Water Quality Analysis of Aghanashini Estuary, Karnataka –A Case Study

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Abstract:- *The present study deals with the assessment of water Aghanashini Estuary.Ten physic-chemical parameters were studied and analyzed during January 2017 to May 2017.The results show that there is high concentration of chlorides, EC, TDS, Nitrates and hardness in four different sampling stations which were brought in two different seasons, in the pre-monsoon season. The estuary shows variations in samplings in different seasons due to the windward movement of sea water during the pre monsoon season .Hence there is higher concentration of various parameters. The results obtained indicate that the water from the estuary can be effectively used for irrigation purpose with necessary treatment methods. The conveyance of water to Bengaluru city also being discussed briefly.*

Key Words: **Estuary, Water quality, Physico-chemical analysis, Sampling, Seasons**

1. INTRODUCTION

Water plays an important role in the world economy. Approximately 70% of the freshwater used by humans goes to agriculture. Fishing in salt and fresh water bodies is a major source of food for many parts of the world. Much of long-distance trade of commodities (such as oil and natural gas) and manufactured products is transported by boats through seas, rivers, lakes, and canals. Large quantities of water, ice, and steam are used for cooling and heating, in industry and homes. Water is an excellent solvent for a wide variety of chemical substances; as such it is widely used in industrial processes, and in cooking and washing. Water is also central to many sports and other forms of entertainment, such as swimming, pleasure boating, boat racing, surfing, sport fishing, and diving.

Water scarcity involves water stress, water shortage or deficits, and water crisis. This may be due to both natural and human factors. But, many reports suggest that the scarcity is more due to the human factor than anything – such as industrialization, irrigation, domestic use etc.

Considering the scenario of water crisis, water from various sources have been looked upon and it is been known that estuary water can be taken into an account, in which the river after its continuous flow from miles finally reaches the sea. Hence this water which is flown to the sea and its region is known as the estuary. This project deals with the analysis of one of the estuary to check its suitability for drinking, domestic and irrigational purposes and also to suggest the treatment process based on the results obtained, thus looking forward to reduce the cause of water crisis in the country.

1.1 ESTUARY

The word "estuary" is derived from the Latin word ***aestuarium*** meaning tidal inlet of the sea, which in itself is derived from the term ***aestus***, meaning tide. There have been many definitions proposed to describe an estuary. The most widely accepted definition is: "a semi-enclosed coastal body of water, which has a free connection with the open sea, and within which sea water is measurably diluted with freshwater Water continually circulates into and out of an estuary. Tides create the largest flow of saltwater, while river mouths create the largest flow of freshwater. When dense, salty seawater flows into an estuary, it has an estuarine current. High tides can create estuarine currents. Saltwater is heavier than freshwater, so estuarine currents sink and move near the bottom of the estuary

Estuaries form a transition zone between river environments and maritime environments. They are subject both to marine influences such as tides, waves, and the influx of saline water and to riverine influences such as flows of fresh water and sediment. The inflows of both sea water and fresh water provide high levels of nutrients both in the water column and in sediment, making estuaries among the most productive natural habitats in the world.

1.2 ESTUARIES IN INDIA

India has a coastline of over 8000 km long infringed with several rivers draining a total catchment of 3.02×10^6 km^2 and their estuaries have a water-spread area of 2.7×10^4 km2. There are 14 major, 44 medium and 162 minor rivers which together discharge 1.56×10^{12} m3 runoff every year greatly influencing ecology of their estuaries and coastal areas to which they drain. These estuaries with their wetlands, lagoons, mangroves and sea-grass beds are rich in natural resources including fisheries. They also offer tremendous potential for recreation, aquaculture, and extraction of freshwater and

transport, and play a dominant role in the economy of coastal population. These very areas are the recipients of liquid and solid wastes emanating from domestic and industrial sectors apart from rampant reclamation of their intertidal segments to provide additional spaces for coastal developments.

Over 300 million people living in the coastal zone of India are considered to generate $1.11x10^{10}$ m^3 of sewage annually, a considerable fraction; particularly from coastal cities and towns where sewage collection network exists, is released in estuaries and creeks. Large and medium industries within the narrow coastal belt of 25 km width of India are estimated to generate roughly $1.35x10^6$ m^3 d^{-1} of liquid effluents and about 34,500 t of solid waste. Much of the liquid effluents are released to estuaries and creeks while the solid waste is generally stored in unsecured dump-sites and le-chates which can be toxic, enter nearby aquatic areas via runoff during monsoon.

1.3 ESTUARIES IN KARNATAKA

Karnataka has a rich biodiversity supporting number of ecological functions in the coastal eco-systems besides supporting livelihood systems of millions of people. Coastal systems play a vital role in the State's economy by virtue of their resources, productive habitats and rich Biodiversity. The coastal zone is the dynamic margin where land and sea meet. It is a vital region of complex ecological systems such as coastal lands, bays, estuaries, mangroves, sea grass meadows, algal beds, fresh and salt water and coral reefs. The coastal zone is intimately linked to lakes, rivers and the open ocean. Diverse kinds of flora and fauna are associated with the coastal zone. The Coastal area is assuming greater importance in recent years owing to increased human population, urbanization and accelerated development activities.

The coastal zone in Karnataka is endowed with 320 km of coastline from Ullal in south to Majali in north with 27,000 sq.km of continental shelf and 87,000 sq.km and Exclusive Economic Zone. There are 26 estuaries with more than 70,000 Ha. of water-spread area and 8000 Ha of brackish water area, making the three coastal districts of Karnataka very rich in marine, estuarine and riverine biodiversity. Strictly speaking it is difficult to delimit Karnataka's coastal zone. These rivers carry silt and organic debris from the forested hinterland into the estuarine areas and the coastal sea and contribute greatly to the productivity and diversity of the coastal ecosystems.

1.4 STUDY AREA

- **NAME** : Aghanashini Estuary
- **LOCATION** : Aghanashini
- **TALUK** : Kumta
- **DISTRICT** : Uttar Kannada
- **STATE** : Karnataka
- **LENGTH** : 117km
- **AREA** : 1350 sq km
- **LATITUDE** : 14.5205° N
- **LONGITUDE** : 74.3694° E
- **MSL** : 676 m (above sea level)

SATELLITE VIEW OF AGHANASHINI ESTUAR

2. MATERIALS AND METHODOLOGY

1. The sampling has been done in two different seasons, winter and per-monsoon season as per the standard procedures.

2. Water samples were collected in four different stations using grab sampling method.

SAMPLING PHOTOS AT AGHANASHINI ESTUARY

2.1 PARAMETERS ANALYSED

NAME OF THE EXPERIMENT	NAME OF THE EQUIPMENT/METHOD
Determination of pH	Digital pH meter
Determination of Electrical Conductivity	Digital Conductivity meter
Determination of Acidity	Titrimetric method
Determination of Alkalinity	Titrimetric method
Determination of Chlorides	Titrimetric method
Determination of Hardness	Titrimetric method
Determination of Dissolved Oxygen	Winklor's method
Determination of Nitrates	Digital meter
Determination of Sulphates	Digital meter
Determination TDS	Digital meter

3. RESULTS AND DISCUSSION

3.1 RESULT AND DISCUSSION OF SAMPLING 1

- **DATE OF SAMPLING : 24 / 01 / 2017**
- **TIME OF SAMPLING : 10.00 AM**

Parameters	Sampling Stations				Result	Standard Values (10500-1991)
	S-1	S-2	S-3	S-4		
pH	8.19	8.48	8.55	8.52	8.43	6.5 – 8.5
Electrical Conductivity	40.90	41.11	41.38	41.80	41.29mS	0 - 0.8 mS
TDS	1867	1867	1876	1883	1873ppm	500 ppm
Sulphates	3700	3250	3300	3500	3437.5 mg/ltr	200 mg/ltr
Turbidity	8.32	1.77	2.60	2.93	3.90 NTU	5 NTU
Nitrates	280	240	280	320	280 mg/ltr	45 mg/ltr
Chlorides	32400	37600	33400	30000	33350 mg/ltr	250 mg/ltr
Acidity	40	64	32	48	46 mg/ltr	250 mg/ltr
Alkalinity	100	108	72	84	91 mg/ltr	200 mg/ltr
Total Hardness	3860	4140	3920	3900	3955 mg/ltr	300 mg/ltr

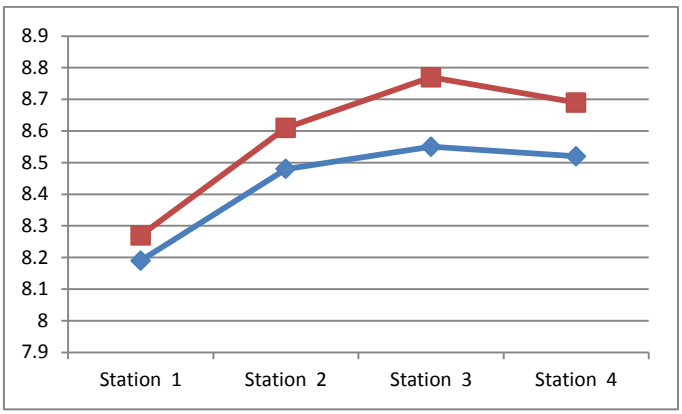
3.2 RESULT AND DISCUSSION OF SAMPLING 2

- **DATE OF SAMPLING: 17 / 04 / 2017**
- **TIME OF SAMPLING: 10.00 AM**

Parameters	Sampling Stations				Results	Standard Values (10500-1991)
	S-1	S-2	S-3	S-4		
pH	8.27	8.61	8.77	8.69	8.58	6.5 – 8.5
Electrical Conductivity	44.15	45.47	45.96	45.65	45.30mS	0 - 0.8 mS
TDS	1997	2063	2081	2067	2052ppm	500 ppm
Sulphates	3300	3850	3750	3900	3700 mg/ltr	200 mg/ltr
Turbidity	93	72.1	31.6	52.2	62.22 NTU	5 NTU
Nitrates	390	290	220	310	302.5 mg/ltr	45 mg/ltr
Chlorides	55520	39680	60400	46000	50400 mg/ltr	250 mg/ltr
Acidity	168	80	132	168	137 mg/ltr	250 mg/ltr
Alkalinity	186	158	152	162	164.5 mg/ltr	200 mg/ltr
Total Hardness	3740	3700	3960	3760	3790 mg/ltr	300 mg/ltr
DO	-	-	-	-	-	5 mg/ltr

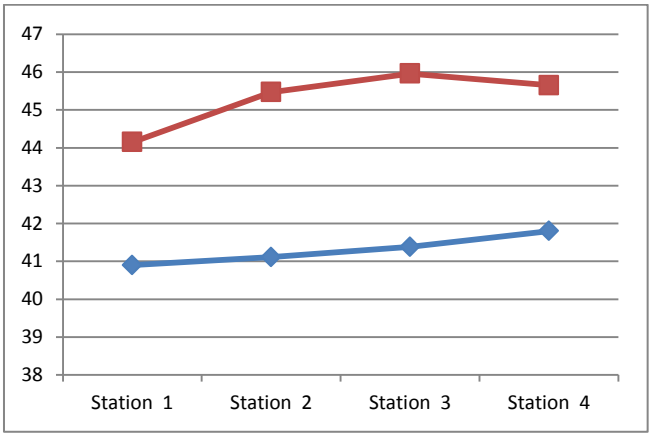
3.3 GRAPHS OF SAMPLING RESULTS

pH



The collected estuary water sample has a pH around **8 – 8.77**, which is slightly higher than the desirable limits. There might be a chance of intrusion of sea water & hence the pH is in the range of 8 – 8.77.

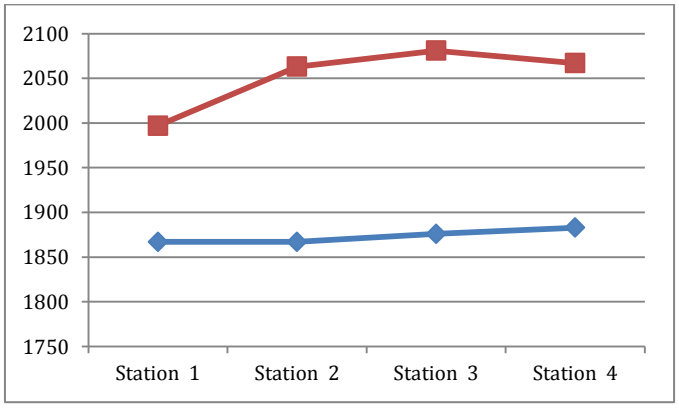
ELECTRICAL CONDUCTIVITY (mS)



The samples had electrical conductivity of around 40 – 46 mS. which was higher than the drinking water standards (0 – 0.8mS). The electrical conductivity is a measure of the capacity of water to conduct electrical current; it is directly related to the concentration of salts dissolved in water.

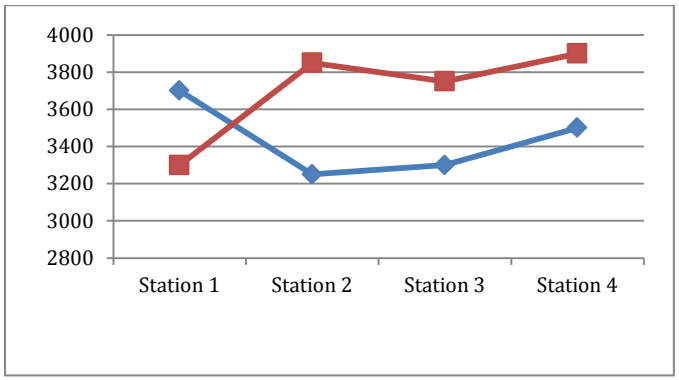
Since the presence of salt concentration in estuary water is higher than the normal water the electrical conductivity increases. Electrical conductivity also increases due to the rise in temperature, each degree rise in temperature results in 2 – 3% increase in electrical conductivity

TDS (ppm)



The collected samples had TDS around **1867 – 2081** ppm. The normal drinking water standard for TDS is **500ppm. Total dissolved solids are those which** comprise of inorganic salts and small amounts of organic matter that are dissolved in water. Some dissolved solids come from organic sources such as leaves, silt, plankton, and industrial waste and sewage. Dissolved solids also come from inorganic materials such as rocks and air that may contain calcium bicarbonate, nitrogen, iron phosphorous, sulphur, and other minerals. Hence due to the higher concentration of these inorganic and organic salts in the samples the TDS values are ranging from 1897 – 2081 ppm.

SULPHATES (mg/l)

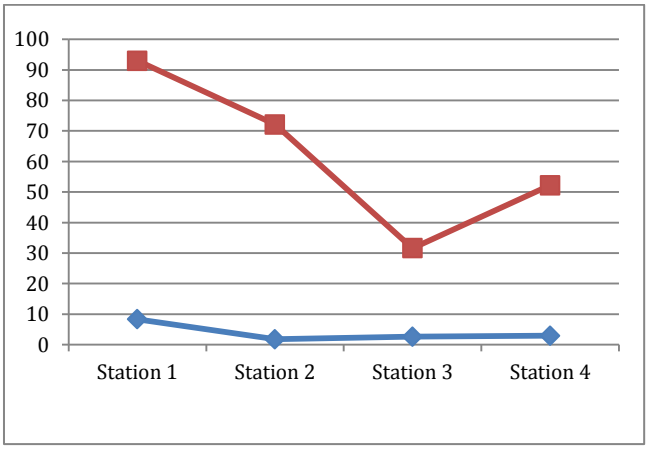


The water samples had sulphate content of **3250 – 3700 mg/L**. The normal drinking water standards for sulphates are **200mg/L**. There is no much variation in all the 4 sampling stations.

Sulphate may be leached from the soil and is commonly found in all water sources. There are several sources of sulphate in water. Decaying plant and animal matter may release sulphate into water.

Numerous chemical products including ammonium sulphate fertilizers contain sulphate in a variety of forms. Human activities such as the combustion of fossil fuels and sour gas processing release sulphur oxides to the atmosphere, some of which is converted to sulphate.

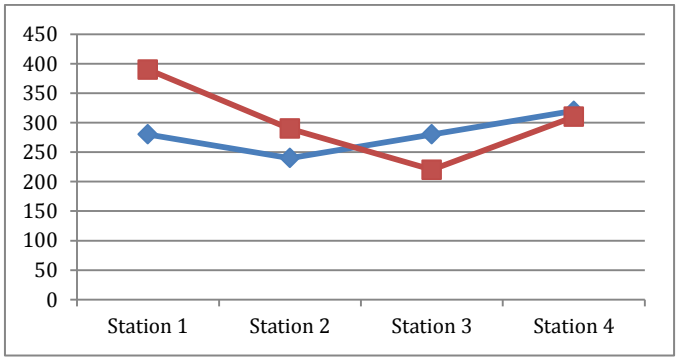
TURBIDITY (NTU)



Turbidity values in the samples brought is between **1 – 8 NTU** in the first sampling and **31 – 93 NTU** in the second sampling. The standard turbidity value is **5 NTU**. As shown in the graph the 1st sample has a turbidity of 8 NTU this is due to the sample which is brought at the shore where all the waste disposal and effluent concentration was slightly higher resulting in cloudiness formation in the water.

Hence the 1st sampling station has a higher turbidity, rest all other stations are having turbidity with 1 – 2 NTU in 1st sampling which are well within the limits. In the 2nd sampling considering the environmental conditions due to the decrease in the river water, the intrusion of sea water was high forming the water more turbid than the 1st sampling

NITRATES (mg/l)

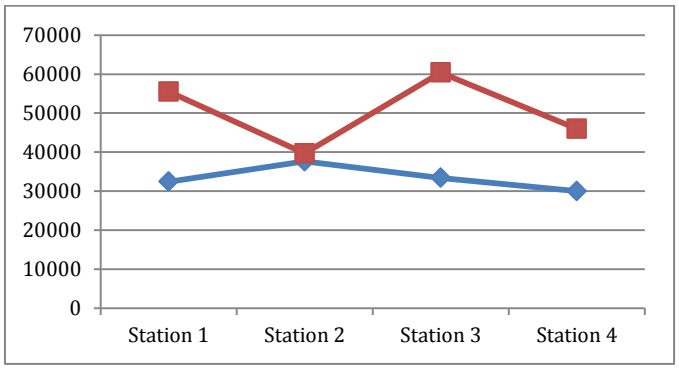


Nitrates in sample were observed to be around **240 - 320 mg/ltr** in 1st sampling and around **220 – 390mg/ltr** in 2nd sampling. Which was higher than the normal standards of drinking water is about **45mg/ltr.**

The aquatic animal's excreta and also when the aquatic animals and plants die. This activity eventually creates ammonia. Some bacteria in the water change this ammonia to produce nitrite which is then converted by other bacteria to nitrate. Nitrates also come from the earth. Soil contains organic matter, which contains nitrogen compounds.

Most sources of excess nitrates come from human activity. The source of excess nitrates can usually be traced to agricultural activities, human wastes, or industrial pollution. Thus due to the above factors the concentration of Nitrates in the water sample is seen to be more.

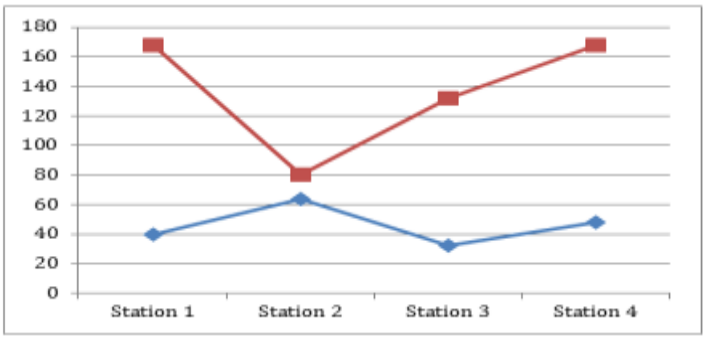
CHLORIDES (mg/l)



Chlorides in sample were observed to be **30000 – 37600 mg/ltr** in 1st sampling and around **39000 – 60000 mg/ltr** in 2nd sampling. Which was higher than the drinking water standards, which is **250 mg/ltr**. Chlorides are present both in fresh and salty water. Chloride ions come into solution in fresh water through underground aquifers, geological formations that contain groundwater. In coastal areas in brackish water chloride come from saltwater aquifers, sea spray, and coastal flooding, Seawater has a natural chloride concentration of 35,000 ppm.

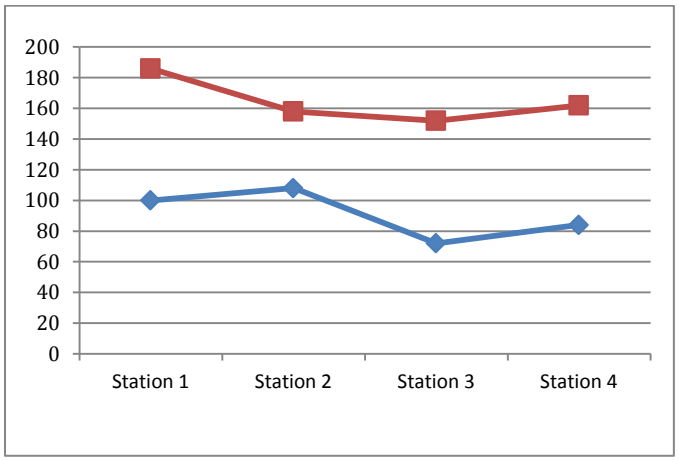
Since the water sample collected in brackish the chloride content value is around 30000 – 37600 mg/ltr

ACIDITY(mg/l)



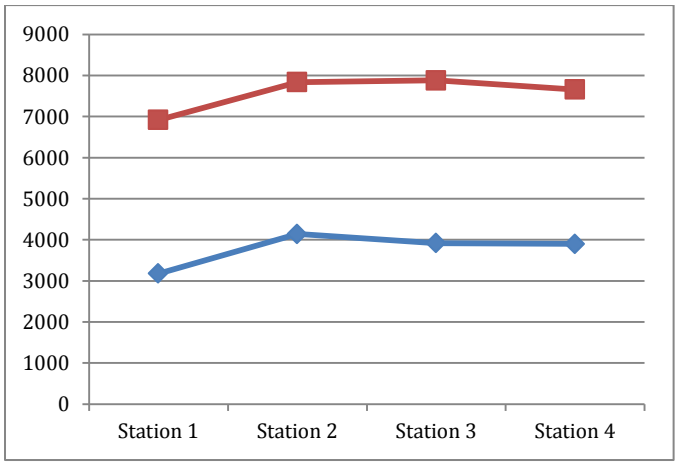
The acidity content in the water sample was around **40 – 64 mg/ltr**. The standard value of acidity content is **250 mg/ltr**. As the water sample collected in brackish water i.e. water which contains both sea water as well as freshwater, this collected water sample has salt concentration in it, resulting in less acidic in nature. Thus the obtained values are within 40 – 64mg/ltr

ALKALINITY (mg/l)



Alkalinity measures the ability of a solution to neutralize acids to the equivalence point of carbonate or bicarbonate. The total alkalinity in the collected water sample is around **70 – 110 mg/ltr.** The standard value of alkalinity is **200mg/ltr**. It is known that the brackish water contains some amount of salt concentration thus making the water alkaline in nature, thus the obtained results are well within the limits.

TOTAL HARDNESS (mg/l)



The sample obtained values was around **3800 to 4200 mg/ltr** which is higher that the desirable limits which is **300mg/ltr**. Water hardness is the amount of dissolved calcium and magnesium in the water. Water is often called the universal **solvent**, and as part of that definition, water picks up minerals as it travels many miles over rocks and through soil as it makes its way to water treatment facilities. Those minerals, mostly calcium and magnesium, are dissolved and held in solution even after going through the rigorous treatment process.

4. TREATMENT METHODS

Considering the parameters analyzed we have seen that the following parameters are exceeding the limits of water quality standards: Electrical conductivity, TDS, Sulphates, Nitrates, Chlorides, Total Hardness, DO, Turbidity.

Suggesting economical and reliable treatment method based on the results obtained

The basic treatment process includes coagulation, flocculation & clarification, sedimentation, filtration, disinfection methods which helps in making the water clean

As shown in the Fig 4.1 flow diagram of water treatment, the estuary water treated through this process may help in reducing the excess concentration of the parameters analyzed. With this process Reverse Osmosis and aeration process can be involved to bring the parameters to the standard limits, thus helping in using the water for domestic, drinking or irrigational purposes.

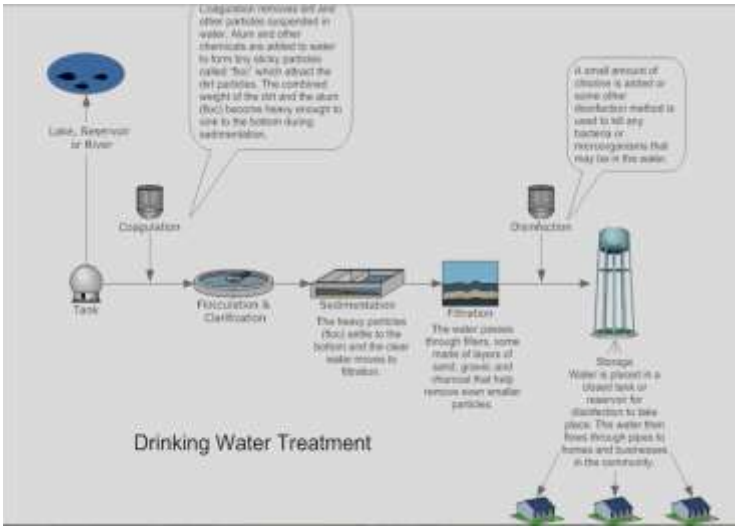
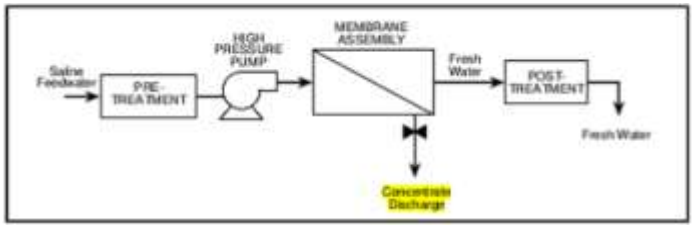


Fig 4.1: Basic Treatment Process Flow Diagram

4.1Working of Reverse Osmosis system

Reverse osmosis (RO) is a water purification technology that uses a semi permeable membrane to remove ions, molecules, and larger particles from drinking water. The largest and most important application of reverse osmosis is the separation of pure water from seawater and brackish waters; seawater or brackish water is pressurized against one surface of the membrane, causing transport of salt-depleted water across the membrane and emergence of potable drinking water from the low-pressure side. The membranes used for reverse osmosis have a dense layer in the polymer matrix-either the skin of an asymmetric membrane or an interfacially polymerized layer within a thin-film-composite membrane-where the separation occurs. In most cases, the membrane is designed to allow only water to pass through this dense layer, while preventing the passage of solutes (such as salt ions). This process requires that a high pressure be exerted on the high concentration side of the membrane, usually 30–250 psi for fresh and brackish water, and 600–1200 psi for seawater, which has around 390 psi natural osmotic pressure that must be overcome. This process is best known for its use in desalination (removing the salt and other minerals from sea water to get fresh water), but since the early 1970s, it has also been used to purify fresh water for medical, industrial, and domestic applications.

Reverse osmosis is an increasingly common method of desalination, because of its relatively low energy consumption. Brackish water reverse osmosis refers to desalination of water with a lower salt content than sea water, usually from river estuaries or saline wells. The process is substantially the same as sea water reverse osmosis, but requires lower pressures and therefore less energy. Up to 80% of the feed water input can be recovered as fresh water, depending on feed salinity.



4.2 Discussion on water conveyance

In the present scenario with the rising crisis of water in various parts of the country, it has become necessary to think on alternative sources that can help fulfil human needs. In which estuary water can be an alternate source, which is being flown directly to sea can be treated and be used for domestic, irrigation or drinking purposes. This Aghanashini Estuary water can be treated as explained in the earlier chapters. In this chapter we have discussed about the possibilities of water conveyance from Aghanashini Estuary to Bengaluru.

There is no ease of transportation from Aghanashini Estuary. The water has to be treated and transferred to Kumta, which is the nearest place having Railway mode of transport, and is at a distance of 15.2km from Aghanashini Estuary. The distance from Kumta to Bengaluru through Airways is 378km, Railways is 693km, Roadways is 466km. In these modes of transportation, Railways will be the economical mode of transport and can carry large quantity of water at once.

Through Railways there are different types of wagons which carry different goods under different class of commodity, in which water comes under class 110. Under railways Freight guidelines it has been known that the entire liquid and gaseous commodity has to be transported through BTPN (Bogie Tank Wagons) or special wagons can be used for transporting water. In recent cases due to the crisis in Latur government transported water from Krishna River to Latur through BTPN wagons, each wagon carrying 54000 litres, 50 such wagons which can carry around 25 lakh litres of water were transported at once. In similar way the treated water can be send through these wagons each carrying 54000 litres of capacity and 50 wagons at once to bengaluru.

Under Railways FOIS (Freight Operation Information System), for water as commodity it is charged Rs.761/tonne of water. Thus considering this, the freight calculation expenses incurred for transporting 50 Wagons of water will be around 30 lakh's including expenses on cleaning exercise, Traffic, workman and other negligible works.

5. CONCLUSIONS

(1) The initial study of the estuary was done in the month of January which shows that the water was almost within the standard limits or slightly higher with maximum number of parameters analysed. This was due to the concentration of salt contents, dissolved, suspended and colloidal solids which was present in the estuary water.

(2) In the next sampling which was done in the month of May all the parameters similar to the first sampling was tested and the results revealed that the water had higher concentration values in all the parameters, this was maybe due to the seasonal variation as in the summer with the lesser amount of water in the river decreased and the sea water intrusion took place resulting in inward flow of sea water.

(3) The water can be effectively used for irrigational and domestic purposes with proper treatment methods as suggested reverse osmosis method will be economical and reduce the concentration of the parameters studied, thus making the water to be used for various purposes.

(4)Discussion on conveyance of water to bengaluru city considering railways as the mode of transport & its expenses is also discussed.

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BIOGRAPHIES

Working as an assistant professor in the department of Civil Engineering, GMIT, Davanagere, Research Scholar in VTU Belgaum and working in the area of water and waste water pollution prevention and treatment Engineering. Life member of Indian Society of Technical Education (ISTE).

Working as an assistant professor in the department of Civil Engineering, GMIT, Davanagere from past 15 years of Teaching and Research Scholar in VTU Belgaum and working in the area of Eco-friendly concrete. Life member of Indian Society of Technical Education(ISTE) .

Working as an assistant professor in the department of Civil Engineering, GMIT, Davanagere, Research Scholar in VTU Belgaum and working in the area of Eco-friendly concrete. Life member of Indian Society of Technical Education (ISTE) .

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