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MUNICIPAL WASTEWATER TREATMENT OF BASRAH CITY USING INTERMITTENT CYCLE EXTENDED AERATION SYSTEM (ICEAS)

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Abstract: An Intermittent Cycle Extended Aeration System (ICEAS) offers advantages for treating sewage; such as easy operation, process flexibility, and low capital cost. The laboratory bench scale experiments were carried out treating domestic wastewater of Basrah City in fabricated ICEAS reactor of 72 L working volume. The domestic wastewater has the following characteristics (average values) pH= 7.5, Biochemical Oxygen Demand BOD= 200 mg/L, Chemical Oxygen Demand COD= 410 mg/L, Total Phosphorus TP= 7 mg/L, Total Suspended Solid TSS= 272. The aim of this research was to evaluate performance of the ICEAS system for treating domestic wastewater. Experimental results showed that the efficiency of ICEAS reactor to remove COD, Ammonia, TN, and TP were 91%, 83%, 60%, and 72%, while SBR efficiency were 87%, 81%, 58%, 69%, respectively. So, removal efficiency of ICEAS reactor was slightly higher than SBR. Comparison the effluent quality of ICEAS reactor with WHO, European and China discharge standards into surface waters were explained that COD concentration (37 mg/L) was meet to all standards (including Iraqi standard), while Ammonia NH_3-N (7.87 mg/L), Total Nitrogen TN (17.16 mg/L) and TP (2.84 mg/L) were to European and China but not meet to WHO standard with slightly differences.

Keywords: *Domestic Wastewater, Biological Treatment, Aeration, ICEAS*

معالجة مياه فضلات البلدية لمدينة البصرة بواسطة نظام التهوية الطويلة بدورات متقطعة ICEAS

الخلاصة: نظام التهوية الطويلة بدورات متقطعة ICEAS يقدم عدة ميزات في معالجة مياه الفضلات من بينها سهولة التشغيل ومرونة العملية وقلة كلفة الإنشاء. تم تصنيع مفاعل ICEAS في المختبر بحجم تشغيلي 72 L وتم تشغيله لمعالجة مياه الفضلات لمدينة البصرة. وجد إن مياه الفضلات المستخدمة لها الخواص التالية (معدل عدة قيم) : pH=6.9 to 7.95, BOD=200mg/L, COD=410mg/L, TP=7mg/L, TSS=272mg/L. الهدف من البحث هو لتقييم أداء المفاعل ICEAS في معالجة مياه الفضلات. النتائج المختبرية بينت أن كفاء المفاعل ICEAS في إزالة COD و الأمونيا و TN و TP هي كانت 91% و 83% و 60% و 72% بينما كفاءة SBR كانت 87% و 81% و 58% و 69% ، على التوالي. لذلك فأن كفاءة ICEAS هي أعلى بقليل من كفاءة SBR . كما تم مقارنة نوعية المياه الخارجة بعد المعالجة باستخدام ICEAS وتصريفها إلى المياه السطحية مع مواصفات WHO والأوربية والصينية فقد تبين أن تركيز COD=37 mg/L قد حقق جميع المواصفات (بما فيها المواصفات العراقية) ، بينما تركيز Ammonia = 7.87 mg/L و TN = 17.16 mg/L و TP = 2.84 mg/L قد حققت فقط المواصفات الأوربية والصينية لكنها لم تحقق مواصفات WHO باختلافات قليلة جدا.

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1. Introduction

Wastewater plays an important role in environment pollution. In various wastewater treatment technologies, sequencing batch reactor (SBR process) is the earliest with advantages of easy construction, stable operation and high removal efficiency. SBRs besides many advantages have some disadvantages: 1) require at least two tanks or an equalization tank, because when designing one tank, there is not possibility to remove one tank for maintenance purposes; 2) flow and loading changed during day which can cause unequal loading to tanks; 3) control system is based on water level in tank and because of diurnal fluctuations, results in real aeration time for biological reactions; and 4) continuous carbon source is essential in biological nutrient removal systems. In these systems wastewater is used as carbon source, while in SBRs this source is disrupted [1,2,3]. In recent twenty years, with the development of automatic control technology, SBR process has attracted attention and research and a series of new improved process has been developed with some typical SBR deformation process including Carrier-Activated Sludge treatment (CAST), demand aeration tank (DAT)/intermittent aeration tank (IAT), Unique Tank (UNITANK) and ICEAS, [4].

The ICEAS process is a modification and enhancement of the conventional SBR. Many of the practical shortcomings that may occur with the conventional SBR process have been addressed by development of the ICEAS system. The ICEAS allows for a continuous inflow of wastewater to the basin during all phases. By utilizing a continuous inflow the ICEAS can reduce the cycles from five down to three. If denitrification is required an anoxic phase is added to the cycles (Idle). In conventional SBRs there are five phases: fill, react, settle, decant and idle; but in ICEAS there are three phases: react, settle and decant. Influent allows that system is controlled based on time (instead of flow) and equal loading reaches to all tanks. The ICEAS system uses a continuous inflow which allows for at time based operational control as opposed a volume based control of a classical SBR. For small plants a single basin can be used, whereas with a common SBR two basins is a minimum. For larger plants the ICEAS system is accordingly easily expandable. The flexibility of the ICEAS system gives the operators a robust system which easily can be upgraded to meet stringent discharge demands and energy consents in the future. ICEAS has been a construction cost less than SBR. In addition, batch flow causes unequal loading (hydraulically and organically) in basin which has negative effects on biomass [5]. ICEAS is divided by a baffle (pre-react and main-react zone). Pre-react zone acts as a biological selector (enhancing growth of desired microorganisms besides limiting filamentous bacteria), an equalization tank and a grease trap [6] .

This investigation employs a laboratory-scale ICEAS to investigate its pollutants removal efficiency by comparison its performance with SBR performance and comparing its effluent quality with different international discharge standards. The study used the effluent from inlet zone of the Hamdan (in Basrah city) Wastewater Treatment Plant as inflow to an ICEAS to determine the removal efficiency of COD, Ammonia, TN and TP of the system.

2. Materials and Methods

2.1 *Reactor set-up and operation*

The laboratory bench scale batch reactor experiments were carried for treating domestic wastewater of Basrah city. The study was conducted under ambient environmental conditions in two fabricated reactor of 27 litters working volume [7]. The first reactor that shown in Fig. 1a was operated as a SBR. While, the second reactor that shown in Fig. 1b was operated as ICEAS. The domestic wastewater was collected from the inlet zone of Hamdan sewage treatment plant in Basrah, Iraq. During the start up of the two reactors they were seeded with activated sludge obtained from the return line of aerobic basin of Hamdan sewage treatment plant and operated for 90 days. The pH of the wastewater was adjusted to within 6.9-7.95 by added of 0.5N sodium hydroxide (NaOH) or 0.5N hydrochloric acid (HCl).

The ICEAS basin is divided into two zones, the pre-react zone and the main react zone as depicted in Fig. 1b. A baffle wall with openings is constructed to divide the ICEAS basin into the two zones. These openings at the bottom of baffle wall help to distribute flows evenly into the main zone. The influent flows continuously into the pre-react zone and is directed down through the openings at the bottom of the baffle wall into the main react zone. The volume of the pre-react zone is typically 10 to 15 percent of the total basin volume. In the ICEAS system, influent wastewater flows into the reactor on a continuous basis. As such, this is not a true batch reactor, as is the conventional SBR. A baffle wall may be used in the ICEAS to buffer this continuous inflow. In general a SBR includes five distinct phases namely fill, react, settle, draw and idle as shown in Fig. 2a. While, in ICEAS there are only three phases namely react, settle, and draw; which in all of these phases wastewater flows to reactor continuously and does not disrupt as shown in Fig. 2b. The design configurations of the ICEAS and the SBR are otherwise very similar. The ICEAS process is a variant of an SBR system where the processes of biological oxidation, nitrification, phosphorous removal and liquids/solids separation can be achieved continuously in a single tank. What makes the ICEAS process different is a continuous inflow, even during the settle and decant phases of the operating cycle [8].

The operation of the ICEAS system is illustrated in Fig. 2b. During the react phase, the air pump is activated to start aeration and the mixer is activated to start mixing and the sewage wastewater level in the tank is continuously rising due to continuous sewage wastewater inflow. During the settle phase, basin agitation from the react phase (aeration and/or mixing) is stopped to allow the solids to settle to the bottom of the basin. a thick sludge blanket is formed. This blanket is heavy enough to prevent disruption of settled sludge and a clear layer of water will remain on top of the basin. During the decant phase, wastewater discharges from the top of the tank was begin. Sludge is typically wasted from the basin during this phase of the cycle. The discharge operation usually lasts only a short time until the wastewater in the tank reaches a set low level. Hence, maximum and minimum levels of sewage wastewater in the tank occurred, at the beginning of the “react” and the end of the “decant” step, respectively. All of the decanted effluent is collected and analyzed [9].

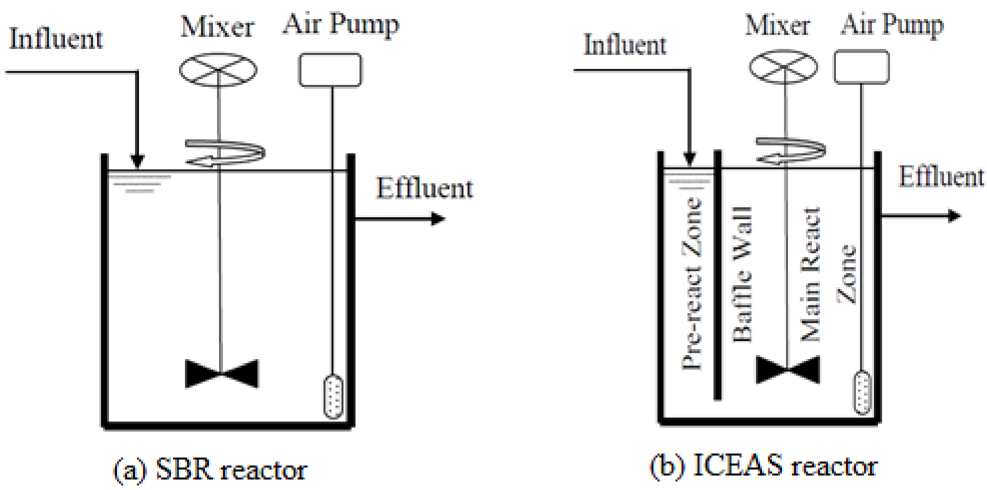

Fig. 1: Reactor Schematic Diagram: (a) SBR , (b) ICEAS

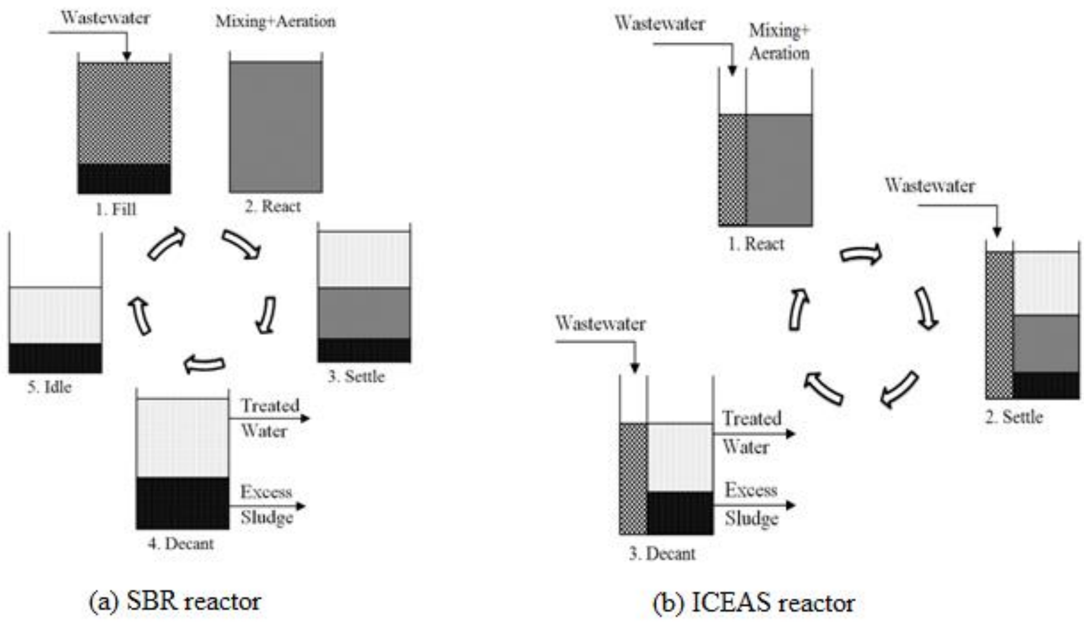

Fig. 2: Schematic layout of phases for reactors: (a) SBR , (b) ICEAS

2.2 *Experiment Process*

The experimental period comprised three different operational cycle modes occurred in each ICEAS and SBR reactor as shown below and in Fig. 3.

- 1st operation cycle mode: the mixed liquor was continuously aerated for 4h.
- 2nd operation cycle mode: the mixed liquor was continuously aerated for 6h.
- 3rd operation cycle mode: the mixed liquor was continuously aerated for 8h.

The three modes were imposed three different aeration time (4, 6, 8 hr) to investigate the effect of aeration time on the efficiency of the two reactors [10]. Therefore, the experiment has been done to choose the best cycle mode which gives good results in each reactor. These operation cycle modes (1st, 2nd and 3rd) were carried out, each with its own set of treatment parameters.

Reactor	Cyclic Mode	Time (Hours)											
		1	2	3	4	5	6	7	8	9	10	11	12
ICEAS	1	F	F	F	F	F	F						
		R	R	R	R	S	D	I	I	I	I	I	I
	2	F	F	F	F	F	F	F	F				
		R	R	R	R	R	R	S	D	I	I	I	I
	3	F	F	F	F	F	F	F	F	F	F		
		R	R	R	R	R	R	R	R	S	D	I	I
SBR	1	F	R	R	R	R	S	D	I	I	I	I	I
	2	F	R	R	R	R	R	R	S	D	I	I	I
	3	F	R	R	R	R	R	R	R	R	S	D	I

F Flow R React S Settle D Decant I Idle

Fig. 3: Operation Cycle Modes in ICEAS and SBR reactor

2.3 *Wastewater Analysis*

The main objective of these processes is to remove chemical oxygen demand (COD), Ammonia (NH_3-N), Total phosphor (TP), and total nitrogen (TN). Therefore, the samples collected from the influent and effluent wastewaters were analyzed in terms of the above parameters. The percent removal efficiency of COD, Ammonia, TP and TN was calculated.

All the experiments were carried out at room temperature (30±5°C) under normal lab daylight lamp conditions. The analytical methods which used in this study were followed Standard Methods for the Examination of Water and Wastewater [11]. The results are means of triplicate determinations. The instruments used during the experimental work are listed below:

1- COD Measurement Device (Loviband, MD 200, COD VARIO)
2- Ammonia Measurement Device (Reagent 721 Visual Spectrophotometer)
3- Total Phosphor Measurement Device (U-1500, Spectrophotometer)
4- Total Nitrogen Measurement Device (Electromantle MV)

3. Results and Discussion

3.1 *Raw domestic wastewater of Basrah City*

The study was conducted in Basrah city. The samples were collected from the inlet zone of Hamdan sewage treatment plant. Three samples were taken monthly during the research period which were continued from November 2013 to August 2014. These samples were kept in dark bottles at 4°C and sent to the laboratory to perform the required analysis. The determination of Total suspended solids (TSS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonia (NH_3-N), Total Nitrogen (TN) and Total Phosphorus (TP) were carried out as proposed by the standard methods [11]. The average value of various parameters observed as temperature range

20 to 30°C and the pH value ranged between 6.9 to 7.95. The others parameters of characteristics for Basrah sewage were analyzed and listed Table 1. Moreover, Table 1 shows the comparison of constituents concentrations of Basrah sewage with universal levels of the major constituents of high, medium and low strength of domestic wastewaters.

Table 1: compositions of Basrah sewage and comparison with typical concentration of untreated domestic wastewater

Parameter (mg/L)	*Mean Values of Basrah Sewage*	*Universal levels of international sewage [12,13]*		
		Low	Medium	High
BOD	200	110	190	350
COD	410	250	430	800
Ammonia	48	12	25	45
TN	60	20	40	70
TP	7	4	7	14
TSS	272	120	210	400
TDS	4460	270	500	860

It is clear that raw Basrah sewage tends to be medium strength with parameters BOD, COD, TP and TSS. While, raw Basrah sewage tends to be high strength with parameters Ammonia, TN and TDS. TDS was high strength due to increase the salinity of water supply in Basrah city. Most houses in Basrah city using septic tank systems that locally treat their wastewater. When a septic system is improperly managed, elevated nitrogen (Ammonia and TN) and levels can be released into sewer network.

3.2 *COD Removal*

The COD concentration variation with operation time under different operation cycle modes (first, second, third) in ICEAS and SBR shown in Table 2. This table had been shown that increasing aeration time lead to reduce the COD concentration in the effluent. So, increasing the aeration time to more hours ensure the effluent quality improvement.

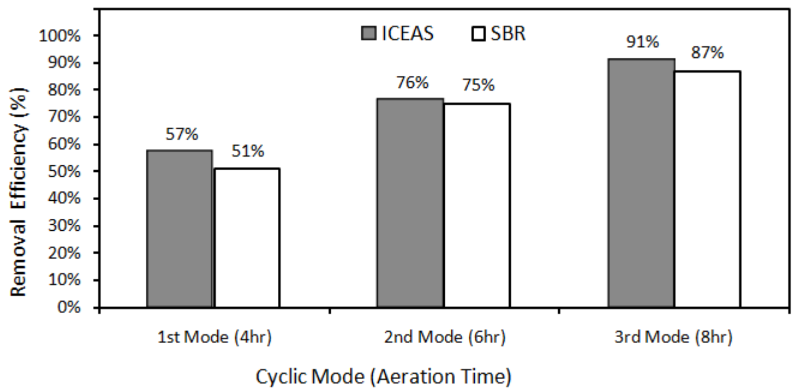

Fig. 4: COD Concentration Variation with Operation Time by ICEAS and SBR

Table 2: Average values of COD variation by CEAS and SBR

Cycle Mode	*Aeration time (hr)*	*COD variation by ICEAS*			*COD variation by SBR*		
		Influent mg/L	Effluent mg/L	Removal Efficiency	Influent mg/L	Effluent mg/L	Removal Efficiency
1st	4	405	174	57%	426	207	51%
2nd	6	387	93	76%	393	97	75%
3rd	8	418	37	91%	421	53	87%

Fig. 4 is implied that longer aeration time spent, higher COD removal efficiency could be achieved and ensure the effluent quality improvement. COD removal efficiencies for ICEAS and SBR operation cycle modes (first, second and third) were (57%, 76%, 91%) and (51%, 75%, 87%) respectively as shown in Fig. 4. Therefore, maximum COD removal efficiency of ICEAS was 91% which occur at third cycle mode with 8 hr aeration time.

It clear from Fig. 4, that ICEAS has been COD removal efficiency higher than SBR by 6%, 1% and 4% for aeration time 4, 6 and 7hr, respectively. The highest raise of the COD removal efficiency by ICEAS with respect to SBR was 6% that occur when the aeration time was 4hr. While, The lowest raise of the COD removal efficiency by ICEAS with respect to SBR was 6% that occur when the aeration time was 4hr. This means that the increase in aeration time leads to reduce the differences between the two reactors in COD removal. With increasing the aeration time to 6 or 8hr, the COD removal was slightly increasing due to reducing the organic substance mass with increasing aeration time.

3.3 *Ammonia Removal*

Ammonia concentration in ICEAS dropped from an initial mean value 48.23 mg/L to 13.41 mg/L in the first cycle mode, while in the second cycle mode decreased from 50.13 mg/L to 11.51 mg/L and from 46.55 mg/L to 7.87 mg/L in the third cycle mode as listed in Table 3. Ammonia removal efficiencies for ICEAS during first, second and third operation cycle modes were 72%, 77% and 83%, respectively as shown in Fig. 5.

Ammonia concentration in SBR dropped from an initial mean value 51.17 mg/L to 19.52 mg/L in the first cycle mode, while in the second cycle mode decreased from 44.56 mg/L to 12.76 mg/L and from 48.77 mg/L to 9.33 mg/L in the third cycle mode as listed in Table 3. Ammonia removal efficiencies for conventional SBR operation cycle modes (first, second and third) were (62%, 71%, 81%) respectively as shown in Fig. 5. Ammonia removal efficiency increased with rising aeration time up to 8 hrs within the limits of the study.

According to these results ammonia removal was relatively high in the third operation cycle mode. This due to increasing nitrification rate when the aeration time is longer so that the ammonia removal efficiency increased [14].

It clear from Fig. 5, that ICEAS has been Ammonia removal efficiency higher than SBR by 10%, 6% and 2% for aeration time 4, 6 and 7hr, respectively. This mean the ammonia removal efficiency of the two reactors were converged with increasing aeration time. This is due with increasing aeration time lead to become the operation properties of ICEAS slightly similar to SBR. As well as, With increasing the aeration time from 4 to 8hr, the ammonia removal was slightly increasing due to reducing the ammonia with increasing aeration time.

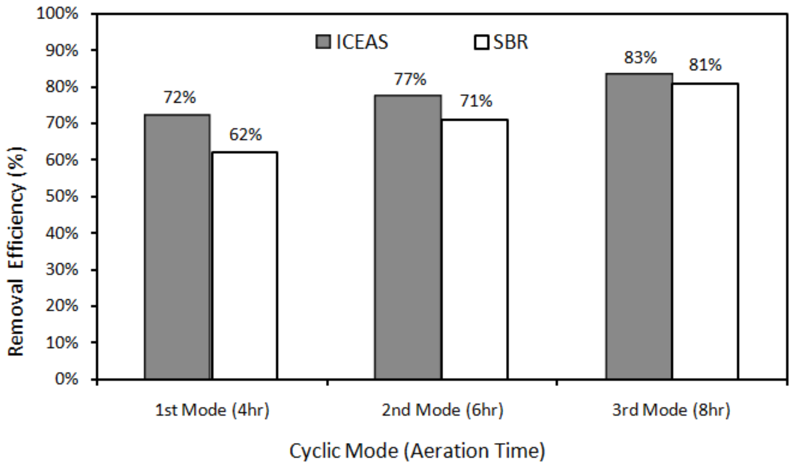

Fig. 5: Ammonia Concentration Variation with Operation Time by ICEAS and SBR

Table 3: Average Values of Ammonia Variation by ICEAS and SBR

Cycle Mode	*Aeration time (hr)*	*Ammonia variation by ICEAS*			*Ammonia variation by SBR*		
		Influent mg/L	Effluent mg/L	Removal Efficiency	Influent mg/L	Effluent mg/L	Removal Efficiency
1st	4	48.23	13.41	72%	51.17	19.52	62%
2nd	6	50.13	11.51	77%	44.56	12.76	71%
3rd	8	46.55	7.87	83%	48.77	9.33	81%

3.4 *Total Nitrogen (TN) Removal*

TN concentrations in ICEAS dropped from an initial mean value as 57.67 mg/L to 30.15 mg/L in the first cycle mode, while in the second cycle mode decreased from 55.32 mg/L to 20.07 mg/L and from 60.34 mg/L to 17.16 mg/L in the third cycle mode as listed in Table 4. TN removal efficiencies for ICEAS during first, second and third operation cycle modes were 48 %, 64 %, and 72 %, respectively, as shown in Fig. 6.

TN concentrations in SBR dropped from an initial mean value as 60.12 mg/L to 35.13 mg/L in the first cycle mode, while in the second cycle mode decreased from 52.73 mg/L to 21.23 mg/L and from 57.71 mg/L to 18.11 mg/L in the third cycle mode as listed in Table 4. TN removal efficiencies for SBR during first, second and third operation cycle modes were 42 %, 60 %, and 69 %, respectively, as shown in Fig. 6.

It clear from Fig. 6, that ICEAS has been TN removal efficiency higher than SBR by 6%, 4% and 3% for aeration time 4, 6 and 7hr, respectively. This means that the increase in aeration time leads to reduce the differences between the two reactors in TN removal. This is due with increasing aeration time lead to become the operation properties of ICEAS slightly similar to SBR. As well as, With increasing the aeration time from 6 to 8hr, the ammonia removal was slightly increasing due to reducing the TN with increasing aeration time.

TN removal efficiency increased with rising aeration time up to 8 hrs within the limits of the study. Therefore, it can be concluded that third cycle mode as the most suitable mode for total nitrogen removal in the case of SBR and ICEAS.

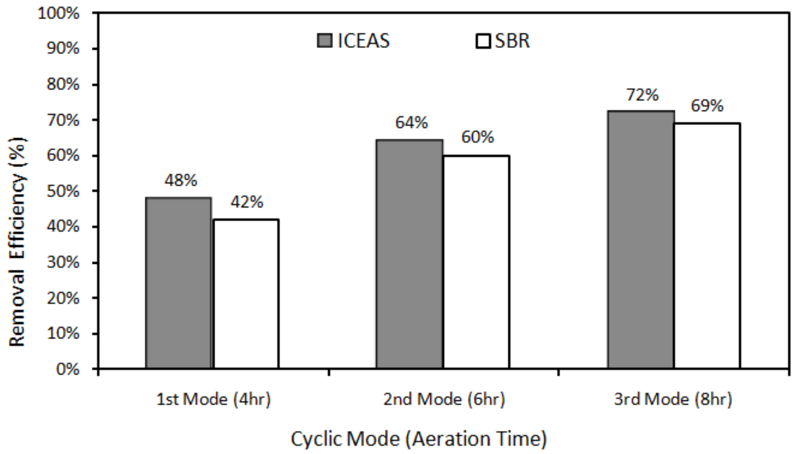

Fig. 6: TN Concentration Variation with Operation Time by ICEAS and SBR

Table 4: Average Values of TN Variation along Experiments by ICEAS and SBR

Cycle Mode	Aeration time (hr)	TN variation by ICEAS			TN variation by SBR		
		Influent mg/L	Effluent mg/L	Removal Efficiency	Influent mg/L	Effluent mg/L	Removal Efficiency
1st	4	57.67	30.15	48%	60.12	35.13	42%
2nd	6	55.32	20.07	64%	52.73	21.23	60%
3rd	8	60.34	17.16	72%	57.71	18.11	69%

3.5 *Total Phosphorus (TP) Removal*

TP concentration in ICEAS dropped from an initial mean value 7.14 mg/L to 3.88 mg/L in the first cycle mode, while in the second cycle mode decreased from 6.05 mg/L to 2.96 mg/L and from 7.21 mg/L to 3.21 mg/L in the third cycle mode as listed in Table 5. TP removal efficiencies for ICEAS during first, second and third operation cycle modes were 46%, 51% and 60%, respectively as shown in Fig. 7.

TP concentration in SBR dropped from an initial mean value 7.76 mg/L to 4.57 mg/L in the first cycle mode, while in the second cycle mode decreased from 6.84 mg/L to 3.42 mg/L and from 7.53 mg/L to 3.13 mg/L in the third cycle mode as listed in Table 5. TP removal efficiencies for SBR during first, second and third operation cycle modes were 41%, 50% and 58%, respectively as shown in Fig. 7.

It clear from Fig. 7, that ICEAS has been Ammonia removal efficiency higher than SBR by 5%, 1% and 2% for aeration time 4, 6 and 7hr, respectively. This mean the ammonia removal efficiency of the two reactors were converged with increasing aeration time. This is due with increasing aeration time lead to become the operation properties of ICEAS slightly similar to SBR. As well as, With increasing the aeration time from 6 to 8hr, the TP removal was slightly increasing due to reducing the ammonia with increasing aeration time.

TP removal efficiency increased with rising aeration time up to 8 hrs within the limits of the study. Therefore, it can be concluded that third cycle mode as the most suitable mode for total phosphorous removal in the case of ICEAS and SBR.

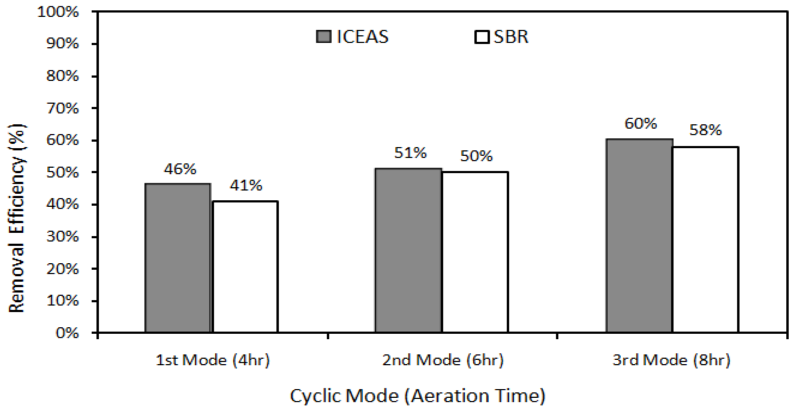

Fig. 7: TP Concentration Variation with Operation Time by ICEAS and SBR

Table 5: Average Values of TP Variation by ICEAS and SBR

Cycle Mode	*Aeration time (hr)*	*TP variation by ICEAS*			*TP variation by SBR*		
		Influent mg/L	Effluent mg/L	Removal Efficiency	Influent mg/L	Effluent mg/L	Removal Efficiency
1st	4	7.14	3.88	46%	7.76	4.57	41%
2nd	6	6.05	2.96	51%	6.84	3.42	50%
3rd	8	7.21	3.21	60%	7.53	3.13	58%

4.6 *Evaluation of ICEAS Performance*

Three bases have been followed to evaluate the performance of ICEAS as biological treatment system as below.

The first is based on comparing the removal efficiency of ICEAS with SBR as shown in Fig. 8 for the third operation cycle mode. It is evident from Fig. 8 that the removal efficiency of ICEAS is higher than the efficiency of the SBR by 4% (91%-87%), 2% (83%-81%), 2% (60%-58%) and 3% (72%-69%) in the removal of COD, ammonia, TP and TN, respectively. The results from this study proved ICEAS flexibility and it has good performance as a suitable alternative system for domestic wastewater treatment.

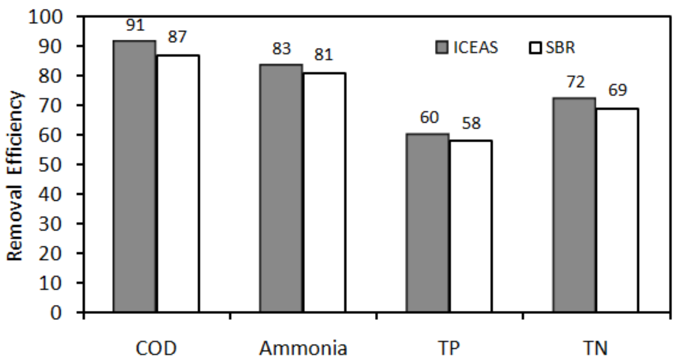

Fig. 8: COD, Ammonia, TP and TN Removal Efficiency by ICEAS and SBR (Third Operation Cycle Mode)

The second is based on comparing the removal efficiency of the present ICEAS with other research using ICEAS as indicated in Table 6. The COD removal efficiency of this study was closest to that studied by Ouyang, et al.[15], Zeinaddine, et al. [16] and Ge, et al. [17]. The Ammonia removal efficiency of the current study was closest to that studied by Hongjing, et al. [18] and Zeinaddine, et al. [16]. The TN removal efficiency of the present study was closest to that studies by Zeinaddine, et al. [16]. The TP removal efficiency of the present study was closest to that studied by Ouyang, et al. [15] and Qiu, et al. [19]. Whereas, The results of Danh, et al. [20] was not close to any removal efficiencies for contaminants of the current study.

Table 6: Removal efficiency of the present ICEAS comparison with other ICEAS researches

Reference	*Year*	*Country*	*Removal Efficiency (%)*			
			COD	Ammonia	TN	TP
Ouyang, et al. [15]	1994	China	91.50	69.60	47.90	68.30
Hongjing, , et al. [18]	2008	China	82.00	78.00	46.00	76.00
Qiu, et al. [19]	2010	China	80.00	80.00	40.00	55.00
Zeinaddine, et al. [16]	2013	Iran	90.50	-	70.30	71.00
Ge., et al. [17]	2014	China	89.57	95.46	-	91.90
Danh, et al. [20]	2016	Vietnam	83.57	-	51.48	-
Present Study	2016	Iraq	91.00	83.00	72.00	60.00

The third is based on comparing the quality of effluent of ICEAS with international standards (WHO, European and China) for discharge the treated wastewater into surface waters as listed in table 7. COD, Ammonia, TN, and TP concentrations of the ICEAS effluent meet to required limits of European and China Standards. Whereas, WHO standard have been achieved only in the COD concentration of the ICEAS effluent, while the rest concentrations (Ammonia, TN and TP) did not achieved but it were very close to the allowable limits. It is worth mentioning that Iraq does not have limitations for all pollutants but some of them, including COD such does not to exceed 100 mg/L [21].

Table 7: Effluent of ICEAS comparison with effluent discharge standards

Parameter	*Third Operation Cycle Mode (mg/L)*		*Effluent Wastewater Standards (mg/L)*		
	ICEAS	SBR	WHO [22, 23]	European [24, 25, 26]	China [24]
COD	37	53	100	125	100*
Ammonia	7.87	9.33	6	10	15
TP	2.84	3.13	2	5	4
TN	17.16	18.11	15	20	25

* this is the same value of COD for Iraqi wastewater discharge standard [C3]

5. Conclusions

Treatment of domestic sewage wastewater was done using two methods, ICEAS and SBR. Three operation cycle modes (first, second and third) for each method. Based on tests and results of the present study the following conclusions could be drawn:

1- Comparison the sewage characteristics of Basrah with the typical characteristics of untreated domestic wastewater showed that BOD (200 mg/L), COD (410 mg/L), TP (7 mg/L) and TSS (272 mg/L) were within the medium strength whereas Ammonia (48 mg/L) and TN (60 mg/L) within the strong strength.

2- Experimental results showed that the efficiency of ICEAS to remove COD, Ammonia, TN, and TP were 91%, 83%, 60%, and 72%, while SBR efficiency were 87%, 81%, 58%, 69%, respectively. So, removal efficiency of ICEAS was slightly higher than SBR

3- Comparison the effluent quality of ICEAS with WHO, European and China discharge standards explained that COD concentration (37 mg/L) was meet to all standards (including Iraqi Standard), while Ammonia (7.87 mg/L), TN (17.16 mg/L) and TP (2.84 mg/L) meet to all standards except WHO standard but it were very close to the allowable limits.

The results from this study proved ICEAS flexibility and it has good performance as a suitable alternative system for domestic wastewater treatment of Basrah city.

6. References

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