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Management

STUDY OF FACTORS ON WATER CONSUMPTION FOCUSING ON STRATEGIES FOR BETTER MANAGEMENT AT A 1000+ BEDDED HOSPITAL

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ABSTRACT An estimation of the water used for human consumption in hospitals is essential to determine possible savings and to fix criteria to improve the design of new water consumption models. Apart from the regular requirements in the person which is about 135 liters per day , hospitals require more in view of patient care activities , supportive services The aim of the study is to assess the total water consumed with the objective of simultaneously identifying potential areas of consumption and water supply and distribution system .

Results and Recommendations ;Totally seven 7.5 Hp motors pump water to the hospital having 1600 bedded teaching general hospital An average the motors work for 10.35 hours and a total of 6,09,800 litres is pumped into the over head tanks .The users consists of 1000+ inpatients ,2000+ outpatients and double of their attendees ,,1000+ staff and 800+ students of medical, nursing , para medic utilize for their physiological needs , Drinking .apart from the major thrust areas like operation theatres , emergency, intensive care units .. Sanitation activities , cleaning of all the floor areas about 5.0Lakh sft in a day , Diet canteen , Laundry, HVAC system, CSSD, utilize ample amounts . The first step in water management of awareness of how much is consumed per day was achieved by this study . it is about 380 litres per bed per day .with a total of 1600 beds ..The authors propose that this consumption is actually was shared by the patient attendees, staff and students . Hence actual patients consume around 150 litres in a day . The strategies should aim to minimize the wastage by keeping controls over the tanks automatic stoppage of motors once the tank is full . vigilant maintenance and frequent audit is a mst . Waste water management was to be explored . Reduction ,Reuse, recycling should be properly planned for effective savings and to protect this natural resource .

Aim :

To Measure water consumption and effective utilization of available resources and suggest the means for minimizing the wastage (or) utilizing the waste water

Objectives

1. To identify the areas of water consumption in a hospital
2. To evaluate the source and supply system
3. To calculated the power consumption
4. To calculate the water consumption / bed / day
5. To identify the factors that minimizes the wastage of water.

Methodology: Retrospective: Study of the water supply system by collecting of data regarding the number of areas and users in the hospital , number of tanks available number of of motors available . Data was collected from Maintenance engineers,maintenance supervisors , plumbing department, housekeeping, canteen, Laundry,and C.S.S.D for the quantity and the system of operating of these areas .Prospective : :observational study of the operation of the motor from bore well for a period of one week following the working of maintenance division of engineering services through plumbers for 24hr in a week . Average time of working of each motor was calculated so that total water pumped into the tanks was calculated in a day . Power utilization was calculated based on the standard formulas of total Hp of all motors and total time of all motors in operation The observational study of the operation of the RO plant and tanks for a period of one week . The capacity of the tanks and the working hours was collected and the total water pumped in to the tanks was finalized. The total water pumped through all motors into all tanks in a day was taken as the total water Utilized in the hospital . (Number of hours multiplied by Pumping capacity of each motor)

KEYWORDS : : water consumption , hospital users , strategies , minimization

Introduction:

Water is the most important natural resource available on the earth " Nature for Water " is the theme of world water day which is on 22 nd March focuses on Nature based solutions to the challenges we face in the 21st century. United Nations declared 2005-2015 as International Decade for Action " water for Life" to highlight the seriousness of water utilization and for measiures for efficient water management Between 1990 and 1995 ,global water consumption rose six fold and the situation becomes worse in next 50 years . India has 18% of world population and has 4% of water resources of the world .Since 1990, 2.6 billion people have gained access to an "improved" drinking water source, one that is designed to protect against contamination. But in 2015, 663 million people – one in 10 – still drank water from unprotected sources.65% of rain water runs off goes into sea , which is a major wastage .

In 1980 the united nation general assembly launched the international drinking water supply and sanitation decade 1981 -1990 the aim being to provide all people with adequate supplies of safe water and sanitation The main sources of water are rain, surface water ,reservoirs, rivers, and streams .,tanks,onds and lakes . rain water sinks to the ground which part of it evaporates to the atmosphereand some runs ultimately to the sea (Water cycle) Rain water is the purest water in nature .Rain water percolating into ground constitutes ground water used by humans . Ground water is superior to surface water because the ground it self provides an effective filtering medium

REVERSE OSMOSIS (RO) :

It is is a process in which dissolved inorganic solids (such as salts) are removed from water . It is a process where water is forced through a semi permeable membrane leaving unwanted pollutants behind. The water is passed through one to 5-microns filter for further removal of suspended solids ,the water following preliminary treatment is pumped by a high pressure pump into the t the RO modulesHardness of water ; is the soap destroying power of water .temporary hardness is due to presence of calcium and magnesium bicarbonates .permanent hardness is due to calcium and magnesium sulphates, chlorides and nitrates . .softening of water is recommended when the hardness exceeds 3 mEq/l.Hard water adversely affects cooking it increasing scaling or furring of boilers. Fabrics washed in hard water do not have long life. It shortens the life the pipes and fixtures.

Temporary hardness can be removed through boiling, addition of lime, addition of sodium carbonate. Permanent hardness can be removed by

addition of sodium carbonate and Base Exchange process

Global scenario;

Water used in hospitals and other health care facilities comprises 7 percent of the total water use in commercial and institutional facilities in the United States.. Different health care or hospital water studies across European hospitals indicate an average annual consumption between 182.5 and 365m3 per bed. However, these indicators fluctuate greatly depending on the locations under study, the type of establishment, the date of construction, the number of users, the number of workers, and the possible green areas.

In USA this consumption ranges from 109.5 to 552.61m3/bed and UK from 193.45 to 415.37m3/bed and in Germany, range 109.5–223.02m3/bed reaching a maximum of 247.84m3/bed . Canadian studies reveal between 328.5 and 657m3/bed . Mexican Institute of Water Technology, which reports annual consumption as 292m3/bed whereas the Pan-American Health Organization (PAHO) indicates 164.25m3/bed .[9]

Indian scenario

Per capita water availability in India dropped almost fifteen percent over a decade to 2011, from 1,816 cubic meter (cu.m) to 1,545 cu.m in 2011.It is projected to have dropped a further 4.6% to 1,474 cu.m between 2011-15.A country is categorised as 'water stressed' when water availability is less than 1,700 cu.m per capita per year.future t per capita water availability will continue to drop to 1,401 cu.m and 1,191 cu.m by 2025 and 2050, respectively.Ref[19]

Water requirement of the community:

In india, the break up of demand for water is put as 135 litres per day per person using BIS 1172;1993 reaffirmed in 1998 .. the break up is Bathing 55 litres , Toilet flushing 30 litres , Washing of clothes 20 litres , washing house 10 litres ,washing utensils 10 litres , cooking 5litres and drinking 5 litres .For communities between 20,000 to 1,00,000 population 100 to 150 litres perhead per day and for population over one lakh , it is estimated as 150 to 200 litres[23]

A daily supply of 150 -200 liters per capita is considered an adequate In India .40 liter of water per capital per day is the set target to be achieved by the end of the 8th five year plan .The reference daily in take (RDT) for water is 3.7 liter s per day for human males older than 18 and 2.7 liter for human females . Food contributes 0.5 to 1 liter and the metabolism of protein fat and carbohydrates produces another 0.25 to 0.4 liter which means that 2 to 3 liter of water for woman should be taken in as fluid. Data from the recent studies and ongoing research may vary from period to period , place and situation .

Human body ; The basic physiological requirement for drinking water have been estimated at about 2 liter per head per day .It will help to reduce the incidence of many water related diseases among the people most at risk .The consumption of water however depends upon climate condition, standard of living and habits of the people.

Water related diseases; those cased by the presence of infective agent in the water include, viral hepatitis, hepatitis E, Poliomyelitis, rotavirus diarrhea in infants, typhoid, Para typhoid fever, bacillary dysentery, Esc. Coli diarrhea, cholera, amoebiasis,, Giardiasis, , roundworm, threadworm, hydatid disease and weil's disease..

Observations and results:

Factors and areas of water consumption:

The study was done keeping in view of the important and first step in water management i.e to get an awareness of how much water is consumed in the hospital .study was carried out at Narayana medical college teaching hospital having broad(1180 beds) and super specialties (220 beds) and around 200 beds of post operative , intensive care units. Casualty and emergency.

The hospital is situated in urban to semi urban area and district head quarters of the state of Andhra Pradesh . The source of water supply is Ground water through Bore wells at strategic places of the location of the buildings and as required to the patient care areas and supportive services like canteen , outpatient block ,

Work load assessment for water consumption

Number of Outpatient average -3000 +and one to two attendees ;Inpatient beds 1180 broad specialities , 240 superspecialities and 200 intensive care unit beds along with emergency beds .Number of staff around 3000 Drinking purpose ; The demand by patients , attendees , staff,and students as per standard usage per head per day ranges from minimum 3 -4 litres . The amount needed depends on the climate, intensity of work, Since the water reserve of the body is small,. Requirement of cool water through refrigeration to inpatients 1000+ and their attendees another 1000+ , staff around 2000+ and around 800 + students from medical both undergraduates and , post graduates , ,nursing all courses ,dental, paramedic students posted in various specialties f the hospital both during day time and night duties .

Physiological Needs for all the categories as listed above which is the minimum basic requirement as per standards Bathing 55 litres ,Toilet flushing 30 litres Washing of clothes 20 litres drinking 5 litres Sanitation purpose ; Huge areas of the hospital which is around 2,80,000 sft of general hospital block , 5.00 lakh sft of superspeciality block and 50,000 sft of OPD block .which has Daily and weekly cleaning schedules Toilets, bathrooms, sinks ; All the areas f the hospital contain which are used 24 hrs a day .special areas of concern are the operation theatres , intensive care units , emergency, central laboratory , paying rooms and all general wards . In addition to patients the load is double or triple the patients which include patient attendees, all categories of staff, students of all disciplines, medical ,dental ,nursing , paramedic.

Diet canteen : The canteen caters to Inpatients , outpatients , Doctors , technical staff, Nursing and students separately.Hospital Canteen caters to around 1000 patients and around 1000 staff . Visitors and Patient attendees canteen caters to around 2000 outpatients and their attendees.

Canteen requirements include for cooking , cleaning vegetables ,, sanitize kitchen utensils, and clean individual mess equipment for staff , and for dining halls drinking water . ,. To reduce water requirements, use disposable eating utensils ..

Hot water supply through geysers one in each ward and intensive care units , operation theatres .

Total water consumption in General specialty hospital: table 1 Four motors of the general hospital works alternatively and pumps water into the overhead tanks ,the pumping capacity was calculated as 8400 litres per hr as per company standards .. The data collected per one week has been depicted At table I .

All the seven motors supply to the general hospital , super specaility and Out patient blocks . On average they work for 10.35 hrs in a day .and pumps around 6,09,000 litres in a day .

Taking into consideration of 1600 total beds ,it comes to around 380 litres per bed per day . Actually it is found from the study that this was shared by the patients along with double to triple numbers of patient attendees , staff and students .Considering this the net consumption used by patients is about 150 litres per day .

It also includes diet canteen , sanitation ,housekeeping activities of cleaning , mopping schedules , patient care activities and supportive services .

Staffing and maintenance ; To achieve Interrupted supply and to prevent short supply , maintenance department works 24/7 days in three shifts .They receive calls and maintain log book and attend to complaints . overflow of tanks is the impending issue for which new tanks were provided with automation which stops the motor as soon as the tank is filled. Leakages from washbasins, taps and sinks is a perennial problem which significantly contributes to wastage .

Inter departmental communication and cooperation between nursing and maintenance is essential .

Canteen water consumption :

The water supply is through the tank of the general hospital block RO water .To cater to the needs of total meals numbers of patients , the hospital kitchen supplies to inpatients , NTR vydyaseva patients , out [patients subsided food , Doctors and paramedical staff .The total meals numbered to 1000 patients , 300 non medical staff and around 200 doctors .

The standard calculation is for each meal and the needs of working staff @ 5 to 8 litres the total required is about 12,500 to 20,000litres The factors affecting varies depending on the leakages and wastages .

LAUNDRY : All categories of linen from different areas of the hospital incude bedsheets , draw sheets , towels curtains , Operation theatre linen , dressing towels etc which is around 5000 to 5500 pieces in a day The process involves to wash soiled ,blood stained foul linen with chemicals first and wash and dried and sent for washing which requires more water..Rinsing , washing three to four times in 60 kg to 100 kg washing machines , consumes 5 to 8 litres per kg of linen .the average total weight of linen washed comes to around 5000 kg and total water consumed was about25000 litres per day .thirty five to sixty percent leaves out through drain which reaches Sewage treatment plant .The actual water used shall varies and approximate consumption was assessed .

C.S.S.D ; The water used by the CSSD depends on the number of cycles , work load , efficiency of equipment and technical expertise and experience .Each autoclave on an average having around 130 litre tank water consumes around 540 litres a day with an average of 5 to 6 cycles . if it croses 10 to 12 cycles the water consumption goes upto 1500 litres . the process consumes around 30 to 40 % and the rest lets out through drain and then to sewage treatment plant . .

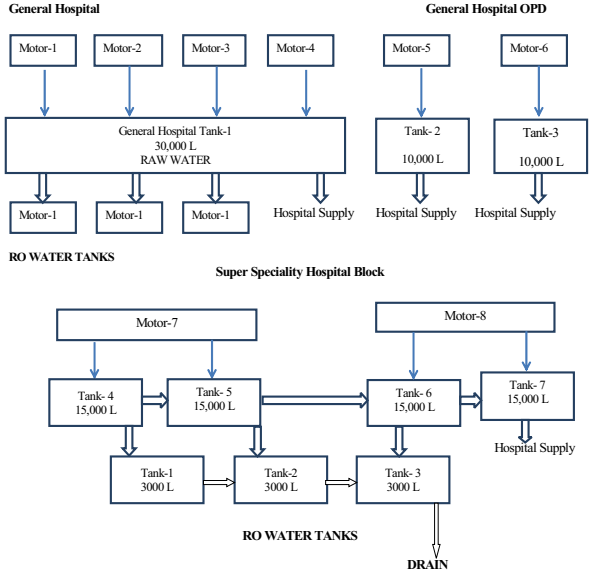
Water supply and distribution system:

Motors and tanks: Table 1

The source is through bore wells placed at different areas of the hospital which pumps into overhead tanks situated on the terrace of general hospital , super specialty block , OPD block and canteen block There are four 7.5 hp motors situated around general hospital and emergency .One more 7.5 hp motor for General hospital out patient block and one stand by 7 .5 hp motor fitted to the bore well near canteen Two bore wells fitted with 7.5 hp motors were available near super specialty block . The flow diagram was depicted in (Diagram I) The flow rate i.e the pumping capacity of all motors depends on the efficiency of motor, the depth of the well and the height of to which water needs to be pumped . The overhead tanks are situated on the terrace of buildings which are four storied and seven storied buildings The power consumption is about 5,5 KWh The water supply system is intermittent with continuous supply to cater to the needs of patients and not to interfere with the routine operations of the hospital

Fire tanks ; In addition to regular water tanks , fire tanks were available at to cater to the fire emergencies .

Water collection and Supply system ;Diagram I



M 1 = Near ER

M 2= At Lawn Opp. S.S Block

M 3 = Near GH ATM (IngVYsya)

M 4 = Near ING Vysya Bank ATM

M 5 = Near GHOPD – Dining

M 6 = Near Canteen Lawn

M 7 = S.S Block Lawn

M 8 = S.S Block Lawn

Motors total hours : Table I

Motor	Average working hrs/ day	Pumping capacity/ hr	Total Water Pumped
MOTOR-1	11 hr	8400	92,400
MOTOR -2	11 hr	8400	92,400
MOTOR -3	10.5 hr	8400	88,200
MOTOR -4	8.5 hr	8400	71,400
MOTOR -5	7 hr	8400	58,800
MOTOR -6	12 hr	8400	1,00800
MOTOR -7	12.5 hr	8400	1,05000
			609000

Power consumption of motors Table 2

ALL MOTORS CAPACITY =7.5 H.P OR 750 W
MOTOR PER HOUR _ POWER CONSUMPATION =5.5 K.W H UNITS

Motor	Average working hrs/ day	Power Consumption /hr	Total power consumption
MOTOR-1	11 hr	5.5 kw	60.5
MOTOR -2	11 hr	5.5 kw	60.5
MOTOR -3	10.5 hr	5.5 kw	57.75
MOTOR -4	8.5 hr	5.5 kw	46.75
MOTOR -5	7 hr	5.5 kw	38.5
MOTOR -6	12 hr	5.5 kw	66.0
MOTOR -7	12.5 hr	5.5 kw	68.75
			398.75

Power consumption by motors : Table 2

Each motor consumes around 5,5 kw per hour .The toatal power consumed was calculated basing on the toatal number of hours that the motors worked . The average consumption is about 398.75 kwh . which can be used for costing of the consumption .

Functioning and areas of supply of Reverse osmosis water in the hospital :

The general hospital block had 3000 lts per hour capacity reverse osmosis (RO) plant with input of 7000 lts per hour. It draws water from the main raw water tank of capacity 30,000 lts. 1.5 hp motor pumps raw water from main tank situated at the terrace of general hospital block. The water passes through sand filter, carbon filter and micron filter. Five hp motor is utilized to pump at the stage to membranes of RO plants system. after processing RO water is pumped into water tanks, three numbers each of 2000 lts capacity. The drain pipe lets out the water into the sewage treatment plants for treatment.
RO water was supplying to CSSD, ophthalmology OT, General ot complex , kidney transplantation unit, general ICU complex, main kitchen and canteens and for drinking water in all the floors and dining halls and to emergency.

The Super specialty block contains RO plant of 3000 lts per hour capacity. 1.5 hp motor pumps raw water from four tanks each with 15000 lts capacity situated at the terrace of the super specialty block. water passes through sand filter, carbon filter and micron filter. Five hp motor is utilized to pump at the stage to membranes of RO plants system. After processing RO water is pumped into RO water tanks three in numbers each with 3000 lts capacity. The drain pipe lets out the water into the sewage treatment plants for treatment.

The RO water from the specialty block supplies RO water to emergency operation theater, causality, incentive care units, specialty operation theater complex, dialysis, central laboratory and for drinking water at specialty out patients and dining halls of the specialty block.

There is a separate 2000 lts capacity RO plants exclusively for dialysis unit of the hospital. 1.5 hp motor draws from the raw water tank of the specialty block this water passes through sand filter and carbon filter. Here softener is added and then water passes through micron filter. Finally the water is used for dialysis of patient.

One more separate RO water tank of 1000 litre capacity to the general

hospital out patient block one hp motor to draw water from the main tank of 10,000 lt capacity .2 hp motor is ised for pumping the water after the Reverse osmosis process . The water is supplied to all five floors for drinking and the dining and waiting hall of the ground floor .

Discussion ;

A direct water intake study was conducted for one year, involving 423 individuals from arsenic (As) affected villages of West-Bengal, India. Average direct water intake per person was found to be 3.12±1.17 L/day and 78.07±47.08 mL/kg/day (±SD).(Ref 5)

The areas where water consumption in a hospital is high are as follows: patients rooms 20%, domestic hot water (DHW) 15%, laundry areas 15%, maintenance of green areas 10%, therapeutic pools 9%, kitchens 8%, cleaning 5%, refrigeration towers 5%,sterilization 5%, heating ventilation and air conditioning (HVAC) 4%, and others 4% Ref (9)

The water consumption in the hospital varies and depends on many variables . Apart from the routine use of water like a person at home , the patient, their attendees , visitors and staff require and use for medical treatment .

Any incident of scarcity or non availability can lead to crisis . Eg; Non availability of Water at sample collection centre of the laboratory leading to improper hand wash and leads to infection. Non availability of linen leading to postponement of surgeries was a common problem , Study done in Calcutta hospital revealed Usage pattern was for drinking 1% , handwash18% , HVAC 36% , toilet flush 24%, cssd 4% , hot water 5% shower 6% kitchen 2% , housekeeping 4% Supply interruptions will lead to Loss of drinking water and sanitation services for disinfection, sterilization, ,. Loss of HVAC systems . Loss of fire suppression capabilities and for. decontamination process.

Conclusions and Recommendations ;

The management after identifying the defects in the current consumption and to implement methods to minimize .overflow of water is the commonest issue . Focus should be on waste water management even t hough the outlet of sewage treatment plant is partially reused .

Water supply to hospital has to be properly planned, executed and operation and maintenance has to be assured.. microbial quality, chemical acceptability especially hardness & iron are typical parameters. Equally important will be the management of waste.

Strategies ; should aim at reducing wastage , recycling and reuse . water management should be given an special consideration in order to withdraw the viable cost of the user facility while contributing to renewable development of the community at large.

Creating Awareness among all stake holders of the hospital both patients population and staff ..Vigilant maintenance and electrical departments.

stores and purchase systems should be flexible at least in emergencies for spare parts availability Regular audit of the supply and distribution systems helps awareness of the issues to take further action in time .

Emergency response ; . Provision of emergency water supply options Reduction of the Hospital Bed Capacity and quantum of cold surgery The emergency response plan must identify essential hospital functions and minimum water needs Implement Emergency Water Conservation Measures Implement Emergency Water Restriction Plan Evacuate patients to an alternate facility, if Water Supply Interruptions are expected to last beyond a pre-defi ned period,

Patient attendees control was required as significant usage by them and also to prevent health care associated infections . security and attendees pass system to be made compulsory,

Management Plan: Reduction in water usage is the first step in water conservation as it is the most important factor in using water more efficiently. Reuse of less contaminated water like shower water. And recycling the treated effluent from STP for gardening, toilet, road washing .

Metering and gauging helps us in evaluate the facility water usage and appropriate management of mechanical equipments which outcomes in higher water efficiency. Enhance sanitary appurtenances (moisture less urinals, less flow toilets, spout flow control.

Regular checking and repairs of leakages from toilets , sinks and washbasins .

Creating awareness among patients , staff by way of boards , information brochures ,

Displaying the maintenance numbers for contacting and informing plumbing department 24 X 7 days to arrest leakages and prevent wastage.

Frequent audit of the implementation strategies at regular intervals and evaluation and Revision is essential for constant vigilance of the issues Limitations of the study ; The present study was limited to assess the water consumption at gross level and has not covered in detail of each service in the hospital .subjective bias in data collection can not be ruled out ..Calculations of consumption are not supported by mathematical formulas but depend on the specifications and experience of manufacturers

Future scope of study ; further studies to measure water consumption by each and every area like Canteen , CSSD , HVAC system , Laundry , Also apportionment studies are required for Drinking , housekeeping , hot water , toilet , gardening etc .

Costing both capital and maintenance cost studies , water qualitys and effect on hospital infections studies and water conservation and waste water management strategies etc

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