COMMISSIONING/PERFORMANCE ACTIVITIES OF HEAVY WATER PLANT(HAZIRA)

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Introduction :

Heavy Water Plant,Hazira is the fourth in the line of plants based on monothermal NH3-H2 exchange process. The experience gained during operation of other Heavy Water Plants is reflected in construction, commissioning and operation of HWP, Hazira. While the commissioning problems have been discussed separately as case studies, this paper aims at out lining the strategy adopted for both commissioning and operation.

Commissioning & operational strategy :

(A) Chemical cleaning was carried out in all strategic areas for both equipments and piping in advance to minimise future problems mainly of chockings.

(B) The whole plant was divided into various loops and were leak tested with nitrogen followed by hold-up test. The results of hold-up tests were extrapolated to arrive at leakage rates with synthesis gas at actual pressure conditions (as per the guidelines given by PDSC appointed by Atomic Enery Regulatory Board(AERB) for clearance of the project). Later, the units were leak tested with synthesis gas at actual operating conditions and results were checked for leakage rates, to be within the limits of extrapolated values.

The purpose of these tests was to ensure not only the leak tightness of the plants but also to avoid environmental pollution.

(C) After clearance from PDSC, on submission of results of the hold- up tests with actual operating process fluids, permission was obtained to commission the plants in various stages.

The first units to be commissioned were ammonia refrigeration and ammonia synthesis unit. It may be mentioned that utilities such as Water Pre-treatment Plant, Cooling Tower, Instrument Air, Nitrogen, Steam Net-work and Effluent Treatment were commissioned much in advance.

(D) The ammonia synthesis section was commissioned, to meet the requirement of ammonia for ammonia washing of the plant. The purpose of ammonia washing was three fold.

(a) To remove all the impurities including moisture down to traces.

(b) To test the exchange tower pumps, other moving equipment and to commission crackers.

(c) To simulate all the system control loops and check instrumentation for proper functioning.

For ammonia washing, plant refrigeration system was needed. As commissioning of main plant refrigeration system was delayed, an interconnection of main plant refrigeration loop with synthesis refrigeration was resorted to and utilised to avoid delay in main plant commissioning.

(E) For commissioning of main crackers fuel gas was needed. As there was delay in natural gas supply from M/s.ONGC, synthesis gas was used as a fuel, for refractory curing of main cracker. This was done to avoid delay in commissioning.

After the fuel gas supply was made available from M/s.ONGC, the cracker catalyst was reduced and put on ammonia service.

(F) The entire plant covering all units such as synthesis, drying, purification, isotopic exchange, catalyst purification, crackers & final enrichment were put on dynamic run with synthesis gas and ammonia to simulate actual operating conditions. In this process, many of the process problems like 14C1 reflux, improper draft in cracker furnace etc.) were identified & rectified.

(G) During the above period, potassium amide catalyst preparation was taken up as a parallel activity, as the capacity of preparation unit is small & volume required was large.

(H) On clearance from AERB, charging of amide catalyst began in mid December,1990. Thus the process of extraction was commenced & it was possible to commence production of off-grade heavy water by end December,1990.

PLANT PERFORMANCE DURING THE FIRST YEAR OF OPERATION

The performance during the inaugural year ending December,1991 has been quite satisfactory. It is significant to note that loss of onstream hours could be attributed essentially to external factors such as power failures from GEB and non-availability of natural gas from ONGC to KRIBHCO/HWP. The loss of onstream hours due to non-availability of synthesis gas from KRIBHCO and problems in the plant had been minimal. The break-up onstream hours is as under.

		Plant-A Hrs/Min	Plant-B Hrs/Min
Total available hours	=	8760.00	8760.00
Loss of hours due to GEB power failure	=	295.07	232.50
Loss of hours due to non-availability of natural gas from ONGC	=	270.00	272.00
Loss of hours due to non-availability of gas from KRIBHCO	=	258.20	256.10
Loss of hours due to HWP problems	=	460.00	210.50
Loss of hours due to Annual Turn around	=	1026.00	781.20
Total loss of hours	=	2309.27	1753.10
Percentage of onstream hours	=	73.6 %	80.0 %

The performance of various units in the plant & strategies adopted are highlighted below.

I. Driers :

The incoming wet gas to alumina gel driers is being precooled to -5 degree C (against design temperature 5 degree C) to knock out maximum moisture, thereby reducing load on driers. Further continuous closed loop draining of driers into return synthesis gas header, is adopted to conserve synthesis gas lost in open draining.

Also, advantage is taken of reduction in moisture load, by operating the driers on 12 hours cycle against conventional 08 hours cycle, while keeping the heating period same (i.e. 06 hours). This resulted in steam saving and less wear & tear of drier valves.

II. Purifiers :

Initially the purifiers were charged with potassium amide to get catalyst concentration of 50-60 gm/kg ammonia.

However, at this concentration carryover of amide into down stream units was observed and it was reduced in steps to 25-30 gm/kg of ammonia. By operating at this concentration it is found that carryover problem is minimised. Owing to the advantage of getting clean gas from ammonia plants it was not required to change over the purifiers for the past one year.

III. Isotopic exchange towers : 12T1/T2 :

During the guarantee test run of synthesis and cracker units 12T2 was operated at 105% of cracker load and 12T1 was operated with maximum possible liquid to gas ratio. At these conditions, deuterium extraction in 12T1 was found to be maximum (inlet D/D+H = 102 ppm and outlet D/D+H = 18 ppm). Also, it is observed that the 12T2 extraction is higher when down-stream MP loop concerntration is maintained low.

Further 12T1 is operated at maximum possible pressure (i.e. 207 kg/cm2) by throttling the control value (09HCV08) in the return synthesis gas header to improve the extraction efficiency. From the experience gained during the past one year, it is observed that amide concentration of 25-30 gm/kg ammonia in 12T1 is quite sufficient. 12T2 was operated in the temperature range of -5 degree C to +8 degree C and it was found that the best performance was achieved at temperature of +5 degree C by way of maximum extraction in 12T2. The performance of 12T1/12T2 during GTR and present conditions is highlighted below.

Sl. No.	Description	D/D+H in ppm during GTR (March,1991)	D/D+H in ppm at present (December,1991)
1.	12T1A inlet/outlet	103/18	102/20
	12T1B inlet/outlet	103/19	102/27
2.	12T2A inlet/outlet	1.83%/147	1.37%/145
	12T2B inlet/outlet	1.68%/136	1.94%/164

IV. Catalyst purification unit :

It has been possible to operate this unit at full load without any problems. The main contibutary factors are :

(a) By having good water quality control on cooling water side. Column 14C1 is being operated at lower pressure of 22 kg/cm2 aginst normal operating pressure of 25 kg/cm2.

(b) By modifying tunnel tray of amide-ammonia distillation column(14C1) for feed to pure ammonia vessel 14V3, has led to improved reflux thus elimininting slippage of potassium to cracker unit.

(c) Catalyst stripping column 14C2 is being operated with liquid amide/vapour ammonia in feed ratio of 2.4/2.9 tonns per hour thereby achieveing an approach of 5 to 10 ppm 'Deuterium' at 14C2 outlet.

V. Crackers :

Both the cracker units are functioning quite satisfactorily for the last one year. During guarantee test run, the crackers were operated at 105% of the rated capacity for meeting the design specifications.

The design temperatures of cracker tube skin, cracker catalyst bed & pigtails are 717 degree C, 630 degree C & 625 degree C respectively. However, in recent findings, it was observed that it is harmful to have tube skin temperatures above 680 degree C as at this limit granular deformation of tube takes place. For these reason PDSC has set stipulations to control these temperatures by putting limit on pigtail temperatures at cracker outlet not to exceed 590 degree C. Hence crackers are being run at slightly lower temperatures resulting in less cracking by about 5% than the design. Various operating parameters depicting design, guarantee and present operating conditions are tabulated below.

Sl. No.	Parameters	Cracker-A			Cracker-B		
		Design	GTR Mar'91	Actual Nov'91	Design	GTR	Actual Nov'91
1.	Liquid feed flow rate(Te/hr)	15.673	16.156	16.357	15.673	16.416	16.559
2.	Ammonia free cracked gas flow rate (Te/hr)	12.817	13.814	12.440	12.817	13.810	12.600
3.	Quantity of cracked gas as % of NH3 on mole basis	Maximum 10	7.815	13.600	Maximum 10	8.623	13.500
4.	Specific energy consumption as MM Kcal/1000 NM3 of cracked gas	0.460	0.402	0.430	0.460	0.411	0.4159

This reduction on cracker load has resulted in less extraction in isotopic exchange tower 12T1.

VI. Ammonia synthesis unit :

The ammonia convertor performance continuous to be good from the last one year. The tabulated data given below highlights the performance of synthesis loop.

Parameters	GTR(Mar,1991)	Actual(Nov,1991)
Total ammonia production	768 T/day	800.0 T/day
Liquid ammonia production	720 T/day	789.1 T/day
Quality of ammonia	99.9 %	> 99.99 %
Steam production per tonne of ammonia	990 Kgs.	1083 Kgs.
Steam pressure	15 kg/cm2 g	15.8 kg/cm2 g
Power consumption per tonne of ammonia	142 kwh	88.1 kwh

VII. Downstream efficiency :

It has been possible to increase downstream efficiency for production of Heavy Water(downstream of isotopic exchange tower 12T1) from 85% in the initial stages of plant run to more than 95% at present. This has been possible due to mainly providing of rupture discs for zero leakage from potential leakage sources from vents in deuterium rich area such as safety valves in 14- Unit, vent control valves in 14 & cracker units etc.

FUTURE MODIFICATIONS PROPOSED/CONCLUSIONS

Already schems are in hand to enhance deuterium in feed synthesis gas from present value of 102 ppm at inlet HWP to about 115 ppm, by way of improvements in steam/condensate networks of ammonia plants. Further to improve extraction in isotopic exchange tower 12T1, in the present system, increase in capacity of main cracker by 10% addition of tubes may have to be contemplated.

With these it should be possible to achieve rated production capacity, as other factors such as availability of good quality synthesis gas and good onstream factors are assured from M/s.KRIBHCO. Further with augumenting of power generation and strenghtning of power grid, power supply position from GEB is bound to improve, in near future, which is required for improvement in onstream running hours for the plant.