Cost Factors of Municipal Water Has Social Values and Scientific Applications

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Abstract

Water (H2O) is an important bio-chemical compound and it has life-supporting role. Water purification is a scientific process of chemical treatment. High-quality water demand for pure chemical synthesis such as boiler feedwater. Drug industries welcome centralized compared to onsite treatment, recycling technologies considering economics of scale. Boiled Feed (V) Water is important for IVF (Inter Venus Fluid) and its comparative costs and lessons learned could be used to build treatment facilities. Government policy and regulations, economic cost, corporate sustainability, environmental agency can enforce to get high-quality water.

Keywords: Life, Water, Economic, Quality, Chemical

Introduction

Water (H_2O) is an important chemical compound for social drugs and its purification is a scientific process. The cost estimation of the water treatment system has an integral role in planning, implementation and administration [2]. Now a day, it has developed a substantial amount of cost data and related cost components. These can be used to estimate the cost of various unit processes for aggregating into water treatment systems. Water treatment plants are administered by public authority and these are infrastructure projects including buildings, underground piping and equipment [5]. Water treatment technology has prompted many municipalities to identify more efficient uses of water resources, chemical plant including more widespread acceptance of the use of non-conventional water sources [3]. Water treatment system cost components are installation, chemical, operating, and maintenance, distribution etc [4].

Research of purification and social aspects

Its purification indicator of Ph level: 7.0, >7.0, <7.0, Smart Capsules: Nano-, micro- and milli- capsules: alginate-based capsules (10 nm-1µm), carbon nanotubes (1µm-1mm), polymer swelling capsules (>1mm), Limits of Inorganic: calcium, carbonate ions and magnesium, Non-metallic: arsenic and selenium and Organic: benzene, cyanide, naphthalene, anthracene, ammonia, phenols, Range of BOD (3-5 ppm for clean)/ COD (20 to 1000 mg/L), (BOD is 60% of COD):

a) The results of this study will assist planners for the water treatment plant, distribution of the water to the customers in the city and the power needed to supply certain amount of water.

b) It will be capable to project the amount of water for the increasing population, cost of equipment like pipes, installation cost, maintenance cost and to choose the best cost-effective treatment system.

c) This study will help to solve the long-term water problem as a result of poor taste of water and high amount of minerals in the water and water shortage in the city.

d) The data could be used to estimate costs of distribution for water, capital and operation cost and the pattern of water demand in specific city.

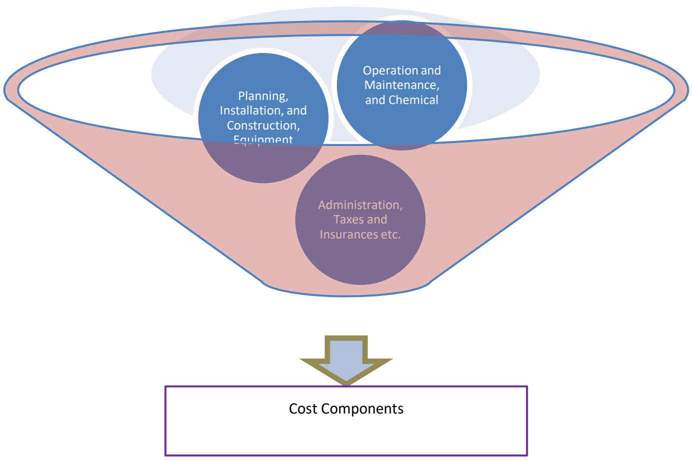
Scope of the study

The study would require detailed information on cost for trench, pipe, and energy. The study also requires knowledge of the effect of specific variables such as diameter of the pipe, width and depth of the trench, horsepower, distance of the pipeline on overall capital and operating cost. The main areas of the estimation include the well and pipelines to the treatment plant and the distribution system [6]. The development of the cost criterion may be specific to each particular case, especially to assess variable operating costs [8].

Cost classifications

Capital costs are estimated for equipment, materials, construction etc. It can be estimated using a recently developed model that divides water system cost into major cost components. These categories include pipes, valves, membranes, pumps, electrical and instrumentation, tanks, frames, buildings, electrical supply, treated water storage and pumping, etc.[Figure-1].

Figure 1: Major cost Classifications



Total construction cost includes all costs related to a construction contract, overhead and 10% profit of the contractor. Generally, there are economies of size so as the capacity of the system increases the unit cost of capital declines. Operation and maintenance costs of water treatment plant normally consist of labor, supervision and administration, power, chemicals, maintenance, repairs, insurance, miscellaneous supplies and services, cost of the policy of the owners, the complexity of the system, the local environment and weather. Operating cost can also be fluctuated due to continuing inflationary trend of labor, power and equipment. The cost of distribution depends upon the quantity consumed by individuals at various distances from the plant. The distribution system includes the meters, trunk lines, transmission pipelines and distribution mains, and storage facilities necessary to convey the water from the transmission system to the consumer.

Methods of Cost Estimation of Water Treatment Systems

There are two alternative treatment systems that will be considered with different sizes. A nanofiltration (reverse osmosis) treatment plant system can serve a thousand people. Considering economies of scale, a plant that will serve may be more economically viable and the cost estimates in three main categories; capital cost, operating cost and distribution cost in a form of description, unit, quantity, unit cost and total cost [Figure 2].

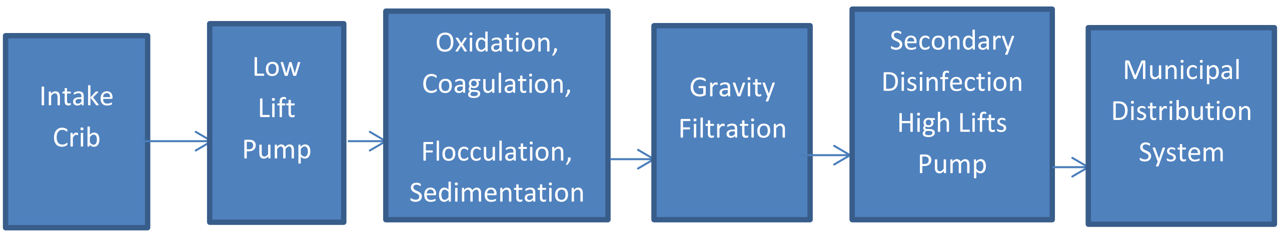


Figure-2: Municipal Water Treatment System [2]

Estimation of Investment and Annual Capital Cost

Capital costs are mainly for construction cost, engineering cost and cost of treatment equipment. After installation, these become the fixed component of cost. Capital costs are expected to be incurred mostly at the beginning of the planning process and in future years when the equipment is replaced or renovated. The capital cost can be calculated as the sum of material cost and equipment cost, trench cost, fixed pipe cost and contingency cost. Contingency (Cont.,) is a construction cost estimated as a lump sum cost and the contingency fund depends on the estimator of the project; usually ranges from 2% to 15%. The approach of accounts for the individual economies of scale related to different equipment and facilities, and thereby considered an overall economy of scale for the entire water treatment and delivery system.

Estimation of Pipe Cost and Trench Cost

The pipe cost is part of a fixed component of cost. Pipe cost is a function of its diameter. Mathematically,

$FPC = IP*(Día)*MF$............ (1)

Where FPC = the Fixed Pipe cost, Día =Diameter of the pipeline and MF = Mortgage factor, IP= Investment Cost of pipe.

Trench cost is the cost of excavating the trench to lay pipes. The trench cost is a function of width and depth of the trench. The size of the pipe is proportion to trench width. The depth of the trench varies with the size of the diameter of the pipe. The model be:

$T_i = a + bD_i$.................... (2)

$T_h$is the cost of trenching, D_i is the depth of the trenching which varies with the cost of pipe; a, b are the parameters of the model and are estimated using the regression technique. Trenching cost is the sum of the cost for backfill, packing, trench cost and total operating cost

$Exif = T_i + P_i + B_i$ .... (3)

Where Ebb is the Total cost of Excavation and backfill, T_i is the trenching cost, $P_i$es the cost of packing on the sides of the pipe in the trench, B_i is cost of backfilling.

Cost Estimation for Treatment Plant, Well and Plant Operation

Construction cost data provides cost information for a list of building materials and equipment. The cost of the drilling of the well is a capital cost and it is estimated by the current prices from the means construction cost data. Plant operation is a variable cost and it comprises of chemical cost, energy cost, staff, maintenance, monitoring and labor cost. Labor and operation cost depends on wage rates, operation hours, cost of potassium permanganate ($KMnO_4$) and chlorine (Cl_2) etc.

Chemical Cost

Chemical cost estimating depends on the quantity of the chemical used during treatment process and the price of the chemical per unit. The following baseline assumptions should follow to estimate chemical cost:

a) This unit cost $Cl_2$is considered on the quantity of the chlorine use. Cl_2 is the important chemical for water treatment and it is used to kill bacteria in water.

b) The unit cost of the $KMnO_4$ is used during the treatment. $KMnO_4$ is used primarily to control taste and odors, remove color, control biological growth in treatment plants, and remove iron and manganese.

c) The unit cost of the scale inhibitor which is developed to manage the problems associated with hard water, specifically hardness salts and the formation of scale in a wide range of commercial and industrial process environments.

The chemical cost is based on P_i= unit cost of $KMnO_4$, Q_i= quantity of $KMnO_4$, i_n = unit cost of scale inhibitor, S_i=quantity of the scale of inhibitor, α_i=unit cost of $Cl_2$and C_i is quantity of Cl_2.

Total chemical cost (CN) is calculated as

$CN=P*Q + \delta_i * S_i + \alpha_i* C_i$ .... *(4a) for Nanofiltration*

$CN=P*Q + \alpha_i*C_i$............................*(4b) for Aerator*

Energy Cost

The energy cost (water horsepower + brake horsepower) is the cost of energy needed to run the machines or treatment plant and other facilities:

a. Pumping efficiency (50-85%) is the ratio of water horsepower and brake horsepower. Mathematically, Pump efficiency = Whp/Bhp.

b. Motor efficiency (80-95%) is the ratio of Bhp to Mhp where Mhp is Motor horsepower. Algebraically, Motor efficiency = Bhp/Mhp.

Blake Horsepower (Bhp) is the hydraulic horsepower supplied to the pump from the motor. It depends on the water horsepower. It can be calculated as

$$Bhp = \frac{GPM*Head\ (pr)}{3960*Peff*Meff} \text{-------------------------} (5)$$

Where GPM is a gallon per minute, P_{eff} is Pumping efficiency, M_{eff} is Motor efficiency and Head is the pressure flow.

Water Horsepower (Whp=GPM*Head/3960) is the theoretical power required to pump a given volume of water. Therefore, the head loss is estimated as

$$Head\ Loss, Hd = \frac{[10.51*(GPM/C)\text{^}2 *Dist]}{[(Dia)\text{^}4.87]} \text{-------------------------} (6)$$

Dia is the diameter of the pipe, Dist= distance of the pipe in feet, C= coefficient of roughness for type of pipe. Again, EC is Energy (Pumping) Cost, GPM is a gallon per minute, Hd is a head loss, Peff is Pump efficiency, Meff is motor efficiency, KwBhp is kilowatt per brake horsepower, happy is an hour per year, and pelec is electricity cost:

$$EC = \frac{\{(GPM*Hd)*Kwbhp*hpy*pelec\}}{[3960*Peff*Meff]} \text{-------------------------} (7)$$

Labor Cost

The labor cost is the function of hours of working and the cost of the labor. The total labor cost can be calculated by multiplying the current labor cost and working hours, plus the worker's compensation (insurance) and payroll tax. The payroll tax and insurance are the percentage of the labor cost.

Determination of Annual Economic Cost

The annual economic cost of the treatment system is expressed as the sum of annual capital cost and combination with the operating cost of treated water produced. Total investment capital costs are amortized over the design life of the plant to get total annual fixed capital cost.

Annual Economic Cost = $(C_{hon} + C_{eng} + C_{eqp} + Cont.)(A/C) + C_{op}$............ *(8)*

Where C_{con} is the construction cost, C_{eng} is the Engineering cost, C_{eqp} is the Equipment cost, C_{op} is the Operating cost and (A/C) is the amortization factor, the interest rate for the capital investment cost, i_{ce} and the life span of the plant, LS:

$$(A/C) = \frac{[ic*(1+ic)^\wedge LS]}{[(1+ic)^\wedge LS]}$$ ------------------------*(9)*

The cost per thousand gallons a day (CPT) of treated water could be expressed as:

$$CPT = \frac{[((Ccon + Ceng + Ceqp + Cont.)(A/C) + Cop)*1000]}{Qdes}$$ --------------------------*(10)*

Where Q_{des} is the quantity of water treated.

Results and Discussions

Water treatment plants include coagulation, flocculation, sedimentation and filtration etc. Pure water has PH level: 7.0; its biochemical purification demands smart capsules (Nano, micro and milli), ranges of BOD, COD, and limits of inorganic (calcium, magnesium and carbonate ions), non-metallic (arsenic or selenium), and hydrocarbons (benzene, naphthalene, phenols) etc [7]. The relatively low capital and operational and maintenance costs are suitable for smaller water demand situations. The optimum of cost estimation among the various alternative water treatment systems that meet standards may be selected on the basis of minimum cost, including construction, capital, and maintenance and operating and cost associated with plant maintenance cost over a designated planning horizon. The reliability of cost estimates is a function of basic data, geographical region, stage of development, definition of scope, the time expended on the analysis, and experience of the analyst for guiding research etc. Pre-design estimates are useful desirable of design alternatives. Many water treatment processes originate in the laboratory and are tested through field-scale pilot plant studies.

Conclusions

Water is an essential substance with many unique properties that contribute to its life-supporting role. Now a day it is important to fix up the quality of municipal drinking water- its sources, substances dissolved in it, potential contaminations and determinations of their concentrations. All choices can be made of the unit for purifying processes that are most attractive from an economic viewpoint considering all factors.

Recommendations

The final decision to build a treatment facility is complex and involves many factors that must be weighed by justification. Comparative costs and lessons learned could be used to evaluate these factors. The next step is to conduct further evaluations in which laboratory data and pilot plant data could be translated into equipment designs, piping features, layout processes, buildings, etc.

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