STP (MBR Based) & RO system At NTPC-Badarpur.

Himansu Karmakar

Deputy General Manager
Department: Chemistry
Badarpur, NTPC Limited, INDIA
Email: himansukarmakar@ntpc.co.in
Mobile: +91 9650996245

Manish

Manager
Department: Chemistry
Badarpur, NTPC Limited, INDIA
Email: manish01@ntpc.co.in
Mobile: +91 9650993774

Neeti Sarpal

Deputy Manager
Department:Chemistry
Badarpur, NTPC Limited, INDIA
Email: neetiarora@ntpc.co.in
Mobile: +91 9650993756

Introduction:

Badarpur thermal power station is one of the oldest power station in India situated in south of Delhi with five no units of total capacity of 705 MW (3X95 MW+2x210 MW). Three units of 100 MW were commissioned in period 1973-75 respectively. 210 MW units were commissioned in period 1978-81 respectively. There are two DM plants WTP-I &II. Currently WTP-II plant is in operation with capacity of 35*4 M^3/hr of each stream.

NTPC Badarpur water source is Agra canal drawn from Yamuna River near Okhla Barrage. The water flow is the river is almost negligible throughout the year almost all water flowing is due to various sewage and other drains of Delhi and adjoining areas. Due to this the quality of intake water is very poor with high organic, inorganic, biological & chemical contaminations. This was leading to various problems in DM plant, cooling water systems and even after best efforts DM water quality could not be met. To overcome the problems of DM plant MBR based STP & RO system was conceived and executed as R&M package for NTPC-Badarpur.

The system has been commissioned and it is under regular operation since March 2016. The plant uses latest technology of Membrane Bio Reactor based STP for inlet raw water treatment. This is followed by RO treatment. The capacity of the plant is designed so that RO permeate generated will be 100 m^3 /hr.

MBR is an activated sludge process that utilizes a physical barrier, the membrane, to filter contaminants from wastewater. Utilizing submerged membranes eliminates the need for secondary clarification and tertiary filtration. By decoupling the activated sludge process from the settling characteristics of suspended solids (MLSS), the footprint of a waste water treatment is reduced significantly. In addition, a MBR is ideally suited for biological nutrient removal (BNR) applications as, coagulated metal salts are easily filtered and captured phosphorous can be collected as Waste Activated Sludge (WAS). The process of MBR uses chemical process of Nitrification, De nitrification and membrane based filtration to achieve desired quality of water at MBR outlet. The MBR membrane pore size is < 0.04µ.

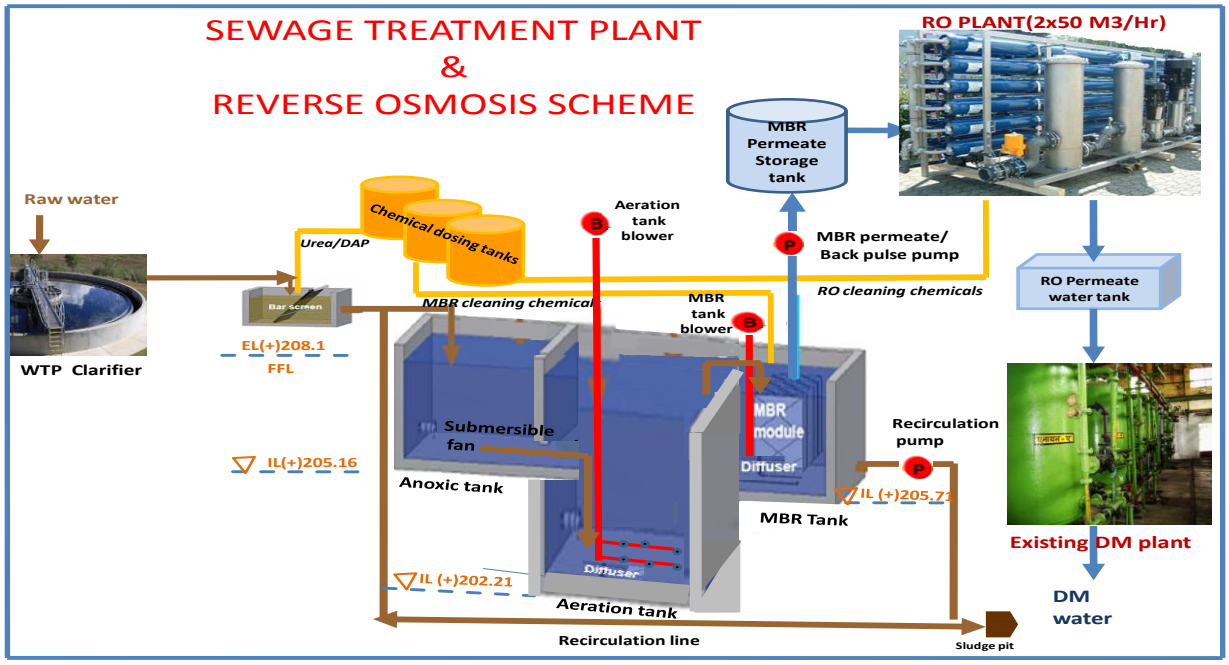
The process sequence of the plant is:

Distribution chamber- Anoxic tank – Aeration Tank – MBR (with MBR cleaning system) tank – MBR permeate tank- RO (with RO cleaning system)-existing filter water tank (RO permeate tank)-existing DM plant.

Another process of biological treatment is MBBR (Moving Bed Bio Reactor) which biologically treats wastewater by circulating moving media in aerobic and anaerobic activated sludge environments. The moving media is typically a floating plastic substrate colonized by a community of bacteria called a bio film. Increased levels of bio film enhance the biological treatment process by introducing a more robust microbial community to break down nutrients

Process Description:

The treated water from existing secondary clarifier will be routed to one number of RCC construction screen chamber. The screened influent water from screen chamber will be routed to two numbers of parallel anoxic tanks. In anoxic tanks denitrification process takes place wherein denitryfying bacteria consumes carbon (Carbon source: Sewage from existing township STP plant) and carry out the de nitrification process. The effluent from this tank will be transferred to aeration tanks by gravity through RCC channels. In aeration tanks MLSS development and oxidation of organic matters takes place. Required dosages of Urea and Di-Ammonium Phosphate (DAP) will be added in to the tank, nitrifying bacteria with the help of Urea and DAP produces desired MLSS and converts nitrogen in various forms in to nitrates and decomposes complex organic matter to simple CO_2 (Carbon Dioxide) and H_2O (Water) molecules. The activated sludge from aeration tanks will be routed to 2 nos. of parallel membrane tanks where further aeration and filtration take place. The membrane bioreactor (MBR) is a combination of two basic processes –biological degradation and membrane separation, where suspended solids and micro-organisms responsible for biodegradation are separated from the treated water by membrane filtration system. The pre-treated water is taken from MBR permeate storage tank with the help of three numbers (2 working + 1 standby) of feed pumps. This water will be disinfected and then it will be allowed to pass through cartridge filter units of <5 micron size cartridge elements. Outlet of Cartridge filter is connected to high-pressure pumps for feeding in RO module for removal of TDS. The Reverse Osmosis unit essentially works on molecular level. It separates the molecular impurities from the water thus making reject stream rich in salt molecules and other stream lean in salts hence reducing the TDS of the permeate water.



Schematic of STP & RO at NTPC-Badarpur

The output quality at MBR outlet will be:

Turbidity <0.5 NTU

BOD< 5 PPM

Total N<10 PPM.

Outlet of MBR is fed to RO and final outlet quality after RO will be:

TDS<150 PPM at maximum design conductivity i.e 2500 µS/cm

Benefits:

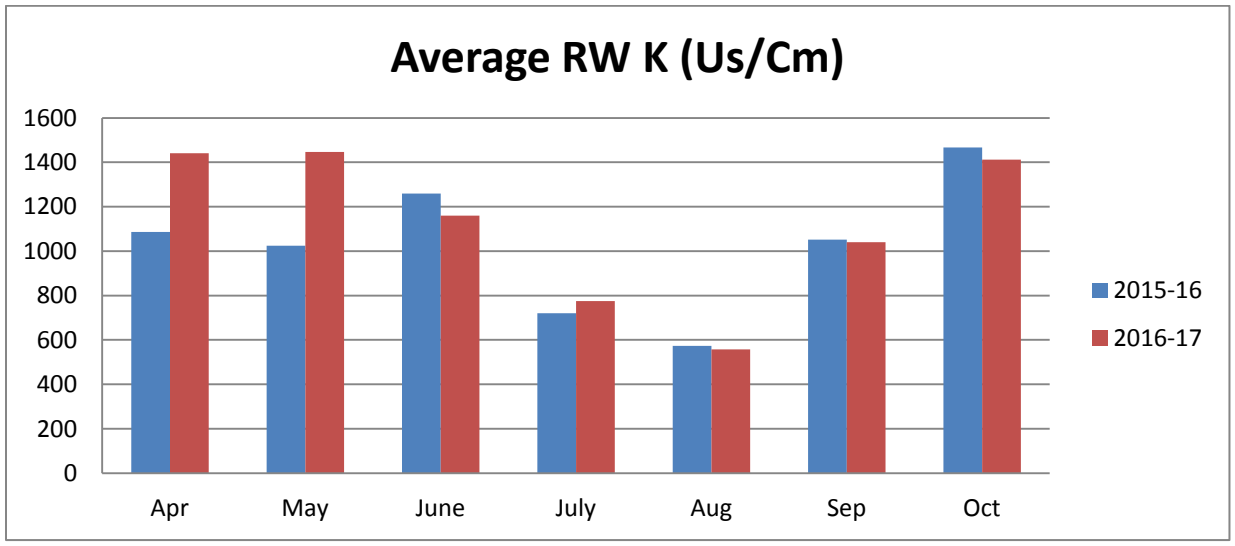
After the regular operation of the plant we have significant benefits in terms of regenerations numbers, chemical consumption, meeting the quality of DM water.

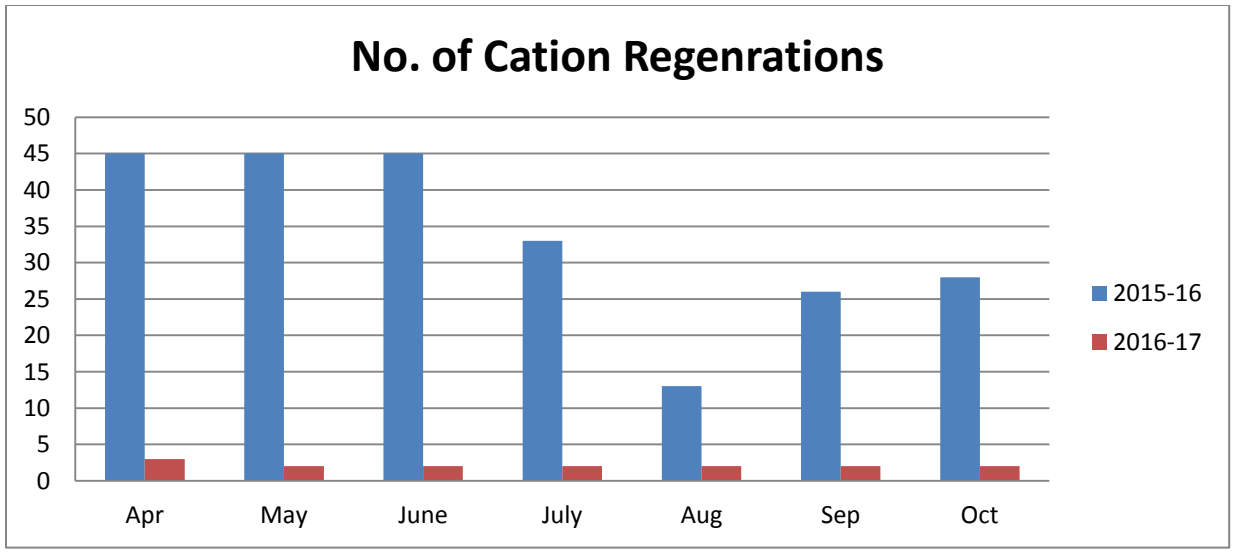
DM WATER COST FOR YEAR 2014-15							DM WATER COST 2016-17			
	DMW PDN(M3)	Cost Rs/MT	Resin used	Ltr	Cost Rs/lt	Total resin cost(Rs)	DMW PDN(M3)	Cost Rs/MT	Resin Qty(Ltr)	Resin Cost(Total Rs)
Apr	32935	28.85	Cation	7500	67	502500	15357	3.71	625	41875
May	43419	38.47	WBA	8600	192	1651200	16290	2.36	716	137600
Jun	46971	44.75	SBA	4200	132	554400	18110	2.42	350	46200
Jul	46918	39.97					17244	2.40	Resin quantity ratio is 12:1 from 2014-15 consptn.	
Aug	37107	22.52					20378	2.65		
Sep	26704	52.62					16626	3.20		
Oct	34593	73.08					18181	3.55		
Nov	25838	62.10								
Dec	19453	62.14								
Jan	21041	71.87								
Feb	11062	89.5								
Mar	18059	49.88								
Total	364100	52.98				2708100	122186	2.90		225675
Total Cost Of DMW(Rs)				**Chemical+resin cost**		21997815		**Chemical+resin cost**		1281044.86
Savings after STP & RO operation(in Rs)										**20716769.7**

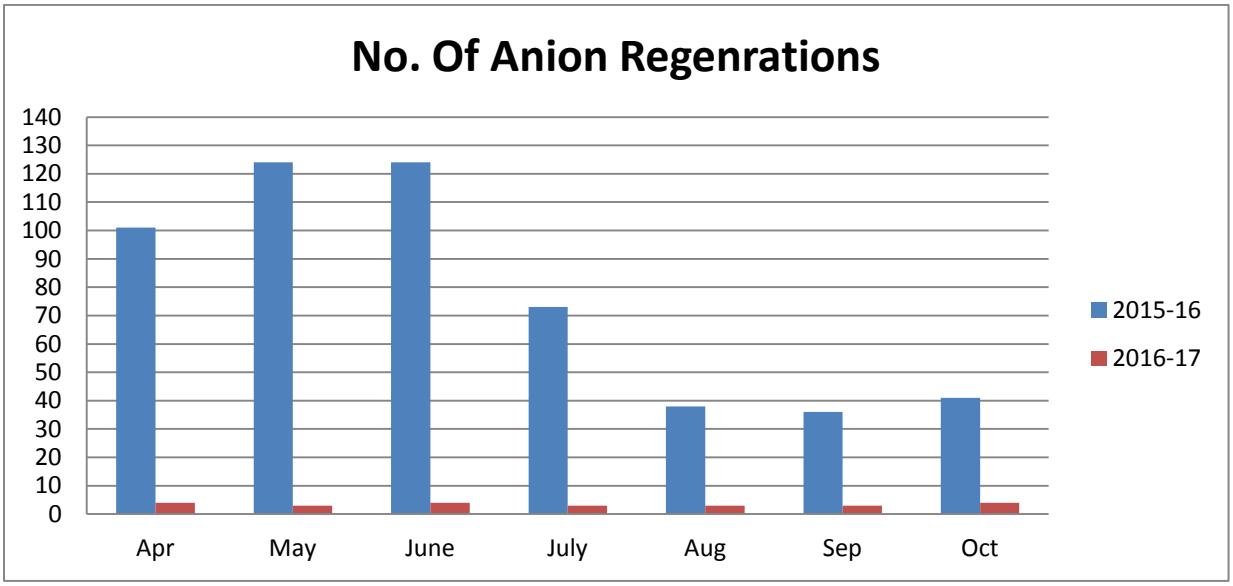
Notes:

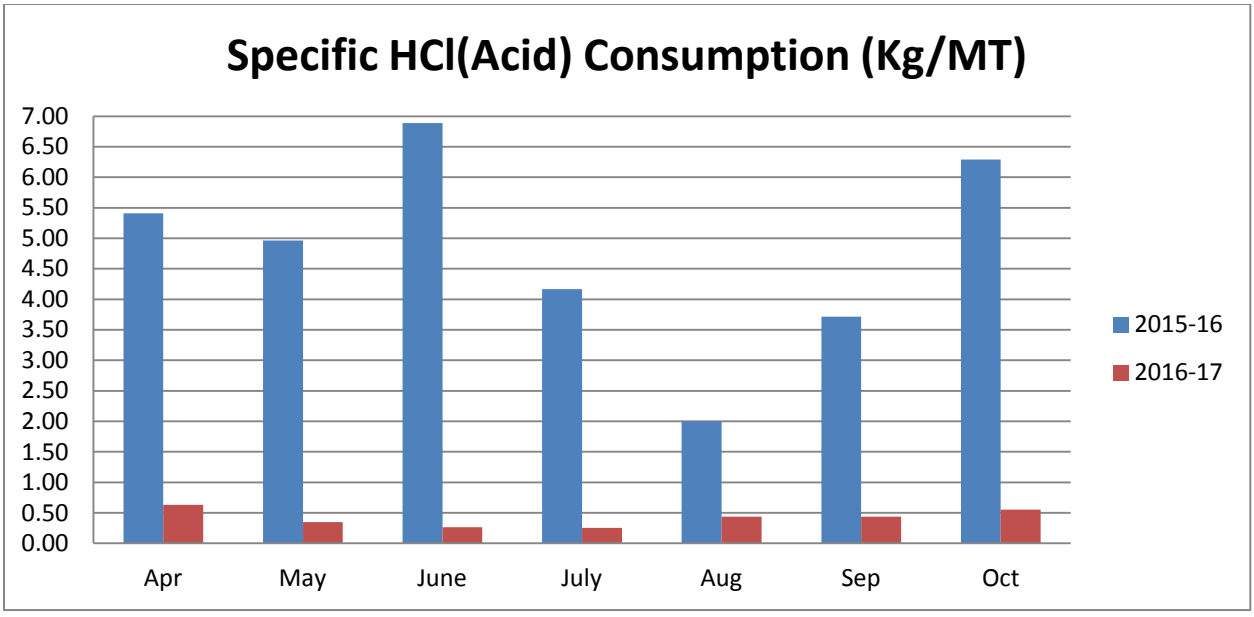
1) The calculation for chemical cost has been done for full year in 2014-15 and for year 2016-17 seven month values has been taken and extended for the whole year.
2) Reduction in maintenance costs of DM plant (WTP-II & WTP-I), chemical handling cost reduction; ACF cost etc. has not been included in calculations. Similarly O&M cost of new STP&RO system has not been taken into account for purpose of calculations.
3) Resin consumption ratio after implementation of STP & RO has been taken as reduced in ratio of 12:1 from earlier period due increased output & better quality of inputs.
4) Benefits in CBD hrs reduction, boiler chemical consumption etc not included.

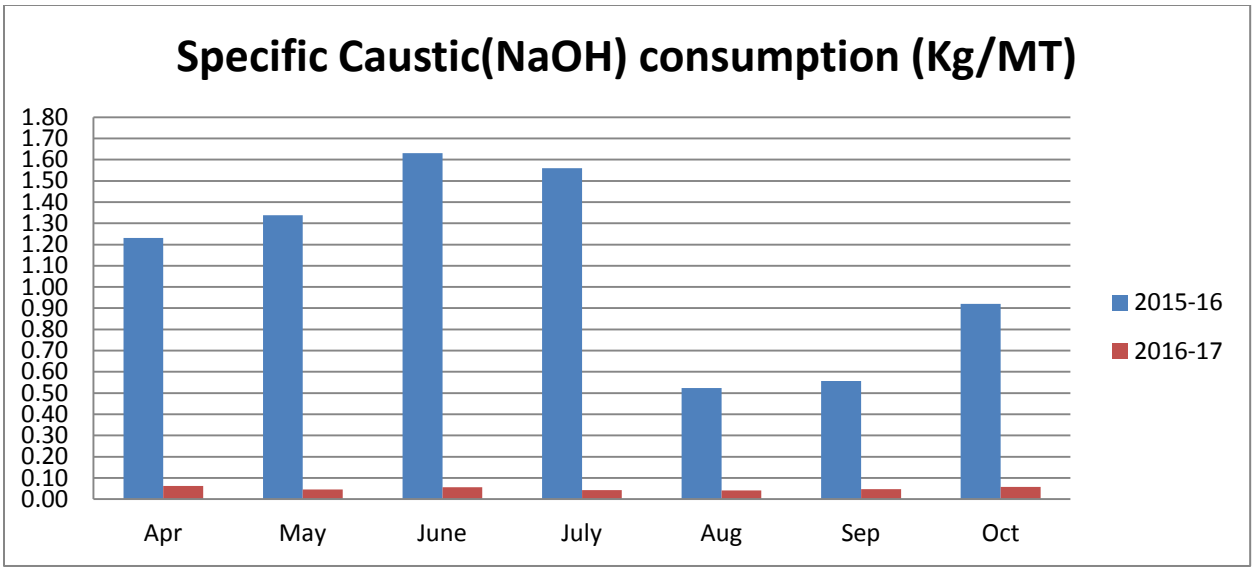
Comparison of various Chemical parameters of Apr-October 2015-16 & 2016-17

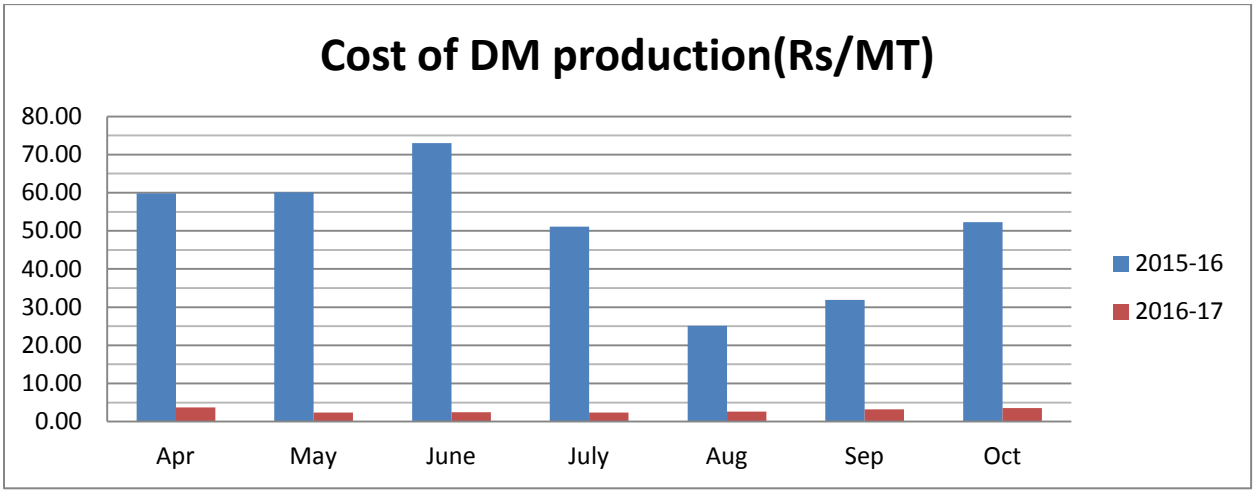





No. Of Anion Regenrations
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Apr
May
June
July
Aug
Sep
Oct
2015-16
2016-17


Specific HCl(Acid) Consumption (Kg/MT)
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Apr
May
June
July
Aug
Sep
Oct
2015-16
2016-17





Conclusion:

The introduction innovative new technology of MBR based STP followed by RO treatment of raw water at NTPC Badarpur has led to significant improvements in terms of quality of DM water produced and reduction in hazardous chemical consumption. The quality of DM water has improved significantly and at mix bed outlet with cond <0.2 µS/cm against 0.8-1.2 µS/cm during earlier period. The conductivity of DM tank which used to go up to 7-10 µS/cm during summer season is now in the range of 1.0 µS/cm.

Better quality of DM water has led to:

1) Significant improvement in boiler water quality with ACC now in range of 0.4-0.5 µS/cm as against 1.0 µS/cm.
2) Reduction in blow down as now average blow down in units is approx 1hr/day as against 4-5 hrs/day.
3) Significant reduction in chemical consumption in regeneration is helpful in eco friendly and sustainable power generation at Badarpur.

References:

1. Technical diary, NTPC, Badarpur
2. Manual of STP & RO
3. Internet resources
4. Power Plant Performance By NTPC
5. NTPC, Badarpur intranet
6. ORT data of NTPC Badarpur

Authors Profile

Shri Himansu Karmakar is currently working as Deputy General Manager at NTPC-Badarpur. He has joined NTPC in 1990 as executive trainee. He has done is post graduation In Chemistry with specialization in Inorganic from University of Calcutta.

Shri Manish is currently working as Manager (Chemistry) at NTPC Badarpur. He has joined NTPC in 2002 as Assistant Chemist Trainee .He has done is post graduation In Chemistry with specialization in physical chemistry from University of Delhi.

Smt Neeti Sarpal is currently working as Dy.Manager (Chemistry) at NTPC Badarpur. She has joined NTPC in 2005 as Assistant Chemist Trainee .He has done is post graduation In Chemistry with specialization in organic chemistry from University of Delhi.