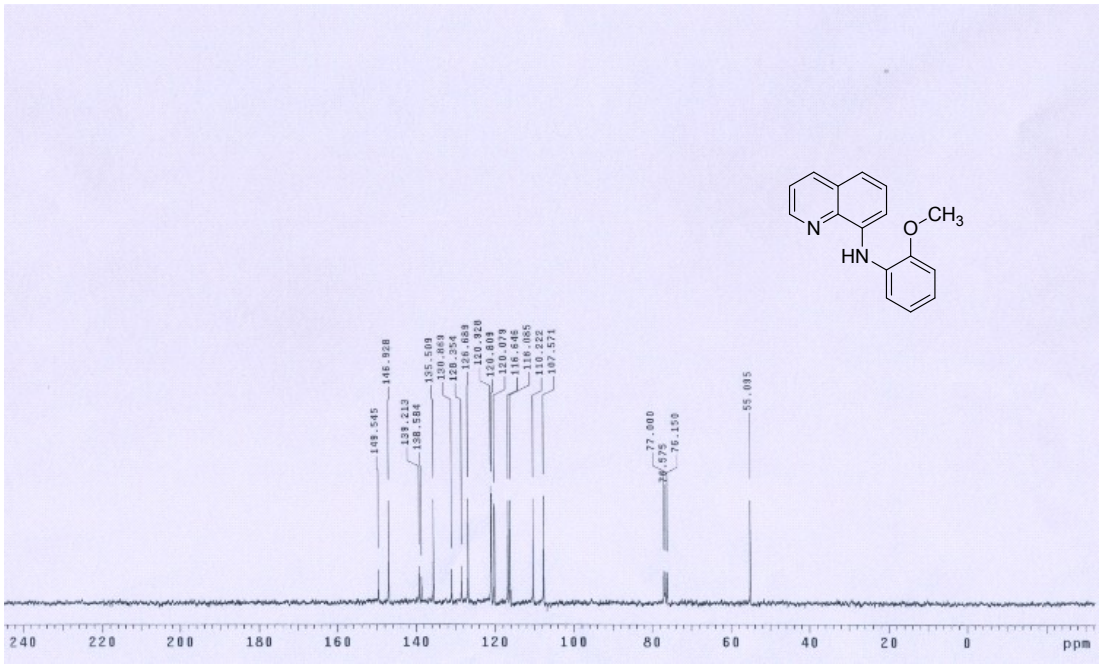
^{1}H NMR


8.72
8.71
8.04
8.02
7.44
7.43
7.36
7.35
7.34
7.33
7.32
7.23
7.21
7.19
7.18
7.16
7.14
6.83
6.81
2.35
0.00
N
HN
CH3
0.97
0.93
1.04
0.95
1.91
4.14
1.04
3.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

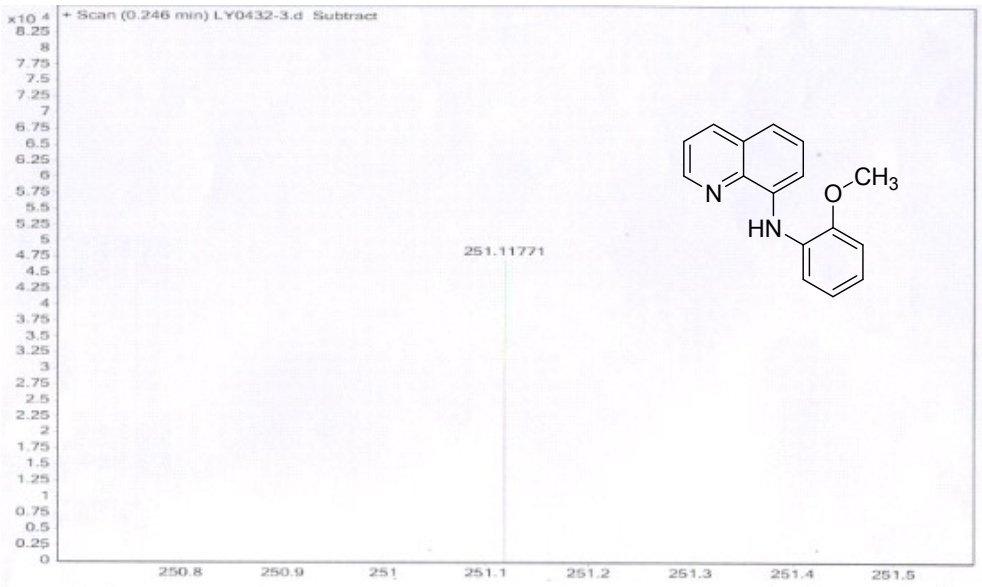
H NMR



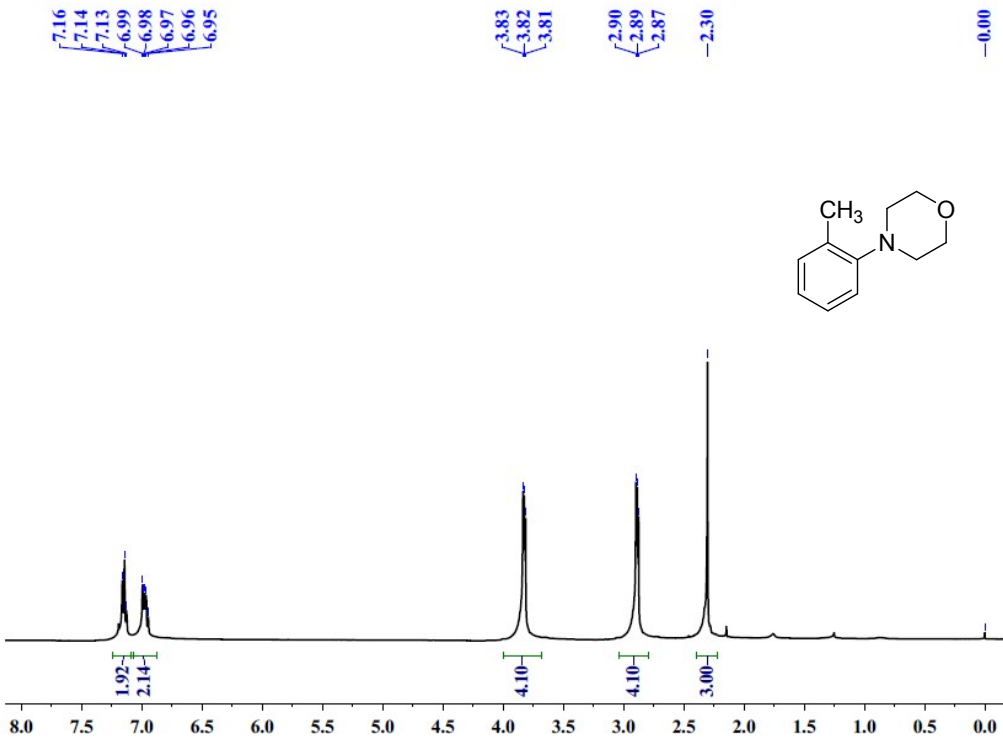
^{1}H NMR



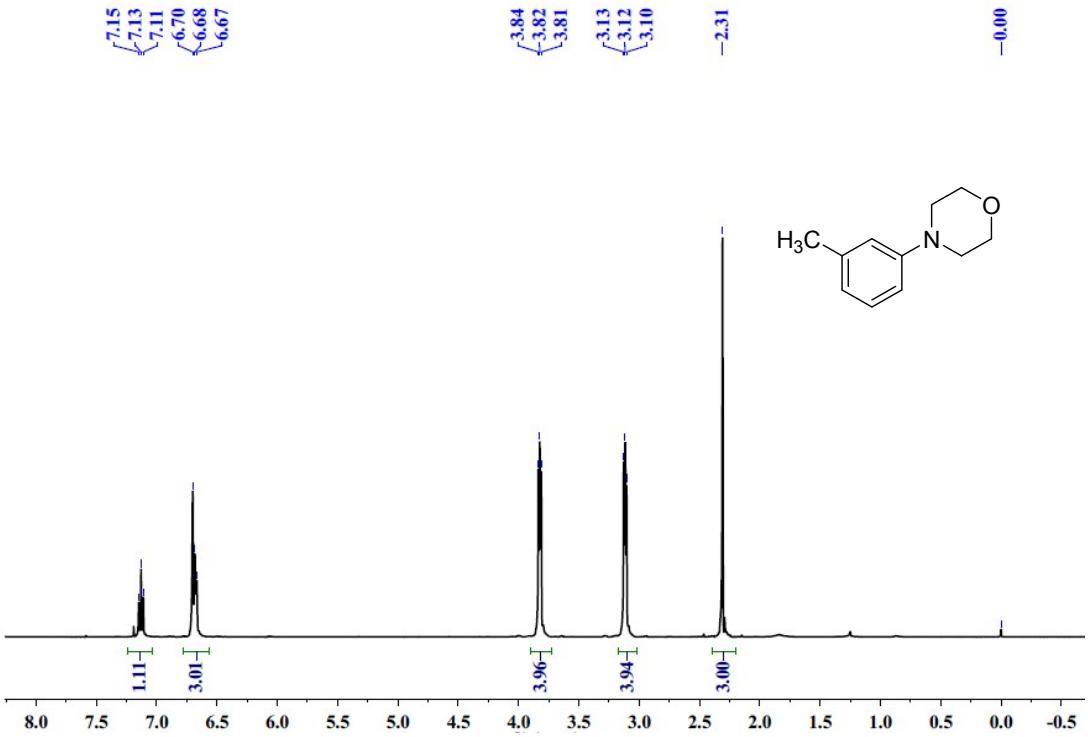
^{13}C NMR


+ Scan (0.246 min) LY0432-3.d Subtract
x10 4
251.11771
N
HN
O
CH3

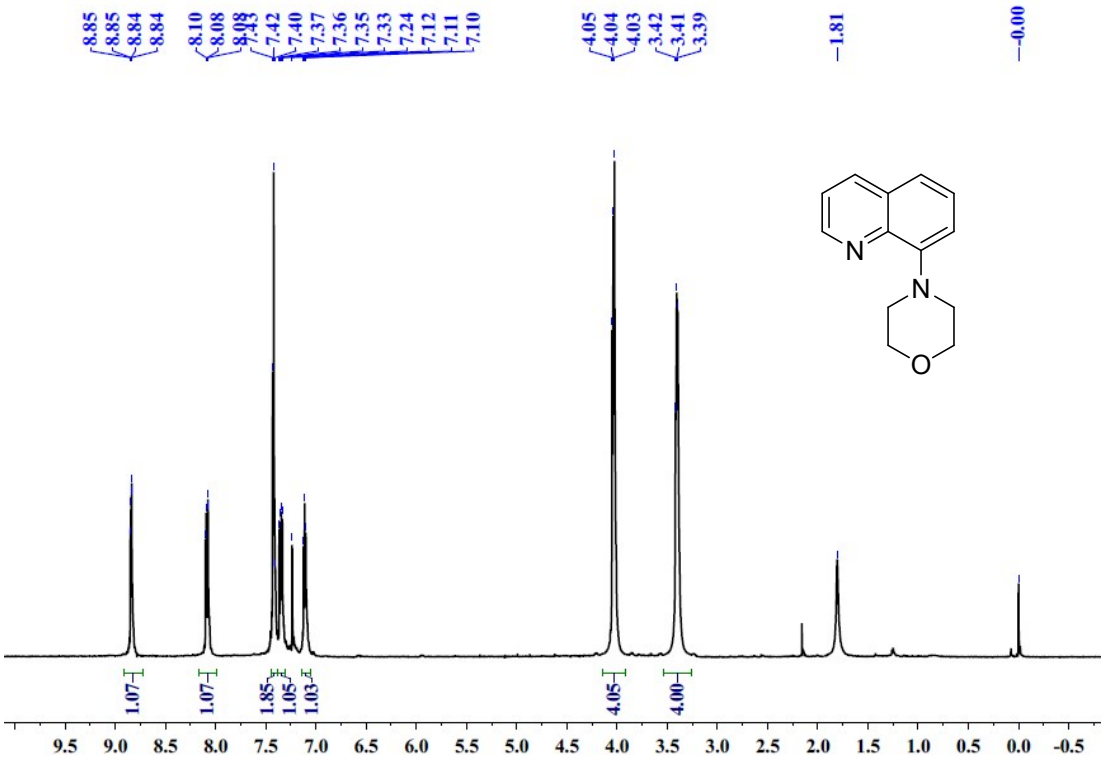
HRMS


7.16
7.14
7.13
6.99
6.98
6.97
6.96
6.95
3.83
3.82
3.81
2.90
2.89
2.87
2.30
0.00
CH3
N
O
1.92
2.14
4.10
4.10
3.00

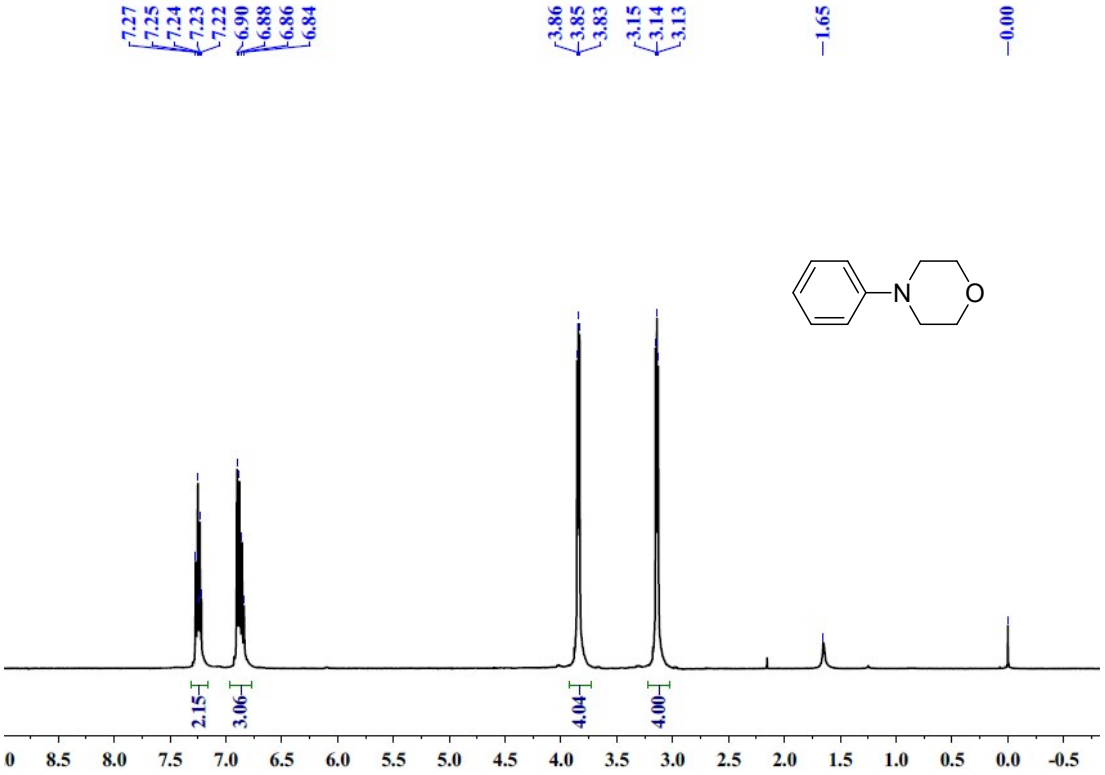
H NMR


7.15
7.13
7.11
6.70
6.68
6.67
3.84
3.82
3.81
3.13
3.12
3.10
2.31
0.00
H3C
N
O
1.11
3.01
3.96
3.94
3.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

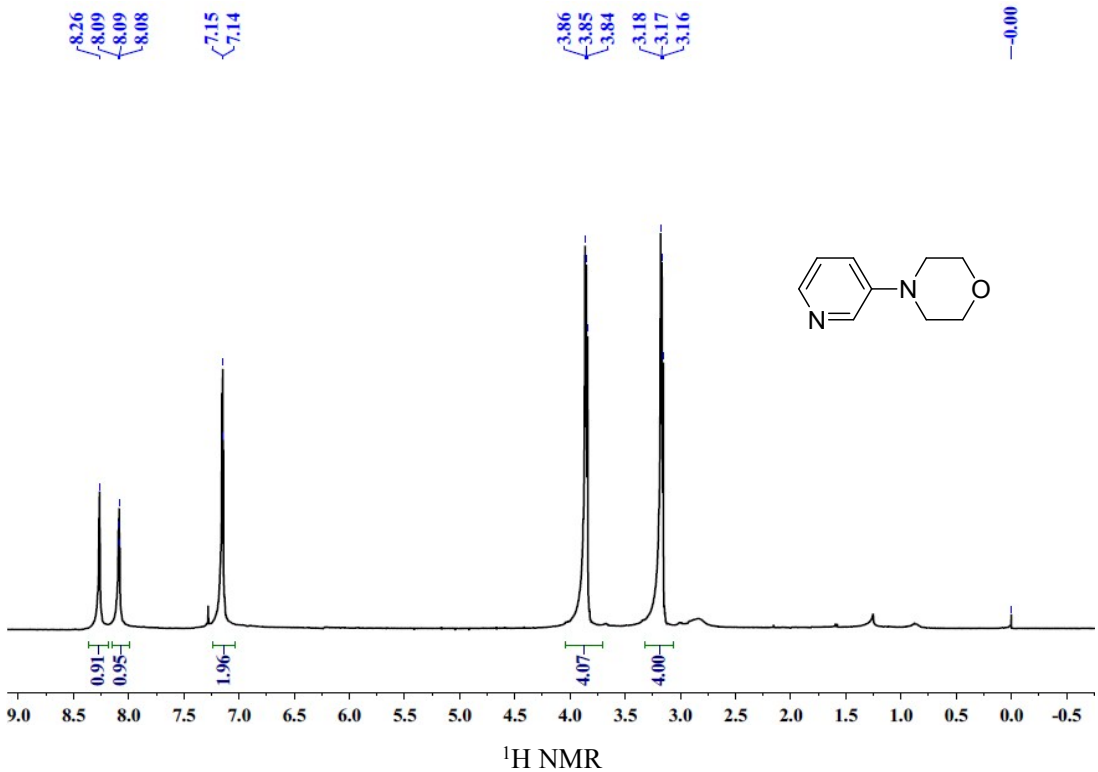
^{1}H NMR


8.85
8.85
8.84
8.84
8.10
8.08
8.08
7.43
7.42
7.40
7.37
7.36
7.35
7.33
7.24
7.12
7.11
7.10
4.05
4.04
4.03
3.42
3.41
3.39
1.81
0.00
N
N
O
1.07
1.07
1.85
1.05
1.03
4.05
4.00
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

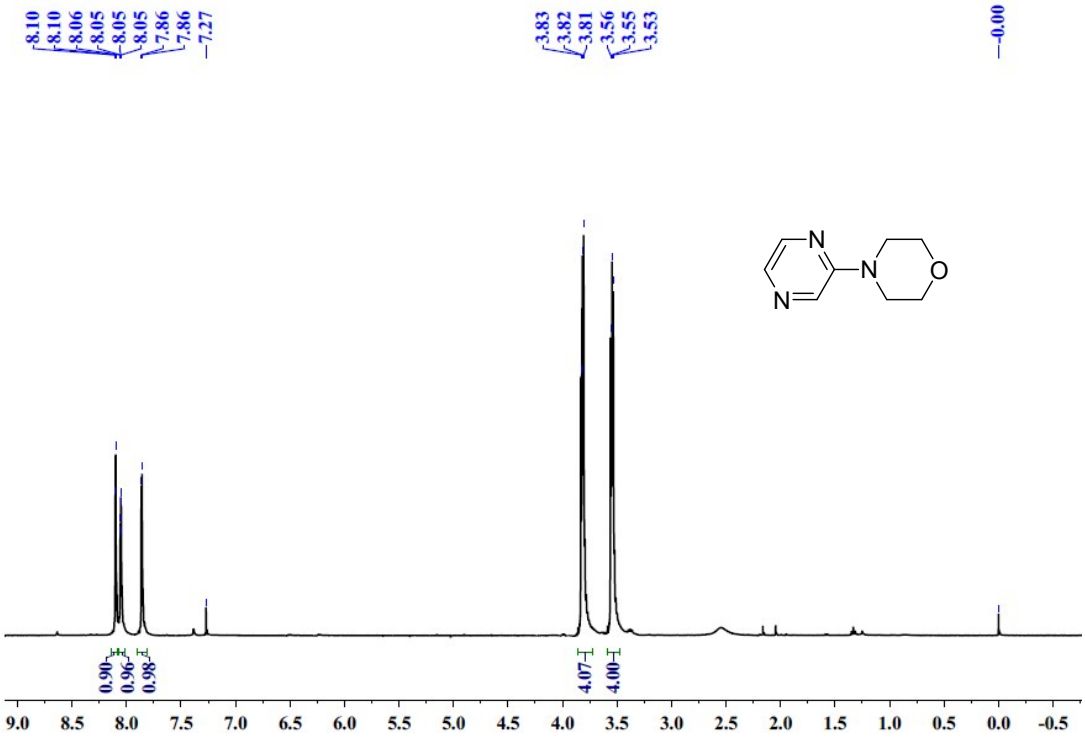
^{1}H NMR


7.27
7.25
7.24
7.23
7.22
6.90
6.88
6.86
6.84
3.86
3.85
3.83
3.15
3.14
3.13
1.65
0.00
N
O
2.15
3.06
4.04
4.00
0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

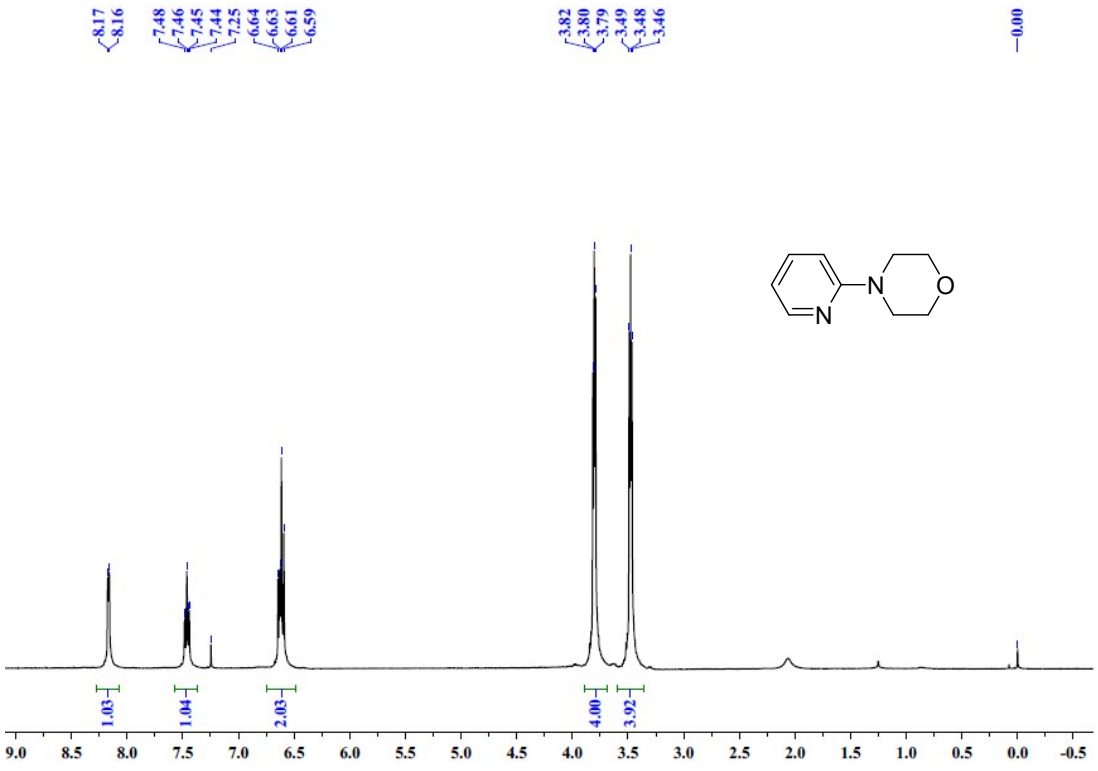
^{1}H NMR


8.26
8.09
8.09
8.08
7.15
7.14
3.86
3.85
3.84
3.18
3.17
3.16
0.00
N
N
O
0.91
0.95
1.96
4.07
4.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

^{1}H NMR


8.10
8.10
8.06
8.05
8.05
8.05
7.86
7.86
7.27
3.83
3.82
3.81
3.56
3.55
3.53
0.00
N
N
N
O
0.90
0.96
0.98
4.07
4.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

^{1}H NMR


8.17
8.16
7.48
7.46
7.45
7.44
7.25
6.64
6.63
6.61
6.59
3.82
3.80
3.79
3.49
3.48
3.46
0.00
N
N
O
1.03
1.04
2.03
4.00
3.92
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

^{1}H NMR

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