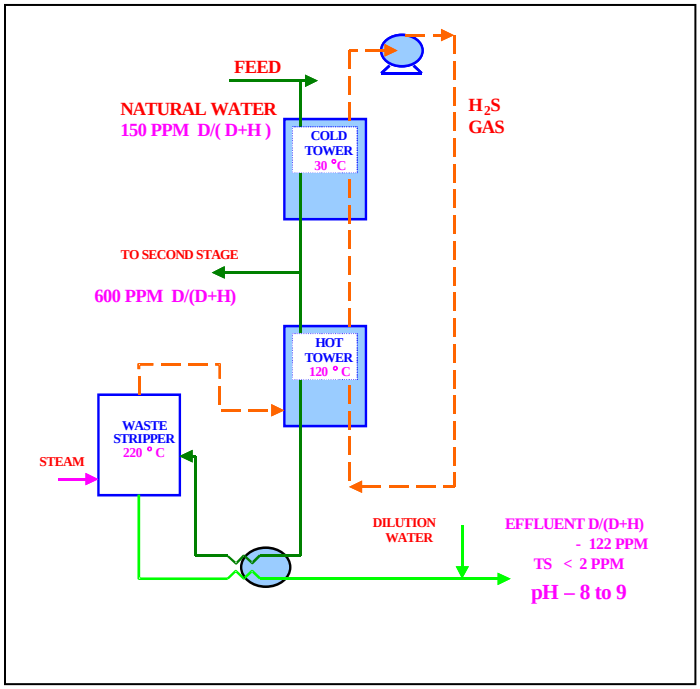
Unit profile

Heavy Water Plant(Kota), one of 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 demineralised 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.

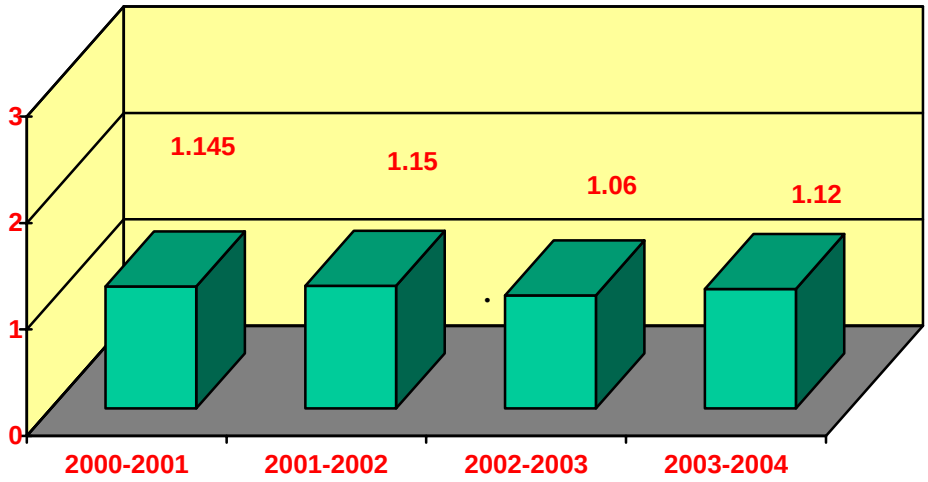
(ii) Energy consumption

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 :-

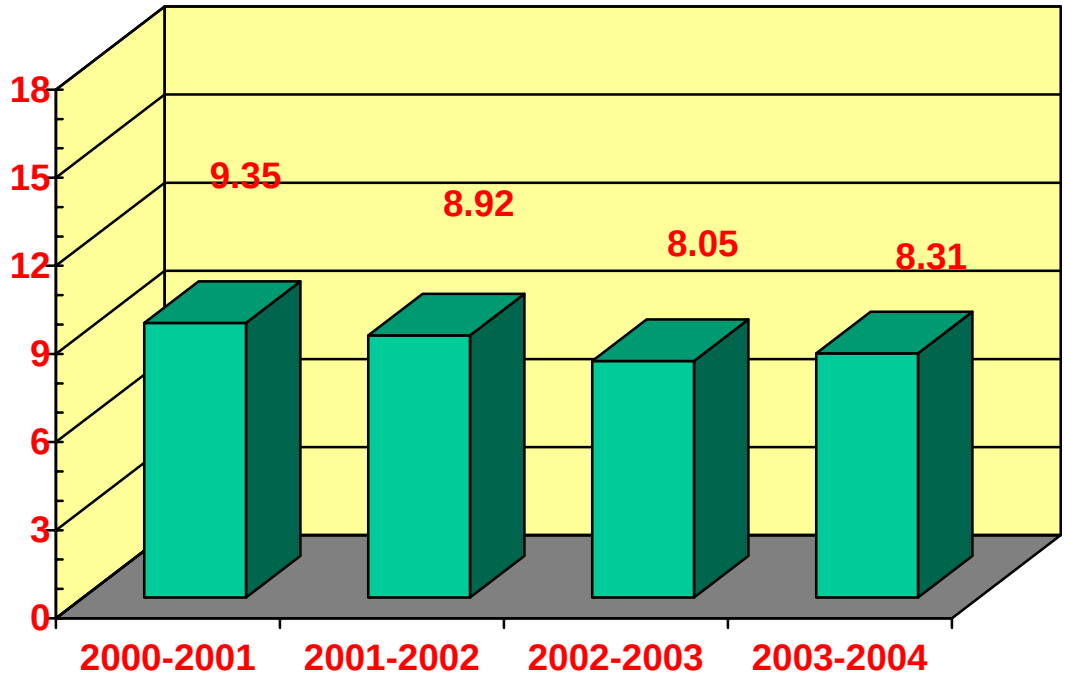
Consumption per Kg of D_2O production

		2000-2001	2001-2002	2002-2003	2003-2004
Electricity	MWH	1.145	1.15	1.06	1.12
Steam (equivalent)	MT MWH	9.35 1.994	8.92 1.90	8.05 1.72	8.31 1.77
Overall Sp. Energy	MWH	3.139	3.05	2.78	2.89

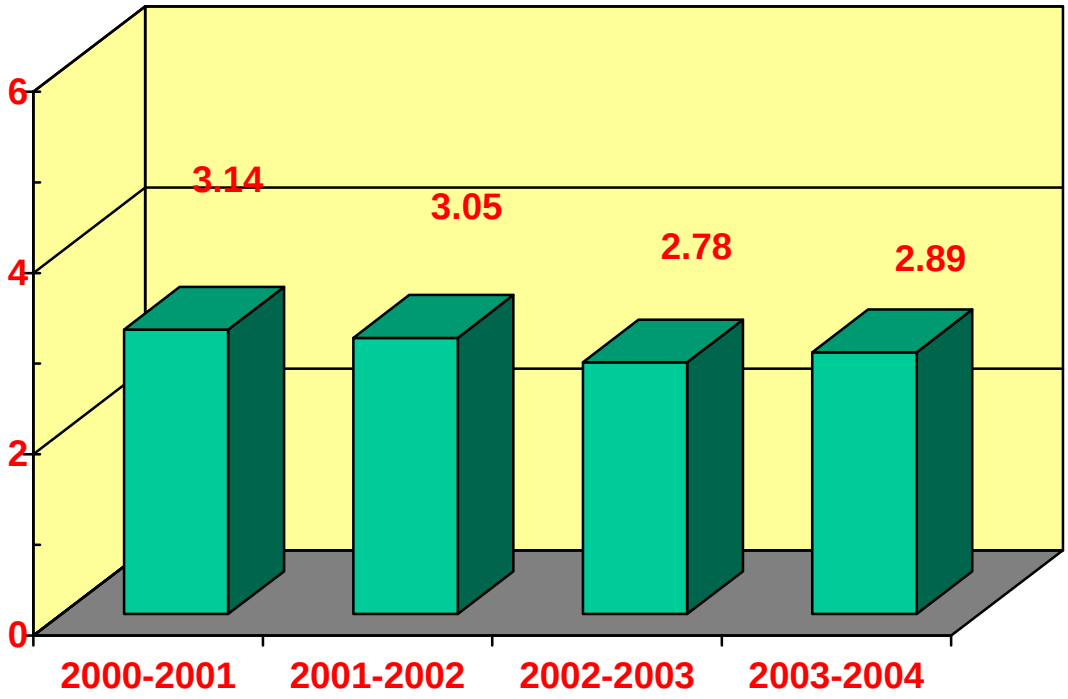
DECREASING TREND OF ELECTRICITY CONSUMPTION MWH/ Kg D_2O



DECREASING TREND OF STEAM CONSUMPTION MT/ Kg D_2O



DECREASING TREND OF OVERALL SPECIFIC ENERGY CONSUMPTION MWHR/Kg D_2O



(iii) Energy conservation commitment, policy and organizational set up

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, boilers etc., 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 Chief 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.

(iv) 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 32.2 % reduction in specific energy consumption progressively in the last four consecutive years taking 1998-99 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 2003-2004:

1. Replacement of existing raw water pump with 1300 m^3/hr capacity : –

The production of Heavy Water at HWP(Kota) is based on GS process. In this process large quantity of water and H_2S gas is circulated in cold and hot towers. A pump having capacity 2280 m^3/hr was installed to meet the requirement. As a step towards energy conservation and reduction in natural resources, HWPK has brought down the total consumption of raw water from 2280 to 1300 m^3/hr. by inhouse technological innovation This has given a large margin in capacity of existing pump, which resulted in efficient operation of the pump. This called for replacement by smaller capacity pump.

By replacing the above pump 160 KW electrical power was saved and a total of 13.7 lakhs was spent on procurement of the pump.

2. Replacement of 3 nos. of atmospheric degasser pumps in WTP with 2 nos. better efficiency pumps.:

The process water used in the plant is de-mineralized in water treatment plant. During this process raw water passes through atmospheric degasser to remove (dissolved CO2) carbonic acid if any. For circulation the water 3 pumps were installed with a theme that 2 pumps will always be in line, whereas one pump in standby position. As a step towards energy conservation it was felt that changing these 3 pumps with 2 nos. of better efficiency pumps, and operate only one pump in place of 2, will consume less power. With this theme all the 3 pumps were changed with 2 new pumps.
By operating one pump in place of two 80 KW power saving was realized.

3. Replacement of steam tracing with electrical tracing.: –

In Heavy water plant kota @ 200 MT H_2S gas is re-circulated through tanks, towers and pipelines etc. During winter season hydrate formation takes place when temperature reaches below 29.5°C. To avoid this pipelines are insulated and steam tracing was provided to maintained the temperature above 30°C. It was seen that around 3 MT steam gets consumed in maintaining the temperature. A new technology of electrical heat tracing maintains the temperature of the pipelines at lower expenditure than the steam tracing is incorporated in the plant. A Rs. 30 lakhs was spent on this project the saving envisaged was Rs. 18.42 lakhs per year.

4. Transfer line from feed storage tank to vacuum degasser.: –

The de-mineralized water before feeding in exchange unit passes through vacuum degasser for removal of dissolved oxygen. A pump of 55 kw motor was installed to pump the water from storage tank to vacuum degasser. The vacuum degasser which operate at 40 mm of Hg. Considering the height of water level in the storage tank and vacuum in the vacuum degasser, the net head available was adequate to facilitate the required process feed water flow from feed storage tank to vacuum degasser, thus it eliminated the operation of one pump, which was operating to feed the same to vacuum degasser. This resulted in saving of 55 KW electrical energy.

5. Replacement of booster suction control valves.: –

At HWPK Hydrogen Sulfide gas is circulated across a pair of towers named as cold tower & hot tower. The Exchange Unit consists of three stages and first stage consists of three feed streams. To overcome the pressure drop across the towers five numbers of centrifugal H2S gas boosters have been used. The first stage gas boosters are of the rating 3100 H.P. The gas flow across the towers are controlled by the control valves located at suction of the boosters. The gas pipe lines are having the size 24", and the control valves were of 18" size. At the time of installation of the plant only 18" size control valves were available in the market.
The control valves being smaller size were creating larger pressure drop across the gas loop. The pressure drop across the control valves were measured, and it was observed that if the size of the control valves could be increased which can give lesser pressure drop, larger gas flows can be obtained and the same was implemented. The replacement of control valves three nos. costs Rs. 60 lakhs and benefit drawn has been realised in terms of more Heavy Water production and decreasing specific energy consumption.

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 in sharing with HWP(Thal).
2. **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.
3. "**National Energy Conservation Award – 2001"** second prize in Chemical Sector by **"Ministry of Power**" Government of India.
4. **ISO-9001 & ISO-14001 from M/s. BVQI**. in March, 2002.
5. "**National Energy Conservation Award – 2002" CERTIFICATE OF MERIT** in Chemical Sector by **"Ministry of Power**" Government of India.
6. "***GOLDEN GREENTECH INDUSTRIAL SAFETY AWARD***" for the year 2002-2003 among chemical sector by "***GREENTECH FOUNDATION*.**
7. **GOLDEN GREENTECH ENVIRONMENT EXCELLANCE AWARD** for the year 2002-2003.
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10. **YOGYATA-PRAMAN PATRA from '*National Safety Council of India*'**.
11. **Successful certification of IS-18001 [** Occupational Health and Safety Management System (OHSMS) by BIS**].**

(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	Providing a effluent cooling tower for reusing the effluent.	525 MWH/year
3	Installation of Packed Column Distillation Unit.	3.5 MT Steam/Hr. 5600 MWH/year
4	Installation of steam turbo generator	15000 MW/year
5.	Replacement of 4 filter water transfer pump with 2 higher capacity pump in WTP	135 MW/year
6.	Installation of 700 m^3/hr capacity raw water pump	1125 MW/year

(vi) Environment and safety

Environmental protection is given the prime importance in this plant and for this very reason lot of engineered safety features, pollution monitoring equipment and control check points have been provided as a part of normal plant operational routines. Plant effluents are discharged only after adequate treatment. Two independent agencies i.e. Environmental Survey Laboratory situated at Bhabha Nagar and Rajasthan Pollution Control Board monitor these discharges at regular intervals within the plant premises and outside the plant, ensuring that the effluent quality is well within the specified limits. The H_2S in air/ air quality and plant liquid discharges are monitored continuously with the help of on-line instruments in the plant. Ambient air quality is also regularly monitored as per the guidelines issued by Rajasthan Pollution Control Board.

HWPK is certified by ISO-9001, ISO-14001 and IS-18001 Occupational Health and Safety Management System(OMSMS).

Plant has received a clearance Certificate from Rajasthan Pollution Control Board. A copy enclosed as annexure.

FLORA AND FAUNA IN & AROUND OF EFFLUENT DISPOSAL AREA.

Modification No.-4 : Replaced Booster Suction Control Valve of lower pressure drop.

Modification No.-5: Modified pipe-lines from feed storage tank to Vacuum Degasser.

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HEAVY WATER PLANT - KOTA

Unit profile

Heavy Water Plant(Kota), one of 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.

Process at heavy water plant kota is based on duel temperature isotopic exchange of deuterium between water and hydrogen sulphide gas. Special equipment used include pairs of cold and hot tower, having sieve trays and H2S gas boosters for circulating the gas through the towers. Main raw materials used are the natural water and H2S gas. The effluent generated is the demineralised water depleted in deuterium content and having total H2S < 1 ppm.

Energy consumption

Production of heavy water is an energy intensive process. Therefore employees at all level in the plant are highly energy conscious. Due to continuous and consistent effort made towards energy conservation program, Heavy Water Plant, kota has brought down its specific energy consumption drastically during last four years. The annual consumption of electricity , steam and specific energy consumption for consecutive years is given below.:-

AN OVERVIEW OF HEAVY WATER PLANT,KOTA

Consumption per Kg of D_2O production

		2000-2001	2001-2002	2002-2003	2003-2004
Electricity	MWH	1.145	1.15	1.06	1.12
Steam (equivalent)	MT MWH	9.35 1.994	8.92 1.90	8.05 1.72	8.31 1.77
Overall Sp. Energy	MWH	3.139	3.05	2.78	2.89

Energy conservation commitment, policy and organizational set up

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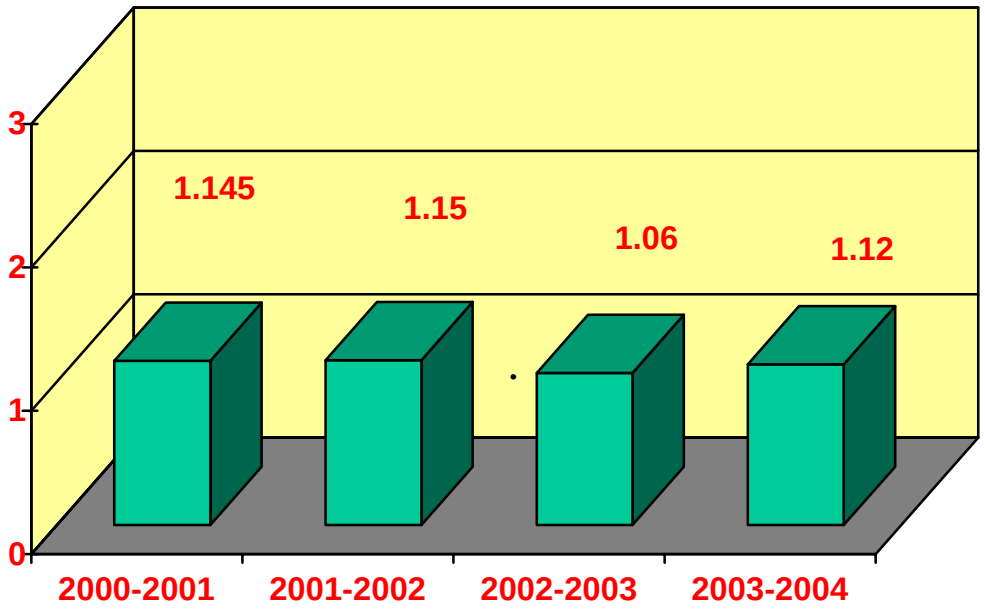
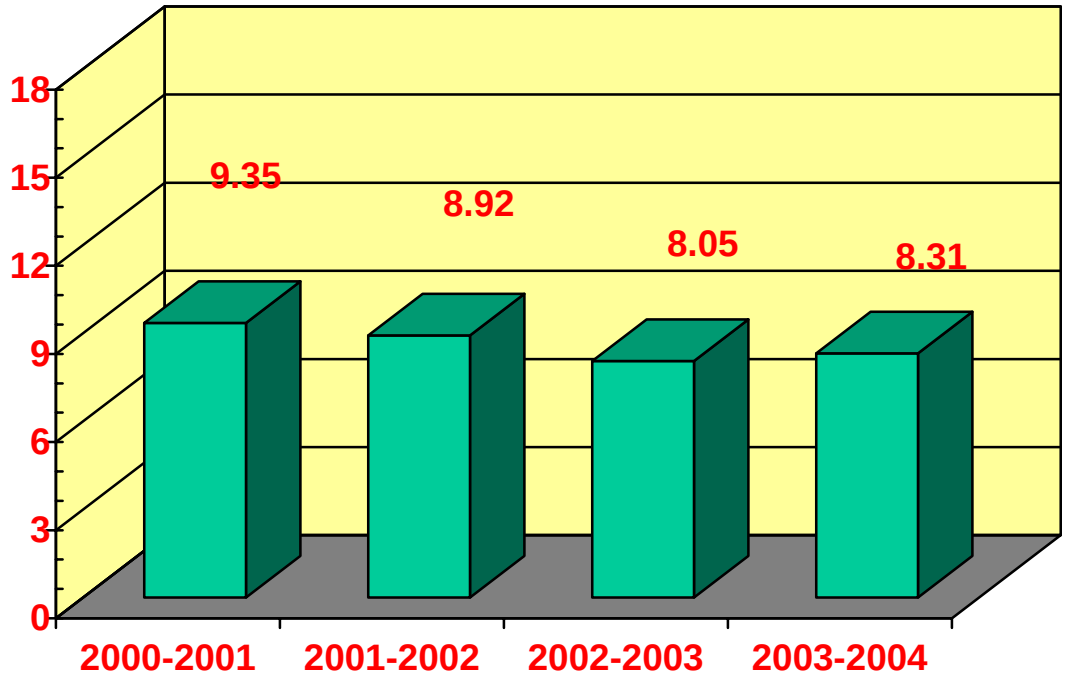
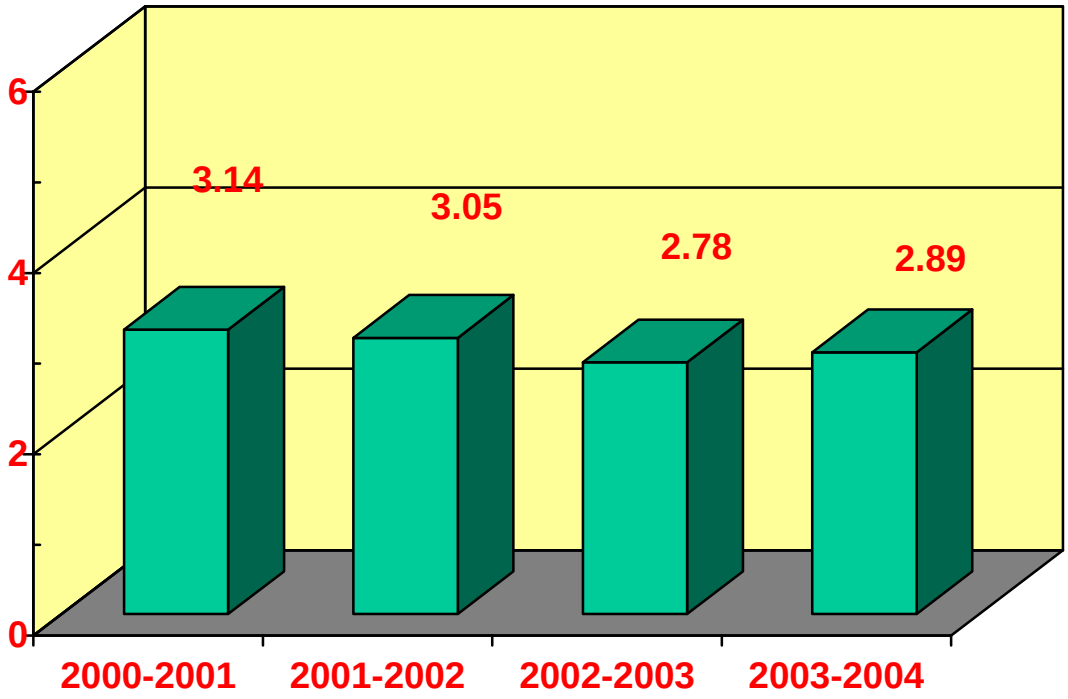
DECREASING TREND OF ELECTRICITY CONSUMPTION
MWH/ Kg D_2O



DECREASING TREND OF STEAM CONSUMPTION MT/ Kg D_2O



DECREASING TREND OF OVERALL SPECIFIC ENERGY CONSUMPTION MWHR/Kg D_2O



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

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

Modification incorporated during 2003-2004

SR. NO.	DESCRIPTION OF MODIFICATION	Actual benefit realized
1.	Replacement of existing raw water pump with 1300 m3/hr capacity.	160 KW power saving equivalent to annual saving of Rs 32 lakhs .
2.	Replacement of 3 numbers of atmospheric degasser pumps in WTP with two nos. better efficiency pumps.	80 KW power saving.
3.	Replacement of steam tracing with electrical tracing.	About 3 tonnes/hr steam saving.
4.	Replacement of booster suction control valves.	Increased feed processing. About 4% Energy saving realized.
5.	Replacement of vacuum degasser packing with structured packing.	Removal of O_2 content in process feed water, up to 10 ppb.
6.	Transfer line from feed storage tank to vacuum degasser .	55 kw power saving equivalent to annual saving of Rs. 9 lakhs

Awards:

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