ISSN:2319-6890 (O), 2347-5013(P)
2-3 March 2020

# Treatment of Food Processing Industries Wastewater by Anaerobic Reactor

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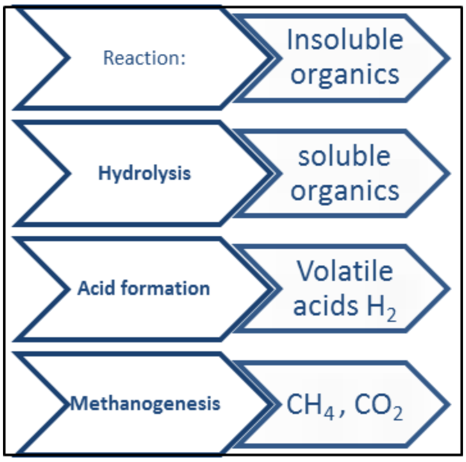
***ABSTRACT: Treatment of effluent is one of the greatest challenges faced by food processing industry. The role of established food processing wastewater treatment processes becomes challenging to environmental engineers with increasing more and more restrictive effluent quality by water agencies. The purpose of this work is to evaluate the generation of Bio-gas by an an-aerobic treatment of food processing industry wastewater.***

***Keywords:*** *Anaerobic digester, Biogas, food industry wastewater*

## I. INTRODUCTION

The current times are one of transition from an economy that is linear in nature, hea
vily '\=/economy that is progressively more and more relying on bio or renewable resource-based economy where the by-products and also the wastes again re-enter a circular economic system. In a circular economic thought school, ideas in view of a mixture of bio resources, byproducts and wastes are going forth. Consequently, there is a vast option for anaerobic digestion systems, as multiple useful procedure that affiliate environmental protection, re-newable energy creation, minerals & water reusing.

Anaerobic digestion processes have the potential to be the center of any remediation procedure for biodegradable refuse or wastewater rich in carbon, in conjunction with appropriate physicochemical or biological post treatment processes. All organic waste matter, originating from either plant or animal sources such as substrate of municipal solid waste, animal waste, industrial wastewater and green crop residues, all are suitable for use as feedstock in biogas systems. A prime benefit of anaerobic digestion is the ability to liberate bio-gas, a flexible re-newable energy carrier that can be utilized to vehicle fuel, aviation fuel replacement, electricity generation, space heating & instead of natural gas by injection of biogas in the natural gas grid. Moreover, bio-gas can also regarded as the primary compound for the production or synthesis of chemicals. On the other side, organic waste stabilization & nutrient re-distribution are, besides energy production, objectives of any anaerobic digestion.




- An over-view of An-aerobic Digestion:

When organic material enters into an anaerobic reactor, it has great fraction of suspended solids (SS)& complex soluble matter. In an-aerobic system, these large organic molecules are transferred, into methane ($CH_4$) & carbon dioxide ($CO_2$) by the activity of microbes. The overall biochemical reaction can generally express as:

An Organic material→$CH_4$ +$CO_2$ +$H_2$ +$NH_3$ +$H_2S$

The treatment of an an-aerobic digestion conducts in mainly three stages;

- Hydrolysis
- Acid formation &
- Methanogenesis

- Bio methanation process:

The bio-methanation procedure incorporates the revolutionized to the $CH_4$ under an anaerobic atmosphere. The translation of complex organic matters are converted to $CH_4$& $CO_2$. It requires a variety of a bacterial groups that can rely on one another for their development &contains four reaction steps: hydrolysis, acidogenesis, acetogenesis & methanogenesis. Depending on the temp. at which the procedure is occurring an an-aerobic procedure of organic wastes is fundamental of three types.

The Bio-methanation completed at temperature range 45°Cto 60°C is referred to as thermophilic, while the temperature ranging at 20°Cto 45°C is known as mesophilic. The anaerobic assimilation of organic matter at low temperatures (<20°C) is referred to as psychrophilic digestion. In nature, $CH_4$ is formed more than a wide temperature range, from 0°C-97°C. The bio methanation process at meso-philic & thermo-philic ranges is well seen and documented. Be that as it may, there is a wide distinction in the learning about the bio methanation process at the psychrophilic temperature range.(Zaman 2010)[15]

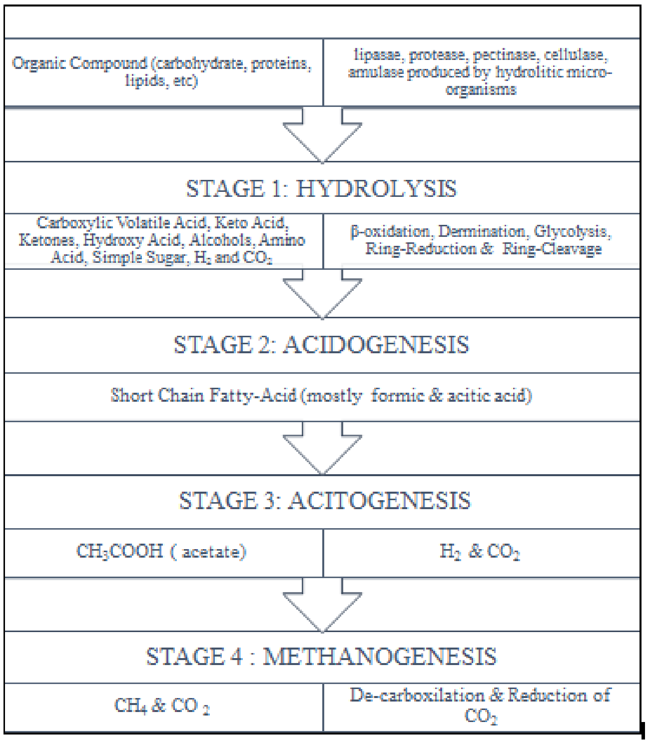



**Figure 1 Metabolic courses of the transformation of natural matter to the methanogenic substrate (acetate, $CO_2$ & $H_2$) & end of the process to $CH_4$ & $CO_2$**

- Micro-organisms included in bio methanation under psychrophilic condition

The assimilation at the psychrophilic temperature range appear to have filled in by the meso-philic microorganisms integrated to psychro-philic temperature range, & there is an incredible difference in writing concerning utilization of psychrophiles segregated from permanent cold domains.

Therefore, it gives the thought the microbial union integrated at lower-temp. reaches, to the greater portion of the researcher for bio methanation at the psychrophilic temperature range are doesn't true psychrophiles. These has been derived from the way that true psychrophiles won't live due to expanding temperature. Most of the examination demonstrates increment in gas creation by the improve temperature. Subsequently, it can be gathered that these are psychrotrophs (living creatures that can withstand warm fluctuations).

Some of the customary qualities demonstrated by the organic entities during integration procedure are decreasing in the no. of ion pair, the side chain contribution to the uncovered surface & the polar parts of the uncovered surface, this may be the explanation behind they're brought down the action at a lower temperature range.

Further studies are bound to find properties of the psychrophiles and mesophylls. Moreover, parametric studies in assessing the execution of these psychrophiles in the bio methanation procedure to be completed.(Kashyap, Dadhich, and Sharma 2003)

## II. LITERATURE REVIEW

**Akunna, Bizeau, & Moletta, 1992** have concluded, based upon their Laboratory-scale tests of completely mixed anaerobic digesters fed using synthetic lab mixed wastewaters containing nitrates & nitrites& with glucose, the only source of carbo-hydrate. This paper investigates the de-nitrification potentials of an-aerobic digester in the presence of nitrate & nitrite. At fixed COD and HRT, the input nitrate and nitrite concentration convert $CH_4$ obtain without de nitrification occurred at ratio of COD / N-$NO_X$ greater than 53; denitrification & $CH_4$ yield at 8.86 less than COD / N-$NO_X$ less than 53 & only de-nitrification at COD/N-$NO_X$ less than 8.86. At COD/N-$NO_X$ greater than 53, ammonia formation appeared to mainly nitrate and nitrite reduction. The successful competition of ammonia formers over the true de-nitrifies at higher ratios was referred to the lower initial nitrate & nitrite concentrations.

**Björnsson, Murto, & Mattiasson, 2000** have studied anaerobic digesters at municipal effluent treatment plants operate on sludge left after the treatment are co-digested along with food processing waste which is a carbohydrate-rich. At a constant pH of 6.8, the parameters of alkalinity, adsorption of volatile fatty acids, gas yield & its composition were observed. Changes in the load, reflected as slow responses in the Gas-phase parameters. The superiority of VFA for indicating an overloaded microbial system was evident, however, pH, as well as alkalinity, also came about as well monitoring characteristics. Despite the above, the chances of using pH as an indicator for the process are strongly dependent on the buffering capacity. In this study, a strong relationship between the buffering effect of the scheme and the carbohydrate measure was observed.

**Maya Altamira et al. 2008** In this study, they have keyed out that due to the characteristics of wastewater, the theoretical & practical methane potential varies. The $CH_4$(Ultimate practical) yield ($Bo_p$) were relate to the $CH_4$(Theoretical) yield ($Bo_{th}$) to find the bio-degradability of the used wastewater & the impact of their Physio-chemical parameters. The evaluating method put into appraised the wastewater's organic portion to prove effect of the evaluation of their theo-retical production. The Substrate to inoculum ratio, the dilution factor of the wastewater's aspect the $Bo_p$ individually in each of the wastewaters evaluated. Chemical oxygen demand (COD) proportions didn't explain any impact on $Bo_p$; otherwhile, that was explored that they were averse truly by proportion of total in-organic carbon when effluents were 25% & 50% diluted & averse not truly by proportion of total acetate when effluents were undiluted. Carbon compound & protein proportion affect not truly to the max. estimated $Bo_p$.

**Fantozzi and Buratti 2009** have been studied curious mixtures were digested in a single-phase, batch process in lab-scale meso-philic an-aerobic digester at the Bio-mass Research Centre Laboratory (University of Perugia).

The production & its composition of bio-gas were measured and cumulative curves were calculated from the different substrates. Two experiment were carried out, in the 1st tried the three mixtures of non-vegetarian fertilizer and in the 2nd tried the animal & vegetal biomasses (chicken & cow-dunk fertilizer, olive coat) with multiple inoculate (digested sludge). In the 1st , pig-manure mixture indicate the max bio-gas yield of 0.35 N $m^3$ / kg & energy generation is 1.35 k Wh / kg VS; & 2nd is separate in generating bio-gas to the discrete inoculate were analyzed and found that olive husk with piggery fertilizer an-aerobically digested as inoculum indicated the more bio-gas of 0.28 N $m^3$ / kg VS & $CH_4$ production of 0.11 N $m^3$ / kg VS, similar to energy obtain of 1.07 k Wh / kg VS. All the results received to the lab-scale an-aerobic digester is as good as the worth in this article for various biomasses & in special for olive coat, dairy fertilizer, & chicken fertilizer.

**Sun et al. 2012** have been investigated the Anaerobic treatment using an up flow several stage an-aerobic reactor of cassava starch wastewaters. The outcome indicates that the inauguration was achieved in 22 days. The max. 87.9% Chemical Oxygen Demand (COD) was eliminated at a Hydraulic Retention Time (HRT) of 6.0h at specific concentration of 4000 mg/L. Furthermore, 77.5% - 92.0% COD was fallen as organic loading rates in 10.2 - 40.0 kgCOD/($m^3$d) at specific HRT of 6.0 hour. The Grau second order kinetic model & changed Stover Kincannon model was utilized to construct up a kinetic model of the experimental data. Further, the specific methanogenic activity was of 0.31 & 0.73 g $CODCH_4$/ ($gVSSd^{-1}$) for the 1st & 2nd feed successively. At last, morphological examination of the sludge declared that Methanothrix spp. & Methanosarcina spp. were intense micro-organisms. Altogether it was implied that the U-MAR could be used affectively for the cure of effluent containing greater COD on cassava starch production.

**Rajagopal, et al. 2013**have been carried out the review article to compile the different advances made in sustainable high-rate an-aerobic process with put on their operation accession when processing Agri- food industrial effluent, since 2008. This review studied the formation & characteristics of differ Agri- food industrial effluent ; the requirement for the operation of the high-rate anaerobic reactor, such that an up-flow an-aerobic fixed bed reactor , an up-flow an-aerobic sludge blanket (UASB) reactor , hybrid systems , etc. & management problem in running condition , energy generation estimation , hazardous, mass transfer considerations , modeling, technology appraisal & good words for successful performance.

**Maamri and Amrani 2014** was experimenting thermo-philic an-aerobic digestion of Waste Activated Sludge (WAS). WAS is made by used of cow dung as inoculums & Total Solids (TS) concentrations of 12.02, 17.58, 23.28, 26.75, and 35.2 $gL^{-1}$ were digested an-aerobically in a batch digester at thermo-philic temp. at 55 °C at a retention period of 15th days. Effect of Total Solids percent on the quantity & quality of the evaluated gas , the kinetics of bio-gas yield & pH changes was study. The finding showed that bio-gas yield, potential & rate increased by an improoving Total Solids percent. The max. bio-gas produce from Total Solids concentration 12.02 , 17.58 , 23.28 , 26.75 , & 35.2 $gL^{-1}$ were 0.186 , 0.189 , 0.93 , 0.213 , & 0.231 L / (gVSS) $^{-1}$ , accordingly. To model bio-gas yield at various substrate concentrations a modified Gompertz formula was used. This formula gave a safe estimate of the bio-gas yield potential & the max. bio-gas generation ($R_m$) with the co-relation coefficient ($R_2$) is 0.996 . The digestion at Total Solids present at 35.8 $gL^{-1}$ gave the best consequences. The max. bio-gas yield reaches to 0.856 L $day^{-1}$, and the biogas yield was 6.650 L at the remnant of the 13 day of the practical. This quantity of bio-gas with composition of 72.59 % of $CH_4$ & 23.6 % of $CO_2$ is equivalent to 190.00 k Wh of electricity. An effective feedstock for bio-gas yield, giving a great cumulative bio-gas yields these outcome exhibits that were mixed with cow dung.

**Krishna and Kalamdhad 2014** studied food waste for the yield of biogas with greater decomposition rate can be efficiently digested an-aerobically. An an-aerobic digestion can be a more serious option as a energy source as the fossil-fuel reserves declining. The byproducts such as bio-gas with 50-60 % $CH_4$ content can be used as renewable energy & the at least digested sludge as a compost. An-aerobic digestion is a corrected technology but though it has some technological problems like, organic loading rate, SRT, bio-gas composition & specific gas generation. Also, technical understandings like C/N, VFA generation, pH changes & nutrient concentration phase difficulties in running reactors for solid organic wastes. An over-view of some technical side of an-aerobic digestion is reported, considering special for the digestion of food waste & its bio-chemical reactions. It also describes food waste as the substrate & its optimal conditions for the increased activity of bio-gas output. At last, it has been reviewed about that the operation of the various pre-handling methods & an-aerobic reactor configurations increase methane content in the biogas for the digestion of food waste for.

## III. CONCLUSION

Emissions due to food industry wastewater, its application in food processing industry as well as discussions on the restrains and opportunities are in the heart of this article. Approaching emissions can allow numerous possibilities for conducting in food processing industries more efficient. Zero-emission is a concept of the production, manufacturing, & utilization of stocks & services to an establishment that is sustainable & no impact on the environment. The concept of generating biogas from the effluent of the food processing industry which is substituted as renewable fuel. The chemical oxygen demand depletion can achieve in the de-nitrification processes of the nitrate & nitrite feeding reactors collate sympathetically to the acquired from the blank reactor when alone $CH_4$ yield was given output from 60 to 70%. An incorporate arrangement can acquire a remarkable COD reduction efficiency than instead of a single arrangement. If the scheme is such that solid loosen is lower & the survival in area of the various bacterial presence included is viable.

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