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A Review on Hybrid Processes for Palm Oil Mill Effluent: Possible Approaches

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Abstract. The aim of this review paper is to explore and examine hybrid processes and systems for polishing palm oil mill effluent (POME). Nitrification process, and nutrients removal are highly significant to process highly contaminated POME. Besides, quality of POME process is extremely important to solve fresh water shortage that has blocked millions of people from accessing a clean water. Hence, attentions have been made on water pollution to raise a global demand to improve POME processing and discharge unharmful effluent to the waterways. For decades, using a stand-alone technology to treat POME has faced fouling, and disability to deliver the promising quality. A new approach is termed as hybrid or combined system has the ability to deliver higher performance and more effective contamination removal than stand-alone technologies. Hybrid system is a novel technique can be used to achieve higher efficacy that single physical, chemical, or biological technology can't accomplish. This review reports various hybrid systems and united technologies to treat POME including their advantages, disadvantages, and limitations.

1. Introduction

Annually, diarrhea problem causes death for two million people and 1.2 billion people suffer from water scarcity and can't find valid water for drinking purposes [1]. These consequences are still occurring because of careless wastewater discharge that have grown awareness towards fresh water lack, and wastewater treatment [2]. Wastewater contains various pollutants could be biological, chemical, and physical, which dangerously and severely impact the waterways [3]. Nutrients in palm oil mill effluent (POME), such as phosphorus (P), and nitrogen can cause groundwater contamination, and undesirable aquatic evolution, while physical pollution such as suspended solids (SS), and biodegradable matter can produce septic conditions, and oxygen depletion [4]. Therefore, polishing processes are made to deliver satisfying treatment quality, prevent diseases spread, secure aquatic life, and provide harmless environment [5][6]. Consequently, the concept of hybrid system has been introduced showing decent ability to produce energy and deliver treatment in one time for wastewater. However, hybrid system is still in their early stages because there are several unbeaten challenges yet, such as poor electricity generation, require expensive materials, and slow wastewater treatment.

Globally, Malaysia is the second major producer of the most traded cooking oil, named as palm oil. It produces massive discharge of palm oil mill effluent which leads to global pollution into the fresh

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water sources. The generated POME amount in 2011 was around 60 million ton, while it was around 30 million ton in year 2004 and 44 million ton in year 2008 [6][7][8]. Major demands to invent sustainable technologies having strong management system to protect and secure the waterways. Also, governments have decided to look for sustainable methods to polish POME [9]. Aerobic, anaerobic, and facultative operations have been advanced for POME treatment, but they are still costly, and requiring large surface area, long retention time, and gas capture facilities.

2. Hybrid System

Since POME is contaminated with multiple pollutants, such as metals, phosphorus, nitrogen, irons, degradable organics, volatile organics, oil and grease, and suspended solids, for that it requires a massive technology to remove all kinds of contamination, and it's impossible to make it done with a stand-alone technology. A system from various mechanisms like biological, chemical, and physical can be united in one system to defeat treatment limitations and disadvantages and deliver efficiency, performance, quality, and energy saving named as combined or hybrid system [10]. Also, combining two or more technologies unites their weaknesses and strengths which leads to major obtainable balance. Therefore, hybrid system can remove more than one sort of pollutants so that its more preferable. For instance, A physical-biological treatment like membrane bioreactor (MBR) can be employed to remove organic and inorganic matters, oil and grease, and high suspended solids from wastewater. In addition, MBR has many advantages such as stable nitrification, reusable water production, and good capability for handling large organic loading rates [11][12][13][14][15][16]. There are numerous possible combinations of POME hybrid systems, such as coagulation and flocculation, activated sludge and biofilm process, and hybrid membrane. Combined system owns many advantages such as stability, bioenergy generation, efficacy, and energy saving, while often, it requires costly materials, and this can be considered as a major disadvantage. There are several limitations restrict the hybrid system from getting developed like low energy production. Moreover, selection of a reliant combined system is very complex because it depends on kind and amount of POME pollutants. For instance, chemical treatment is used for heavy metals removal, physical treatment for suspended solids removal, and bioprocess for toxic organic, phosphorus, nitrogen, volatile organics, and degradable organics removal. Figure 1 presents the possible hybrid systems between biological, chemical, and physical treatments to treat wastewater. It's worth mentioning that there are differences between hybrid systems and group of processes employed to produce various polishing level named as preliminary, primary, secondary, and tertiary.

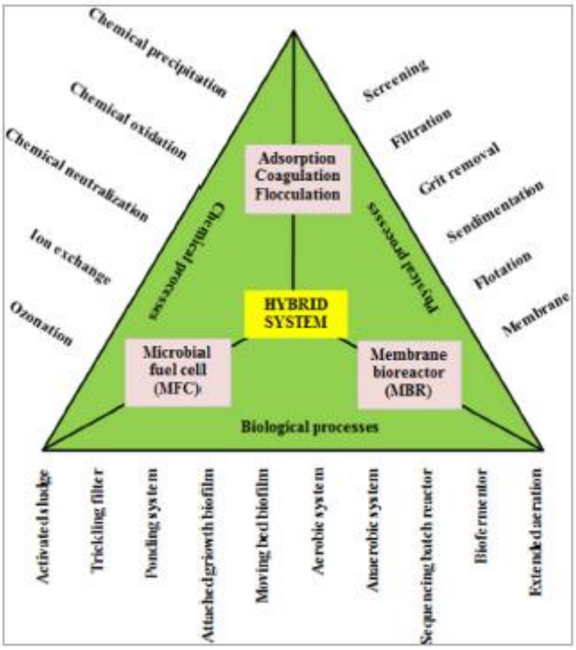

Figure 1. Possible combined systems for wastewater treatment [17]

2.1 Coagulation and Flocculation

When a coagulant and flocculant are streamed in a wastewater treatment tank, the operation is named as coagulation and flocculation process. Norulaini et al. (2013) defined coagulation-flocculation process as a physical-chemical hybrid system, which through this integration a reagent should be added and mixed thoroughly with the contaminated water to thicken solids layer into larger particles so its easily removed with physical means. This type of hybrid system is used to drop turbidity concentration in wastewater [18]. The most common coagulants for wastewater treatment are aluminum chlorohydrate, ferric sulfate, ferric chloride, and aluminum sulfate. Using poly aluminum as a coagulant can deliver 75, 88.8, and 99.9% reduction of chemical oxygen demand (COD), total nitrogen (TN), and total phosphorus (TP), respectively. Satyanarayan et al. (2005) examined wastewater coagulation-flocculation by using many coagulants materials such as alum, lime, ferrous sulfate, and anionic polyelectrolyte [19]. It removed 41.9, 36.1, and 38.9% of TSS, COD, and biochemical oxygen demand (BOD) concentrations, respectively by using lime, while using lime-ferrous sulfate combination produced 56.8% removal of COD. In addition, combining alum and lime had given 42.6% removal of COD. This empirical work proves that using a hybrid system produces efficacy and quality. Figure 2 shows simple scheme for coagulation and flocculation process.

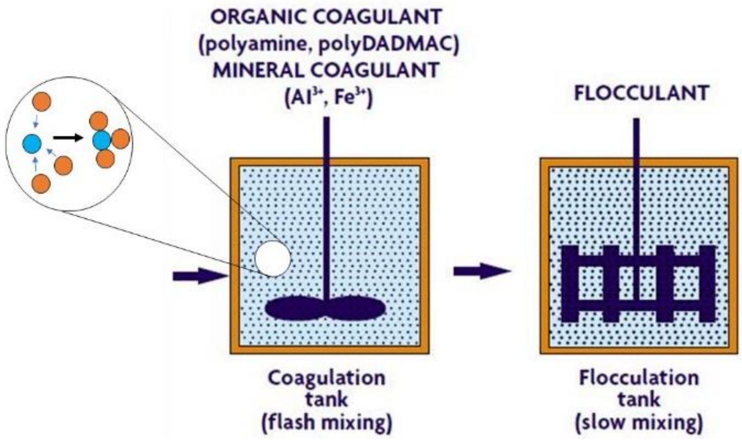

Figure 2. Coagulation and Flocculation system

Non-renewable, and oil based raw materials are employed to synthesis polymers for the coagulation-flocculation process. For decades, polymers have been used to reduce dosages of coagulants [20]. Since the world style is moving towards sustainable way, so a great interest to replace polymers with biopolymers which they are cellulose derivatives. Liimatainen et al. (2012) examined flocculation process by using cationic (CDAC) and anionic (ADAC) cellulose derivatives, and figured out using anionic cellulose produces higher flocculation efficacy, also Hok-kanen et al. (2013) confirmed Liimatainen's results [21][22]. Amuda and Alade (2006) conducted laboratory scale coagulation-flocculation treatments for wastewater with utilizing many reagents. It eliminated 98, 34, and 65% of TSS, TP, and COD, respectively [23].

Coagulation-flocculation combination for POME processing can reduce turbidity, and COD concentrations, and utilizing ferric sulfate as coagulant, with employing high dicarboxylic acid nanocellulose nanofibril content gives tremendous polishing process for POME. Ho and Tan (1989) had examined POME treatment by using coagulation (aluminum sulphite)-flocculation (cationic polyacrylamide) and it removed 97% of the suspended solids [24].

2.2 Activated Sludge and Biofilm Process

Activated sludge process has been employed as a secondary polishing process for wastewater with using long time hydraulic. It can be improved by many ways but combing it with another process leads to impressive performances. For instance, additional clarifier is highly required from time to time to improve the activated sludge quality and defeat the high organic load. Besides, purchasing and installing another stand-alone process is costly, and may not produce the expected treatment. Hence, the hybrid system got a huge attention by proposing to unite two different biomass processes through using suspended biofilm carriers, named as integrated fixed film activated sludge process (IFAS) [25][26][27][28]. It handles a higher dosage of the bio sludge and the final settling tank faces not a significant growth in the organic load. It occurs because biofilm have attached naturally by effective bacteria on the media elements and it is counted as a huge advantage for the IFAS hybrid system. In addition, the high retention time allows biofilm bacteria to acclimatize, develop, and mature [29][30]. Many studies conducted and investigated the quality of IFAS process with using different media elements for nitrogen and organic matter removal [31][32][33]. It confirmed that biofilm have the ability to attach on fixed or moving carrier media, for that these carriers can be fixed inside the reactor or freely moving [25][34][35][36].

There are advantages of using IFAS system, such as high surface area, low cost, low sludge production, doesn't need backwashing, doesn't require filter channeling, and can be operated in various temperatures and pH. On the other hand, uncontrollable biofilm growth, and longtime startup are major disadvantages for this hybrid system, and these are limiting the process efficiency. The below diagram presents IFAS system for wastewater treatment.

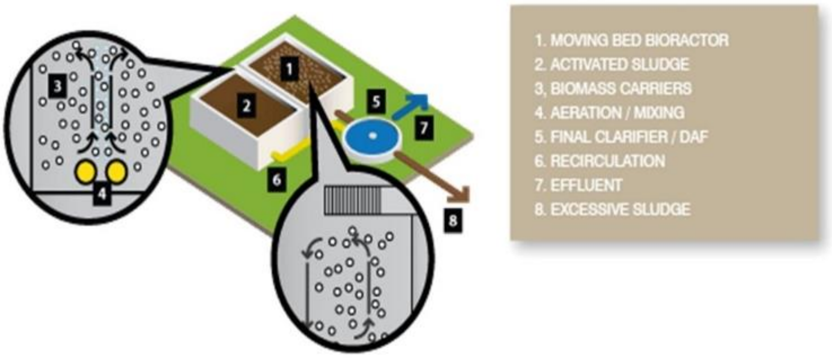

Figure 3. IFAS process

2.3 Hybrid Membrane

Hybrid membrane system refers to a combined system involving a biological, chemical, or physical process followed by ultrafiltration, reverse osmosis (RO), forward osmosis, nanofiltration, or microfiltration membrane. This integration empowers membrane process to defeat their limitations (e.g., membrane clog, fouling). Figure 4 shows a general hybrid membrane system for treating wastewater.

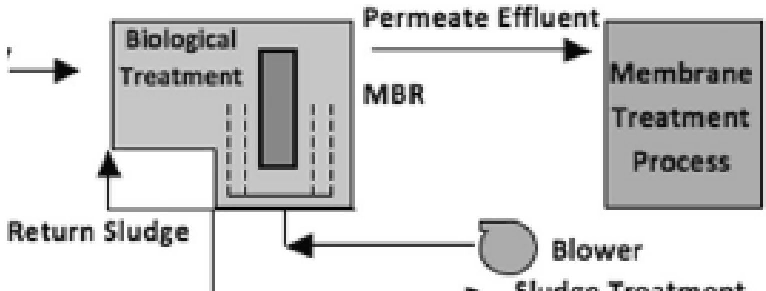

Figure 4. Flow process of general Hybrid membrane treatment

A lot of studies have showed that using a stand-alone membrane is pricy because it has many limitations, and it's unprofessional to neglect it (see table 1). Hence, membrane bioreactors (MBR) have been used broadly for wastewater treatment [37]. The selection process of a hybrid membrane system is quite sensitive because it should be constructed based on the wastewater characteristics, and depending on the wanted treatment quality [38][39]. The most common used membranes in MBR system is microfiltration (MF) and ultrafiltration (UF). Also, the combination between biological and membrane treatment produces high declining in ammonia nitrogen (NH3-N), biochemical oxygen demand (BOD), and chemical oxygen demand (COD).

Table 1. Hybrid Membrane Systems

System	Membrane type	Results	Limitations	Ref.
MBR	Chlorinated polyethylene nano filtration (NF) + conventional activated sludge	Good efficiency in removing polar pollutants	TN/TP removal	[43]
Hybrid membrane bioreactor (HMBR)/ conventional membrane bioreactor (CMBR)	Aerobic reactor + hollow fiber membrane (MF)	Eliminating organic contaminants and lowering COD concentration	-	[44]
Nonwoven fabric filter bag (NFFB)+MBR	Nonwoven polyester fabric + conventional activated sludge	Good performance in removing TSS, and sludge	-	[37]
ANMBR	Polyvinylidene difluoride (PVDF) flat sheet membrane/ PES tubular membrane	Great discharge quality with low sludge production	High organic strength, pore size, and membrane operational properties	[45]
Hybrid membrane anaerobic membrane bioreactors (ANMBRs)	Polyethylene (PE) flat sheet membrane + CSTR	Efficiency in removing TSS, and COD concentrations	Flux, and pore size	[46]
Submerged anaerobic membrane bioreactor (SANMBR)/HANMBR	PE flat sheet membrane	High COD, and SCOD removal with low energy consumption but it is easy to foul.	Restricted at limited temperatures	[47]
Submerged membrane bioreactors (SMBRs)	Conventional activated sludge + hollow fiber MF membrane	Fouling	Membrane fouling with Bio sludge generation	[48]
SMBR with chorine	PVDF hollow fiber	Good performance in reducing TSS concentration	Low efficiency for dissolved organics removal	[49]
Nitrogen loading rate (NLR)+SMBR	Acrylic hollow fiber	Efficiency in reducing TN, and COD amounts	Low ability to remove phosphorus in high polluted wastewater	[50]
Staged anaerobic fluidized membrane bioreactor (SAF-MBR)	Anaerobic fluidized-bed reactor (AFBR) + anaerobic fluidized bed membrane bioreactor (AFMBR) +PVDF hollow fiber	Low fouling, with low energy consumption	-	[51]
NF+MBR	NF flat sheets +PVDF MF membrane hollow fiber + activated sludge	Good quality in removing organic matter	-	[52]
Dynamic membrane reactor (DMR)	Activated sludge, diatomite, kaolin clay and powder activated carbon (PAC) + nylon membrane flat sheet	Short treatment time, easy backwash, and high filtration flux.	Microbial layer formation	[53]
Bio-enhanced powder activated carbon dynamic membrane (BPDM)	Asymmetrical PAC +mesh support	Good performance in removing organic and inorganic matters	-	[11]
ANMBR-psychrophilic condition	Flat-sheet MF polyether sulfone membranes	Flux managing, with efficiency in decreasing BOD, and COD levels	-	[54]

In the pharmaceutical treatment, Dolar et al. (2012) investigated RO and MBR hybrid system for polishing wastewater and it delivered 95-99% of total reduction [40]. Moreover, Chon et al. (2013)

tested MBR and Nanofiltration membrane for municipal wastewater treatment [41]. The laboratory scale hybrid system declined fouling and flux occurring probability. Therefore, hybrid membrane produces great quality of wastewater treatment with cost-effectiveness, and eco-friendliness, and it's expected to be employed in industrial and domestic scale.

POME is highly polluted, and it needs a massive treatment with high quality to stream reusable discharge. Hybrid membrane system is quite suitable for POME treatment to deliver high polishing process but there are concerns regarding unexpected membrane fouling [42]. The successful treatment of membrane is constructed on the previous treatment performance which determines the overall treatment quality.

2.4 Hybrid Up-Flow Anaerobic Sludge Bed (HUASB) Reactor

Often, wastewater industry uses anaerobic conditions to process POME like HUASB reactor. HUASB is a combination of up-flow anaerobic sludge bed (UASB) and anaerobic filter [55]. HUASB reactor has several benefits such as stability, and well ability to remove organics, and it can process high organic load POME processing. Shivayogimath and Ramanujam (1999) achieved 80% reduction of COD concentration by using HUASB reactor for 6 hours of HRT and the organic load rate was 36 kg $COD.m^{-3}.d^{-1}$ [56]. In addition, 80% of the produced gas was methane. Lew (2004) had conducted empirical work on Hybrid UASB reactor for domestic wastewater treatment at different temperatures [57]. The treatment efficiency was found stable by 80% at temperatures range 28 to 20 °C, but COD removal performance declined by 60% at temperatures less than 20 °C. Another report by Rajakumar and Meenambal (2008) found that HUASB reactor has short-start time around 120 days, with 80% efficiency of organic removal. Other researchers, reported that HUASB is very effective to process dilute to medium strength contaminated water [58]. Microorganisms have shown fast developing in HUASB reactor because POME is quite fitting with their biological activities. It produces biomass, which accumulates in major range around 86% at the sludge section, while the rest amount 14% of the total biomass settles at the biofilter layer, according to Tur and Huang (1997) [59]. Figure 5 presents HUASB structure diagram which is involving packing media, influent distributor, sludge bed, and weirs for industrial scale, while laboratory scale involves filter media, sludge blanket, sludge bed, and gas displacement system.

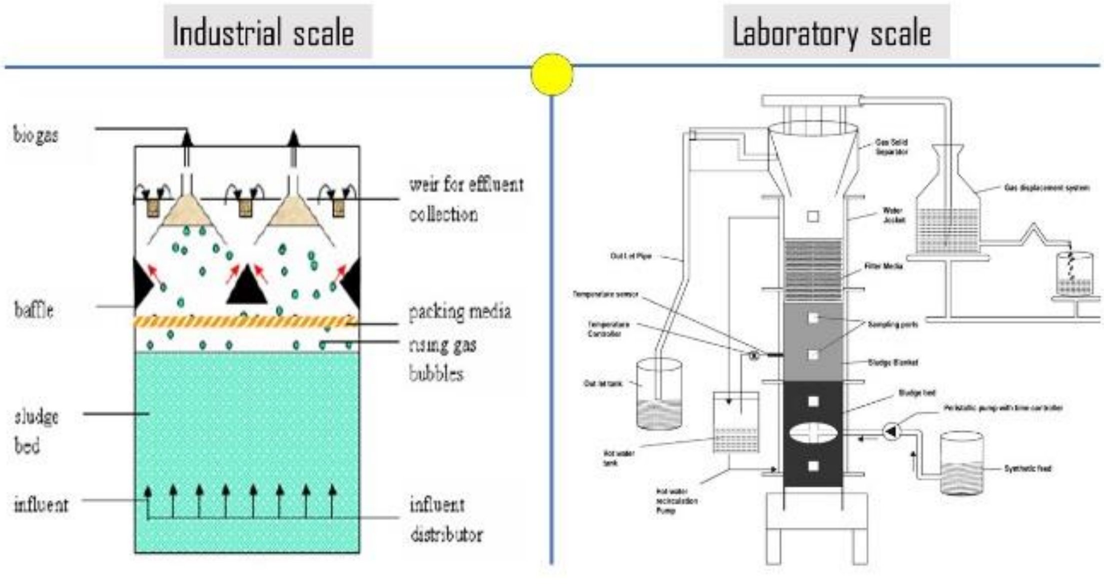

Figure 5. HUASB reactor schematic diagram

2.5 *Ultraviolet and Fenton Oxidation (UV-Fenton)*

Fenton oxidation process is the most common process for eliminating organic pollutants among advanced oxidation processes (AOPs). It requires high chemical amounts, and high operating costs and leads to excessive sludge production. Hence, a hybrid system termed as UV-Fenton has been introduced to decrease operating cost and improve the treatment quality. UV-Fenton system oxidizes and breaks down large organic matters into smaller size. Hydrogen peroxide (H_2O_2) can be photolysis by using UV lights, which leads to oxidation process by radical addition, electron transfer, or hydrogen abstraction and generates powerful fundamental of HO [60][61][62]. In comparing to all AOPs, UV-Fenton can deliver wastewater treatment in short time, without sludge production at the end of the reaction [63][64]. UV-Fenton system can remove 91.2% of COD concentration, while using stand-alone Fenton process removes 81.4% of COD concentration. It shows that using UV-Fenton for high polluted discharges such as POME, can produce well treated effluent with major reduction in COD, color, and total organic carbon (TOC) concentrations with ranges 91.2, 99.9, and 78.5%, respectively. In below, combined pictures to illustrate UV-Fenton process.

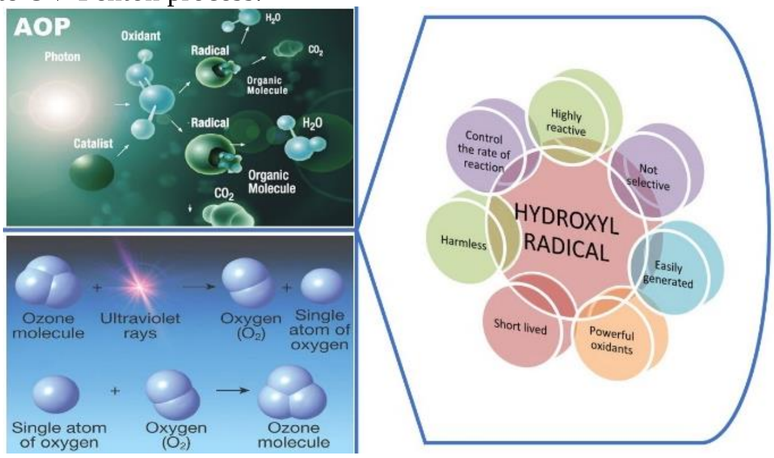

Figure 6. UV-Fenton process

There are parameters affect UV-Fenton process quality, such as pH, pollutants, H_2O_2 concentration, light intensity, catalyst, and temperature [65][66][67][68][69]. Muruganandham et al. (2006) and Shu et al. (2005) reported that pH level is a major factor determining UV-Fenton degradation performance [70][71]. Another report by Schrank et al. (2007) and Shu et al. (2005) declared that high pH level increases the degradation efficiency [72][73]. Some advantages of UV-Fenton are effective destruction of hazardous organic pollutants, and organic matter mineralization [74].

2.6 *Ultrasound and H_2O_2*

Ultrasound and H_2O_2 combination produce higher quantity of radicals than using a stand-alone oxidation process like Fenton oxidation. The attach of the free radicals against wastewater pollutants over time period determines the process quality. Several parameters can advance process performance such as influent composition, pollutants concentration, temperature, Fenton's reagent dosage and pH. A report by Olson and Barbier (1994) found that increasing ultrasound intensity raised the rate of degradation process [75]. Another researcher reported that ozone amount rapidly declined from 620 µM to 40 µM when ultrasound was applied during 3 minutes of time period [76]. The generated acoustic streaming by ultrasound leads to turbulence which terminates mass transfer limitations with the ozonation process. Hence, combined system comprising of ultrasound and H_2O_2 can give impressive treatment due high degradation rate [77][78][79]. Moreover, it shows a great promise for wastewater treatment because it possesses simple design and easy operation.

There are two kinds of pollutants in the wastewater, known as hydrophobic and hydrophilic. The degradation rate is determined by the pollutants kind and amount. Also, Ultrasound and H2O2 hybrid system causes pyrolysis followed by high temperature and pressure [80]. In addition, there are two kinds of cavitation or sonication process which they are hydrodynamic and acoustic cavitation. Several reports declared that it's hard to use acoustic cavitation process for wastewater treatment in industrial scale because its associated with issues and high costs, but it's a quite successful process at the lab scale [81]. Venturi, valve, or orifice passages are capable to produce hydrodynamic cavitation when the liquid is streamed and constricted through it. In comparing to acoustic cavitation process, hydrodynamic method produces less destruction rate within same pressure and temperature [82]. Ma (2010) conducted experimental work to compare the performance of individual Fenton process against Ultrasound and Fenton (US-Fenton) system [83]. The stand-alone system reduced 15% of TOC, and 40% of carbofuran within 120 minutes, while the hybrid system gave more than 99% of carbofuran removal with 40% mineralization for 30 minutes.

2.7 Sequential Batch Reactor and Forward Osmosis (SBR–FO)
Forward osmosis is a novel technology of membrane separation family which can be used to save energy. FO membrane has been combined with various technologies such as electro dialysis (ED), and membrane distillation (MD). This combined system of Sequential Batch Reactor and Forward Osmosis (SBR–FO) involves a two flat sheets of FO membrane submerged inside SBR. Sequential batch reactor and forward osmosis (SBR–FO) can achieve 100, 88.4, 96.2, 58.4, 62.4, and 98.55% reduction of phosphate, ammonia, nitrite, nitrate, total nitrogen, and dissolved organic carbon concentrations. Two different liquid concentrations are separated by FO membrane, water moves from the low concentration liquid (FO influent) to the high concentration side (Draw solution) to get equilibrium state. While SBR process involves various stages of treatment like filling, aeration, settling, decantation, and idling, with great ability to remove COD and phosphor concentration [84]. Fouling is still a major issue with all the kind of membrane because of organic molecules, colloids, and particles, and when a clog occurs because of extracellular polymer substance (EPS) it is named as biofouling.

2.8 Other Combinations
Majority of other combinations are expensive, hard to be operated at the industrial scale, and not quite effective for POME treatment. Hence, at the present, researches and developments are conducted to come out with high performance, and appropriate hybrid system for large quantities, and highly polluted wastewater like POME. Some researches occurred on uniting electrocoagulation with electro dialysis system for wastewater. It can deliver 100, 100, 100, 92-87% of color, Cr, NH_3-N, and COD removal, respectively. Mahtab et al. (2009) evaluated combined system of coagulation and adsorption for wastewater processing with using different coagulants like lime, ferric chloride, ferrous sulfate, and alum. The process delivered optimum reduction up to 92% removal of COD by using alum. Table 2 shows researches results on combined or hybrid systems for the last five years. In addition, figure 7 presents the achievement of stand-alone technologies versus their hybrid systems.

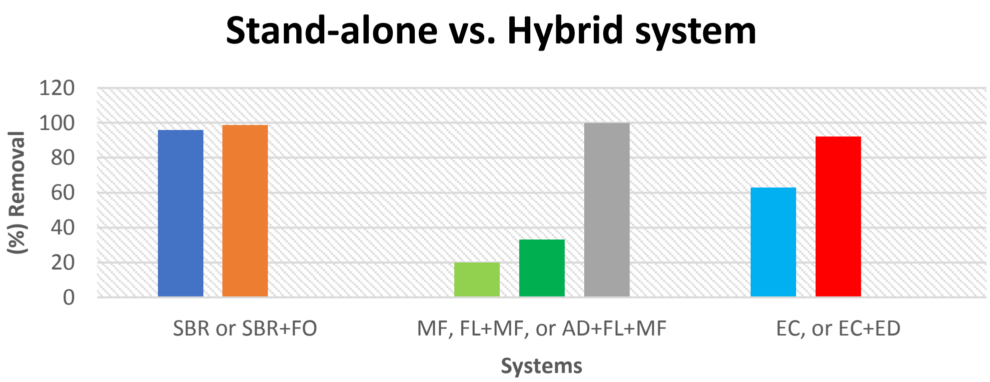

Figure 7. stand-alone technologies versus their hybrid systems. Where FL is flocculation, AD is adsorption, and ED is electrodialysis

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Table 2. Hybrid systems for wastewater treatment

Hybrid System	Wastewater	Characteristics	Results	Ref.
Anaerobic Hybrid Reactor Packed with Special Floating Media	Slaughter House Wastewater	pH (6.9-7.1), COD (27800), BOD (16680), Oil and grease (246)	COD (86.0%-93.58%), BOD (88.9%-95.71%), HRT (1)	[85]
Hybrid anaerobic baffled reactors	Dairy wastewater	Organic loading rate (OLR) (3.33±0.03), packed with sponge media characterized by specific surface area (157), density (65), and voids ratio (0.65)	COD (87.86±2.12%), biogas yield (155.80±7.02), sludge yield (0.067)	[86]
SBR–FO	Synthetic domestic wastewater	COD (439.47), TN (60.23), P (9.42)	Dissolved organic carbon (DOC) (98.55%), TN (62.4%), nitrate (58.4%), nitrite (96.2%) ammonium (88.4%), phosphate (100%)	[87]
Hybrid Constructed Wetland	Domestic Wastewater	pH (7.91), NO_2 (0.059), NO_3 (2.83), PO_4 (0.197), SO_4 (0.095), total dissolved solids (TDS) (480), electrical conductivity (EC) (510), Cl (35.87), TSS (478), DO (2.5), BOD5 (134.83), COD (199.23)	HRT (20), COD (97.55%), BOD5 (97.5%), PO_4 (89.35%), SO_4 (80.75%), NO_3 (96.04%), NO_2 (91.52%), fecal coliforms (98.6%)	[88]
Hybrid moving bed biofilm reactor (MBBR)	Municipal wastewater	Hydraulic load (2208), TSS (28), COD (214), BOD (111), total kjeldahl nitrogen (TKN) (41.3), TN (41.3)	TSS (63%), COD (56%), BOD (74%), TKN (85%), TN (20%)	[89]
Adsorption-Flocculation-MF	Biologically treated wastewater	TOC (1.6–3.8), Turbidity (0.8–6), PO_4^{-3} (0.5–12), SS (2–15)	TOC (99.7%), PO_4^{-3} (94%)	[90]
EC- electro dialysis (ED)	Tannery wastewater	pH (4.10) at T (6.5), Conductivity (11.71), COD (2200-3000), SS (912), Color (824), NH_3-N (180)	COD (92%), NH_3-N (100%), Cr (100%) and color (100%) were based on conductivity value (0.371) at 45 minutes, and by using aluminum electrodes	[91]
UF-osmotic membrane bioreactors	Raw wastewater	-	COD (96%), TN (82%), P (99%)	[92]
Ultrasonic-Membrane Anaerobic System (UMAS)	POME	BOD (437.31), COD (42800), total solid (TS) (11740), volatile suspended solid (VSS) (13270), T (55), pH (3.97)	HRT (11), sonication operation (2 hr.), COD (98.75%), CH_4 generation (32,595)	[93]
Fenton and sequencing batch reactor (FE-SBR)	Petroleum refinery wastewater	BOD5 (173), COD (1259), TOC (186), DO (3), pH (9.4), TSS (124), Oil and grease (233)	COD (76.5%), BOD (37.6%), TOC (45.0%), oil and grease (100%)	[94]
HUASB reactor	POME	COD (47750), TN (817.5), TP (272.5), TSS (9225), Color (5975), turbidity (5887), pH (4.45)	COD (82%), TSS (80%), turbidity (45%), HRT (57)	[95]

OLR (g-COD/L.d), Hydraulic load (m^3/d), Turbidity (NTU), T (℃), Conductivity (mS.cm^{-1}), biogas yield (mL.CH_4/g. COD_r), sludge yield (g.VSS/g.COD), HRT (day), gas size (ml), specific surface area (m^2/m^3), density (kg/m^3), the rest is in mg/l, except pH.

3. Acknowledgment

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4. Conclusion and Future trends

Majority of the reviewed hybrid systems show great capability to lead wastewater treatment. For instance, Mahmoud et al. (2014) proved that using a hybrid system involving anaerobic baffled reactor is highly efficient than using the conventional method [86]. In addition, the hybrid system had reduced 87.86±2.12% of COD, while the conventional anaerobic baffled reactor had delivered 72.50±2.40% of COD for dairy wastewater treatment.

Hybrid system empowers and raises the treatment quality, and possibly able to eliminate several core weaknesses. On the other hand, there are disadvantage like limited energy generation, slow treatment, costly, and vast dosage of wastes.

It is important to knock out the negative aspects and produce a concrete hybrid system involving quality, performance, low operation and maintenance requirement, ecofriendly, cost-effective, and energy productive. In addition, a lot of R&D are occurring on different combinations. Lastly, Global warming, pollution, and contamination, won't stop and wait us till we achieve the optimistic operation, it's quite depressed to notice pollution rises in vast amounts over the planet, and between us, while we are highly powered to defeat it.

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