COST ANALYSIS OF TRICKLING-FILTRATION AND ACTIVATED-SLUDGE PLANTS FOR THE TREATMENT OF MUNICIPAL WASTEWATER

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ABSTRACT
Cost estimation is an important consideration for the development and evaluation of wastewater treatment alternatives. This paper evaluates the most cost-effective treatment scheme among different plants employing two biological processes most commonly used for the treatment of municipal wastewater in Saudi Arabia, activated sludge and trickling filtration, by using a computer-based treatment cost estimating model.

Project, and annual operation and maintenance (O & M) costs of trickling filtration (TF) are compared to those of two activated sludge (AS) systems: complete-mix and oxidation-ditch systems. Each system is a part of a complete treatment scheme for wastewater and sludge. The schemes are designed first on the basis of process variables and the reclaimed-water quality criteria for unrestricted irrigation specified by the Ministry of Water and Electricity, and then costed. In addition, cost effectiveness analysis is performed.

For a flow of 200,000 m^3/day with BOD and SS of 300 mg/L and 400 mg/L, respectively, costs of treatment alternatives are evaluated in 2006 Saudi Riyals. Results reveal that project costs of the AS plants are more than that of the TF plant by about 12%-13%. The present worth costs of the former plants are also higher than that of the latter by about 18%-19%. Results also show that the annual O & M of the completely mixed and oxidation-ditch AS plants cost more than the TF plant by about 53% and 46%, respectively. The per unit cost of the TF plant is estimated at SR 1.06/m^3, while the costs for the complete-mix and oxidation ditch AS plants are respectively, SR 1.25/m^3 and SR 1.23/m^3. Accordingly, the TF is obviously the most-cost effective treatment alternative.

KEYWORDS
Trickling filtration, activated sludge, cost estimation, cost analysis, present worth

INTRODUCTION

In addition to engineering and process related aspects of municipal wastewater treatment plants (MWWTPs), cost is an important consideration for the development and evaluation of treatment alternatives, and could be influential for the economic feasibility of these alternatives. Therefore, accurate and rapid design and cost estimating for MWWTP construction projects is a requirement for quick evaluation of design alternatives.

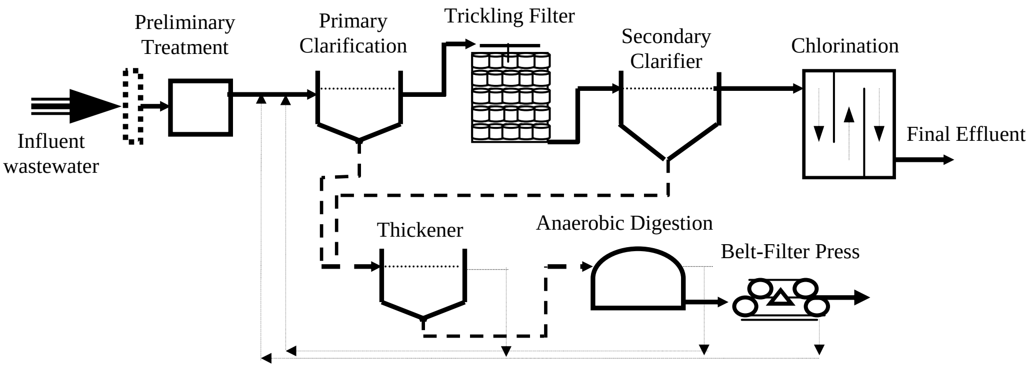
Wastewater treatment costs can be basically divided into two categories: capital costs and operation and maintenance (O & M) costs. Capital costs are incurred during plant construction, while O & M costs are those necessary to operate and provide upkeep for the plant following construction. Cost estimates can be made from data reported for similar size plants with similar wastewater and treatment characteristics, and presented as either a cost versus flow curve or as an equation (Pavoni, and Perrich, 1977; Tsagarakis et al., 2003; Friedler, and Pisanty, 2006). This method is time consuming and relatively inflexible. However, the use of software programs specialized in cost estimation is usually faster and provides better estimates since the design is based on all the characteristics of the wastewater being treated. For instance, the CapdetWorks program had been utilized to calculate capital and annual operation and maintenance costs for existing MWWTPs and constructing new plants in several counties in Detroit, US (DWSD, 2003), and to evaluate the status and efficacy of disposal options for MWWTPs in Florida, US (Koopman et al., 2006). Regardless of the approach used, it is imperative that all cost estimates be referenced to appropriate cost indices to account for inflation and other fluctuations in market prices.

In Saudi Arabia, there is a paucity of information on MWWTPS costs. Thus, the principle objective of this work is to determine the most-cost effective treatment system among different MWWTPs employing different biological treatment systems; trickling filtration and two different types of the activated sludge process: complete mix, and oxidation ditch. These activated sludge systems are increasingly being used in Saudi Arabia MWWTPs, while trickling filters are being either replaced or to be replaced by activated sludge systems even though they are very robust. The CapdetWorks program, which is one of the most widely used models for estimating costs of MWWTPs, is utilized for this purpose.

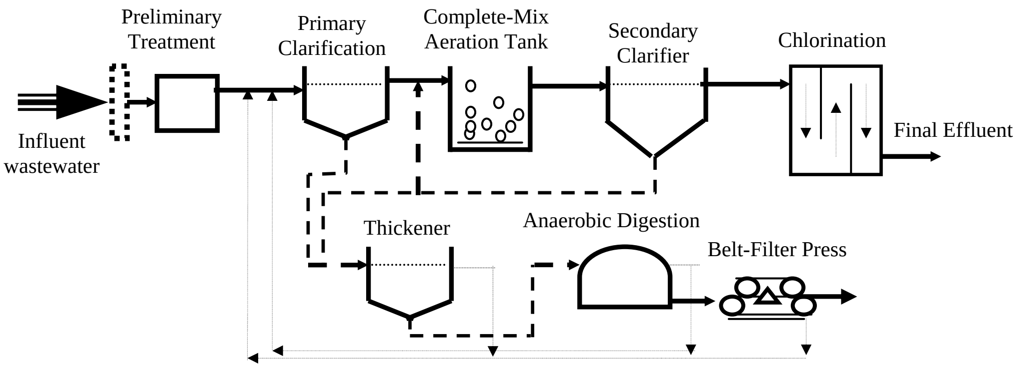
COST ESTIMATION AND ANALYSIS OF TREATMENT PLANTS

Treatment Schemes

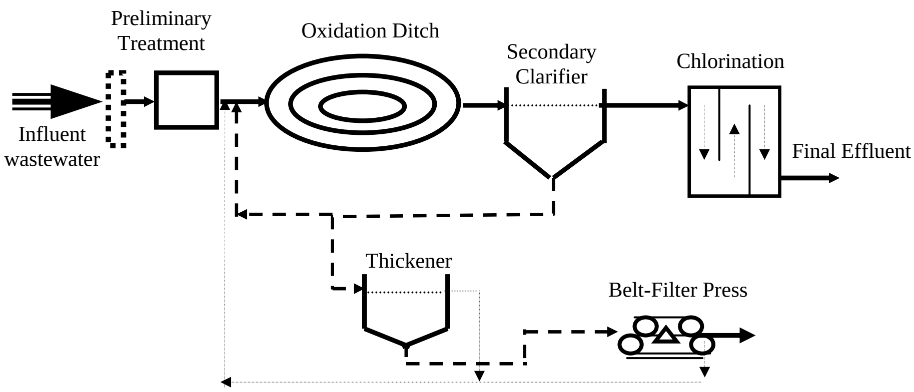
Three complete treatment schemes are assumed; each is consisting mainly of primary treatment, secondary treatment, and chlorination. Treatment of sludge produced is also considered. The secondary stage of one scheme comprises trickling filtration, while the other two schemes include the completely mixed and the oxidation ditch activated sludge systems. Other treatment processes are alike in all schemes. However, as the oxidation ditch process needs long aeration and sludge retention times and thus produces well-stabilized sludge, primary clarification and anaerobic digestion are eliminated from this scheme (Tchobanoglous et al., 2003). Figure 1 shows the layouts of the different treatment schemes.



(a) Trickling Filtration Plant



(b) Complete-Mix Activated Sludge Plant



(c) Oxidation Ditch Activated Sludge Plant

Figure 1: Layouts of Trickling Filtration and Activated Sludge Plants

The CapdetWorks

The CapdetWorks-2.1 is a software program designed primarily as a cost-estimating tool for wastewater treatment construction projects (Hydromantis, 2003). It calculates the design of each unit process based on the influent to the process and then cost that design. It also gives the option to review the produced design and modify it if necessary. The cost estimate the model generates is probably best described as an intermediate level between the planning-level estimate and the engineering estimate. It should be noted that the program is not a mathematical optimization model.

The cost report of the program includes the total project cost (construction, land, planning, design and administrative costs, and contractor profit and overhead) and the annual operation and maintenance costs for the facility after its construction (materials and supplies, energy, and labor). The program uses two cost estimating techniques, parametric and unit costing (US EPA, 1982). The parametric cost method is based on statistical analysis of the cost of facilities of similar size and characteristics at other locations (e.g. process flow and surface area), while the unit cost method is based on identification of cost elements to which input unit prices are applied (e.g. cubic meters of concrete in a clarifier are quantified to which an input cost value for reinforced concrete is applied to obtain construction cost). The program estimates costs using the U.S. July 2000 database (Hydromantis, 2003), and uses a number of equipment-related cost indices to adjust costs to the present (the Marshall and Swift Equipment Cost Index - *MAS*, the Pipe, Valve, and Fitting Cost Index - *PIPE*, and the Engineering News Record Construction Cost Index - *ENR*)

Information required by the program includes wastewater flows (average, maximum, and minimum), influent wastewater characteristics, unit operations and processes to include in the treatment train, and the desired effluent quality. The user can provide values for allowable process loadings, unit costs, and cost indices or rely on default values.

Design and Costing

Design criteria regarding influent wastewater flow and characteristics for the different treatment schemes were taken as those of the Manfuha wastewater treatment plant in Riyadh as shown in Table 1. Other design criteria assumed and used in this study for different treatment processes are shown in Table 2. These data and information were taken from the literature (Tchobanoglous et al., 2003). The concentrations of BOD and SS of the final effluents were set not to exceed 15 mg/L so as to meet the monthly-average values of reclaimed water quality criteria for unrestricted irrigation specified by the Ministry of Water and Electricity (MWE, 1427).

Based on the preliminary design, some design parameters such as number of tanks, diameter, and depth were modified to suite practical conditions and requirements (by overriding the resultant values of the preliminary design), and the layout was then redesigned and costed.

Costs were estimated in Saudi Riyals based on the annual cost indices for 2006 (MAS, PIPE, and ENR) to inflate default unit costs available within the program. The value for the ENR was obtained from the McGraw-Hill Construction web site: www.enr.com, while the values for the other two indices were acquired from the Chemical Engineering web site: www.che.com. As the program does not inflate land costs, a land cost of SR 50/m^2 was therefore assumed and input into the program. Unit prices for some construction activities, chemicals and supplies were also acquired from local markets. Table 3 shows the major costing variables that were used to calculate capital and operation and maintenance costs.

Table 1: Influent Wastewater Parameters Entered for Treatment Schemes

Average flow$^+$	Peak flow$^+$	BOD	COD	SS	TKN	NH_3	Phosphorus	Oil & grease	pH	Temperature (C^o)	
(m^3/d)	(m^3/d)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	-	Summer	Winter
200,000	320,000	300	500	400	50	30	8	100*	7.4	30*	15*

- + : design flows of the Manfuha plant in Riyadh city
- * : assumed
- TKN: total Kjeldahl nitrogen
- Except for temperature, and oil and grease all values are based on the average for the past five-year data (1422-1427H) of the Manfuha Wastewater Treatment Plant in Riyadh city.

Table 2: Design Criteria for Processes of Treatment Plants

Process	Design Criteria
Bar Screens	o Mechanically cleaned: 0.63-cm Inclined bars (30^o) o Cleaned depth = 90 cm o Max. allowable velocity = 1 m/s
Aerated Grit Tank	o Design basis: depth = 2 m o Detention time at peak flow = 3 minutes o Number of tanks = 4
Primary Clarification	o Circular tanks o Design basis: peak flow o Overflow rate = 100 m^3/m^2.day o Weir loading = 190 m^3/m.day o Underflow concentration = 4% o Side-water depth = 3 m o SS removal = 50% o BOD & COD removal = 30%
Trickling Filter	o Media: plastic, specific area = 85 m^2/m^3 o Bed type: circular o Hydraulic loading = 44 m^3/m^2.day o Effluent BOD = 20 mg/L
Complete-Mix Activated Sludge	o Aeration type: diffused aeration – coarse bubbles o Design basis: sludge retention time = 4 days o MLSS = 4000 mg/L
Oxidation-Ditch Activated Sludge	o Process design: carbon removal and nitrification o Design basis: sludge retention time = 15 days o MLSS = 5000 mg/L
Secondary Clarification	o Design basis: peak flow (PF) o Solids loading at PF = 190 kg/m^3.d o Surface overflow rate at PF = 40 m^3/m^2.day o Side-water depth = 4 m o Weir loading = 190 m^3/m.day o Underflow concentration = 1% o Effluent SS = 20 mg/L

Chlorination	o Chlorine: chlorine gas o Chlorine dosage = 10 mg/L o Contact time: 30 minutes at peak flow o Influent coliform count: 10,000,000 / 100 mL
Gravity Thickening	o Design basis: mass loading o Solids loading: 60 $kg/m^2.d$ o Depth: 3 m o Underflow concentration: 5%
Anaerobic Digester	o Location: Warm-Winter > 10 ^oC o Percent volatile solids destroyed = 50% o Concentration in digester = 5% o Detention time in digesters = 15 days o Temperature: Raw wastewater = 20 ^oC; Digester = 40 ^oC,; Air = 15 ^oC
Belt-Filter Press	o Hydraulic loading per meter of belt press width = 381 $m^3/m.day$ o Polymer dose = 1% dry weight o Filtrate solids concentration = 100 g/m^3 o Cake solids content = 19% o Density of cake = 1200 kg/m^3 o Operating schedule per day = 8 hr/day o Days operating per week = 5 days/week

Table 3: Major Cost Analysis Input Parameters

Design period (planning period)	30 years
Construction period	3 year for completion
Interest rate	8%
ENR Construction Cost Index, 2006	7751
Marshall & Swift Cost Index, 2006	1302
Pipe Cost Index, 2006	656
Land cost (SR/m^2)	50
Building cost (SR/ m^2)	1500
Excavation (SR/m^3)	100
Wall concrete (SR/m^3)	1500
Slab concrete (SR/m^3)	1500
Crane rental (SR/hr)	600
Canopy roof (SR/m^2)	300
Electricity (SR/kwh)	0.1
Hand rail (SR/m)	450
Construction labor cost (SR/h)	15
Operator labor rate (SR/h)	20
Average administration salary (SR/h)	30
Pipe installation rate (SR/h)	45
Polymer (SR/kg)	14
8-in pipe (SR/m)	130
8-in bend (SR/unit)	460
8-in tee (SR/unit)	600
8-in valve (SR/unit)	1300

Monetary Cost-effectiveness Analysis of Treatment Alternatives

After estimating the capital, operating and maintenance costs for each treatment plant, cost analysis was carried out to determine the most cost-effective scheme of treatment. Non-monetary factors are, however, not considered (such as operability, implementability, and performance reliability and flexibility). The present worth and the unit cost per m^3 of wastewater treated were used for cost analysis assuming an interest rate of 8% and a 30-year design period as the plants are expected to serve without expansion for 30 years although the plants may be kept in operation beyond that period. The treatment scheme that has the lowest present worth or unit cost is considered the most cost effective.

The present worth of a treatment plant is that amount of money required at the beginning of the planning period to pay the project cost immediately and the present worth of the annual O & M costs for the entire planning period. The program calculation of the present worth is based on the cost-effectiveness analysis procedure promulgated by the US Environmental Protection Agency (US EPA, 1982), which considers salvage values of facility components and revenues but excludes design and planning costs.

The unit cost per m^3 of wastewater is calculated manually by dividing the sum of the annualized project cost and annual O& M cost by the average design wastewater flow and number of days per year. The annualized project cost is estimated by multiplying the project cost by the capital recovery factor (CRF). The CRF (McGhee, 1991) is a factor that converts the present project cost to a series of equal payments at an interest rate (i) over the planning period (n):

$$CRF = [\ i\,(1 + i)^n \ \div \{(1 + i)^n - 1\}]$$

It should be noted here that the calculated present worth values are not absolutely accurate as they are based on generalized cost estimates. They serve to delineate the relative costs among the different treatment plants, and thus identify the scheme that is most cost effective.

RESULTS AND DISCUSSION

Table 4 presents the number and sizes of treatment processes for the three treatment plants. As can be seen, the preliminary stage including screening and grit removal is the same for all plants. Also, the number and sizes of primary clarifiers in the TF and complete-mix AS plants are similar, but the oxidation ditch AS plant has no primary clarification as indicated earlier.

To satisfy the effluent requirements in terms of SS and BOD, a two-stage biological filtration system is needed for the TF plant with two towers in each stage, each 25 m in diameter and 5 in depth. Four 35-m final-clarifiers follow this second stage. As for the complete-mix AS plant, the aeration tanks are arranged in 14 parallel train each consisting of 3 cells, followed by ten 35-m secondary-clarifiers. The oxidation ditch plant contains 16 ditches followed by twelve 35-m clarifiers. The area occupied by the TF system including the final clarifiers is about 6000 m^2, while it approaches 22,000 m^2 for the complete-mix AS system, and 84,000 m^2 for the oxidation ditch system. Although each of the three plants has two thickeners, both the complete-mix and oxidation-ditch AS plants require gravity thickeners of larger size compared to the TF plant (12.5 m and 14.3 m versus 10.4 m, respectively). In addition, five belt-filter presses are required to dewater the TF digested sludge as appose to eight presses for each of the AS plants. As stated before, no anaerobic digestion is needed for the oxidation ditch plant. Nonetheless, it is apparent that the TF plant requires lesser land area and number of processes than the other two plants.

Table 4: Process Design Information for the Treatment Plants

Treatment Process	Trickling Filtration	Complete-Mix Activated Sludge	Oxidation Ditch Activated Sludge
Screening	2 – 1.7m w x 0.9m d	2 – 1.7m w x 0.9m d	2 – 1.7m w x 0.9m d
Grit Removal	4 – 9.1m x 9.1m x 2m d	4 – 9.1m x 9.1m x 2m d	4 – 9.1m x 9.1m x 2m d
Primary Settling	4 – 35m dia x 3m swd	4 – 35m dia x 3m swd	-
Trickling Filter	2 stages, 2 tower/stage 25m dia x 5m d	-	-
Aeration Tank	-	14 parallel trains – 85.7m l x 10m w x 4m swd (3 cell/train)	-
Oxidation Ditch	-	-	16 ditches, each 167m l x 27m w x 3.7m swd
Secondary Clarification	4 – 35m dia x 3.5m swd	10 – 35m dia x 3.5m swd	12 – 35m dia x 3.5m swd
Chlorination	6660 m^3	6660 m^3	6660 m^3
Gravity Thickening	2 – 10.4m dia x 3m d	2 – 12.5m dia x 3m d	2 – 14.3m dia x 3 md
Anaerobic Digestion	2 primary and 2 secondary 20m dia x 6m d	2 primary and 2 secondary 20m dia x 6m d	-
Sludge Dewatering (Belt-Filter Press)	5 – 2m w	8 – 2m w	8 – 2m w

l: length. w: width. d: depth. swd: side water depth. dia: diameter

Table 5 summaries the results of cost estimating and analysis for the three plants. Figure 2-a also compares the costs of constructing unit processes and equipment, total construction costs, project costs, and present worth values for all the plants. It is obvious that these costs for the TF plants are less than the corresponding values for the AS plants. The unit process construction and equipment costs for the complete-mix and oxidation ditch plants are higher than that of TF plant by about 62% and 53%, respectively, as depicted in Figure 2-b. However, when other construction costs, profits and overhead are added (i.e. to obtain the total construction cost), the percent increases in total construction costs of the AS plants when compared to the TF plants become 31% and 27%, respectively.

The project cost of the TF plant is evaluated at about 769 million Riyals, whereas the values for the AS plants are approximately 867 and 859 million Riyals, respectively, a difference of about 12%-13% (Fig. 2-b). In terms of the present worth, the value for the TF plant is estimated at about 751 million Riyals, whereas the values for the complete-mix and oxidation-ditch AS plants are higher by about 19% and 18% (Fig. 2-b), and estimated at 897 and 888 million Riyals, respectively. It should be noted that the land costs account for about 48% to 54% of the total project costs based on the assumption that the per-m^2 land price is SR 50. Lower land prices will definitely results in lower project costs.

Total O & M costs for the TF and AS plants are estimated at 9.2, 14, and 13.5 million Riyals per year, respectively, as indicated in Table 5 and Figure 3-a. Thus, the O & M costs of the AS plants are higher than the TF plant O & M costs by 52% and 46%, respectively, as shown in Figure 3-b. It should be noted, however, that material, chemical and energy costs for all the plants account for about 84% to 89% of the total annual O & M cost as shown in Figure 3-a. This figure shows also that the share of labor cost of the total annual O & M cost for the TF plant is a bit higher than the shares for the complete-mix and oxidation ditch AS plants (16% versus 14% and 11%, respectively). While the O & M labor costs for the TF and oxidation ditch plants are only marginally different (1% difference), the cost for the complete-mix plant is higher than that of the TF plant by about 30% (Fig. 3-b). It can also be seen in Figure 3-b that the annual material, chemical and energy requirements for the AS plants cost more than those of the TF plant by about 54%-57%. Obviously, the TF plant requires less annual O & M labor, material, chemical and energy when compared to the complete-mix AS plant, and only less O & M material, chemical and energy when compared to the oxidation-ditch AS plant.

As for the per unit cost, the complete-mix and oxidation-ditch AS plants are found to have unit costs of SR 1.25 and SR 1.23 per 1 m^3 of wastewater, which are higher than the unit cost for the TF plant of SR 1.06/m^3 by about 18% and 16%, respectively. Apparently, the TF plant is the most cost-effective scheme as it meets the effluent requirements with the lowest cost.

Table 5: Cost Summary for Trickling Filtration and Activated Sludge Plants

Cost Item		Trickling Filtration	Complete-Mix Activated Sludge	Oxidation Ditch Activated Sludge
(1) Unit process construction cost + equipment cost (SR)		88,750,900	144,077,000	135,930,000
(2) Other cost (SR)	(a) Other construction cost *	88,915,100	88,915,100	88,915,100
	(b) Non-construction cost **	73,553,700	96,458,500	93,085,900
	(c) Land cost	411,938,000	413,538,000	419,269,000
	(d) Interest during construction	79,578,900	89,158,500	88,464,000
	(e) Total (a+b+c+d)	653,985,700	688,070,000	689,734,000
(3) Profit and overhead		26,649,900	34,948,700	33,726,800
(4) Total construction cost = 1 + 2-a + 3 (SR)		204,316,000	267,941,000	258,572,000
(5) Project cost = 1 + 2 + 3 (SR)		**769,387,000**	**867,095,000**	**859,391,000**
(6) Annual O & M labor cost (SR/year)		1,459,750	1,902,840	1,477,270
(7) Annual material, chemical and energy cost (SR/year)		7,787,420	12,196,400	12,000,700
(8) Total annual O & M cost = 6 + 7 (SR/year)		**9,247,000**	**14,099,000**	**13,478,000**
(9) Present worth (SR)		**751,425,000**	**896,934,000**	**887,705,000**
(10) Annualized project cost *** (SR/year)		68,475,000	77,171,400	76,485,800
(11) Annualized project cost + Annual O & M cost = 10 + 8 (SR/year)		77,722,000	91,271,000	89,964,000
(12) Cost / m^3 **** (SR / m^3)		**1.06**	**1.25**	**1.23**

* Other construction cost includes costs of mobilization, site preparation, site electrical, yard piping, instrumentation and control, and lab and administration buildings.

** Non-construction cost includes legal and technical costs, engineering design fee, inspection cost, contingency, and miscellaneous cost.

*** Annualized project cost = project cost x CRF. For i = 8% and planning period = 30 years, CRF = 0.089

**** Cost / m^3 (SR / m^3) = [annualized project cost + annual O & M cost] SR/year ÷ [average design flow, m^3/day x 365 days/year]

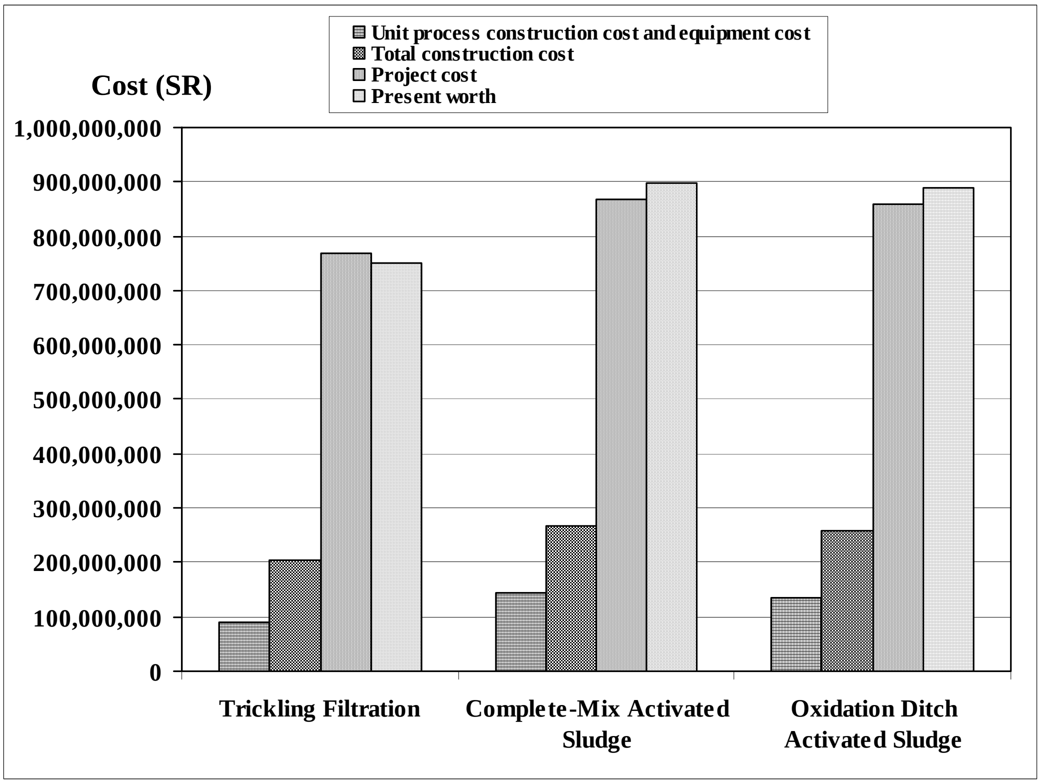


Figure 2-a: Comparison of Costs of Treatment Plants

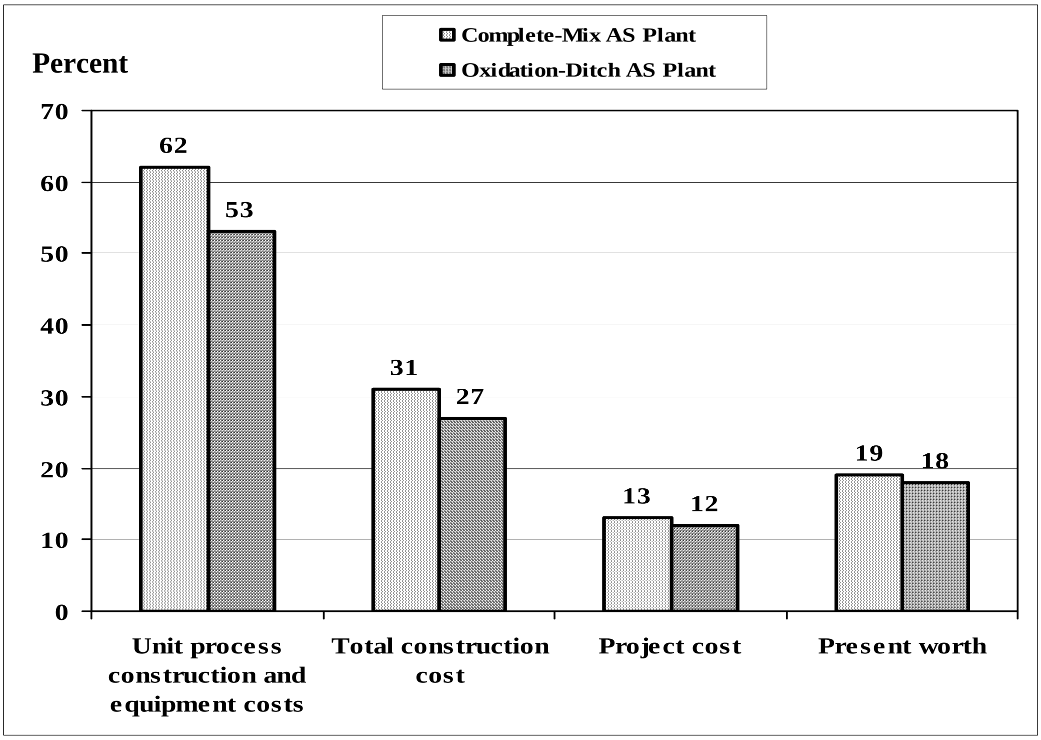


Figure 2-b: Percent Increase in Costs of the Activated Sludge Plants in Comparison to the Trickling Filtration Plant

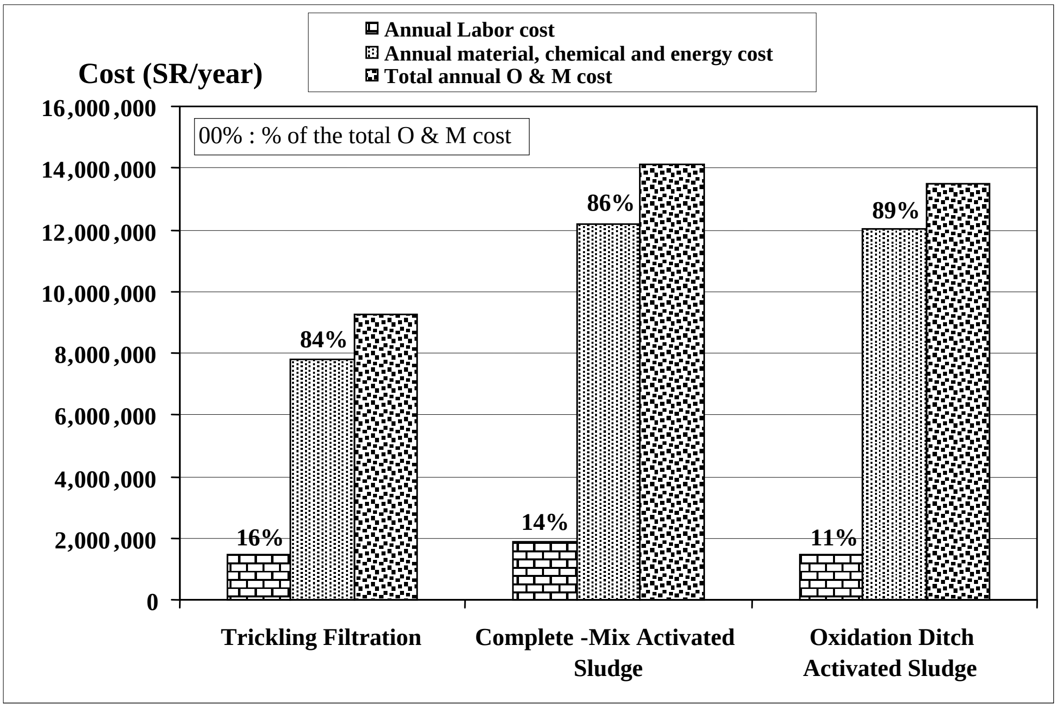


Figure 3-a: Comparison of Operation and Maintenance Costs of Treatment Plants

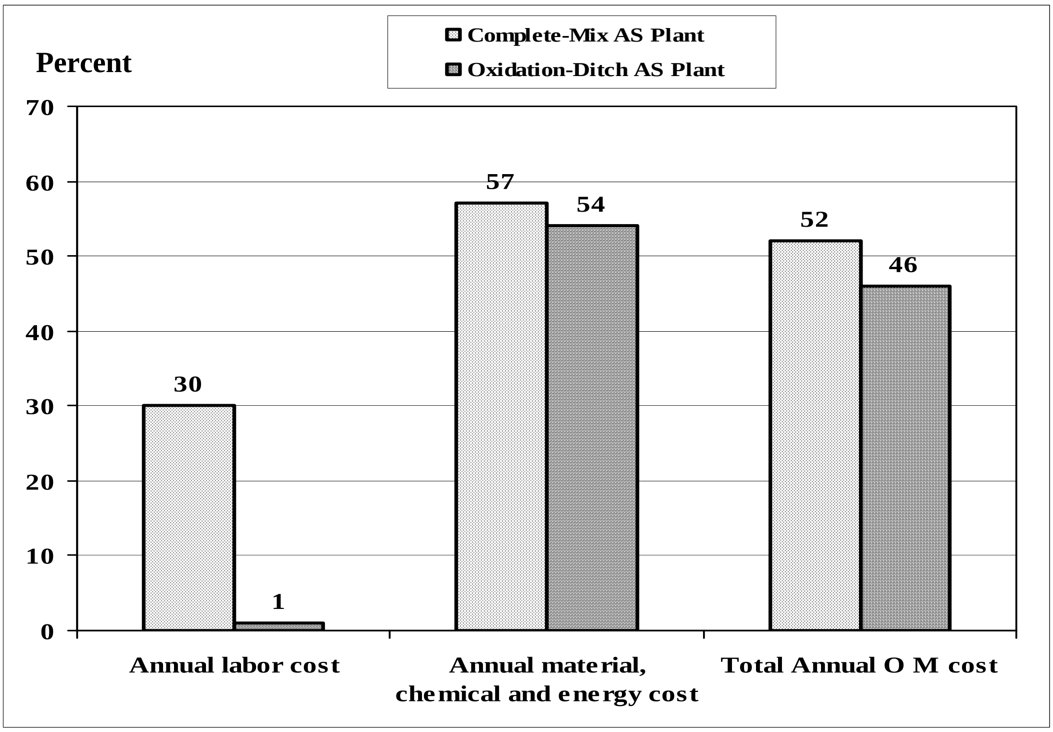


Figure 3-b: Percent Increase in Operation and Maintenance Costs of the Activated Sludge Plants in Comparison to the Trickling Filtration Plant

CONCLUSIONS

Based on the results of cost estimation and analyses of three different MWWTPs (trickling filtration, and complete-mix and oxidation-ditch activated sludge) each treating 200,000 m^3/day with SS and BOD of 400 mg/L and 300 mg/L, respectively, and using the 2006 cost indices, the following findings and conclusions can be made:

- Costs of constructing unit processes and equipment for the complete-mix and oxidation-ditch AS plants are higher by about 62%, and 53% in comparison to the TF plant.

- The project costs of the AS plants are more than that of the TF plant by about 12%-13%. Also the present worth costs of the former plants are higher than the latter by about 18%-19%.

- The total annual O & M of the completely mixed and oxidation-ditch AS plants cost more than the TF plant by about 53% and 46%, respectively.

- The annual O & M labor for the complete-mix AS plant costs about 30% more than the TF and oxidation-ditch plants. The costs for the latter plants are insignificantly different.

- The annual O & M material, chemical and energy costs for the AS plants are higher than that of the TF plant by 54% - 57%.

- The per unit cost of the TF plant is SR 1.06/m^3, while the costs for the complete-mix and oxidation ditch AS plants are respectively, SR 1.25/m^3 and SR 1.23/m^3.

- Considering the above cost findings, it is clear that the TF is the most-cost effective plant.

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تحليل تكاليف محطات معالجة مياه الصرف الصحي: المرشحات الحيوية والحمأة المُنشطة

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ملخص

يعد تقدير التكاليف من الاعتبارات الهامة لتطوير وتقييم خيارات معالجة مياه الصرف الصحي. لذلك فان هذه الورقة تقيم المعالجة الأكثر فعالية من حيث التكاليف لنوعين من أنواع المعالجة الأكثر استعمالا في المملكة العربية السعودية: المرشحات الحيوية والحمأة المُنشطة، وذلك باستخدام برنامج حاسوبي لحساب التكاليف.

تم مقارنة التكاليف الإنشائية وتكاليف التشغيل والصيانة لمحطة مرشحات حيوية بتكاليف محطتي حمأة مُنشطة تعملان بنظامين مختلفين: نظام الخلط التام ونظام أحواض الأكسدة. تم تصميم المحطات أولا بناءً على متغيرات عمليات المعالجة ومقاييس جودة مياه الري غير المقيد الصادرة من وزارة المياه والكهرباء، ومن ثم تم حساب التكاليف. كما تم أيضا حساب القيمة الحالية لتكاليف المحطات وقيمة التكلفة للمتر المكعب لتحديد المعالجة ذات التكلفة الأكثر فعالية.

تم حساب التكاليف بالريال السعودي بأسعار عام ٢٠٠٦م لتدفق يبلغ ٢٠٠،٠٠٠ م^{3}/يوم ويحتوي على مواد عالقة ومواد عضوية بتركيز ٤٠٠ ملجرام/لتر و٣٠٠ ملجرام/لتر على التوالي. بينت النتائج أن التكاليف الإنشائية وقيمة التكاليف الحالية لمحطات الحمأة المُنشطة أكبر من تكاليف محطة المرشحات الحيوية بحوالي ١٢% – ١٣% و ١٨% – ١٩% على التوالي. وبينت النتائج أيضاً أن تكاليف التشغيل والصيانة السنوية لمحطات الخلط التام وأحواض الأكسدة أكبر من تكاليف محطة المرشحات الحيوية بما يقارب ٥٣% و ٤٦% على الترتيب.

أما تكلفة معالجة المتر المكعب باستعمال المرشحات الحيوية فيبلغ ١,٠٦ ريال، بينما تبلغ التكلفة لمحطات الخلط التام وأحواض الأكسدة ١,٢٥ ريال و١,٢٣ ريال على التوالي. وبالتالي فان محطة المرشحات الحيوية هي الأكثر فعالية من حيث التكاليف.