Heavy Water Plant – Kota

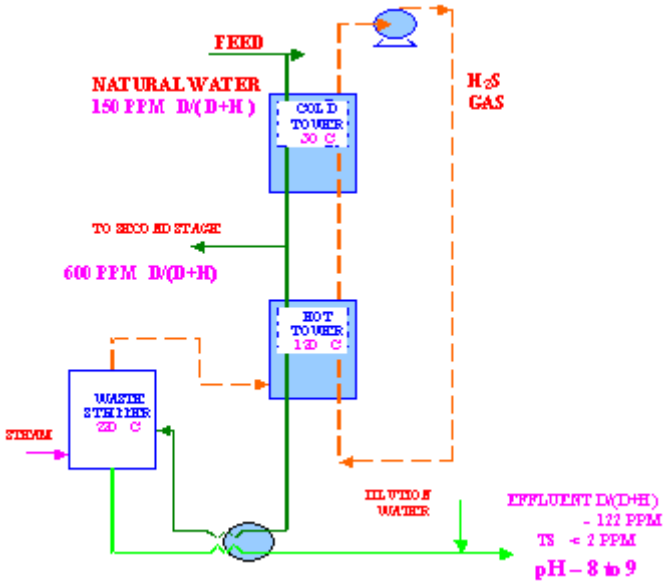
Unit profile

Heavy Water Plant(Kota) is one among the six operating heavy water plants under Heavy Water Board is engaged in the production of heavy water. The heavy water produced is used in natural uranium based Pressurized Heavy Water Reactor (PHWR) as its excellent moderation properties and low neutron absorption cross section makes it specially suited for functioning as a primary coolant as well as moderator in the reactors. Plant is located at Anushakti near Rana Pratap Sagar (RPS) reservoir (close to Rawatbhata/ Gandhisagar road) in Chittorgarh District of Rajasthan State, about 60 kms by road from Kota City.

The Water drawn from river Chambal (150 ppm D_2O) is deminiralised purified for suspended and dissolved impurities, is fed as process feed water in Exchange Unit & is enriched up to 15% by chemical exchange with H_2S in Exchange Unit Towers and followed by vacuum distillation to produce 99.8% D_2O. The exchange unit is arranged in a 3-stage cascade with first stage handling large quantities of process water and H_2S gas and consisting of three pairs of cold and hot towers operating

at 30^0C and 120^0C respectively. The second and third stages each consist of one pair of cold and hot towers.

The purified water enters the top of cold tower and travels down while hydrogen sulphide gas entering the bottom of the tower meets the water in counter current way on tower internals and the exchange of deuterium takes place. In cold tower the water gets enriched with respect to deuterium while gas gets depleted in deuterium concentration. In hot tower the reverse reaction takes place viz the gas gets enriched instead of liquid.



The hot tower bottom liquid coming from the first stage is divided into two parts. One part is recycled to the top of humidification section located at the bottom of hot tower for heat recovery while the other part constitutes the waste. Before discarding the waste to the environment it is necessary to recover the H_2S dissolved in the waste. For this purpose waste stripper is provided to strip H2S by direct steam stripping and the evolved gas and steam is put back to first stage hot towers.

The enriched water (1000N i.e. 15% D2O) from the 3rd stage is stripped off its H_2S in a product stripper and fed to the distillation unit for further enrichment up to nuclear grade. The dynamic hold up of H_2S is about 200 Te and extreme care has been taken in the design of the plant, selection of equipment and materials adhering to stringent fabrication procedures and codes to ensure the production of heavy water in a safe manner. H_2S gas is just a carrier gas and is always in circulation. Periodic make up is done as and when required.

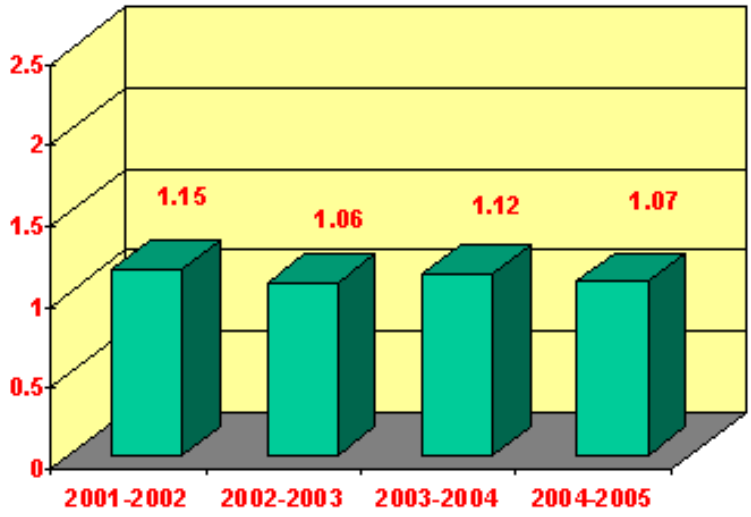
Energy consumption

Production of heavy water is an energy intensive process. The plant consumes about 105 MT/hr steam & about 10 MW of electrical power. Major part energy is consumed because of the irreversibility's in the process. Our efforts on reducing their reversibility is on & we at Heavy Water Plant(Kota) are highly energy conscious. Due to continuous and consistent efforts made by our engineers towards energy conservation programme, Heavy Water Plant, Kota has brought down its specific energy consumption drastically during last three years. The annual consumption of Electricity and steam for the years and total energy for production of one Kg of Heavy Water is given as below :-

Consumption per Kg of D_2O production

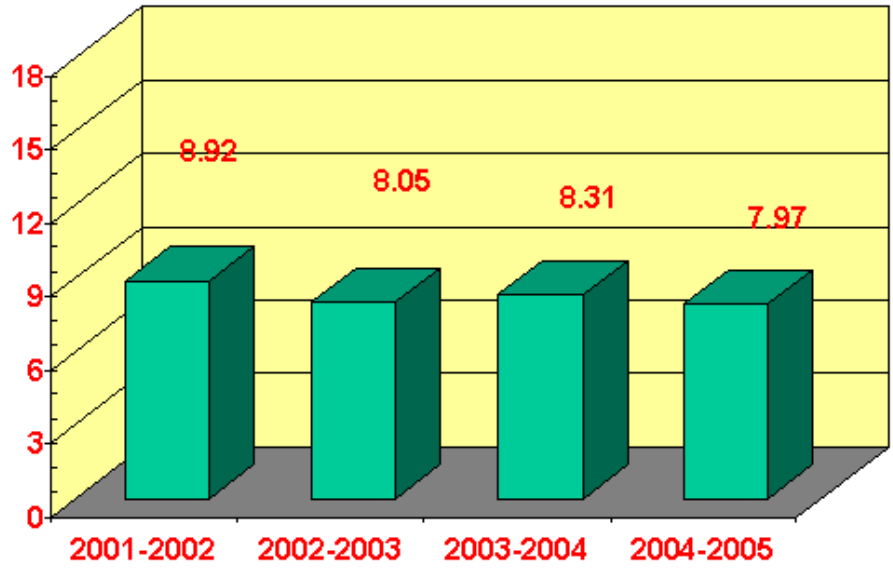
	2001-2002	2002-2003	2003-2004	2004-2005
Electricity MWH	1.15	1.06	1.12	1.07
Steam MT (equivalent) MWH	8.92 1.90	8.05 1.72	8.31 1.77	7.97 1.70
Overall Sp. Energy MWH	3.05	2.78	2.89	2.77

DECREASING TREND OF ELECTRICITY CONSUMPTION MWH/ Kg D_2O

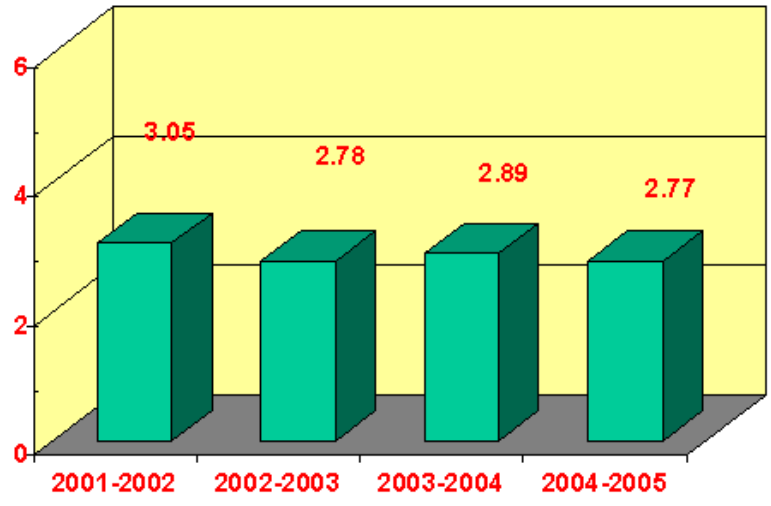


Energy conservation commitment, policy and organizational set up

DECREASING TREND OF STEAM CONSUMPTION
MT/ Kg D_2O



DECREASING TREND OF OVERALL SPECIFIC ENERGY CONSUMPTION MWHR/Kg D_2O



HWP – Kota being an energy intensive plant, achievement of excellence in the field of Energy Conservation is our policy. HWP-Kota has been continuously striving towards minimizing energy consumption.

Energy conservation campaign was given a boost by declaring the year 1999-2000 as energy conservation year. Subsequently every year new target is set for energy conservation and strategies are worked out to meet these targets. To fulfil the commitments towards energy conservation and realize the targets set, following programmes are continuously formulated and implemented.

a) Awareness Programme:

To create awareness for Energy Conservation among all the employees of the plant, publicity through banners at strategic locations of the plant and organization of slogan and poster competition was done. Display of energy consumption parameters viz. steam, electricity and specific energy consumption was done on daily, weekly and monthly basis at strategic locations. Various training programmes for different level of employees through professional organizations were organized to expose the employees to professional approach towards managing energy conservation.

b) Group Interaction for worker participation:

To encourage group activity entire plant was devided into eight plant sections and group of employees including operations, maintainers, supervisors and engineers were formed to interact among themselves and suggest possible measures to reduce energy consumption.

c) Sectional and Plant Level Energy Conservation Review Committee:

Plant maintenance review committee and plant operational review committee was constituted to review major energy consumers like pumps, compressors, etc., to monitor energy consumption versus duty performed, set target for energy consumption on weekly basis and formulate action plan for achieving the said targets.

Plant level energy conservation review committee was headed by General Manager himself and monitoring of energy consumption on daily basis was done. In-house energy audit was conducted once in a year. The merits as well as investments needed verses payback periods in the form of energy savings are discussed in detail.

Energy Conservation Achievements :

The untiring efforts put by plant personnel and encouragement provided by the corporate office particularly by the Chief Executive, Heavy Water Board energy conservation programme has resulted in cumulative 34.79 % reduction in specific energy consumption progressively in the last years taking 1998-1999 as the base year. Most of the energy saving potentials has been exploited during initial three years.

To achieve this, a number of modifications have been implemented. Some of the operational practices and modifications implemented towards energy saving are listed below:

a) Operational Practices Implemented:-

(1) Re-optimization of operating parameters at its best energy efficiency points taking into consideration the cost of energy and other constraints. This required operation of hot towers at 120^{o}C against design operating temperature of 130^{o}C.

(2) Sequential and timely startup of machines to minimize idle running.

b) Modifications completed during 2004-2005:

"INSTALLATION AND COMMISSIONING OF EFFLUENT COOLING TOWER"

The process liquid effluent, which is generated from exchange unit, is waste stripper outlet liquid. This liquid is nothing but depleted de-mineralized water, stripped off H_2S has the following qualities:-

Quantity	:	540 m^3/hr
Temperature	:	70°C
H_2S	:	≤ 100 ppb
pH	:	7.5 to 8.0

EARLIER ARRANGEMENT OF WASTE STRIPPER OUTLET LIQUID DISPOSAL:

The process liquid effluent coming out from waste stripper is having temperature about 68°C after passing through bank of heat exchangers and heat recovery system. This effluent is diluted with about double the quantity of raw water to bring down its temperature below 40°C effluent out fall at Delay Tank, 2.5 km away from the plant. This water is discharged later when dissolved hydrogen sulphide becomes ≤ 72 ppb as per RPCB guidelines. Although effluent dilution system enable us to meet our statutory obligations but it is not economical as it inflates our raw water to almost double. A huge amount of energy is required to pump this raw water.

MODIFIED SYSTEM WITH EFFLUENT COOLING TOWER :

The process liquid effluent is high quality de-mineralized water. This effluent having temperature 68°C is cooled down to 35°C in a newly installed induced draft cooling tower. During this process H_2S in the water is expected to come down < 10 ppb. This water is used for main cooling water makeup, mixed bed feed for generating boiler feed water, irrigation and gardening purpose in the following manners:-

Total water available	:	525 m^3/hr
Cooling water make up	:	285 m^3/hr
Mixed bed feed	:	80 m^3/hr
Evaporation loss	:	40 m^3/hr
Gardening + Green belt development	:	120 m^3/hr

There is an arrangement of chlorination at inlet of cooling tower such that, if H_2S exceeds above 100 ppb, it shall be neutralized by chlorination.

BENEFITS OF THE SYSTEM :

i) The water consumption will get reduced by about 600 m^3/hr thus conservation of natural resources.
ii) 38 KW power is saved by stopping effluent dilution pump, off setting the power consumed by Effluent Cooling Tower equipments when all streams are in use.
iii) On account of this modification raw water consumption will get reduce which will result in operation of smaller capacity raw water pump. Thus saving 180 KW is realised.
iv) Reduction of anion and cation load for boiler feed water generation.
v) Availability of water for green belt development and irrigation purpose.

Achievements

There has been a consistently decreasing trend in the specific energy consumption i.e. MWH/ kg of heavy water produced at HWP-K as a result of which the plant has achieved –

1. **Best Plant Performance Award** trophy for the year 2001.

2. **Best Plant Performance Award** trophy for the year 2002.

3. **Best Plant Performance Award** trophy for the year 2003.

4. **Atomic Energy Regulatory Board (AERB) Safety award** for its best safety performance among all operating units of Depot. Of Atomic Energy for the year 2000.

5. "**National Energy Conservation Award – 2001"** second prize in Chemical Sector by **"Ministry of Power**" Government of India.

6. "**National Energy Conservation Award – 2002" CERTIFICATE OF MERIT** in Chemical Sector by **"Ministry of Power**" Government of India.

7. **ISO-9001 & ISO-14001 from M/s. BVQI**. in March, 2002.

8. "***GOLDEN GREENTECH INDUSTRIAL SAFETY AWARD***" for the consecutive year 2002-2003 & 2003-2004 among chemical sector by "***GREENTECH FOUNDATION***.

9. **GOLDEN GREENTECH ENVIRONMENT EXCELLANCE AWARD** for the year 2002-2003.
10. GREENTECH INDUSTRIAL ENVIRONMENT EXCELLENCE GOLD AWARD 2003-2004.

11. **YOGYATA-PRAMAN PATRA from '*National Safety Council of India*'**.

12. **Successful certification of IS-18001** [Occupational Health and Safety Management System (OHSMS) by BIS] in 2004.

13. **"FIRE SAFETY AWARD-2004 by AERB.**

(v) Energy Conservation Plans and Targets

To achieve further reduction in the specific energy consumption the following modifications are proposed:

Sr. No.	Proposed Scheme	Energy saving potential on Annual basis
1	To provide variable speed drive motors for other two pair of transfer pumps.	615 MWH/year
2	Installation of Packed Column Distillation Unit.	3.5 MT Steam/Hr. 5600 MWH/year
3	Installation of steam turbo generator	15000 MW/year
4	Replacement of 4 filter water transfer pump with 2 higher capacity pump in WTP	135 MW/year
5	Installation of 700 m^3/hr capacity raw water pump	1125 MW/year

Greenery in and around heavy water plant