Electronic Supplementary Information

Chloride Promoted Room Temperature Preparation of Silver Nanoparticles on Two Dimensional Tungsten Oxide Nanoarchitechtures for the Catalytic of Oxidation of Tertiary N-compounds to N-oxides

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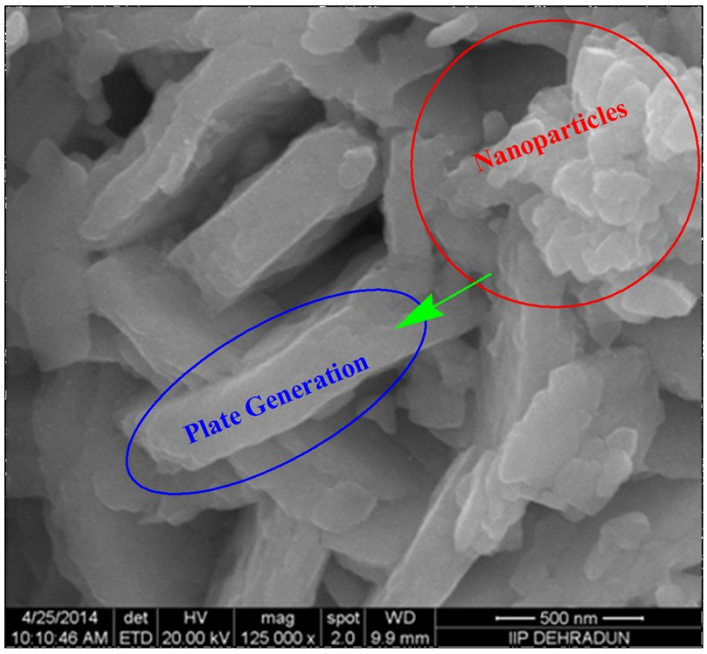


Fig. S1. SEM images of Ag/WO_3 catalyst after 1 h stirring time.

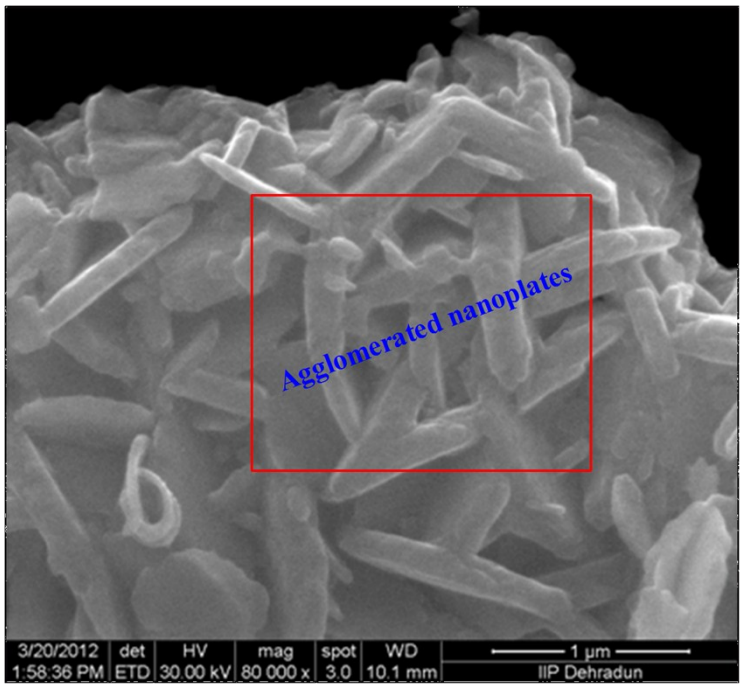


Fig. S2. SEM images of Ag/WO_3 catalyst after 10 hr stirring.

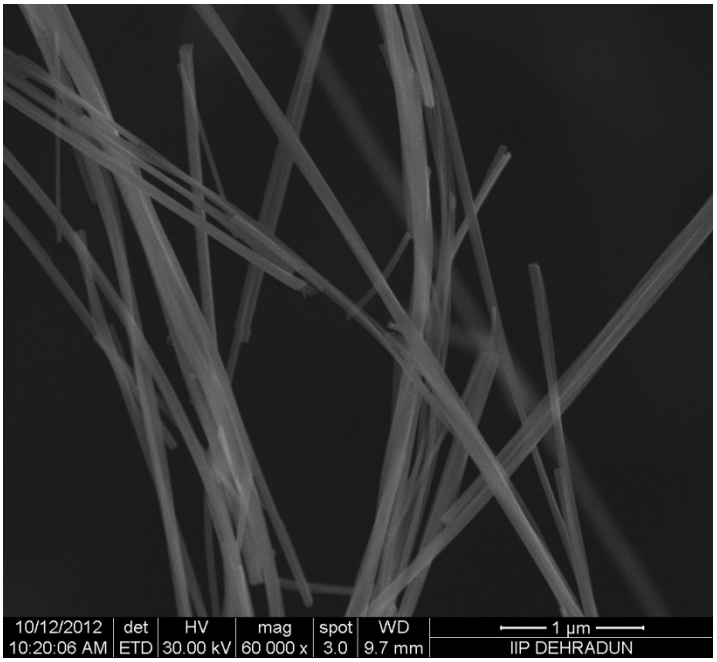


Fig. S3. SEM images of Ag/WO_3 catalyst in a basic solution.

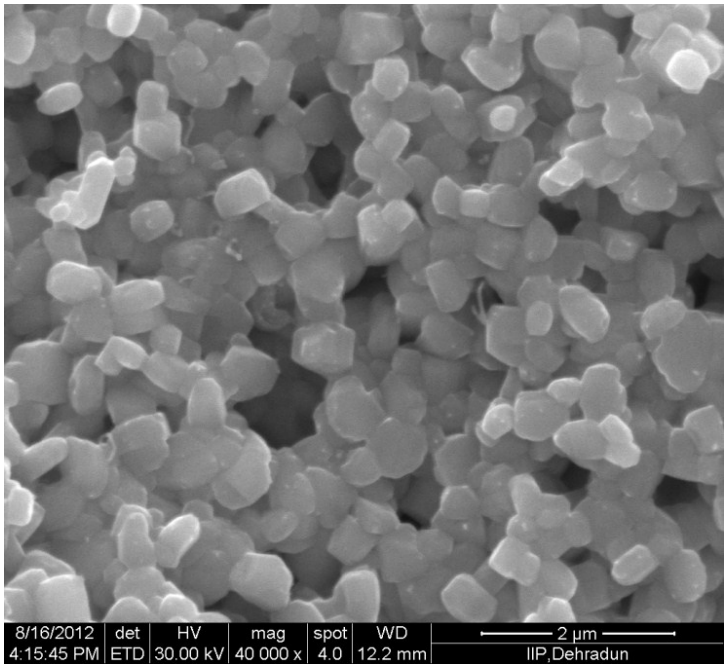


Fig. S4. SEM images of Ag/WO_3 catalyst without addition of chloride.

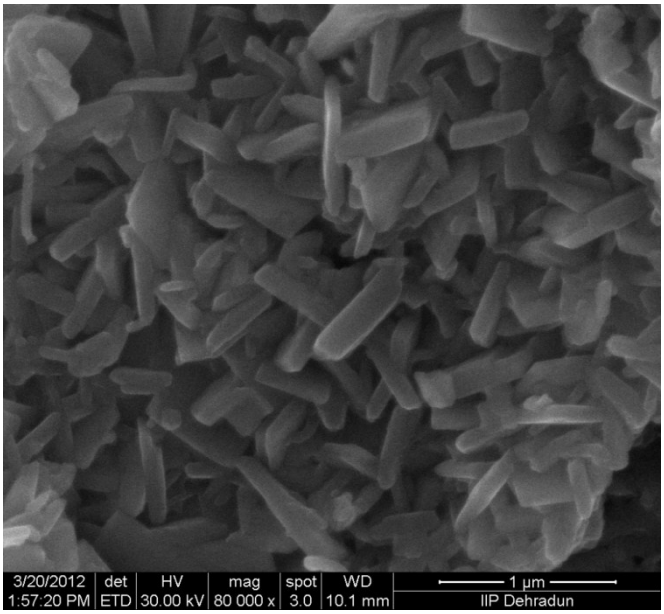


Fig. S5. SEM images of Ag/WO_3 catalyst in HF medium.

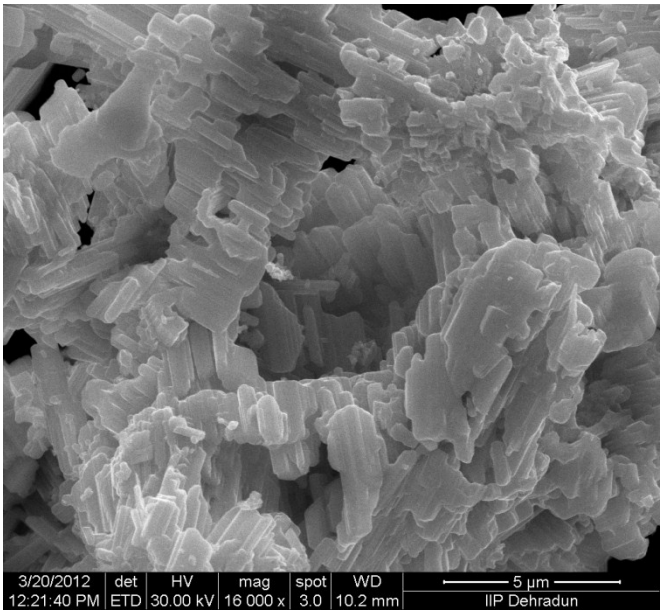


Fig. S6. SEM images of Ag/WO_3 catalyst without addition of CTAB.

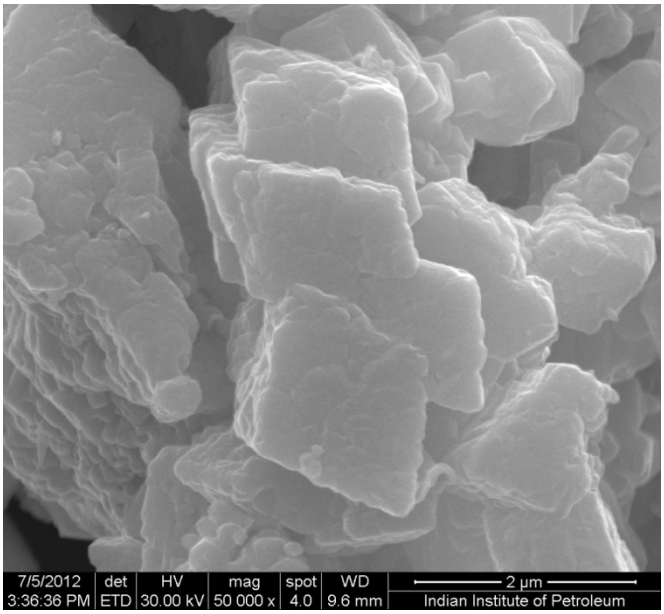


Fig. S7. SEM images of Ag/WO_3 catalyst when Ag: CTAB=1:5.

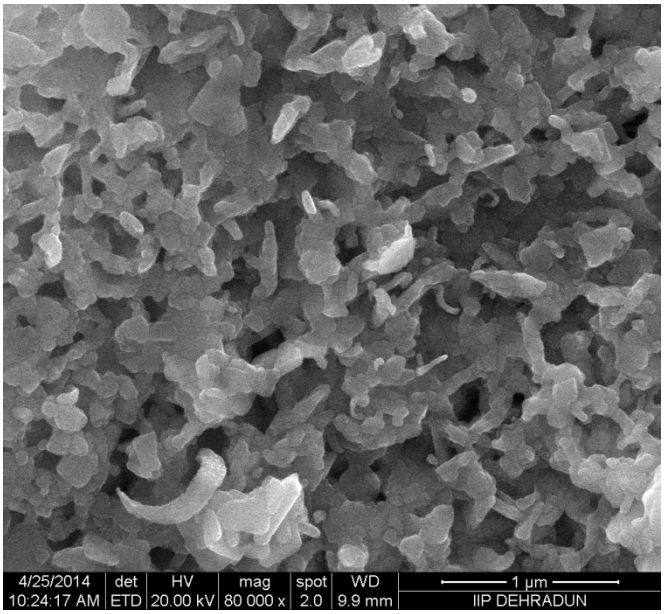


Fig. S8. SEM images of Ag/WO_3 catalyst when Ag: CTAB=1:0.5.

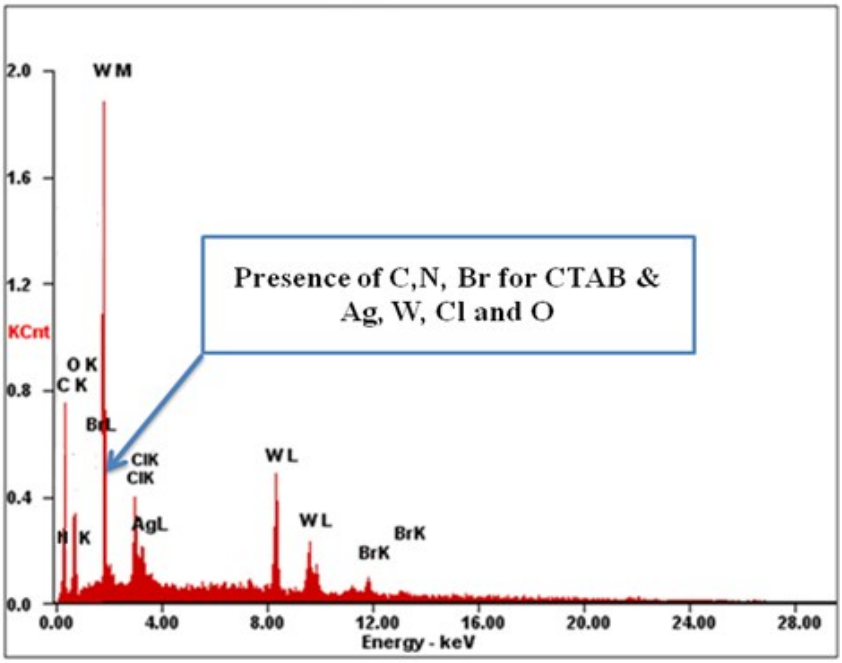


Figure S9. SEM-EDAX of Ag-W catalyst taken in the mid of catalyst preparation.

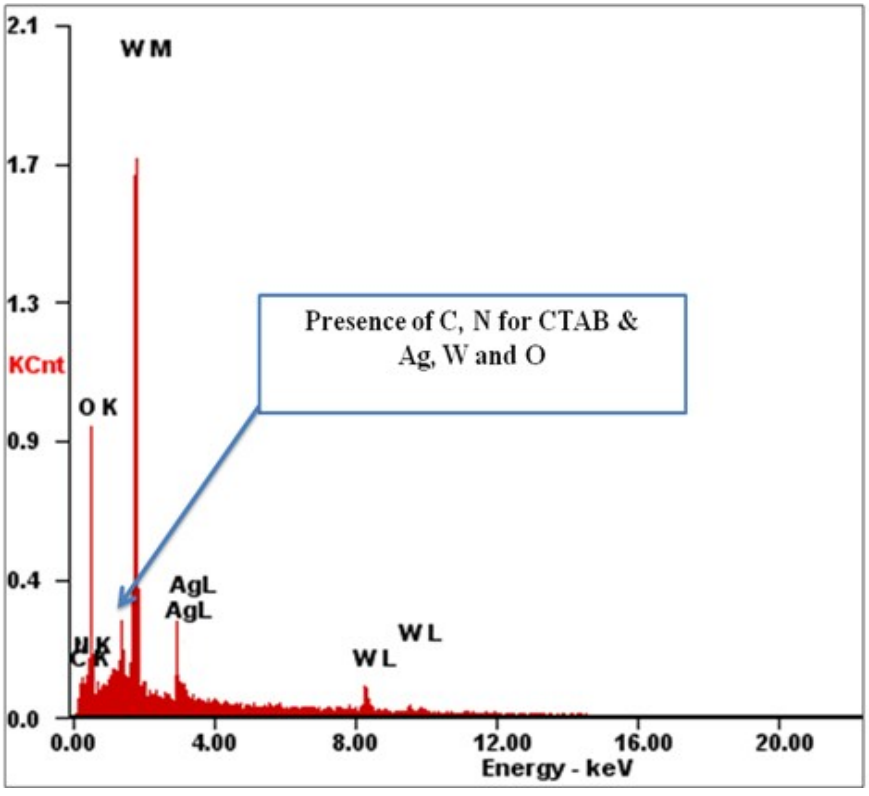


Figure S10. SEM-EDAX of Ag-W catalyst taken just before calcination.

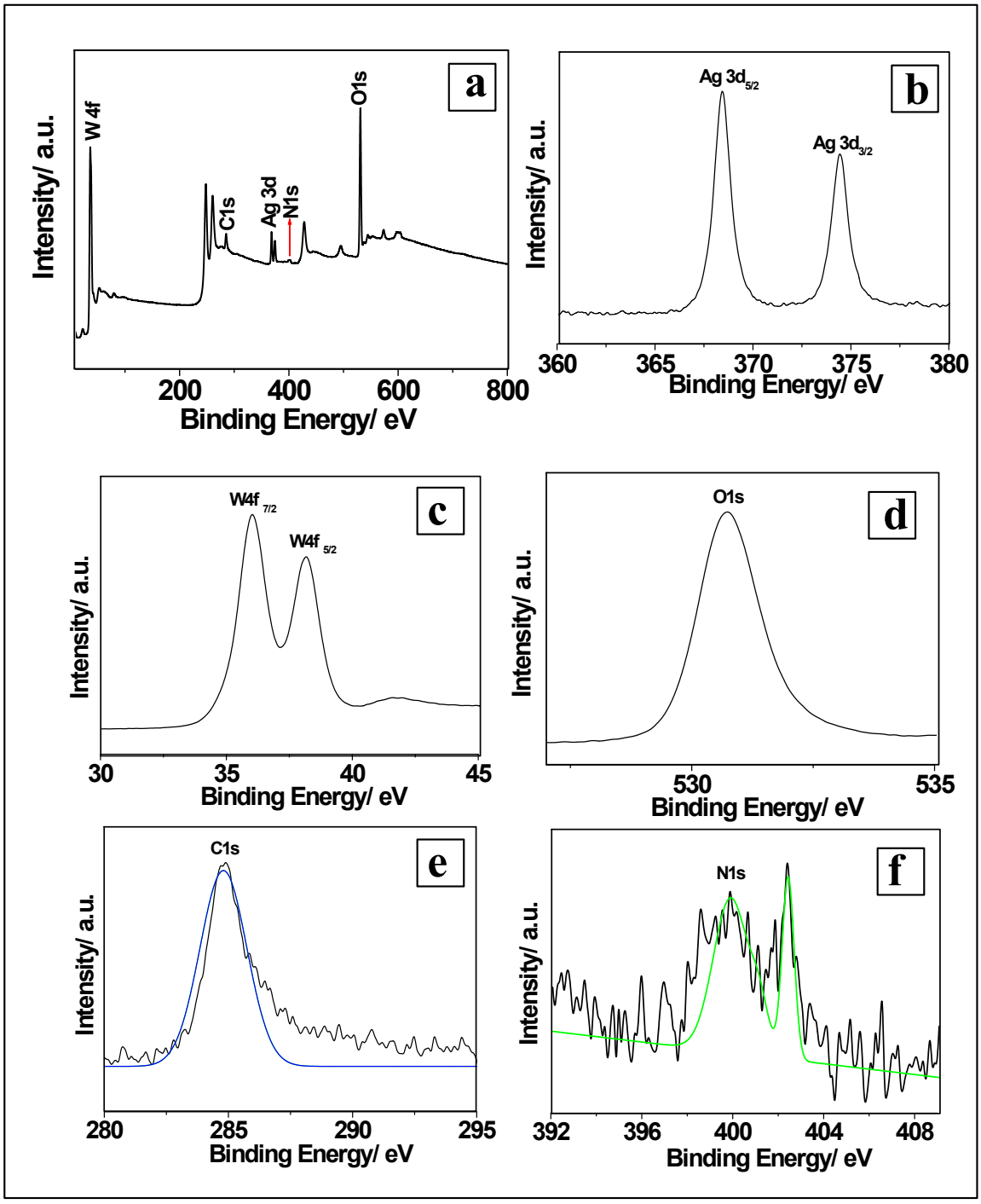


Figure S11. a) XPS survey spectrum of Ag/WO_3 before calcination catalyst, b) Ag 3d, c) W 4f , d) O_{1s} , e) c1s and f) N1s.

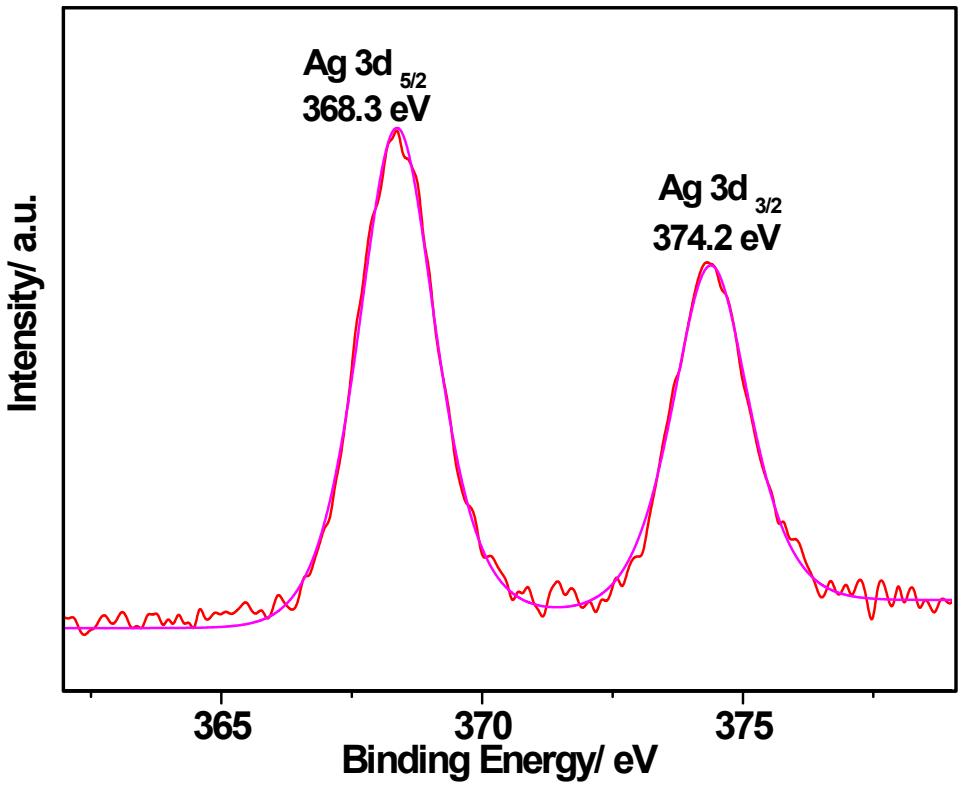


Figure S12. a) XPS of Ag/WO_3 spent catalyst (Ag 3d).

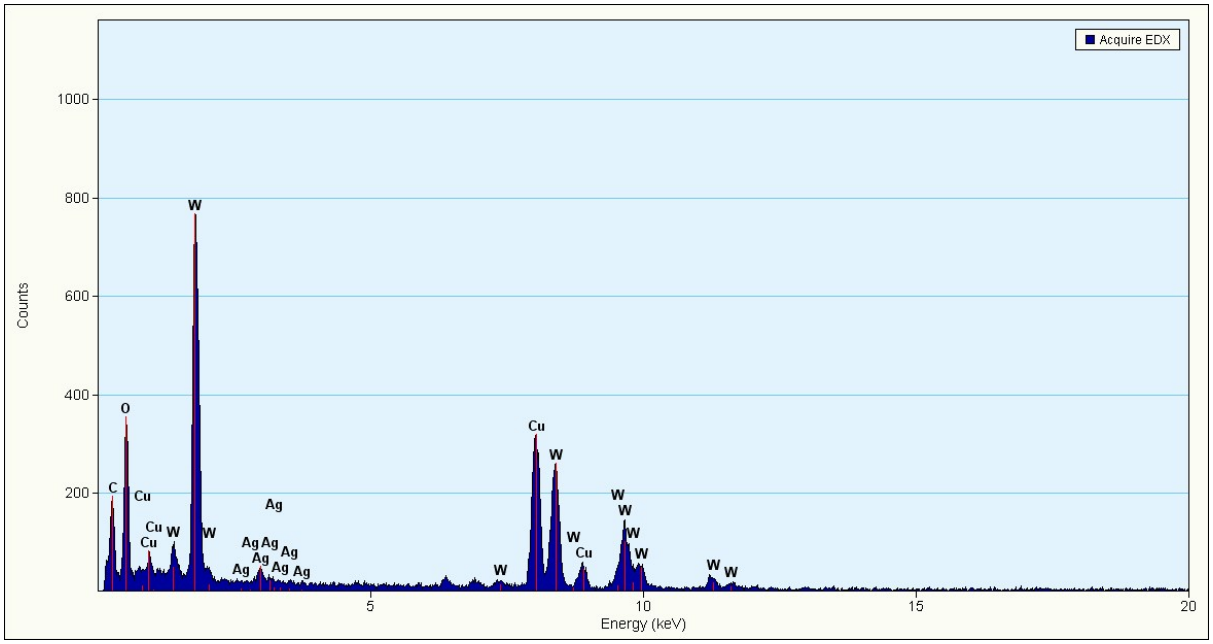


Fig. S13. TEM EDX image of Ag/WO_3 catalyst.

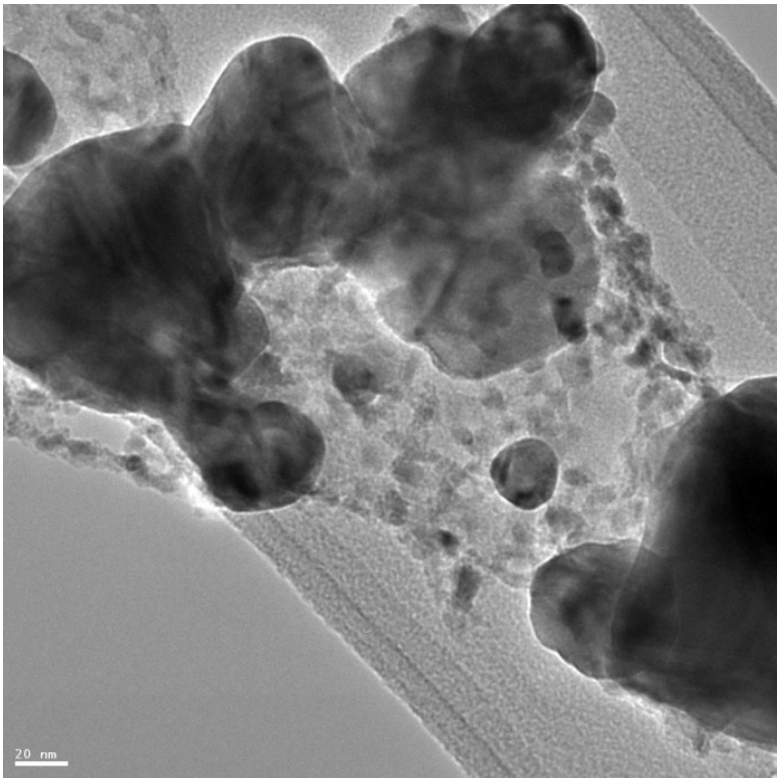


Figure S14. TEM image of Ag-W catalyst prepared by conventional impregnation method.

NMR data of N-oxides:

Pyridine N-oxide (Table 1 entry 1)**:** 1H-NMR (500 MHz, DMSO-d_6): δ 7.35-7.44 (m, 3H); 8.22-8.23 (m, 2H).

3-Picoline N-oxide (Table 1 entry 2): 1H-NMR (500 MHz, $CDCl_3$): δ 2.33 (s, 3H), 7.12-7.37 (d, *J* = 7.5 Hz, 2H); 8.06-8.09 (d, 2H).

3-Chloro Pyridine N-oxide (Table 1 entry 3)**:** 1H-NMR (400 MHz, $CDCl_3$): δ 7.15-7.23 (d, *J* = 7.5 Hz, 2H); 8.05-8.07 (d, *J* = 8.0 Hz, 1H); 8.195 (s, 1H).

Isoquinoline N-oxide (Table 1 entry 4)**:** 1H-NMR (500 MHz, $CDCl_3$): δ 7.591 (m, 2H); 7.63 (m, 1H); 7.69 (m, 1H); 7.79 (d, *J* = 7.5 Hz, 1H); 8.139 (m, 1H); 8.77 (s, 1H).

Quinoxaline N-oxide (Table 1 entry 5)**:** ^{1}H-NMR (400 MHz, CDCl3): δ 7.24 (m, 1H); 7.85 (m, 2H); 8.03(d, *J* = 8.0 Hz, 1H); 8.15 (s, 1H); 8.36(s, 1H).

Pyrazine N-oxide (Table 1 entry 6)**:** ^{1}H-NMR (400MHz, $CDCl_3$): δ 8.09-8.1 (d, *J* =2.5 Hz, 2H); δ8.45-8.46 (d, *J* = 3.1 Hz, 2H).

Phenazine N-oxide (Table 1 entry 7): ^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.87 (m, 5H); 7.91 (m, 2H); 8.58 (m, 1H).

Triphenyl amine N-oxide (Table 1 entry 8)**:** ^{1}H-NMR (400 MHz, $CDCl_3$): δ7.06 (m, 3H); 7.14 (m, 6H); 7.34 (m, 6H).

N, N- dimethyl aniline N-oxide (Table 1 entry 9)**:** ^{1}H-NMR (500 MHz, $CDCl_3$): δ 3.65 (s, 6 H); 7.31 (m, 1H); 7.48 (m, 2H); 7.92 (m, 2H).

N,N- dimethyl cyclohexyl amine N-oxide (Table 1 entry 10)**:** ^{1}H-NMR (500 MHz, $CDCl_3$): δ 1.176 (m, 5H); 1.32 (m,3H); 1.90 (m, 2H); 3.11(m, 7H).

Quiniclidine N-oxide (Table 1 entry 11)**:** ^{1}H-NMR (500 MHz, $CDCl_3$): δ 1.90 (s, 6H); 2.04 (m, 3H); 2.08 (m, 1H); 3.40 (m, 3H).

N,N- dimethyl butyl amine N-oxide (Table 1 entry 12)**:** ^{1}H-NMR (500 MHz, $CDCl_3$): δ 0.92(t, *J* =2.5 Hz, 3H); 1.40 (m, 2H); 1.82 (m, 2H); 3.30 (s, 6H); 3.31 (m, 2H).

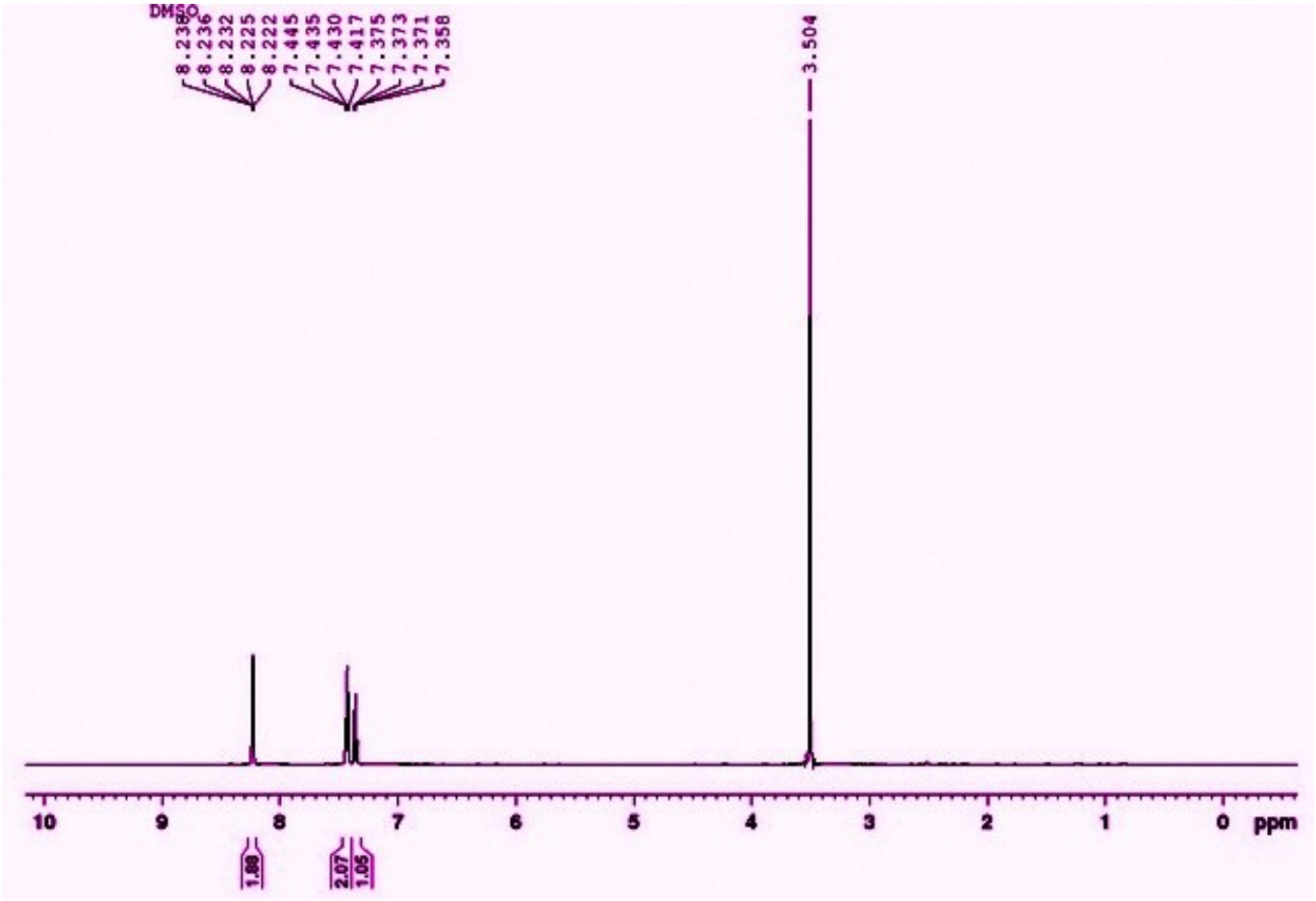
N,N- dimethyl o-toluidine N-oxide (Table 1 entry 13)**:** 1H-NMR (500 MHz, $CDCl_3$): δ 1.91 (s, 3H); 3.79 (s, 6H); 7.23 (m, 3H); 7.79(m, 1H).

N,N- dimethyl m-toluidine N-oxide (Table 1 entry 14)**:** ^{1}H-NMR (500 MHz, $CDCl_3$): δ 2.39 (s, 3H); 5.95 (s, 6H); 6.57 (d, *J* = 6.0 Hz, 1H); 7.33 (m, 1H); 7.63 (m, 1H); 8.43(s, 1H).

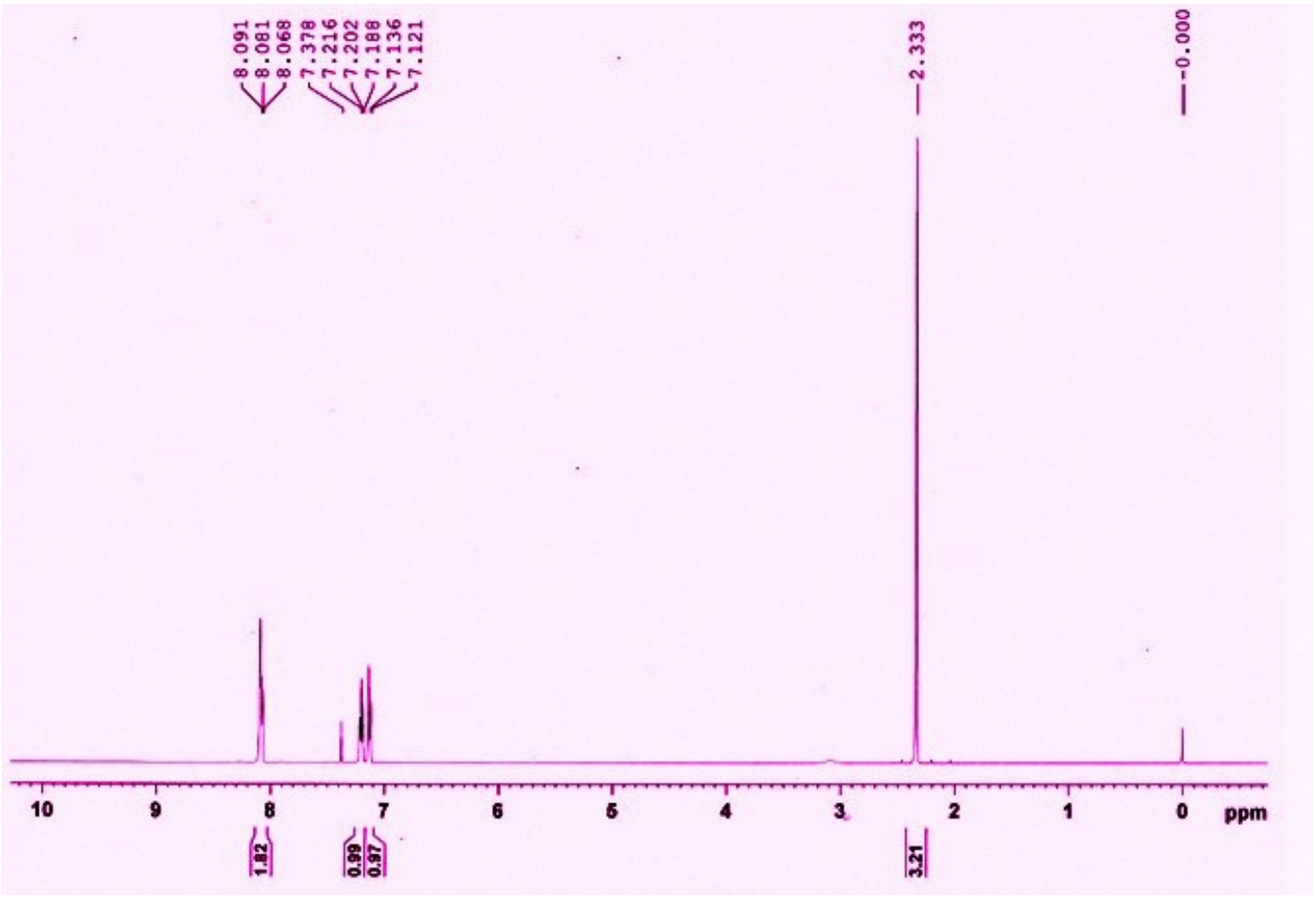
N,N- dimethyl p-toluidine N-oxide (Table 1 entry 15)**:** ^{1}H-NMR (400 MHz, $CDCl_3$): δ 2.14 (s, 3H), 3.44 (s, 6H), 7.02-7.04 (d, *J* = 10.5 Hz, 2H), 7.59–7. 61 (d, *J* = 10.5 Hz, 2H).

NMR spectra of N-oxides:

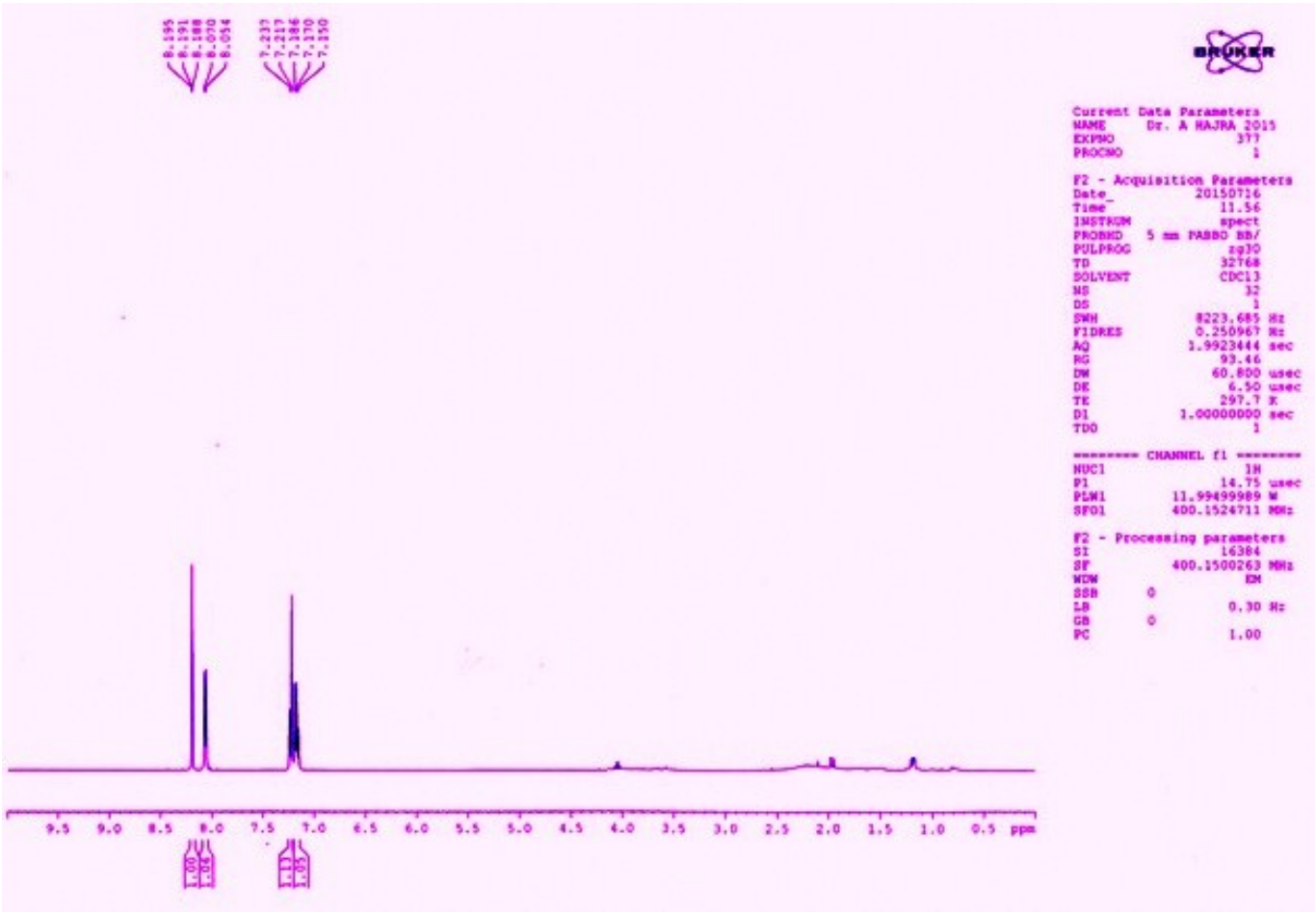
Pyridine N-oxide (Table 1 entry 1)



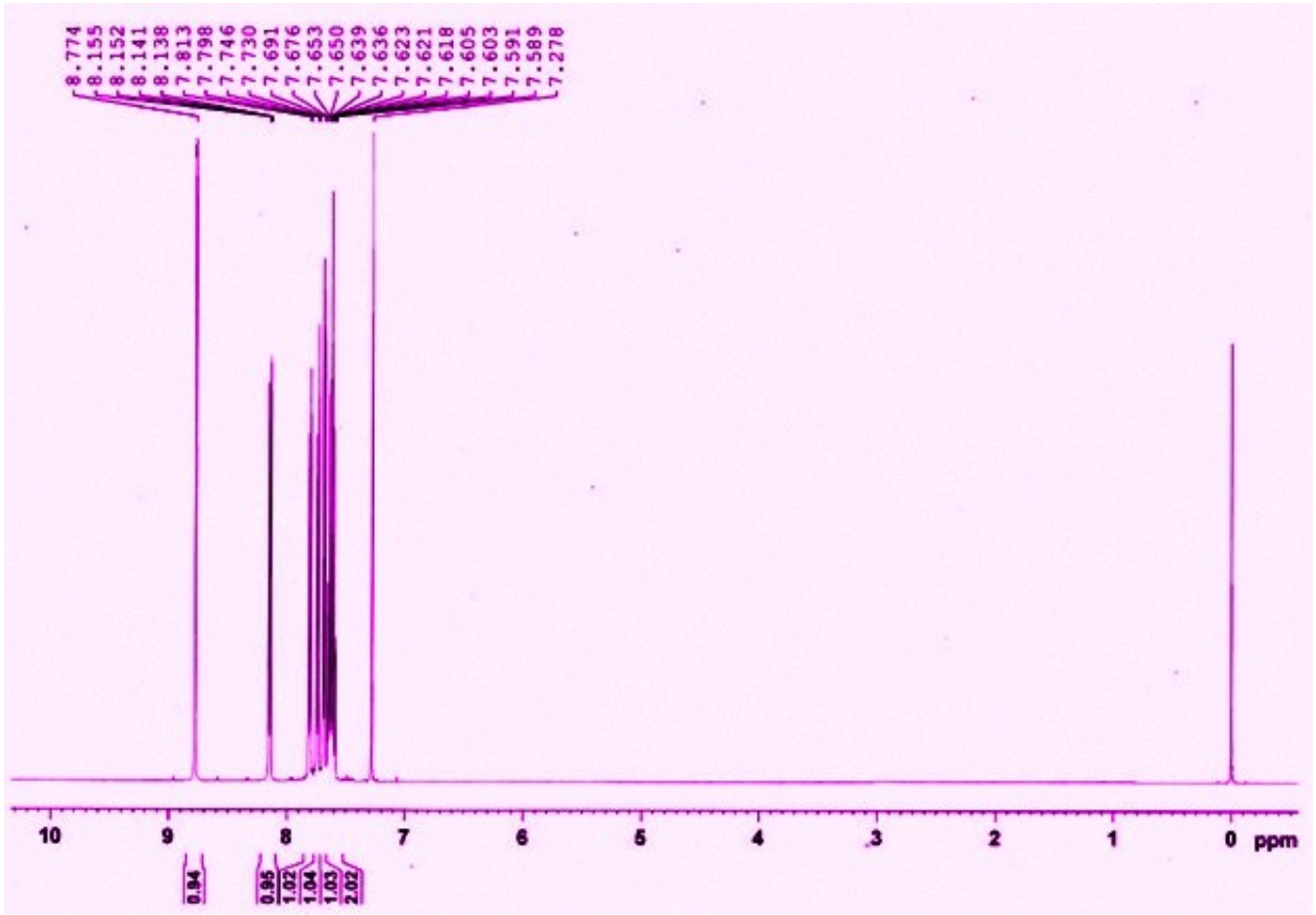
3-Picoline N-oxide (Table 1 entry 2):



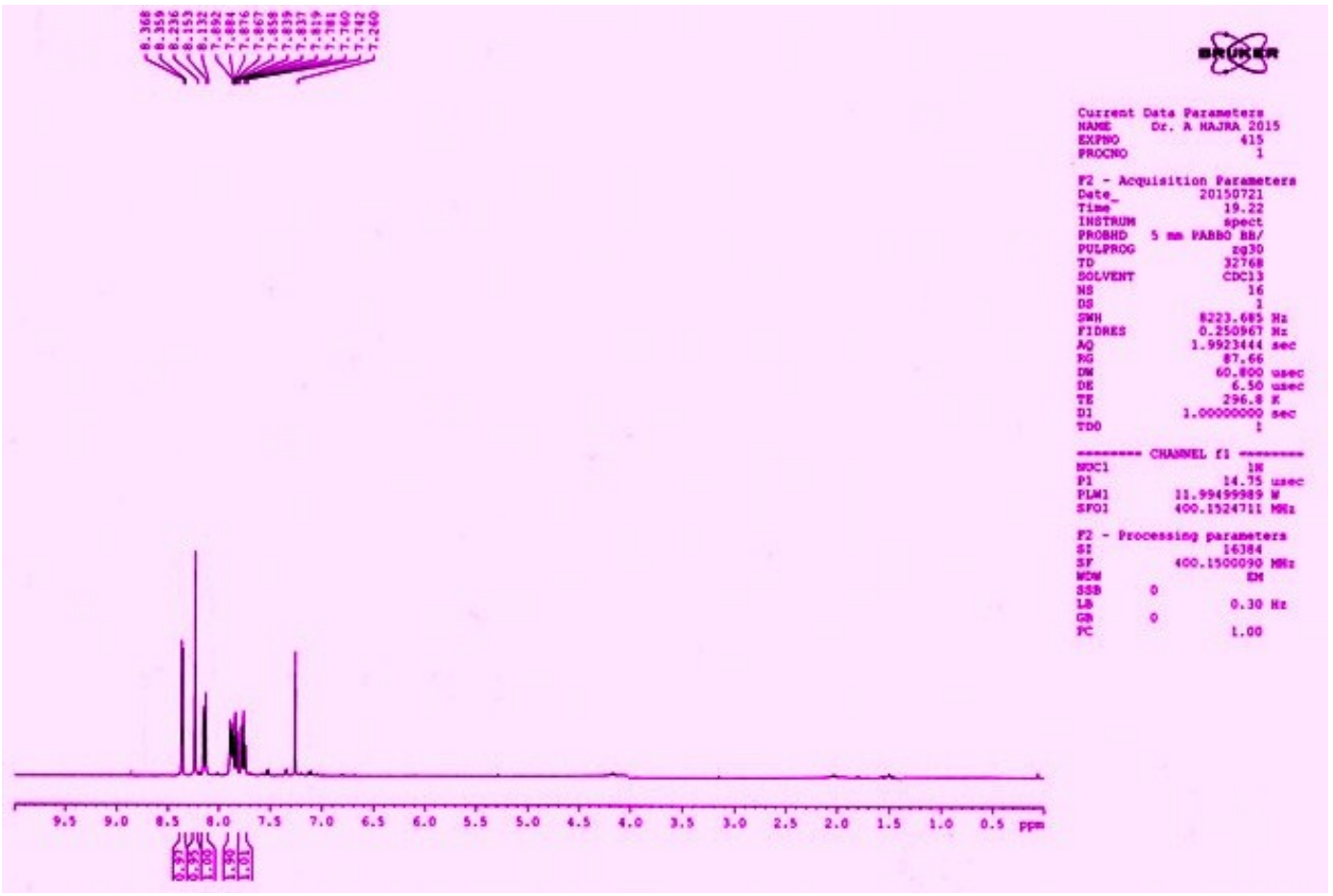
3-Chloro Pyridine N-oxide (Table 1 entry 3)



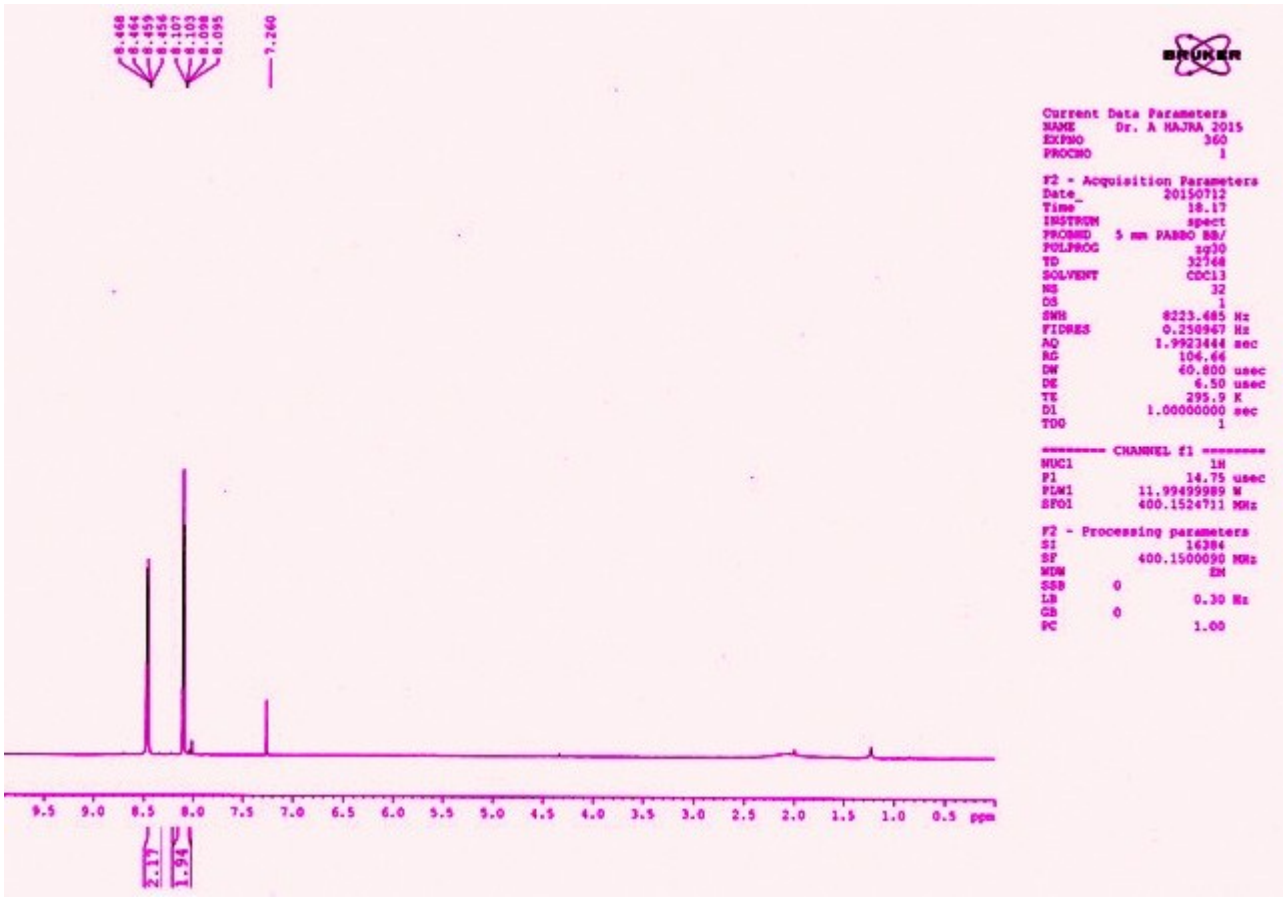
Isoquinoline N-oxide (Table 1 entry 4)**:**



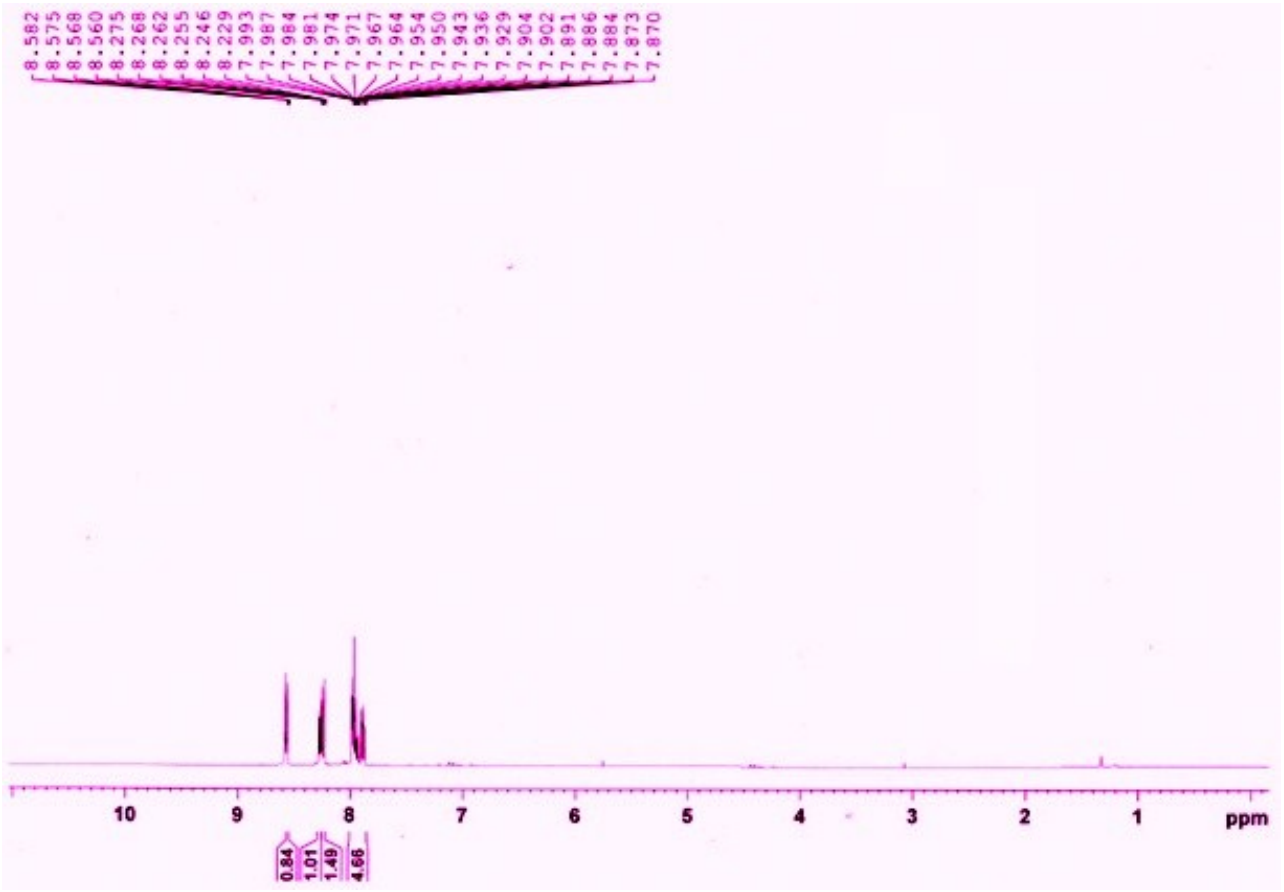
Quinoxaline N-oxide (Table 1 entry 5)



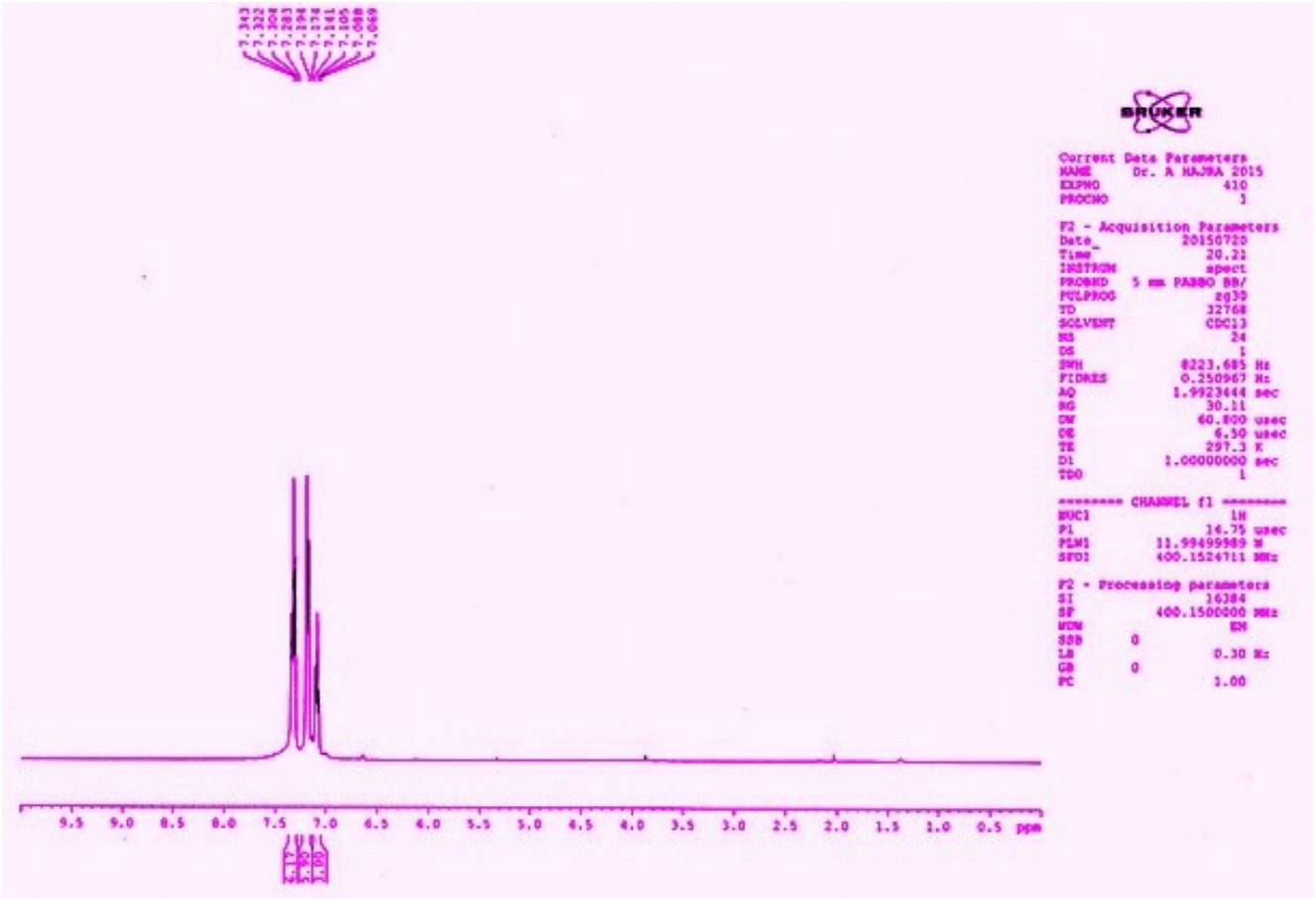
Pyrazine N-oxide (Table 1 entry 6)



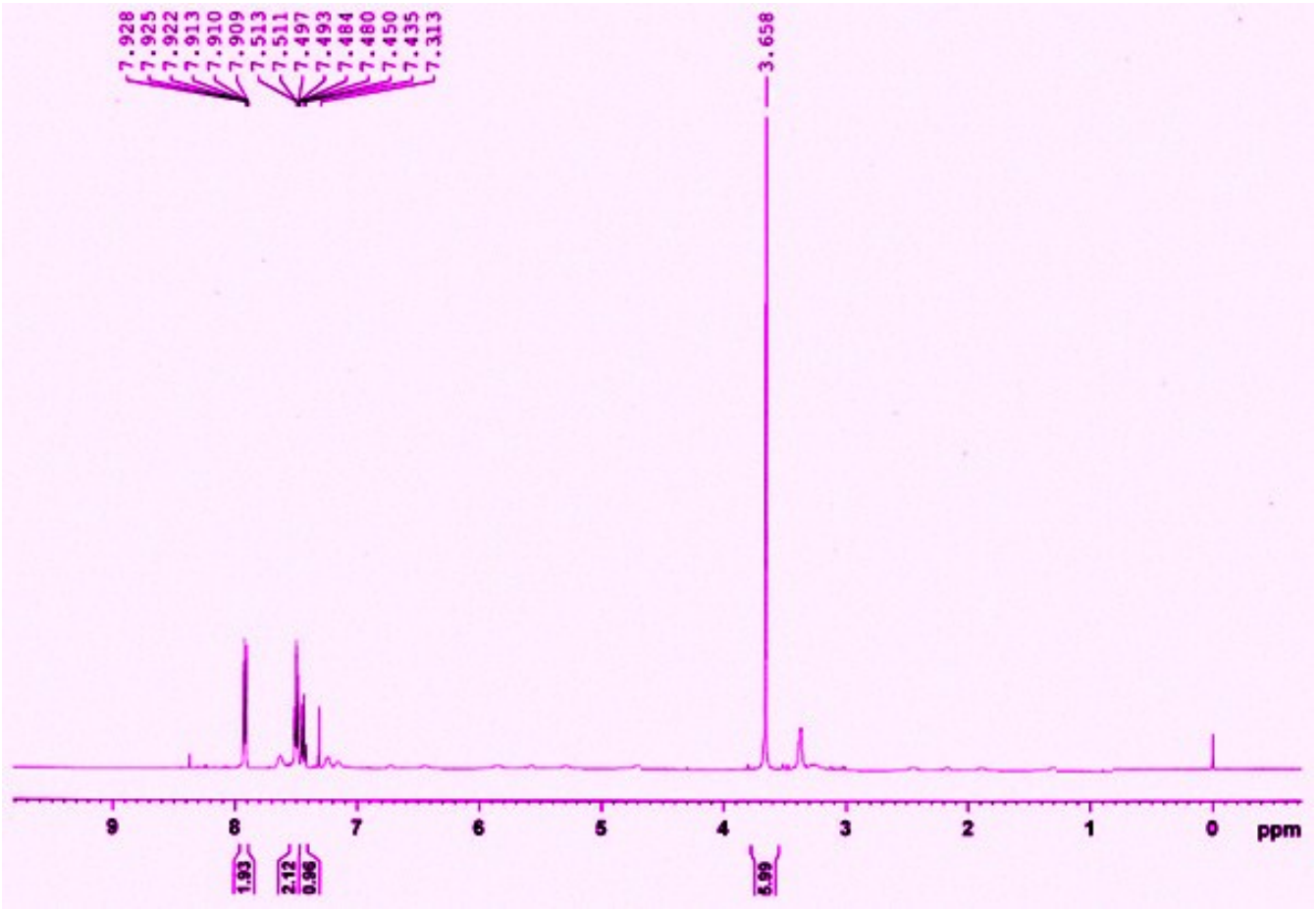
Phenazine N-oxide (Table 1 entry 7):



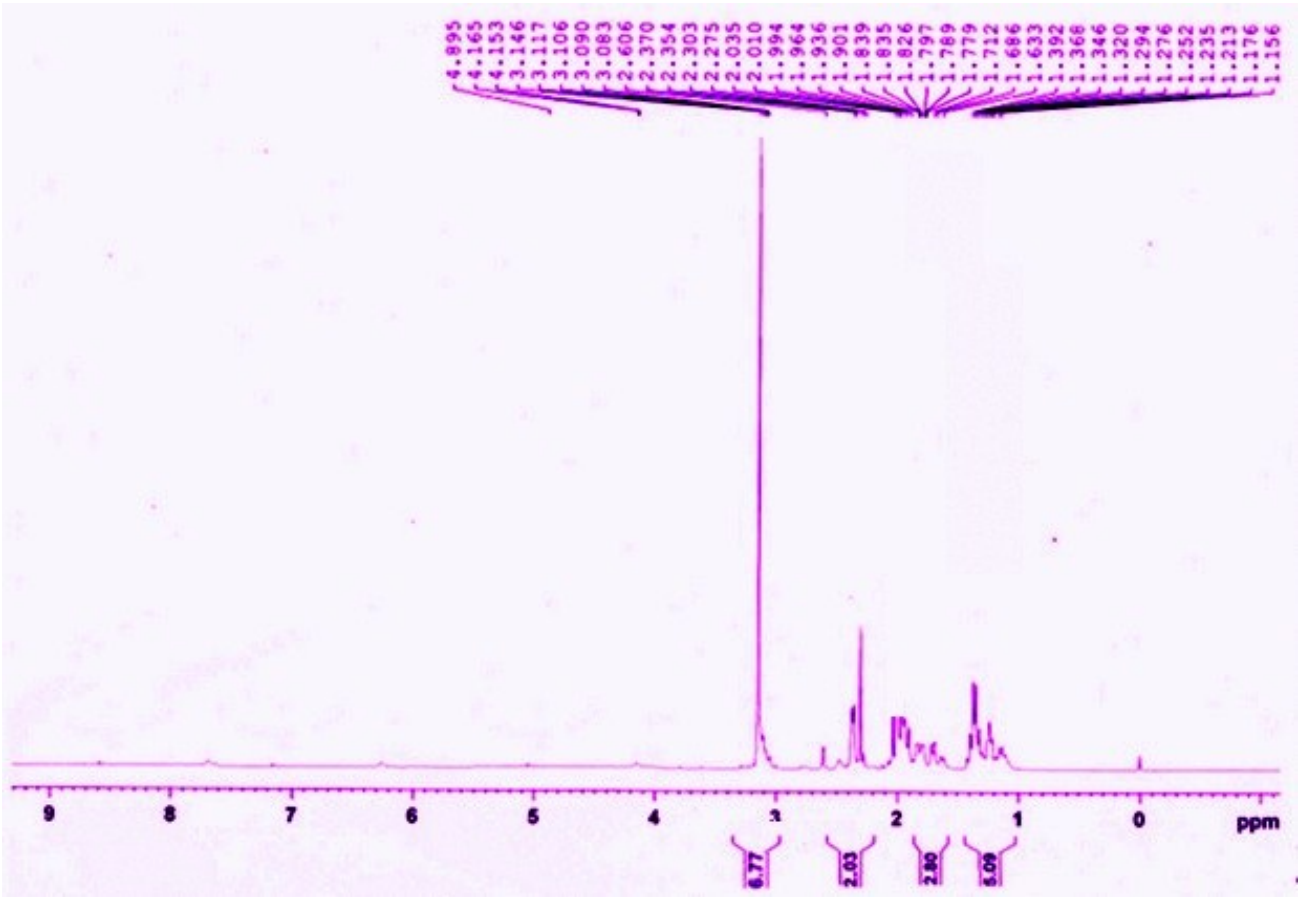
Triphenyl amine N-oxide (Table 1 entry 8)**:**



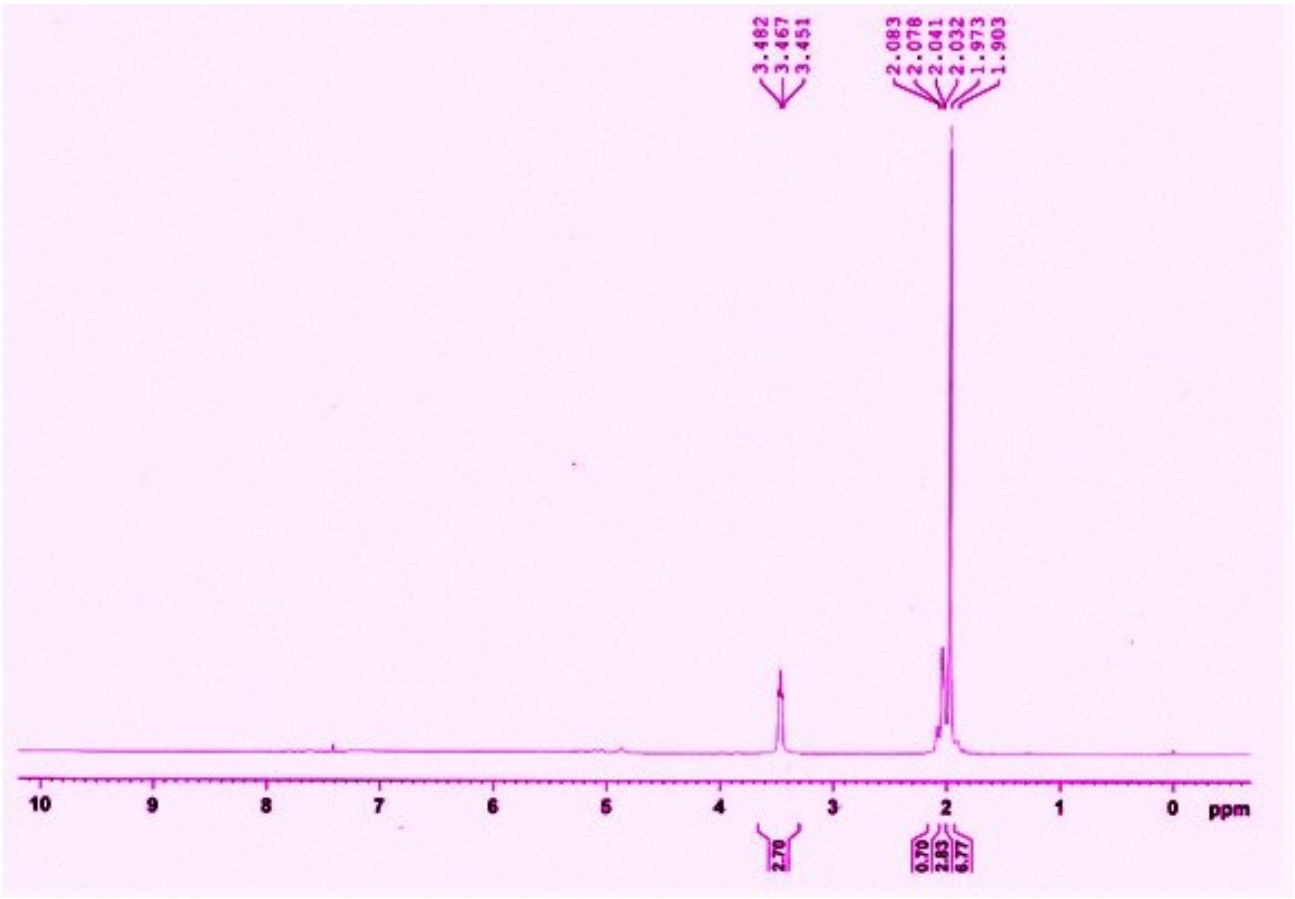
N, N- dimethyl aniline N-oxide (Table 1 entry 9)



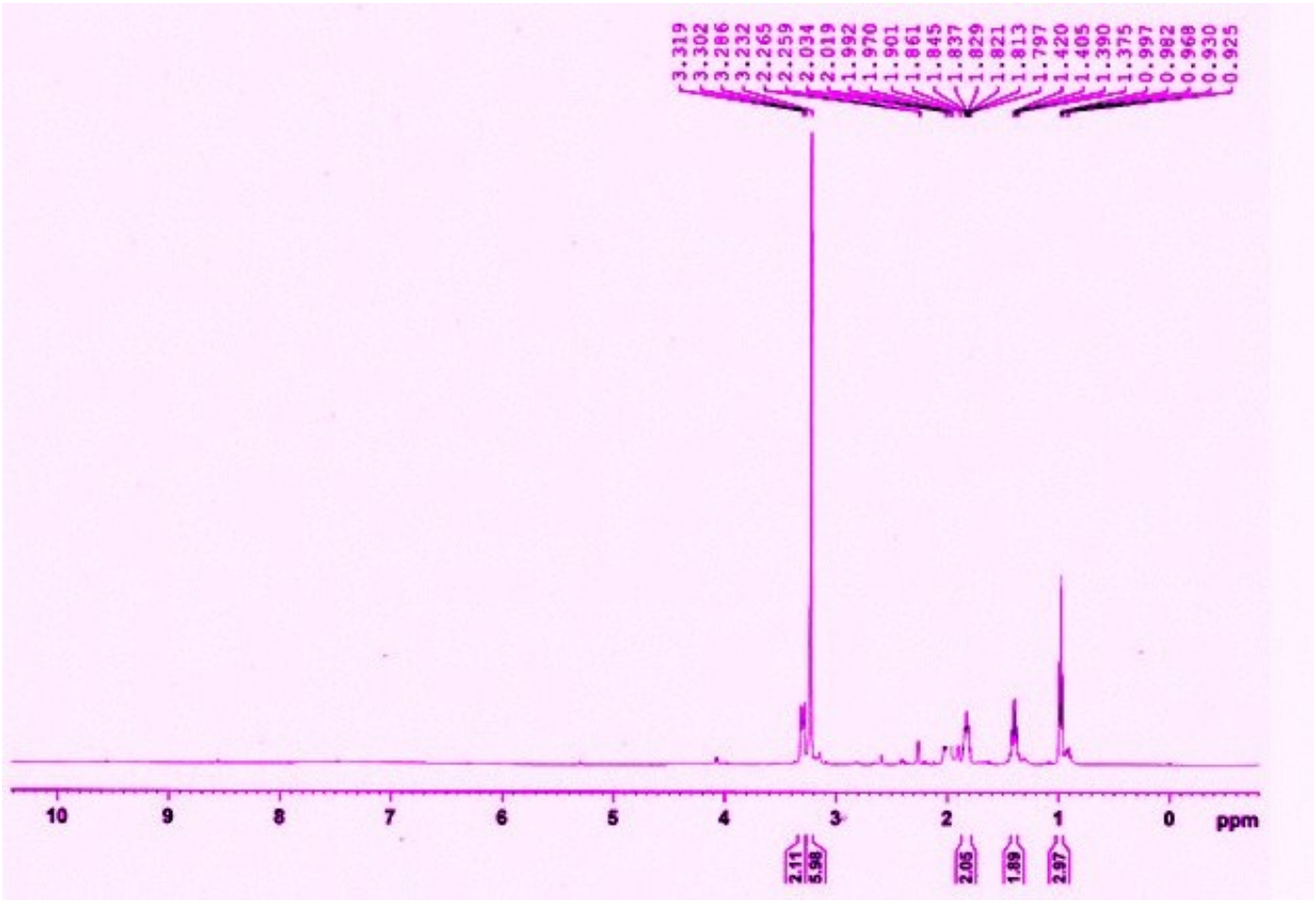
N,N- dimethyl cyclohexyl amine N-oxide (Table 1 entry 10)**:**



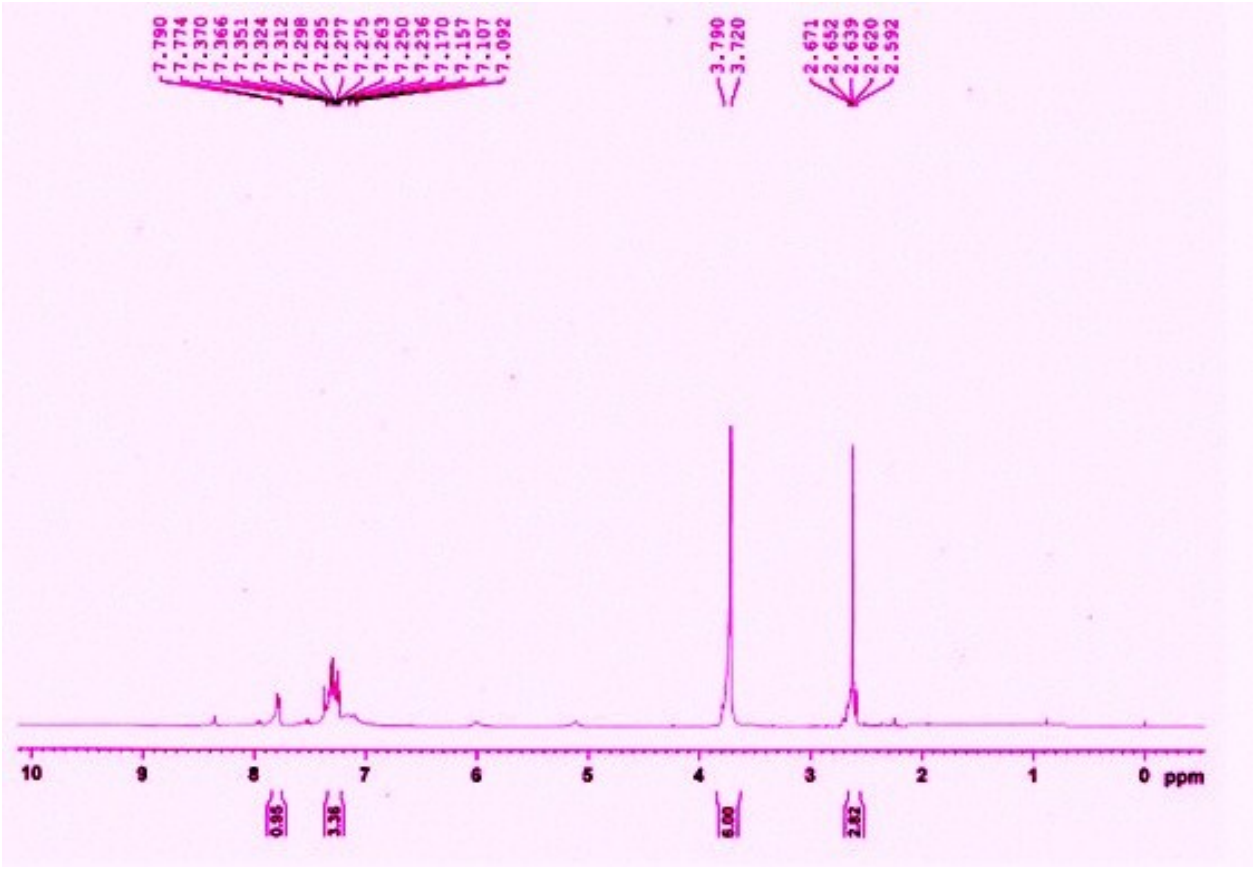
Quiniclidine N-oxide (Table 1 entry 11)**:**



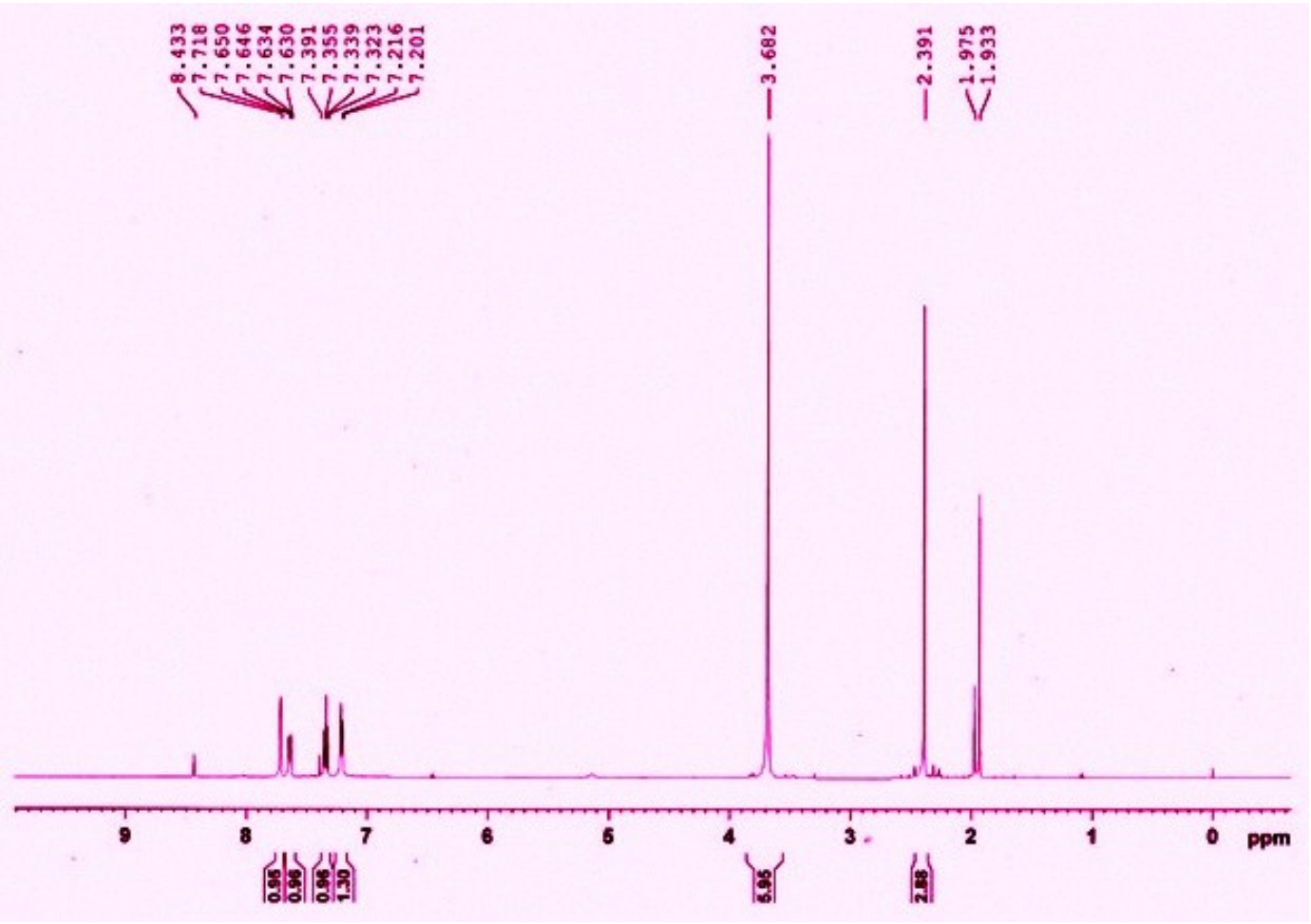
N,N- dimethyl butyl amine N-oxide (Table 1 entry 12)**:**



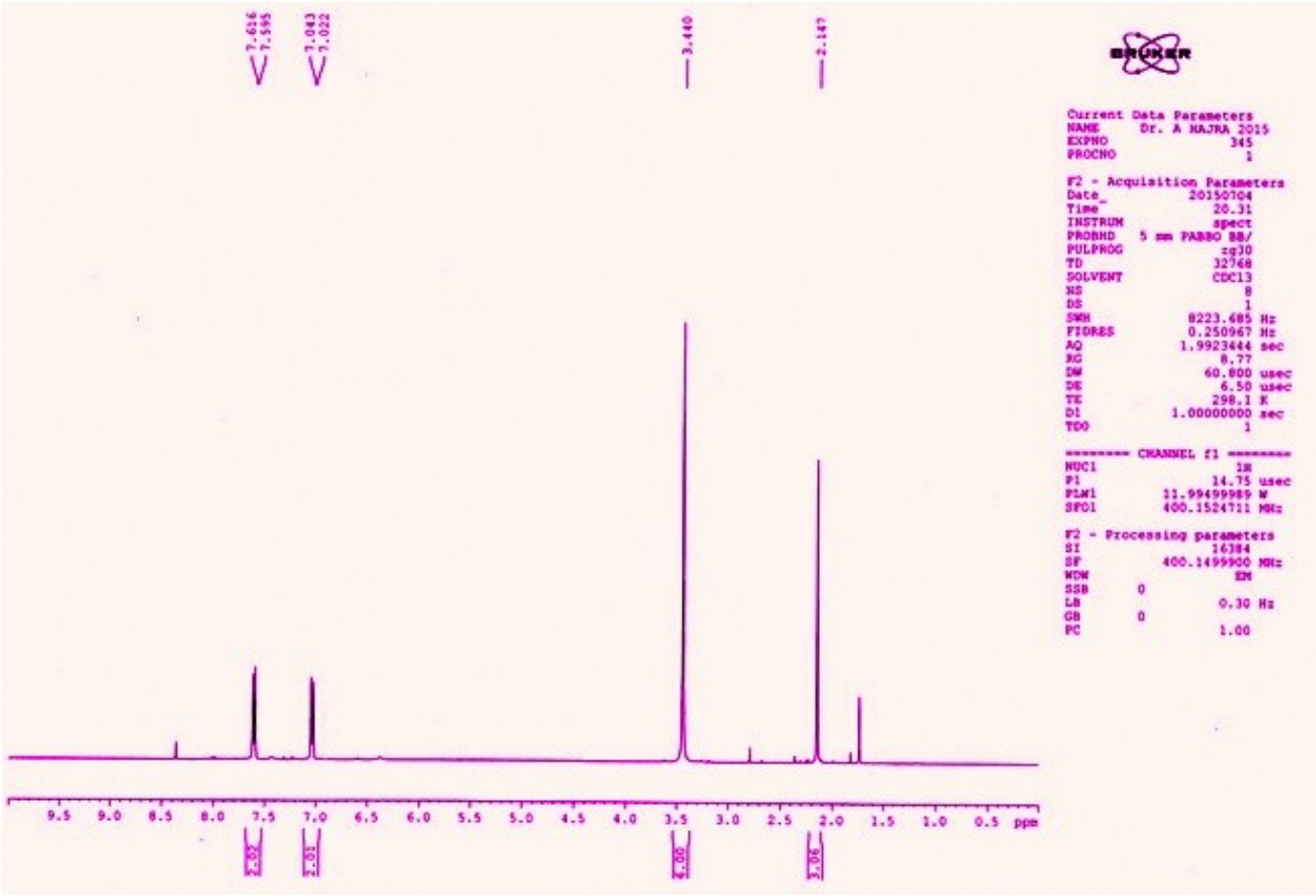
N,N- dimethyl o-toluidine N-oxide (Table 1 entry 13)



N,N- dimethyl m-toluidine N-oxide (Table 1 entry 14)**:**



N,N- dimethyl p-toluidine N-oxide (Table 1 entry 15)**:**



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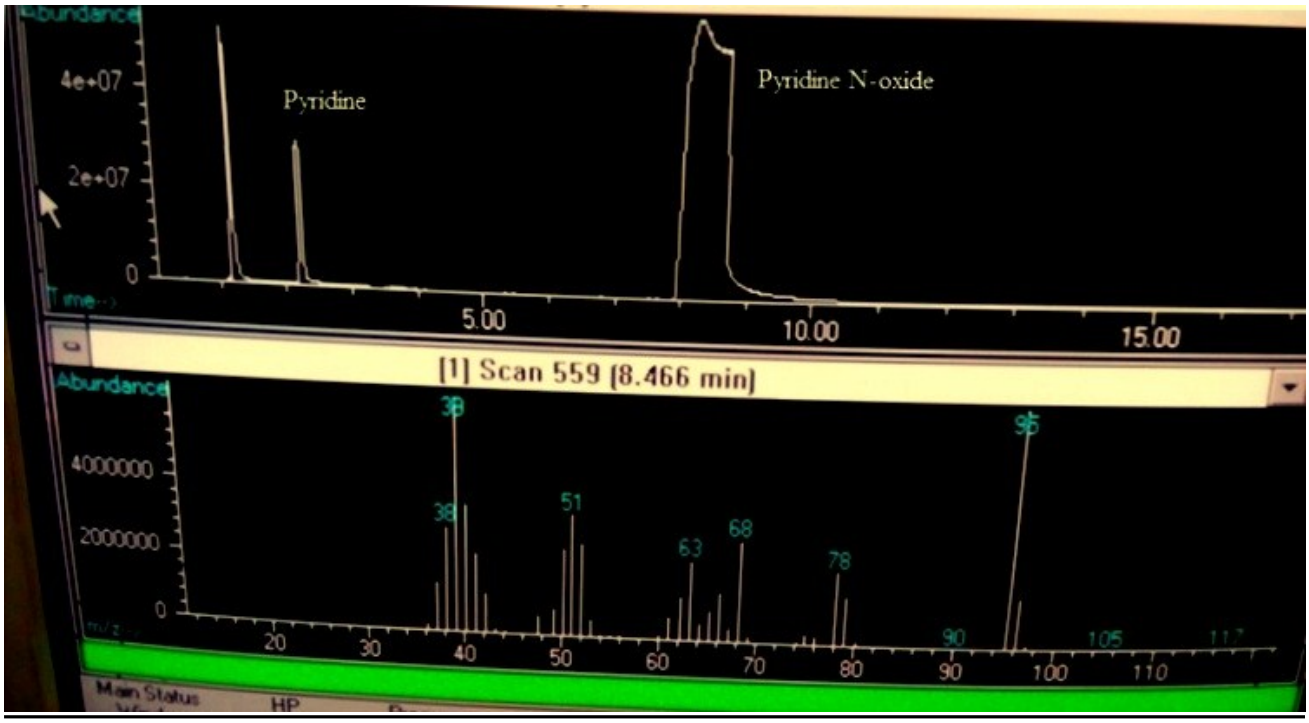
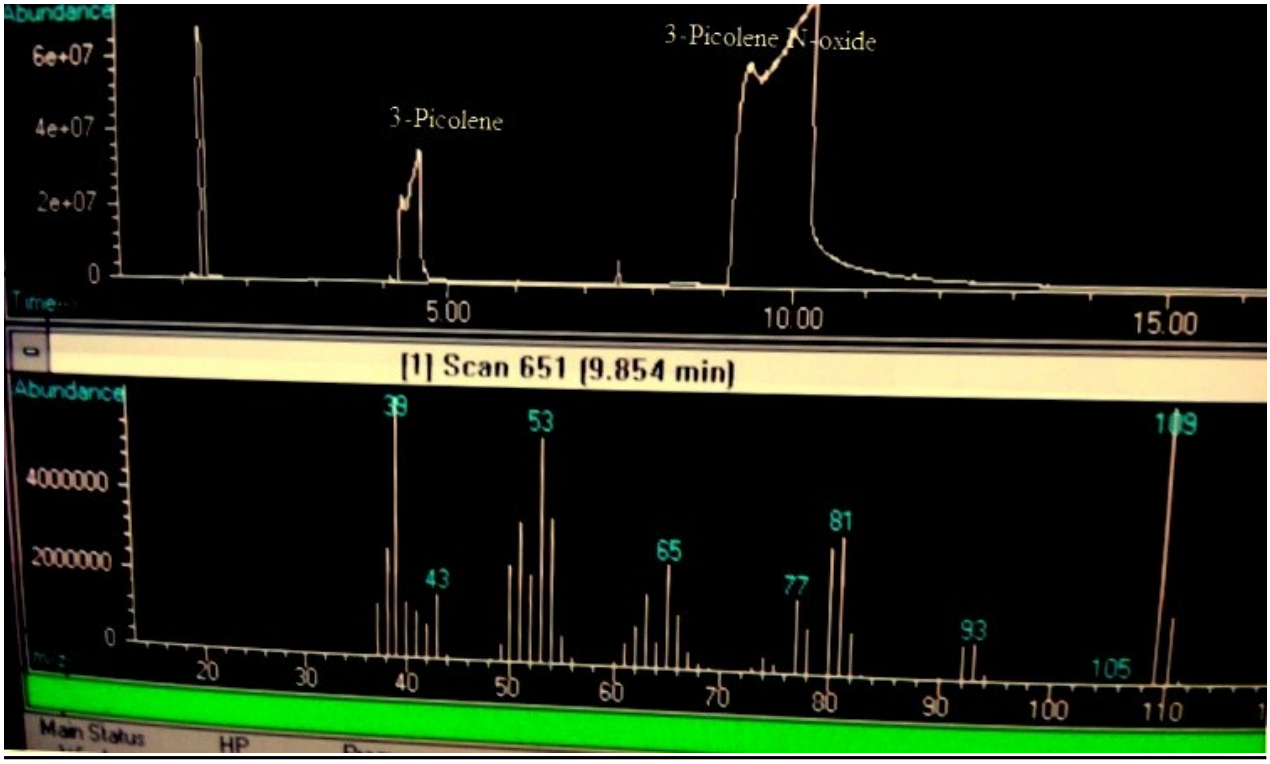
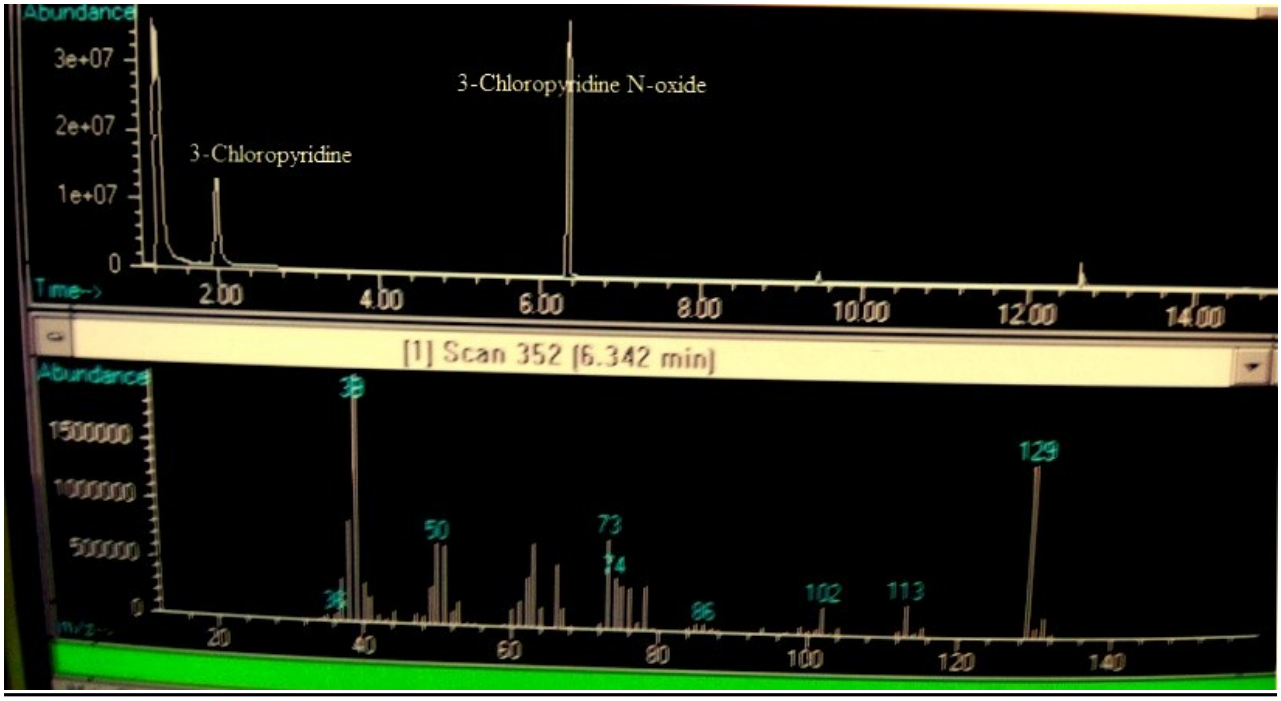
Pyridine N-oxide (Table 1 entry 1)



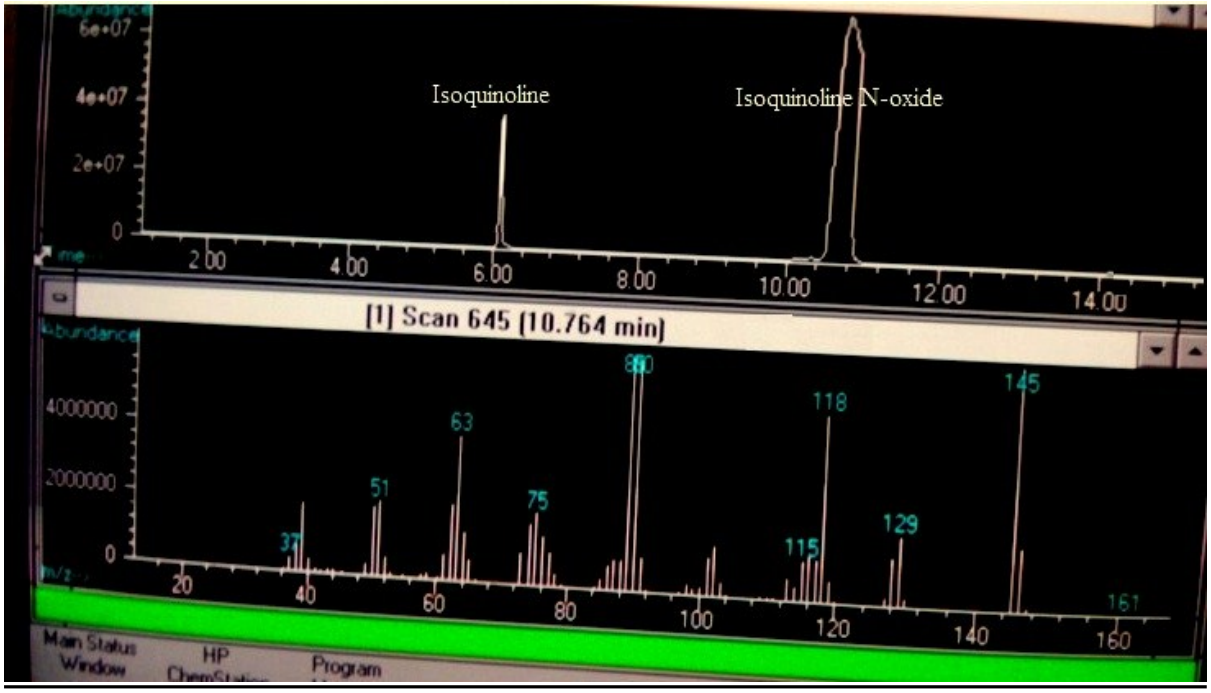
3-Picoline N-oxide (Table 1 entry 2):



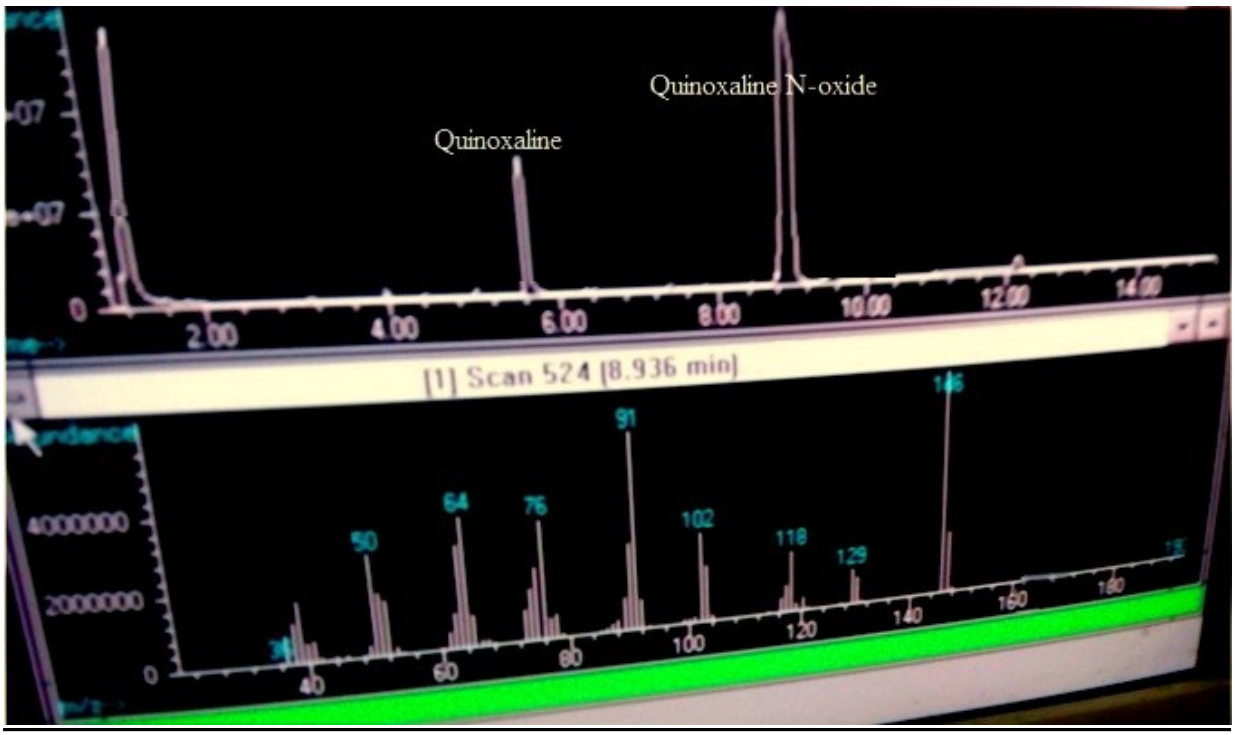
3-Chloro Pyridine N-oxide (Table 1 entry 3)



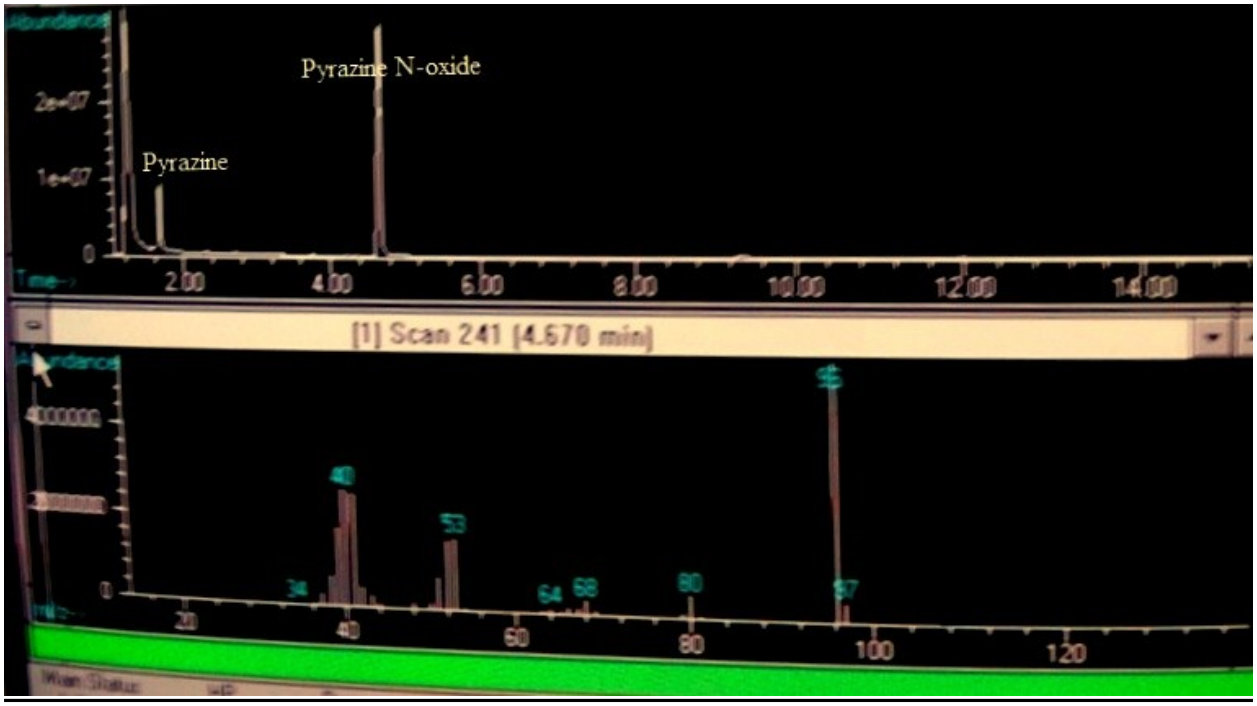
Isoquinoline N-oxide (Table 1 entry 4)



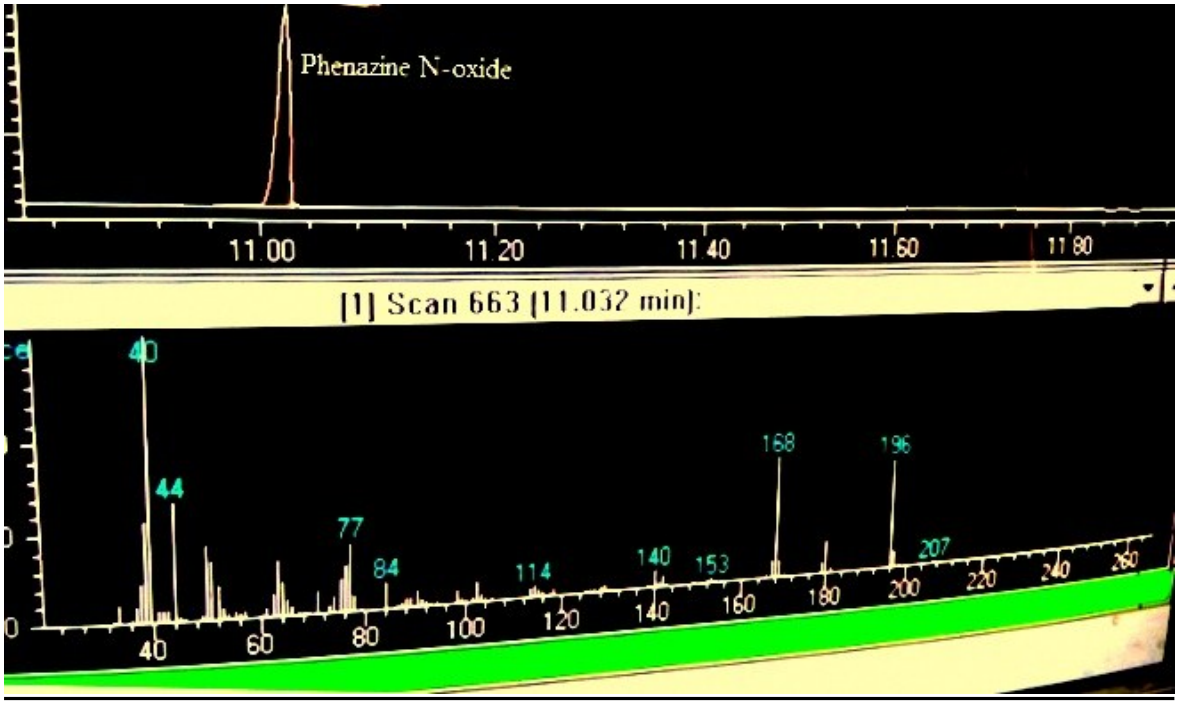
Quinoxaline N-oxide (Table 1 entry 5)



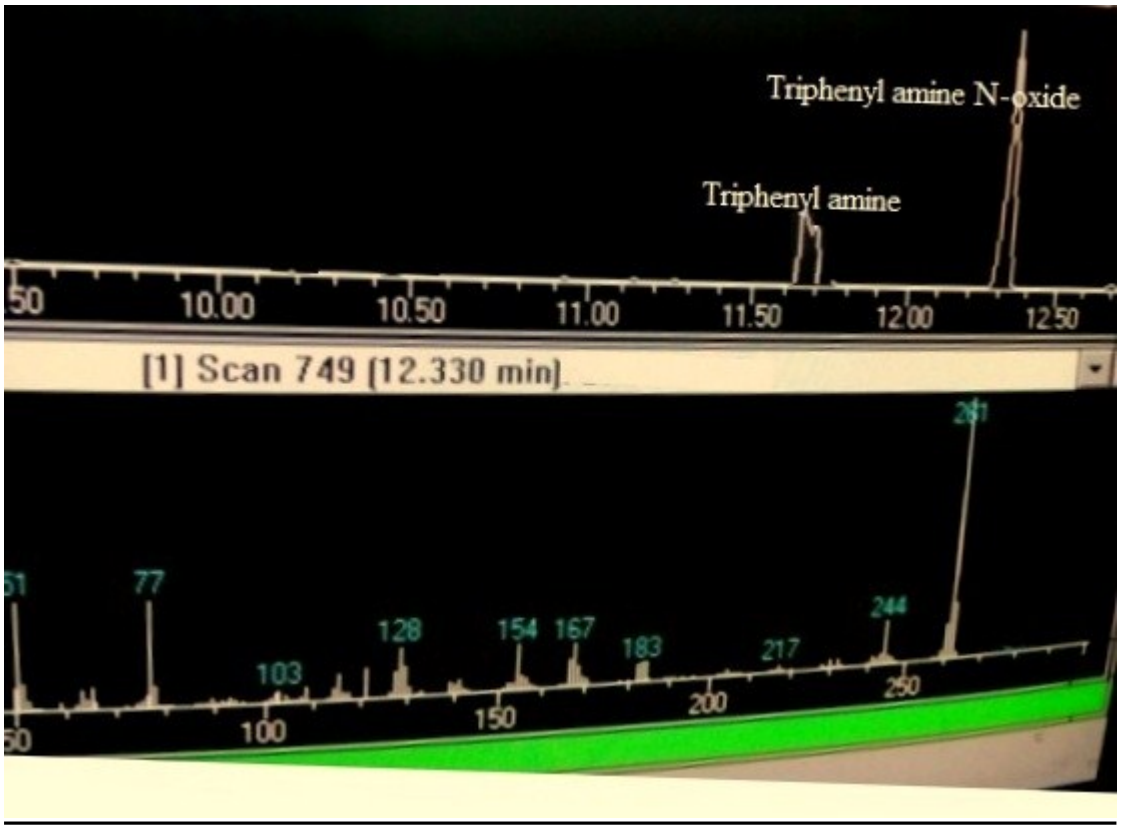
Pyrazine N-oxide (Table 1 entry 6)



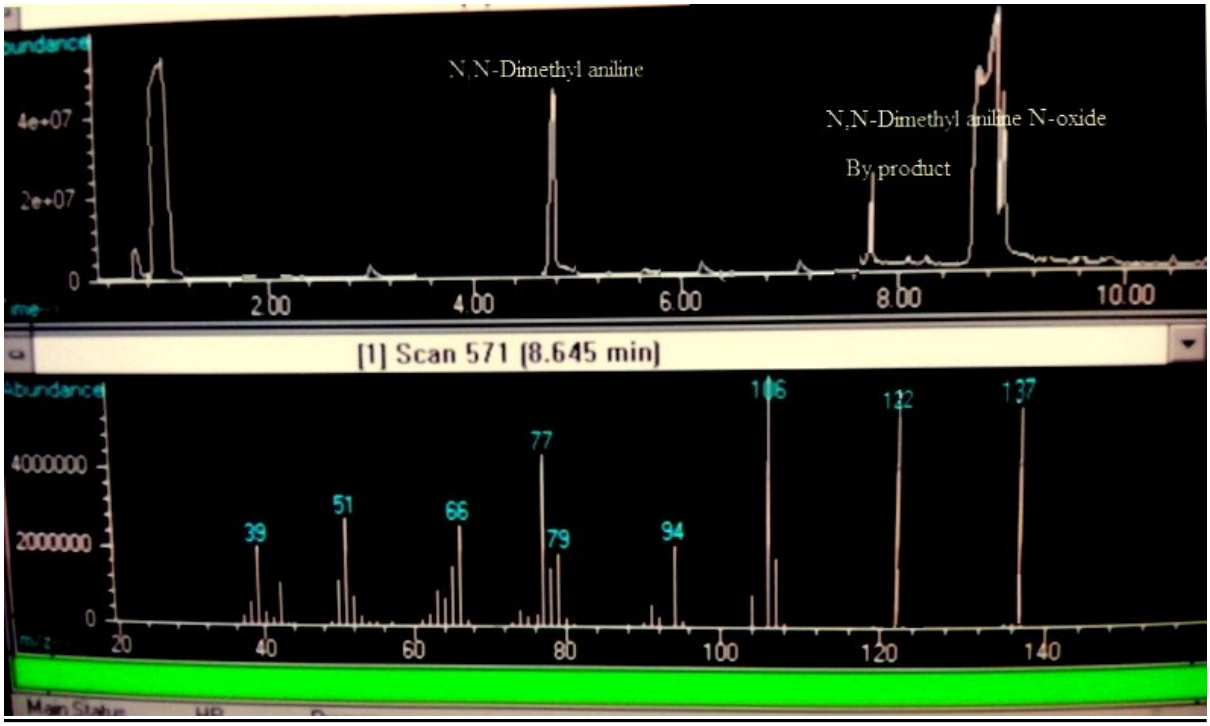
Phenazine N-oxide (Table 1 entry 7):



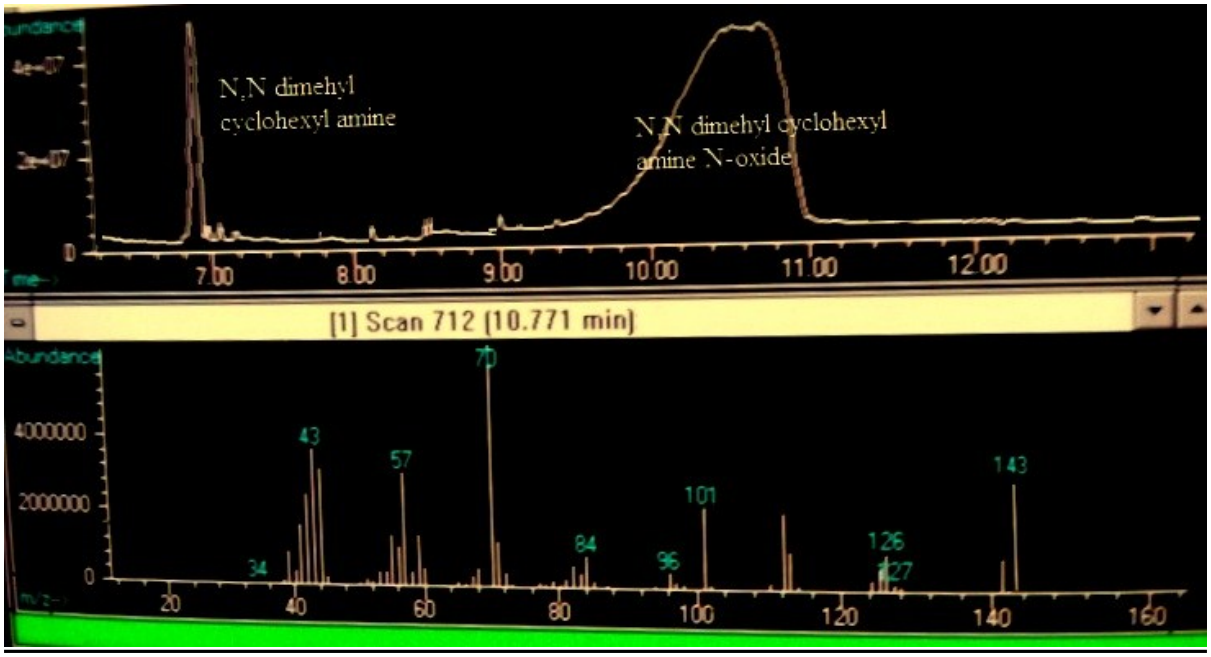
Triphenyl amine N-oxide (Table 1 entry 8)**:**



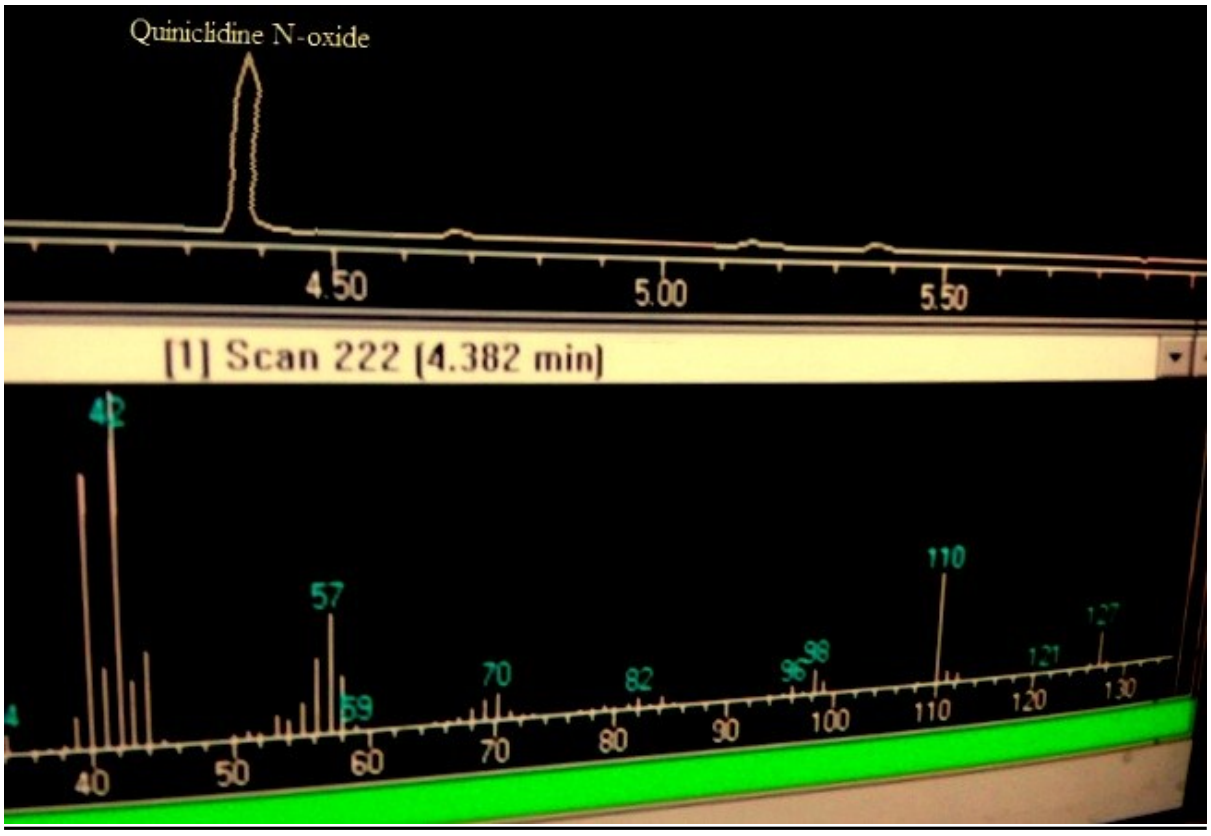
N, N- dimethyl aniline N-oxide (Table 1 entry 9)



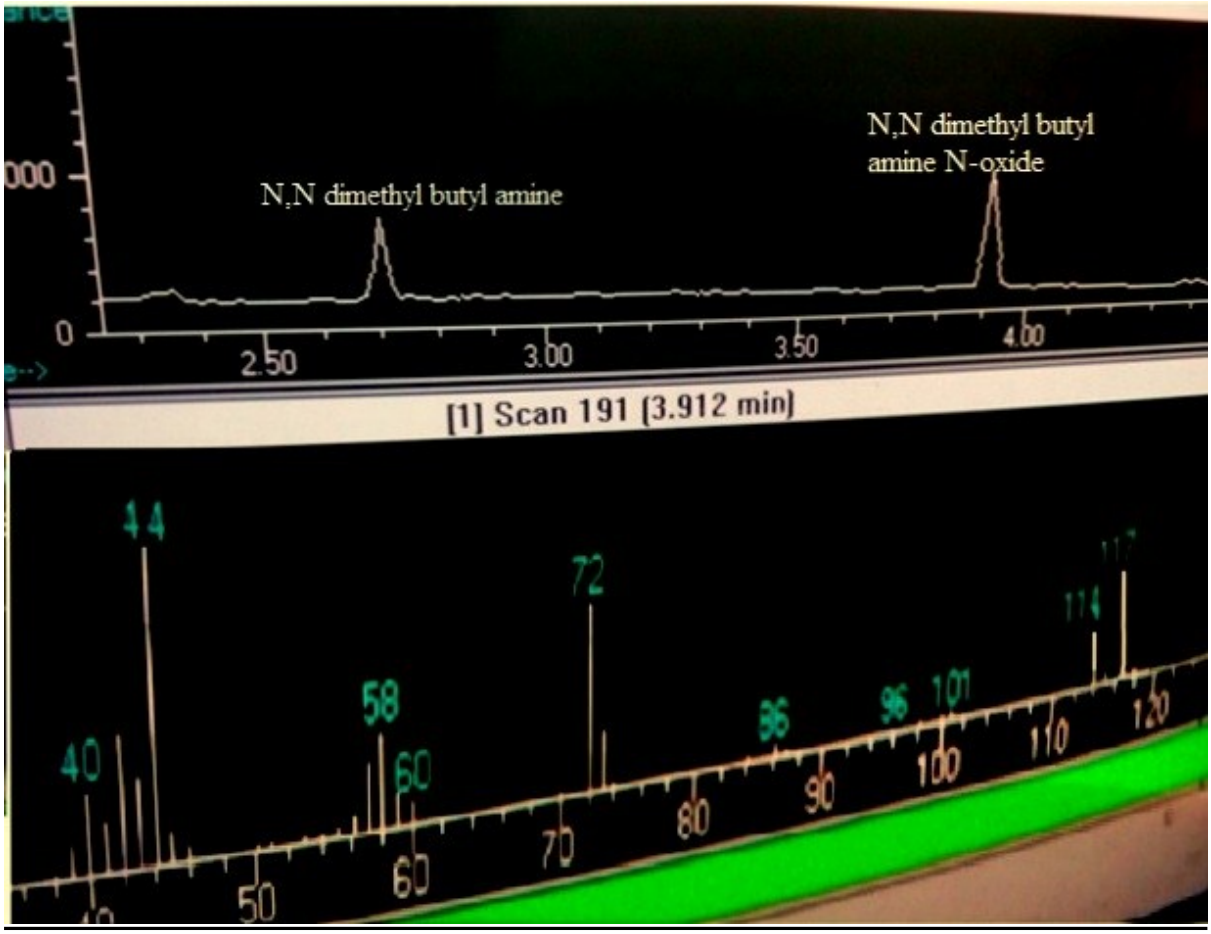
N,N- dimethyl cyclohexyl amine N-oxide (Table 1 entry 10)**:**



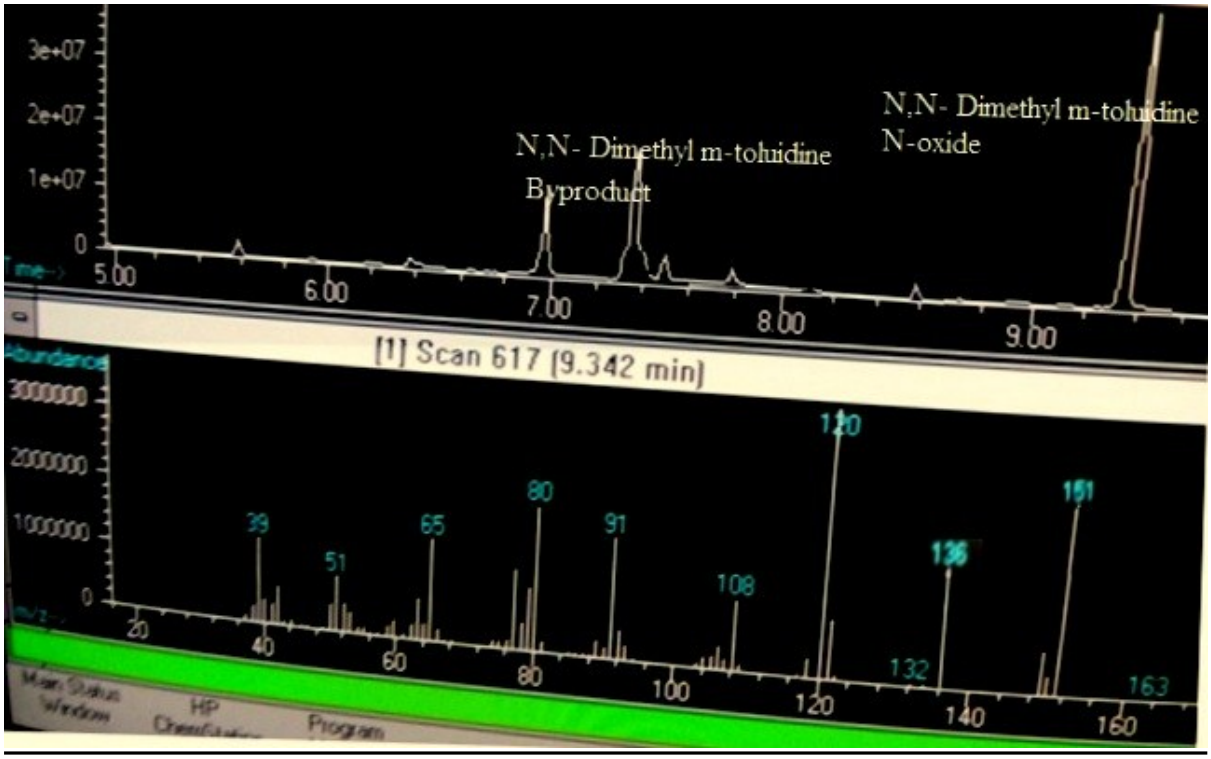
Quiniclidine N-oxide (Table 1 entry 11)**:**



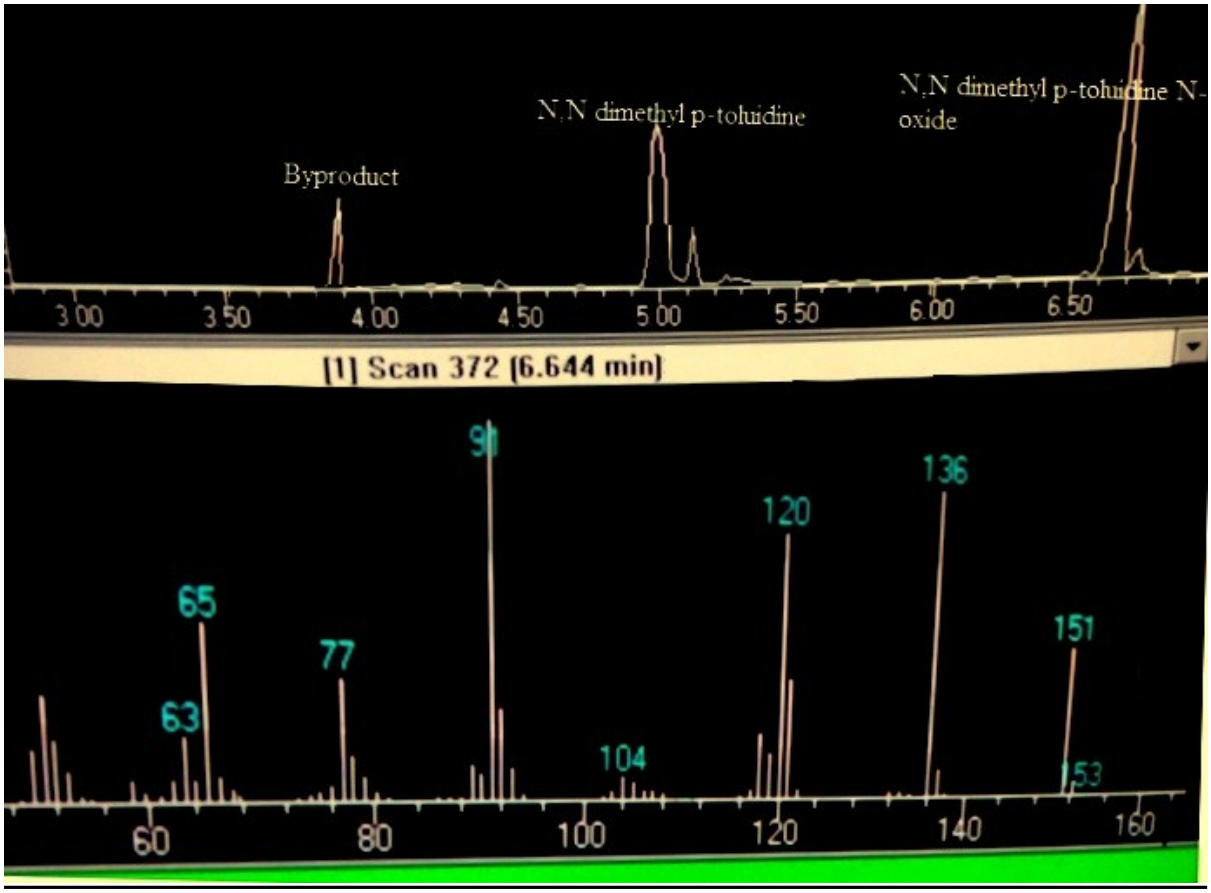
N,N- dimethyl butyl amine N-oxide (Table 1 entry 12)**:**



N,N- dimethyl m-toluidine N-oxide (Table 1 entry 14)**:**



N,N- dimethyl p-toluidine N-oxide (Table 1 entry 15)**:**


Byproduct
N,N dimethyl p-toluidine
N,N dimethyl p-toluidine N-oxide
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3.50
4.00
4.50
5.00
5.50
6.00
6.50
[1] Scan 372 (6.644 min)
91
136
120
65
151
77
63
104
153
60
80
100
120
140
160

GC charts:

Pyridine N-oxide (Table 1 entry 1)**:**

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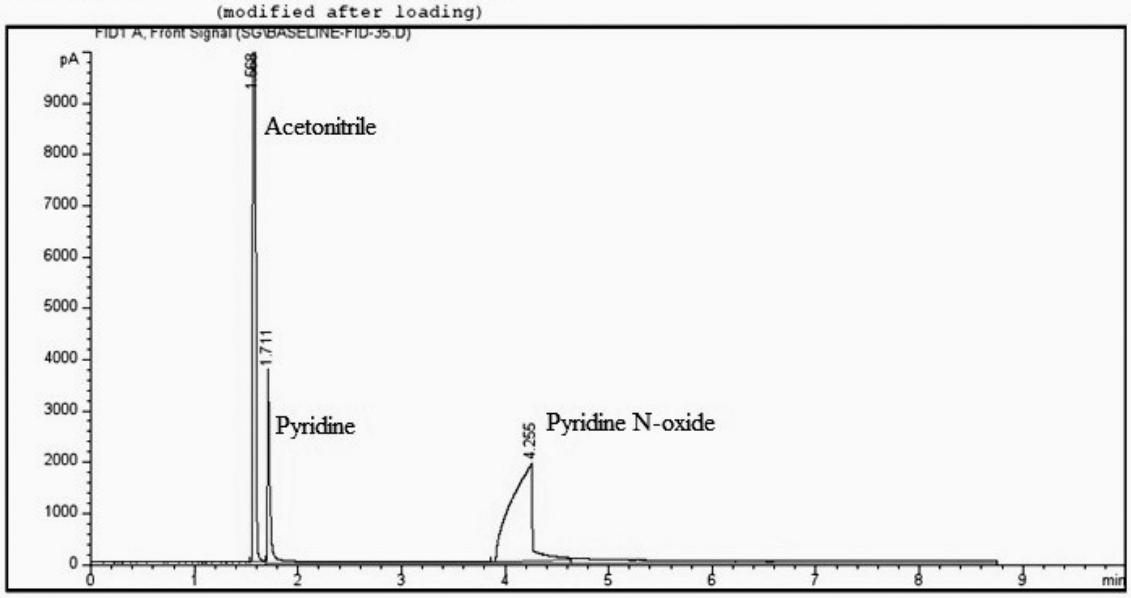
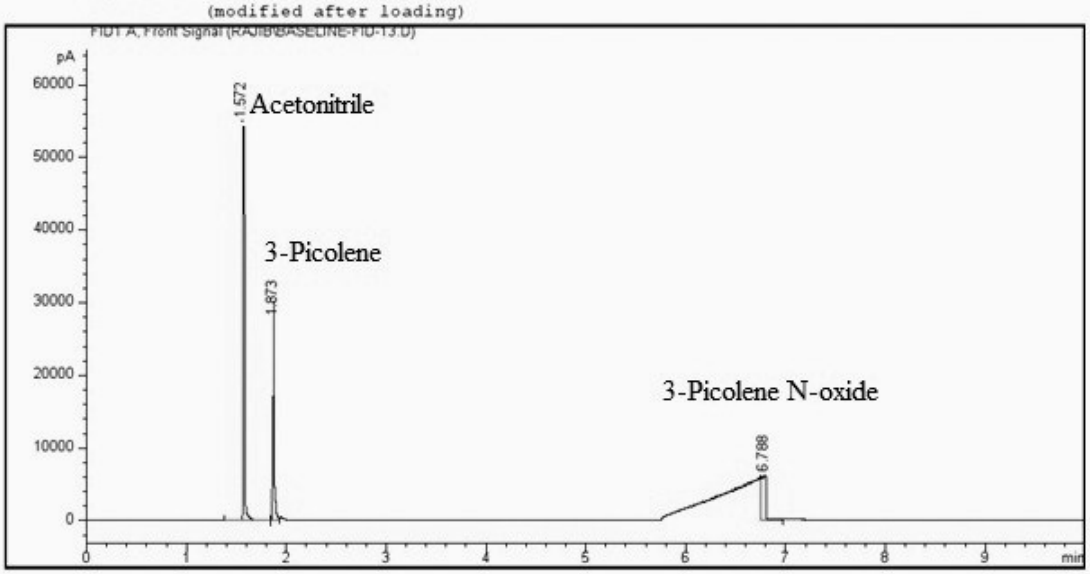
  Analysis Method : C:\CHEM32\1\METHODS\FID.M
  Last changed    : 7/27/2015 3:46:57 PM by sg
                    (modified after loading)
```



3-Picoline N-oxide (Table 1 entry 2)

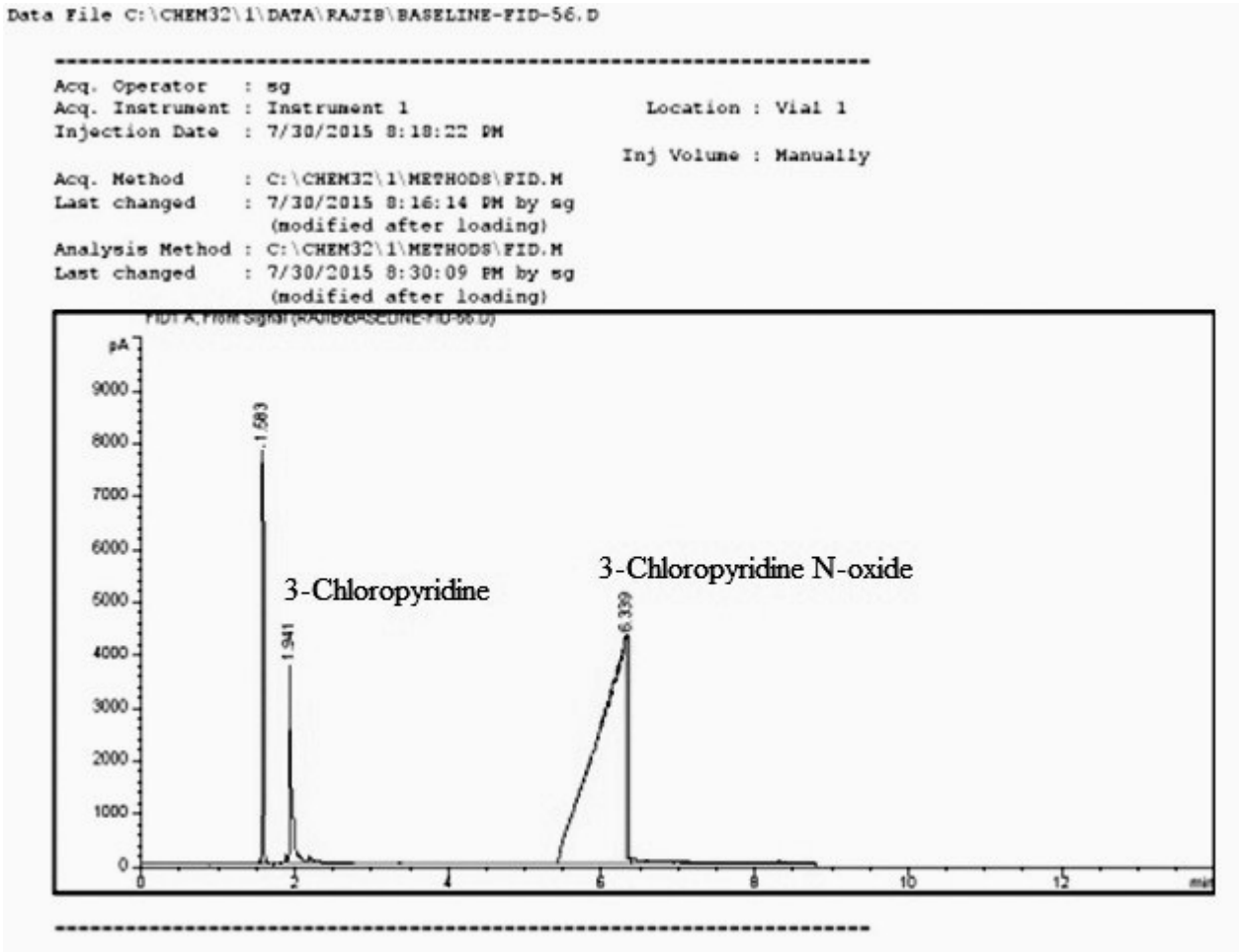
```
Data File C:\CHEM32\1\DATA\RAJIB\BASELINE-FID-13.D

  ======================================================================
  Acq. Operator   : RAJIB
  Acq. Instrument : Instrument 1                    Location : Vial 1
  Injection Date  : 7/26/2015 5:25:59 PM
                                                   Inj Volume : Manually
  Acq. Method     : C:\CHEM32\1\METHODS\FID.M
  Last changed    : 7/26/2015 5:24:04 PM by RAJIB
                    (modified after loading)
  Analysis Method : C:\CHEM32\1\METHODS\FID.M
  Last changed    : 7/26/2015 5:38:30 PM by RAJIB
                    (modified after loading)
```




```
  ======================================================================
```

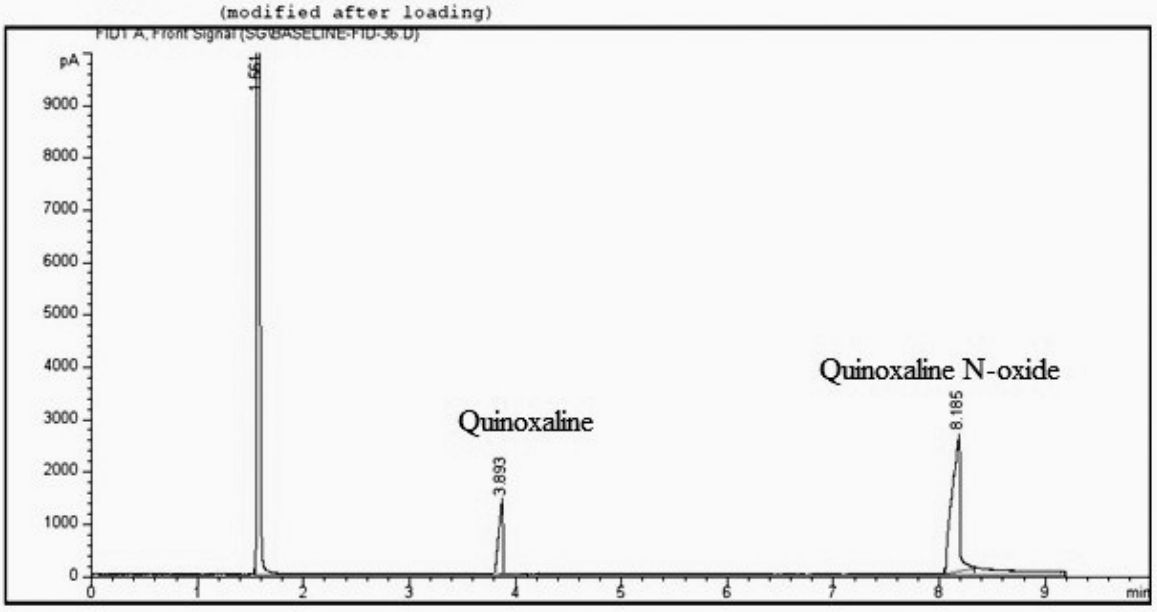
3-Chloro Pyridine N-oxide (Table 1 entry 3)**:**



Quinoxaline N-oxide (Table 1 entry 5)**:**

```
Data File C:\CHEM32\1\DATA\SG\BASELINE-FID-36.D

  ======================================================================
  Acq. Operator   : sg
  Acq. Instrument : Instrument 1                    Location : Vial 1
  Injection Date  : 7/27/2015 3:50:46 PM
                                                   Inj Volume : Manually
  Acq. Method     : C:\CHEM32\1\METHODS\FID.M
  Last changed    : 7/27/2015 3:46:57 PM by sg
                    (modified after loading)
  Analysis Method : C:\CHEM32\1\METHODS\FID.M
  Last changed    : 7/27/2015 4:04:38 PM by sg
                    (modified after loading)
```

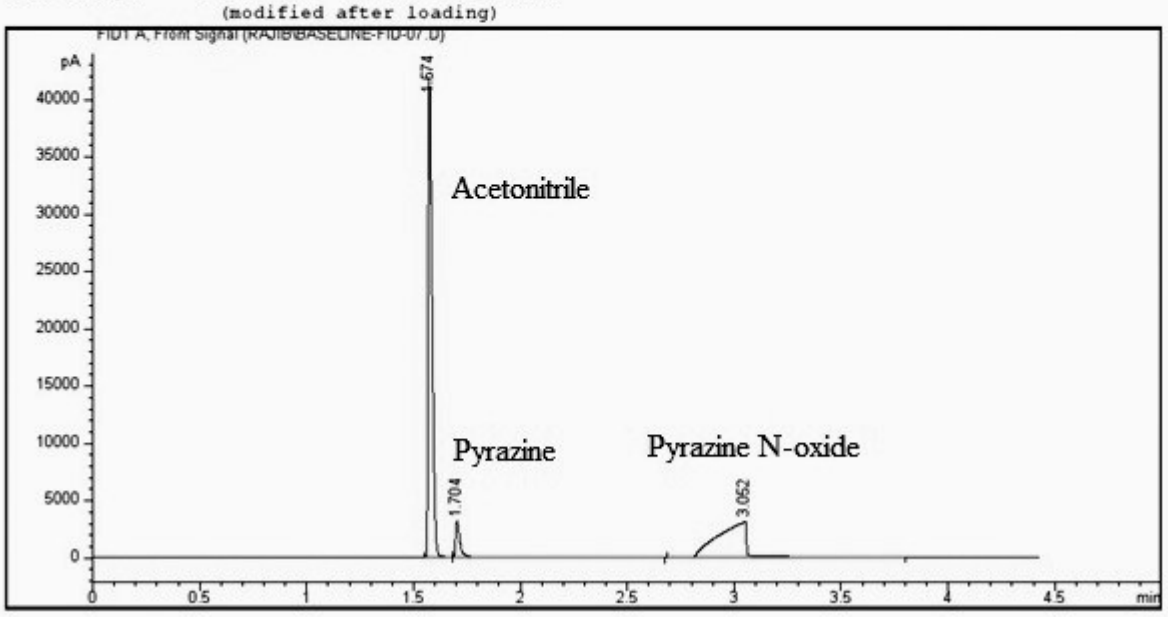



```
  ======================================================================
```

Pyrazine N-oxide (Table 1 entry 6)**:**

```
Data File C:\CHEM32\1\DATA\RAJIB\BASELINE-FID-07.D

  ======================================================================
  Acq. Operator   : RAJIB
  Acq. Instrument : Instrument 1                    Location : Vial 1
  Injection Date  : 7/26/2015 4:26:33 PM
                                                   Inj Volume : Manually
  Acq. Method     : C:\CHEM32\1\METHODS\FID.M
  Last changed    : 7/26/2015 4:24:59 PM by RAJIB
                    (modified after loading)
  Analysis Method : C:\CHEM32\1\METHODS\FID.M
  Last changed    : 7/26/2015 4:31:02 PM by RAJIB
                    (modified after loading)
```

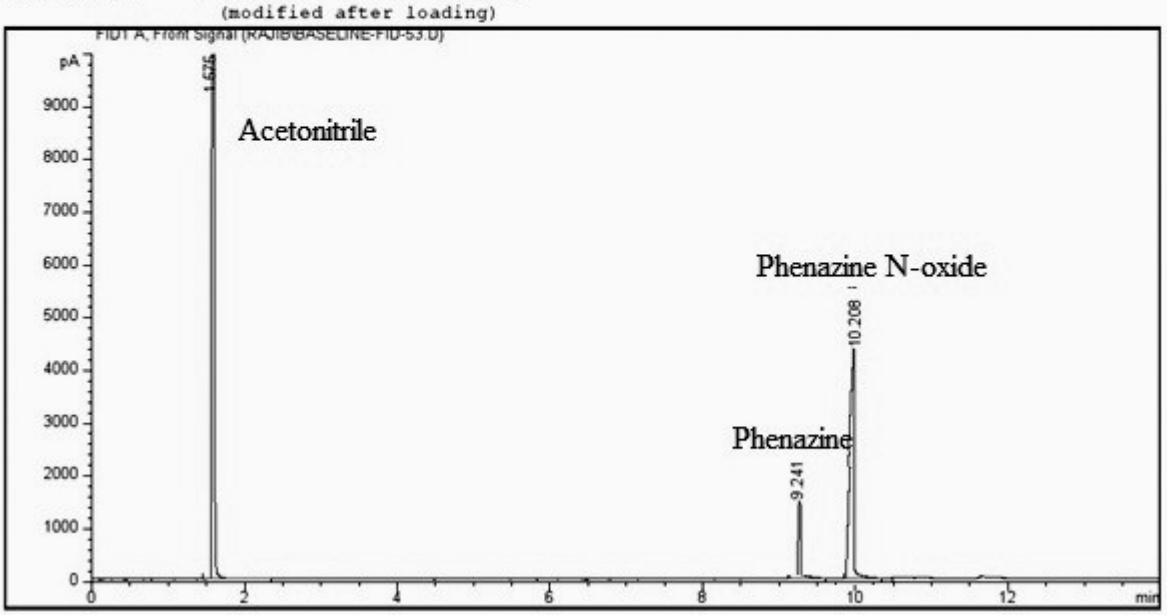



```
  ======================================================================
```

Phenazine N-oxide (Table 1 entry 7)

Data File C:\CHEM32\1\DATA\RAJIB\BASELINE-FID-53.D

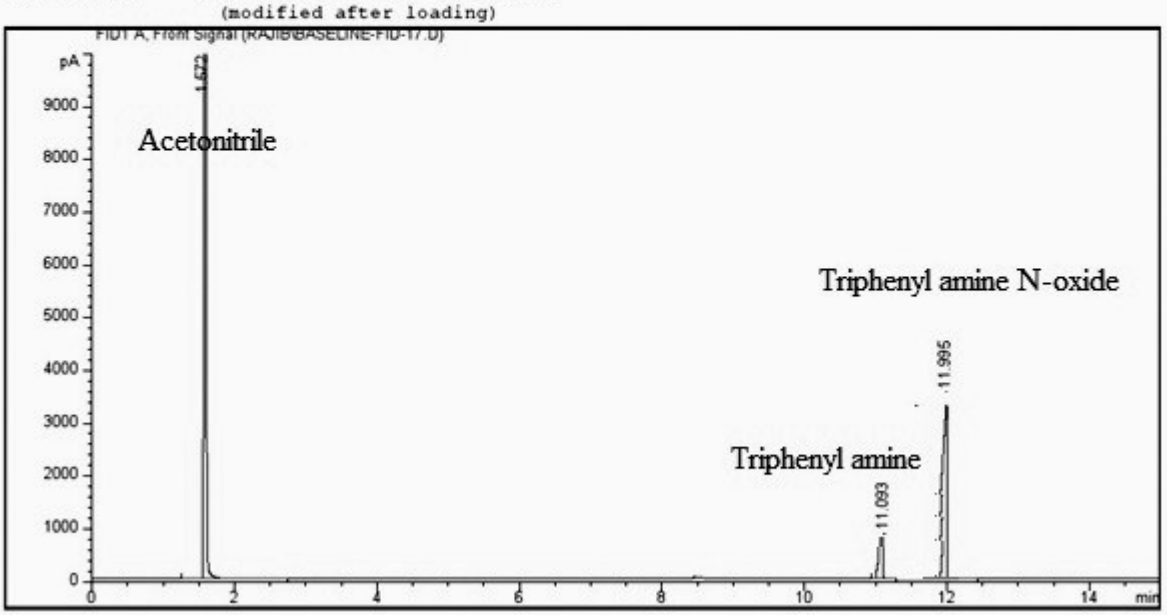
```
Acq. Operator   : sg
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 7/30/2015 7:41:11 PM
                                                  Inj Volume : Manually
Acq. Method     : C:\CHEM32\1\METHODS\FID.M
Last changed    : 7/30/2015 7:39:59 PM by sg
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\FID.M
Last changed    : 7/30/2015 7:58:38 PM by sg
                  (modified after loading)
```



Triphenyl amine N-oxide (Table 1 entry 8)**:**

Data File C:\CHEM32\1\DATA\RAJIB\BASELINE-FID-17.D

```
================================================================================
Acq. Operator   : RAJIB
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 7/26/2015 6:39:28 PM
                                                  Inj Volume : Manually
Acq. Method     : C:\CHEM32\1\METHODS\FID.M
Last changed    : 7/26/2015 6:37:07 PM by RAJIB
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\FID.M
Last changed    : 7/26/2015 6:56:11 PM by RAJIB
                  (modified after loading)
```

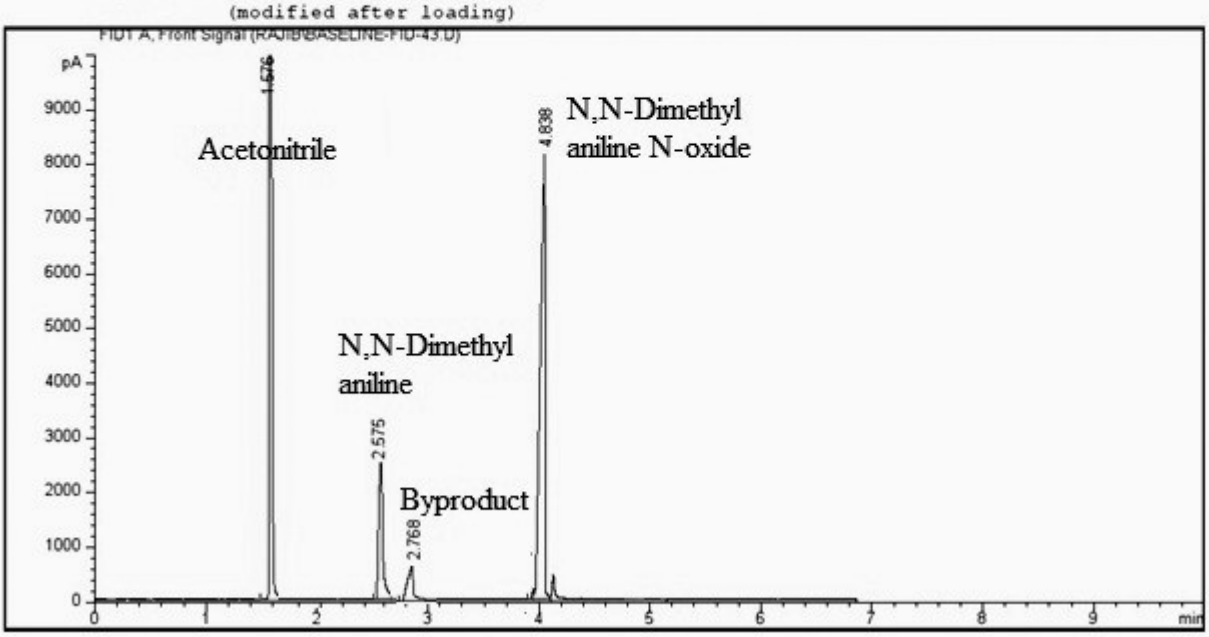



```
================================================================================
```

N, N- dimethyl aniline N-oxide (Table 1 entry 9)

Data File C:\CHEM32\1\DATA\RAJIB\BASELINE-FID-43.D

```
==================================================================
Acq. Operator   : sg
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 7/30/2015 5:35:11 PM
                                                  Inj Volume : Manually
Acq. Method     : C:\CHEM32\1\METHODS\FID.M
Last changed    : 7/30/2015 5:13:07 PM by sg
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\FID.M
Last changed    : 7/30/2015 5:44:04 PM by sg
                  (modified after loading)
```

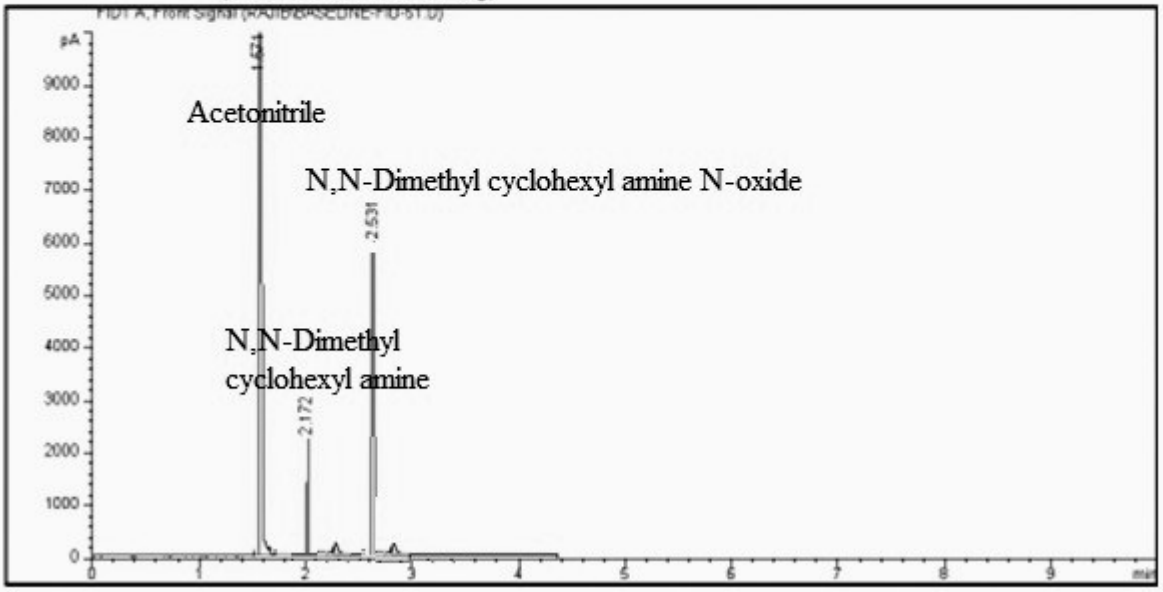


==========

N,N- dimethyl cyclohexyl amine N-oxide (Table 1 entry 10)**:**

```
Data File C:\CHEM32\1\DATA\RAJIB\BASELINE-FID-51.D

  ---------------------------------------------------------------------
  Acq. Operator   : sg
  Acq. Instrument : Instrument 1                    Location : Vial 1
  Injection Date  : 7/30/2015 7:16:17 PM
                                                    Inj Volume : Manually
  Acq. Method     : C:\CHEM32\1\METHODS\FID.M
  Last changed    : 7/30/2015 7:14:32 PM by sg
                    (modified after loading)
  Analysis Method : C:\CHEM32\1\METHODS\FID.M
  Last changed    : 7/30/2015 7:23:21 PM by sg
                    (modified after loading)
```

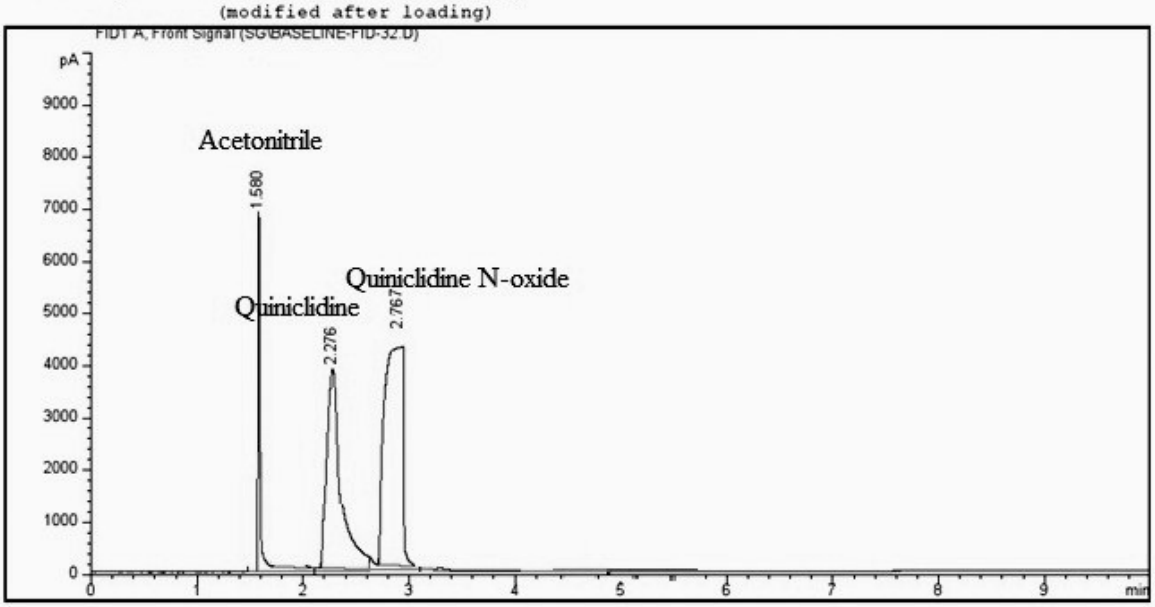



```
  ---------------------------------------------------------------------
```

Quiniclidine N-oxide (Table 1 entry 11)**:**

```
Data File C:\CHEM32\1\DATA\SG\BASELINE-FID-32.D

  ======================================================================
  Acq. Operator   : sg
  Acq. Instrument : Instrument 1                    Location : Vial 1
  Injection Date  : 7/27/2015 2:49:23 PM
                                                   Inj Volume : Manually
  Acq. Method     : C:\CHEM32\1\METHODS\FID.M
  Last changed    : 7/27/2015 2:44:09 PM by sg
                    (modified after loading)
  Analysis Method : C:\CHEM32\1\METHODS\FID.M
  Last changed    : 7/27/2015 3:04:54 PM by sg
                    (modified after loading)
```

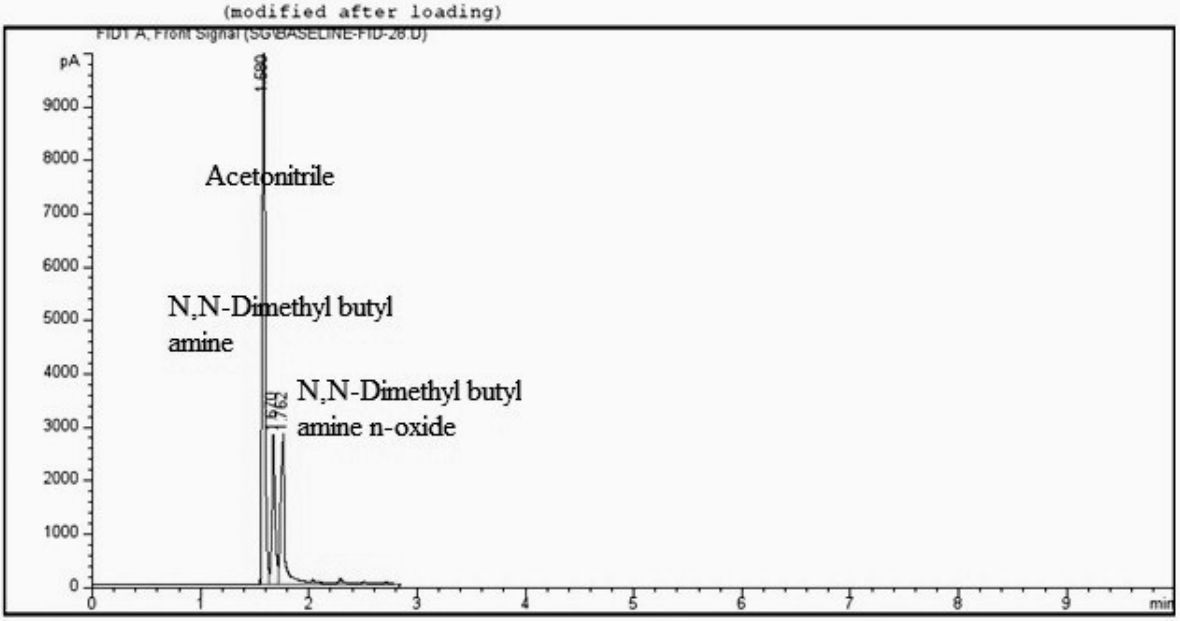



```
  ======================================================================
```

N,N- dimethyl butyl amine N-oxide (Table 1 entry 12)**:**

```
Data File C:\CHEM32\1\DATA\SG\BASELINE-FID-28.D

  ==================================================================
  Acq. Operator   : sg
  Acq. Instrument : Instrument 1                    Location : Vial 1
  Injection Date  : 7/26/2015 8:25:34 PM
                                                   Inj Volume : Manually
  Acq. Method     : C:\CHEM32\1\METHODS\FID.M
  Last changed    : 7/26/2015 8:23:15 PM by sg
                    (modified after loading)
  Analysis Method : C:\CHEM32\1\METHODS\FID.M
  Last changed    : 7/26/2015 8:29:14 PM by sg
                    (modified after loading)
```

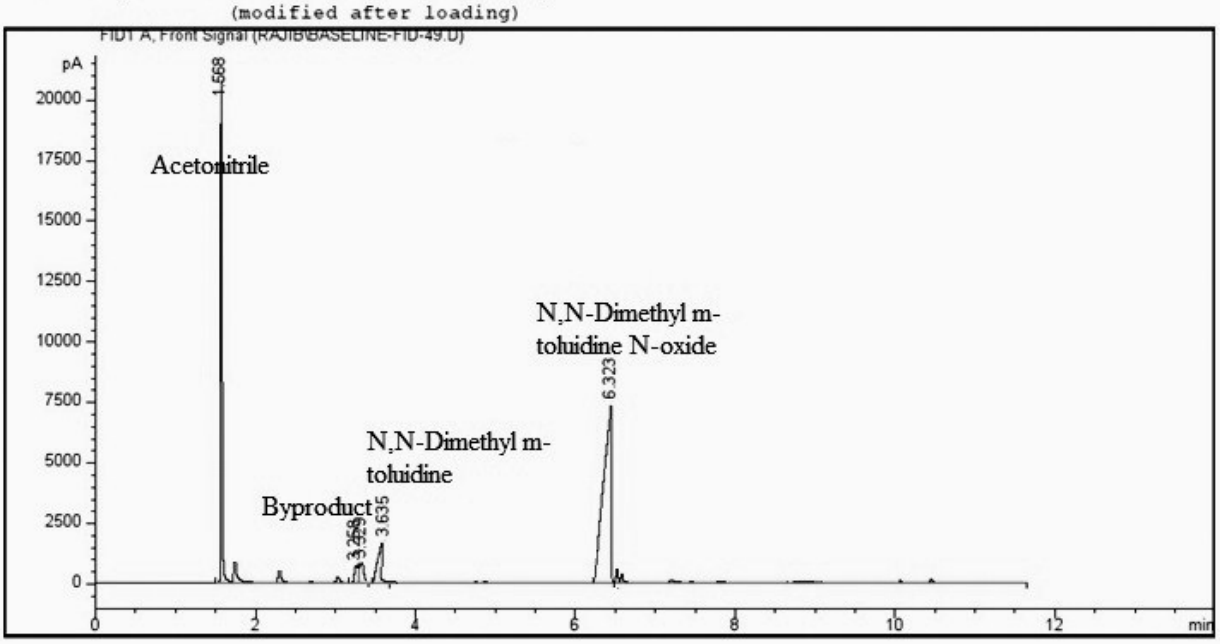



```
  ==================================================================
```

N,N- dimethyl m-toluidine N-oxide (Table 1 entry 14)**:**

Data File C:\CHEM32\1\DATA\RAJIB\BASELINE-FID-49.D

```
======================================================================
Acq. Operator   : sg
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 7/30/2015 6:52:56 PM
                                                  Inj Volume : Manually
Acq. Method     : C:\CHEM32\1\METHODS\FID.M
Last changed    : 7/30/2015 6:49:59 PM by sg
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\FID.M
Last changed    : 7/30/2015 7:04:40 PM by sg
                  (modified after loading)
```




```
======================================================================
```