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Anaerobic Waste Water Treatment Plant with Continuous Bio Filtration

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Abstract:- Anaerobic fermentation is a process which takes part in a natural circle of the organic matter. This process was used for sewage water purification and biogas production for illumination in Exeter, England, since 1895. A bigger development for this process was the period before the Second World War especially in Germany, where the biogas was utilized as a tractor fuel. Investigations were advanced in direction to find alternative energies after the petroleum crisis, during the 1970's. For this purpose, biogas, as a product of anaerobic fermentation was considered to be a proper solution.

Anaerobic fermentation in mesophylic conditions (36°C) is complementary process in aerobic purification of wastewater for sludge treatment in methane tanks, etc. Thus, this process was developed parallel with the aerobic one. The first bio filters - combination between bioreactor and later bio filters - were built in France and in Spain, in wine industry and with complete automation of the working parameters.

Keywords:- *Waste Water Treatment Plant, Retention Time, Anaerobic Fermentation, Continuously Bio Filtration, Fixed Bacterial Film.*

I. INTRODUCTION

Compared to the older procedures of the waste water treatments the data sheet (Tab.1) shows the parameters of anaerobic fermentation with various equipment in mesophilic conditions(36°C) [1,2].

Equipment Parameter	Retention time	Biogas production m3 / m3	Degree of cleaning (%)
Digestor	100 days	max. 0,05	52-56
Bioreactor	5 - 20 days	0,1 - 0,9	56 - 65
Bioreactor with charging	1 - 5	1,0 - 2,0	70

Table 1

- The data's are obtained by author in the laboratory scale [1]

The new anaerobic psychrophilic fermentation procedure [3,4,5] has been selected and begins to develop because it differs from all other known procedures that have many disadvantages, such as: the consuming large quantities of electricity, qualified personnel required for the plant units, specialized equipment, spare parts as well as the locations of stations built far from the settlement, which refers to the insects and stink that develop at the stations during the interruption of the electrical current.

A brief overview to a few well known and mostly applied procedures reveals the maintained of the aerobic waste water treatment plants and their difficulties. The oldest procedure dates back to 1898 year in England (Exeter), connected to the exploitation with auxiliary septic tank. Factually, one digester with retention time of at least 10 days could achieved a clearance rate of around 32%.The second procedure presents the mesophilic bioreactors or so called byotanks that have a retention time of 14-28 days and can achieve a degree of purification of about 54%. The waste energy for heating the wastewater up to 36° C demanded huge investment funds due to the large storage time and to obtain the purificated water was needed 0.5-0.8 kwh/m3 treated water [6]. These waste water treatment aerobic constructions were more of a type of surface or deep aeration and all of these plants used large amounts of electricity, specialized personnel, spare parts, etc. The development of insects inside the stations, as well as the smell that grew around them, the constructions could not be built close to the populated areas.

Aerobic - anaerobic or facultative plants consist of rotary discs, half of which work under aerobic conditions and the other half - under anaerobic conditions (Byodisk, Biorol,etc.) [7]. They have wood maintenance, but they are very sensitive to inhibitors and variations from the organic loadings of water. In all aerobic installations, the nitrogen and the phosphorotide remain in the water so the additional operations with additional equipment should proceed for their removal. With in all aerobic processes we gain 15-20 times larger quantities of precipitates, which should therefore be processed with concentration, drying, burning, etc. or with anaerobic treatment and stabilization.

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II. THE NEW GENERATION OF WASTE WATER TREATMENT PLANT

The main intention for evolution of the anaerobic process was to accomplish shorter retention time, better purification efficiency and bigger gas production. The developing required a new type of bio filters [8] which work with small hydraulic and pneumatic pressure. Their construction begun in 1982-1986 under supervising of the autor (Fig.1).

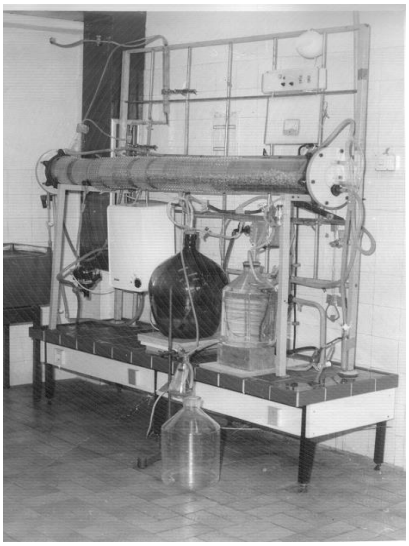

Fig 1:- Laboratory plant in the company Alkaloid, Skopje, Macedonia in 1982-1986

III. BIO FILTRATION METHOD

The experiments which we have done with waste water which had concentration of 1900 mg/l COD. The composition of the biogas was the following :

Methane, CH_4----------87,2 %

Carbon dioxide, CO_2----------6,0 %

Nitrogen, N_2----------5,4 %

Oxygen, O_2----------1,4 %

It is interesting to notice that the new bio filters are very resistant to inhibitors as: phenol, formaldehyde, methanol, heavy metals etc. For instance, 6,4% formaldehyde which passed through the bio filters in mezophylic conditions, is transformed in biogas over 96%. The heavy metal, Cr(6+) is reduced in Cr(3+) less toxic. Phenol does not disturb the bio filters function with concentration 1000 times greater than the concentration that inhibits the aerobic process. The element sulfur from different substances is reduced to the native form. All these processes unwinds in corresponding Redox potential inside the bio filters.

This filter showed the following results, much better compared to the previous technologies (Tab.2).

Retention time, Hour	Work Temp.°C	Biogas production m3/m3.day	Purification grade in rapport with COD,%
3,5 - 6	36	9-11	82

Table 2

IV. RESULTS OF THE NEW WASTE WATER TREATMENT PLANT (ANAEROBIC PSYCHROPHILIC PROCESS)

This kind of bio filtration with small enhances was used for designing and construction of the first in the world anaerobic, psychrophylic, sewage waste water purification plant with capacity of 150 P.E. (People Equivalent or Inhabitant) in Kondovo-Skopje, Rep.of Macedonia (Tab.3) which is in function since March, 1998 without energy consume and without maintenance.

Until now, stations with capacities from 5 P.E to 4000 P.E or with organic loading from 0,32 to 260 kg BOD5/day or hydraulic loading from 1,05 to 840 m3/day waste water were built in different countries through the world, exactly 56 plants in three continents or 12 countries for domestic and industrial wastewater purification under the authors [9]. These stations run with continuously bio filtration on the psyhrophylic conditions (10° C-25°C). The process unwinds also well during all the year seasons.

Meassurments obtained in different times for two waste water treatment plants you can see in Table 3.

Station	Kondovo,159P.E		Rasce, Macedonia for 4000P.E.	
Date	20.10.1998	24.05.2001	31.10.2000	24.05.2001
BOD5,mg/l	2,3	3,2	8,2	1,2
COD,mg/l	2,6	7,9	20,1	14,7
pH	7,0	7,8	7,5	8,1
Suspenden Solids,mg/l	11,0	-	5,0	4,0
Color, Odor	No	No	No	No
Nitrites	No	No	No	No
Nitraties	No	No	No	No
Temperature	18°C	16°C	14°C	15°C
Phosphates were measured only once when concentration was 0,86mg/I PO_4				

Table 3

Other measurments such as the microbiological analysis of the effluent taken from the station in Kondovo, Macedonia showed the:

- Total number of bacteria in 1 ml/37° C---------- 650
- Total colliform (MPN) in 1 l ---------- 240 000

Classification: IV class of water with comparison with the normes of the North Macedonia.

V. CONSTRUCTIVE DATA

- For small stations (max. 500 P.E.) can be used concrete, steel or plastics as a constructive material and for the bigger only concrete and steel. Constructive elements of the anaerobic station are the following (Fig.2).
- The anaerobic stations are underground because of the thermal isolation and esthetical reasons. They don't disturb the view on the surroundings (See Fig.3).
- These stations can function without pumping station only when the hydraulic drop of the terrain is bigger than 600 mm H_2O.

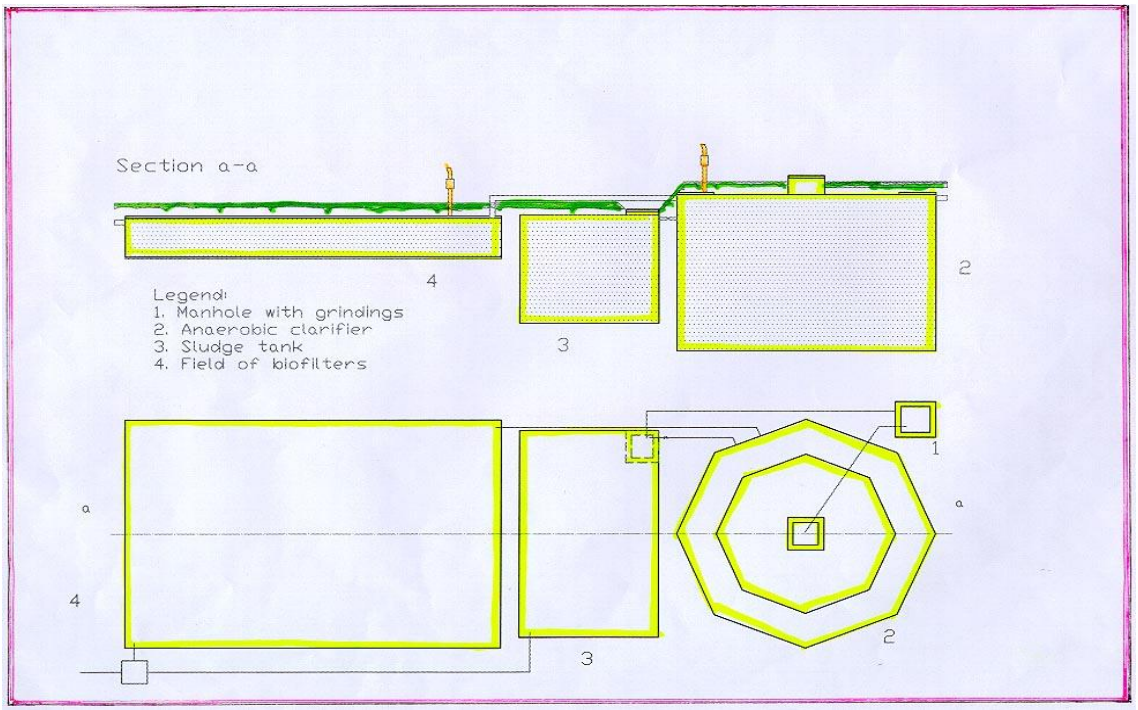

Fig 2:- Technological Scheme of the Waste Water Treatment Plant which Functioned in Real Conditions.

Fig 3:- Our the Underground Station for the University of Podgorica, Montenegro.
Capacity: 700 P.E. with the bio gas outlet

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VI. FUNCTION. SHORT DESCRIPTION

Waste water strains through the grindings where remains only the gross particles (wood, paper, plastics) and enters in anaerobic clarifier. Here, unwinds separation of the floating particles (fats, protein's etc) and heavily particles from the water which falls to the bottom and forms sludge with 15-20% solids. Fats and proteins are subject to hydrophylization on the superior part of the clarifier and in the primary bio filters.

Water with the soluble and colloidal substances enters in primary, secondary and tertiary bio filters. Here, organic matter is transformed in biogas by anaerobic fermentation.

The total retention time in station is 3,5 - 4,0 h. This parameter determines the dimensions and the constructive area of the new biological station.

Our plant do not produce **sludge.** The quantity of the sludge which is obtained in our stations is insignificant in comparison with the sludge from aerobic station ones. This sludge is stabilized over 85%.

VII. INVESTMENT AND MAINTENANCE ESTIMATION.

For better illustration we will compare our station, AN-4000, and aerobic station of BIOGEST Abwassertechnik GmBH from Germany, 3000P.E, (Tab. 4) [10]. This station for 400 P.E was built in poligon Krivolak and was sponzored by NATO Danmark (Fig 4).

BIOGEST Abwassertechik GmBH (Offer documentation: Biogest Abwassertechnik GmBH, from 17.03.1998)		AN-4000 (Rasce) ECOLOGICAL OFFICE
Capacity	3000 P. E. (4000 P.E)	4000 P.E.
INVESTMENT WORKS		
Civil works	28,3%	41,3%
Equpment	55,0%	9,2%
Rest	16,6%	89,7%
Total	100%	31,7%
YEAR SPENDS		
Electric energy(0,114US$/KWh)	100	0
Work means	100	0
Salaries	100	11
Sludge transport	100	0
Sand transport	100	0
Total year spends	100%	5,8%

Table 4

Fig 4:- In Front of the Station in Poligon Krivolak

VIII. CONCLUSION

From the analytical attendee of the stations our technology produces the best optimal solution for recycling of the world largest waste from which we can obtained three very important products for the humanity:

- The treated water have minerals which are useful for irrigation of the agrarian cultures for a production of larger products.
- The same water which contains anaerobic saprophyte bacteria is possible to be used as an insecticide or pesticide for the purpose of the organic food.
- The most useful product is bio gas which contains 87% methane and can be used as a ecological fuel with very high calorie power.

AWARDS

The innovation has been awarded several times, first in Brussels winning the Gold Medal on the World Exhibition of Innovation Research and Technology, EUREKA 2001 and the Special Award of the Belgian Government. But, also with Silver and Gold Medal on the International Exhibition for Inovation-JENA, Germany in 2012, as well as two certificates in Fondation for Energetic Efficency and Reneweable Energies ENERGY GLOBE (Leader in the area of sustainability) in Brussels, in the European Parliament (2008) and in Wien, Austria (2011).

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