Overview of Ammonia Production in India

Manish Goswami
Chief (Technical)
The Fertiliser Association of India, New Delhi
tech@faidelhi.org

Presented at IIChE-FAI Seminar on “Recent Developments in Catalysis in Process Industry” during 21-22 March, 2023, New Delhi

Introduction

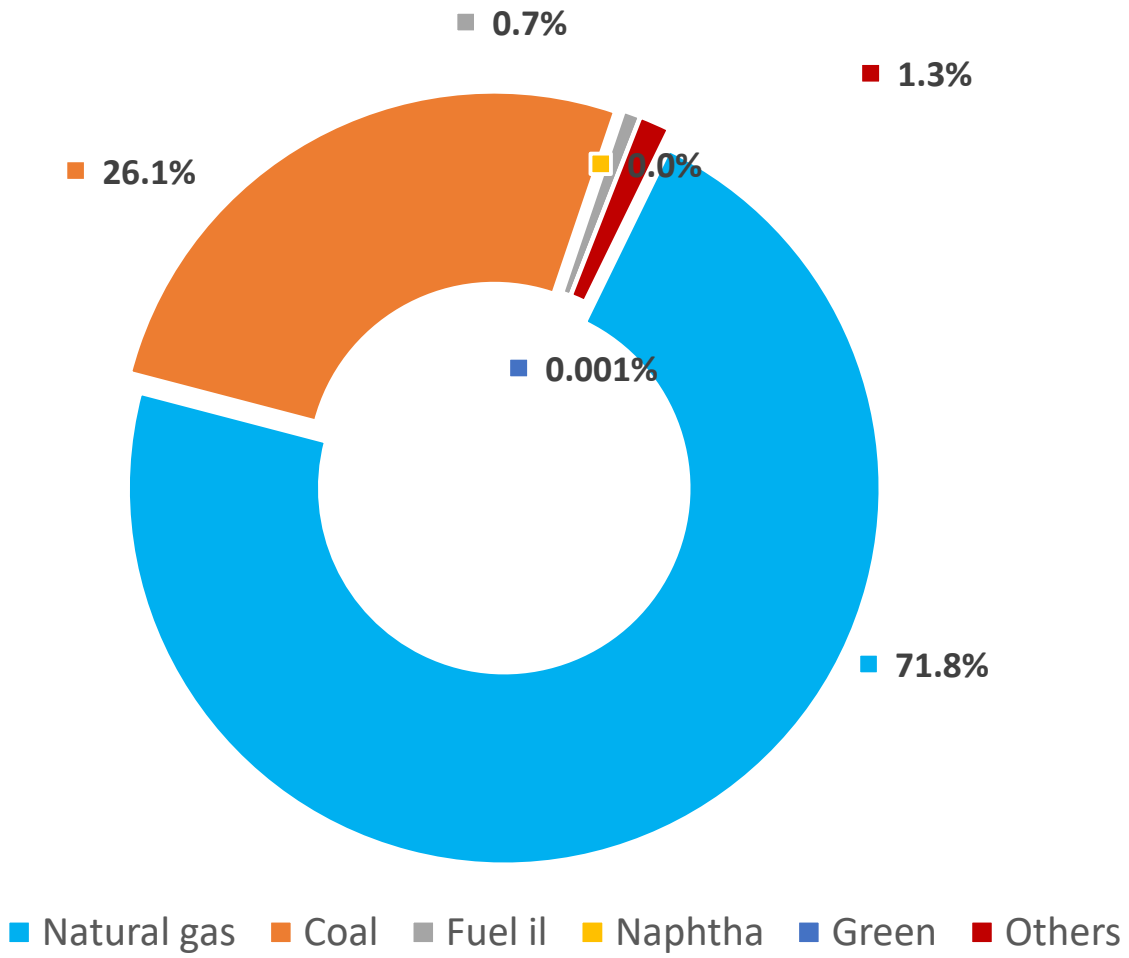
- **Nitrogen is derived from a common intermediate i.e. Ammonia for making all nitrogenous fertilizers and Complex fertilizers.**

- **About 70% of World ammonia production is used for making fertilizers (Source :IEA).**

- **In 2022, India ranks 3rd globally in terms of its capacity.**

Feedstock wise Ammonia Capacity (World) 2022

Feedstock	Capacity (million tonnes)
Natural Gas	166.2
Coal	60.4
Fuel Oil	1.7
Naphtha	0.017
Green	0.002
Others	3.0
Total	231.3



Source: IFA, Paris

Build up of Ammonia Capacity in India

Year	Ammonia Capacity (million tonnes)	No. of Plants
1980 - 81	5.7	29
1987 - 88	8.6	33
1990 - 91	10.4	40
2001-02	13.7	38
2009 - 10	14.3	35
2017-18	14.8	35
2019-20	15.5	38
2021-22	18.5	42
2024-25 (Projected)	19.7	44

Share of Feedstock in Capacity of Ammonia

Feedstock	% Capacity Based on Various Feedstocks	
	As on 1980	As on 2023
Natural Gas	13.8	98.8
Naphtha	54.9	1.2*
Fuel Oil	20.8	-
Coal	10.5	-
Total	100.0	100.0

*one plant is partially based on naphtha due to non-availability of natural gas to its full requirement.

Catalysts in use in Ammonia Plant

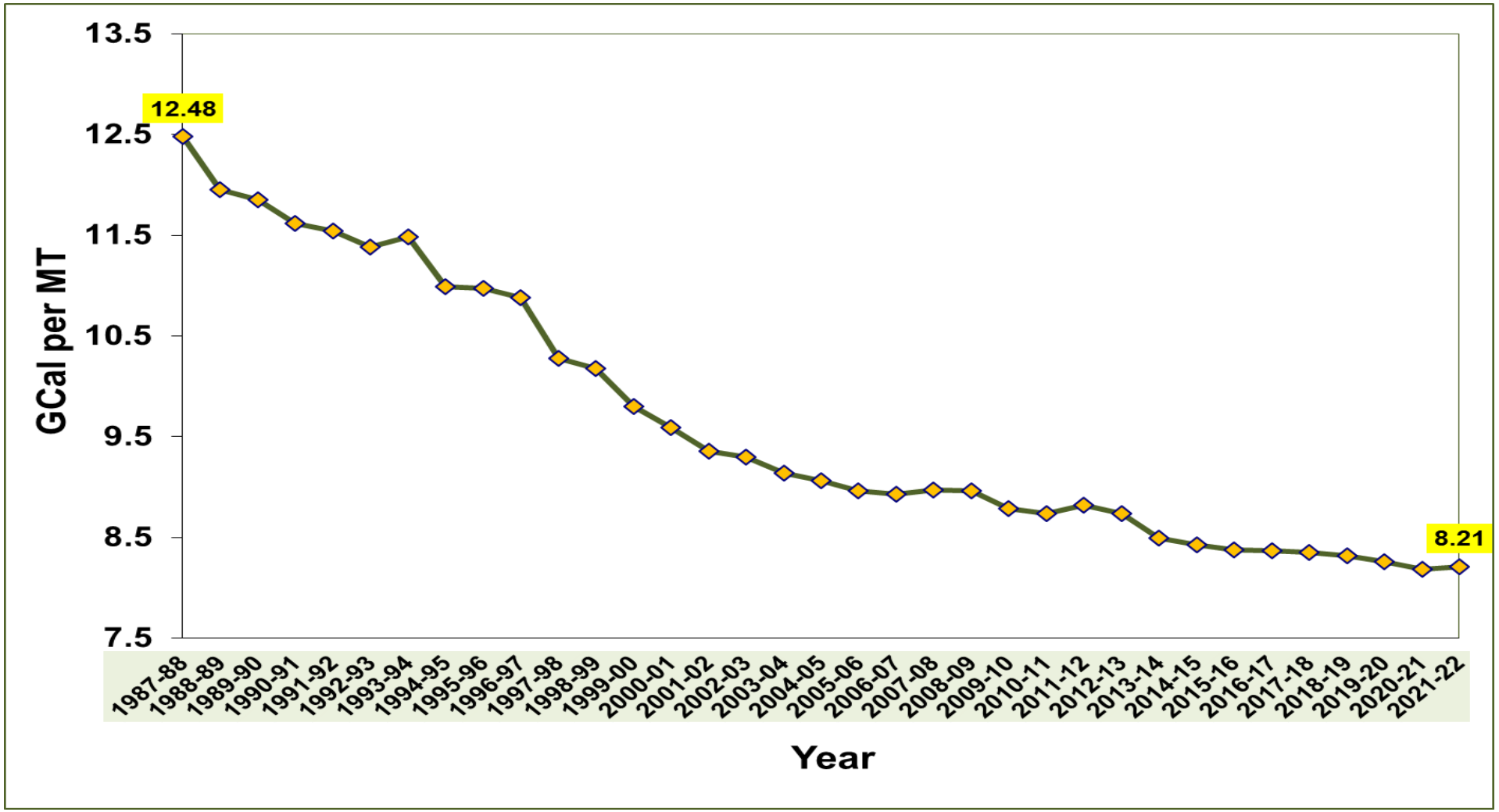
Sl. No	Service	Catalytic System	Operating Temperature (deg C)	Catalyst life Achieved in Plant Operation (Years)
1	Hydrodesulphurization	$CoO\text{-}MoO\text{-}Al_2O_3$ $CoO\text{-}NiO\text{-}Al_2O_3$	350-400	5
2	Desulphurization	ZnO	350-400	2
3	Pre-reforming	$NiO\text{-}Al_2O_3$	700-850	5
4	Primary Reforming (natural gas)	$Nio\text{-}Al_2O_3$	700-800	5-15
5	Secondary Reforming	$NiO\text{-}Al_2O_3$	900-1200	5-10
6	High Temperature Shift	$Fe_2O_3\text{-}Cr_2O_3$ $Fe_2O_3\text{-}Cr_2O_3\text{-}CuO$	350-550	8-10
7	Low Temperature Shift	$CuO\text{-}ZnO\text{-}Al_2O_3$	180-250	5-10
8	Methanation	$NiO\text{-}Al_2O_3$	280-350	10
9	Ammonia Synthesis	$Fe_3O_4\text{-}K_2O\text{-}Al_2O_3\text{-}CaO$	350-550	10-20

Actual Life of Catalyst Achieved (2017-18)

Sl. No.	Catalyst	Maximum Life Achieved	Comments
1	Primary Reformer	15.8 years	About 0.6 M^3 of total charge of about 34 M^3 catalyst was replaced after 8 years and about 8.0 M^3 after 11 years of initial charge.
2.	Secondary Reformer	19.8 years	Another plant reported longer life with partial replacement. The oldest catalyst charge is operating with life of 23 years. Replacement charges are operating with 17.5 years and 5.7 years.
3.	HT/MT Shift	19 years	The top layer about 2.4 M3 of the catalyst was scooped after 11 years. Another plant has reported a life of 15.7 years.
4.	LT Shift	31 years	The plant has reported that the catalyst was never scooped.
5.	Synthesis Catalyst (2-bed/3-bed)	26 years	The first charge is still in service. The plant installed an additional 3-bed converter in parallel after 15 years of operation. Four other plants have reported values about 22-23 years and three plants between 16 to 19 years.
6.	Synthesis Catalyst (single bed additional converter)	13 years	The catalyst is in operation since beginning.

Source: FAI, New Delhi

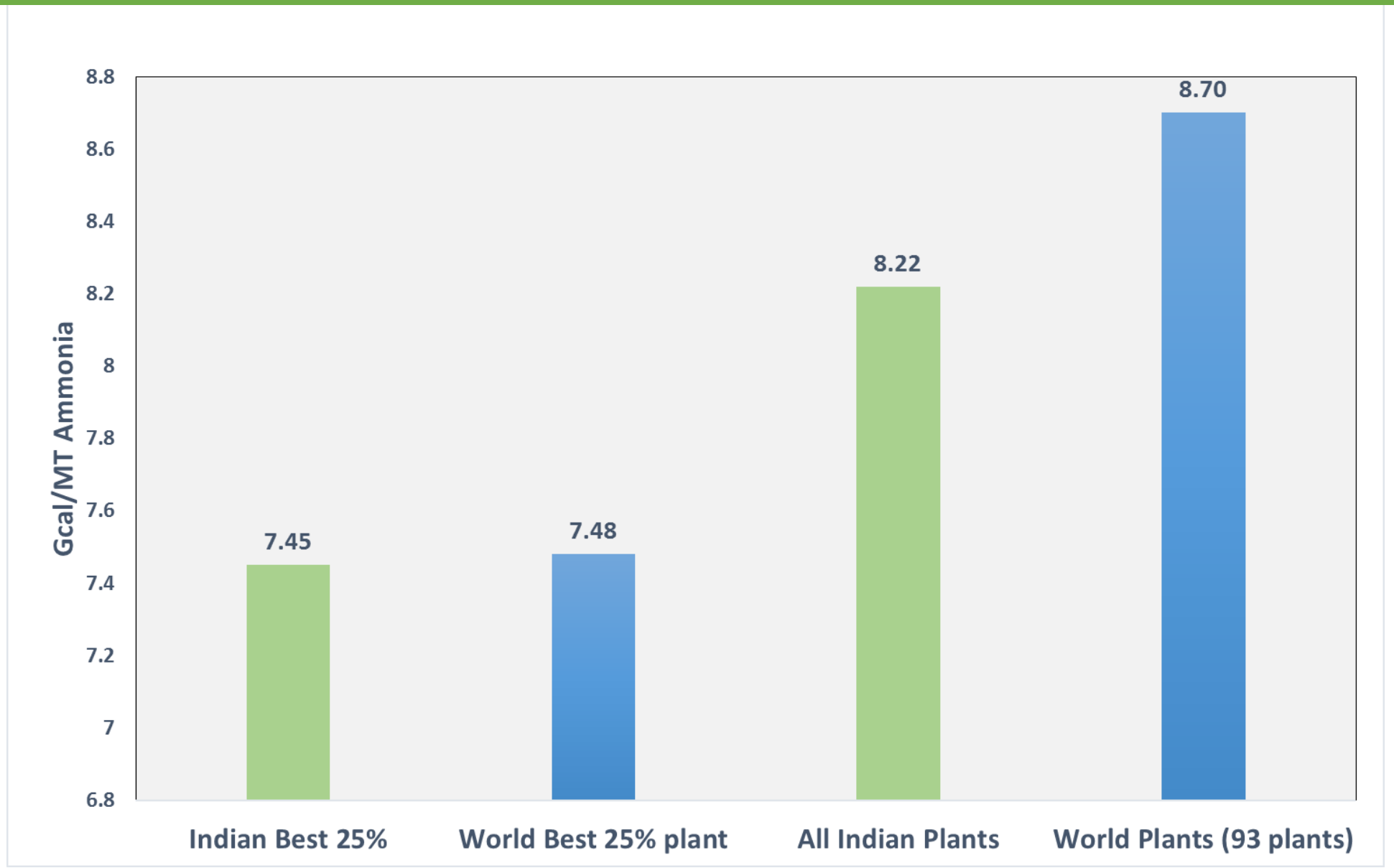
Trend in Energy Consumption of Ammonia Plants in India



- Energy (NH_3) = $E_{feed+fuel\ to\ reformer} + E_{Power} \pm E_{steam}$
- Energy consumption based on NCV at the battery limit of respective plant.
- Steam considered at its enthalpy, Allocated share of utilities , Credit /debit for steam export/import

Source: FAI, New Delhi

Benchmarking of Energy Efficiency of Ammonia Plants 2019-2020



Source: IFA, Paris and FAI, New Delhi

Conclusion

- Indian ammonia plants are of varied vintage and capacity.
- Over the years the feedstock changed from coal, naphtha and fuel oil to almost 100% natural gas.
- There has been consistent capacity addition since 1950s till 1999. After a pause of almost 10 years again about 6 new plants were commissioned with latest energy efficiency features and new designed catalysts.
- Older plants have also modernized through adoption of improved process technologies, improved catalysts, retrofit/replacement of old static and rotating equipment, and change of feedstock.
- Benchmarking with world plants shows that Indian ammonia plants are operating at par with best plants in the world.
- Catalysts also played an important role in moderating the operating conditions in ammonia production, better conversion efficiency and hence improved energy efficiency of individual process steps and ammonia process.

Thank You