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Utilizing Upflow Anaerobic Sludge Blanket (UASB) Reactor For Treating Olive Mills Wastewater

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  - R&D.
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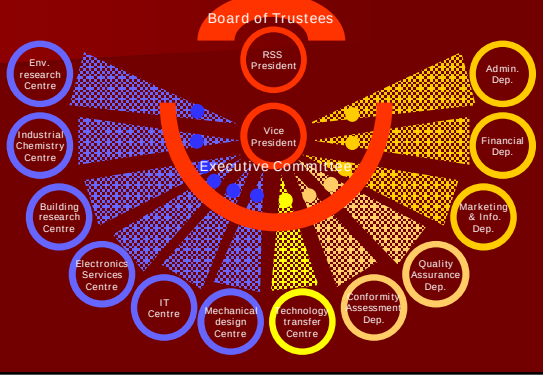
RSS Organization Chart



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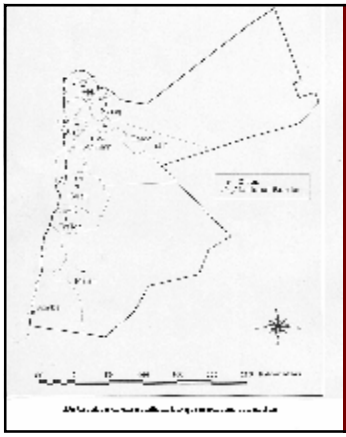

Mills distribution

Irbed:	70.4 %
Mafraq:	2.7 %
Salt:	15 %
Amman:	4 %
Zarqa:	1.3 %
Karak:	4 %
Tafileh:	2.7 %

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INTRODUCTION

- 98% of olive trees are grown in the Mediterranean area.
- In Jordan the area planted with olive trees has increased significantly from 0.93 million dunum in 2004 to 1.3 million dunum in 2009.
- The annual production of olives reached 221500 tons in 2009.
- Around 80% of the olive produce is transferred to oil processing.
- Operating olive mills in 1994 was 77 mills, the number increased to 104 mills in 2004.
- 70 % of the mills are located in the northern part of the country.
- The wastewater is discharged to the environment in uncontrolled manner.

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PROJECT OBJECTIVES

- To determine the characteristics of olive mills wastewater (OMW) in Jordan.
- To study OMW impacts on surface and groundwater.
- To study a treatment method using upflow anaerobic sludge blanket reactor (UASB).

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PROJECT

- RSS with assistance from the IDRC of Canada and U. S. Agency for International Development launched 2 applied research projects.
- IDRC project included a socio-economical component study.

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INPUTS & OUTPUTS OF THE PROCESS

- *INPUTS*:
  - Olive.
  - Water for washing and separation of oil; about 1 m^3 / ton olive.
  - Energy for heating water used in the process (heating the crushed olives)
- *OUTPUTS:*
  - Oil: roughly 1 ton olive results in about 200 kg oil.
  - Solid waste: Pomace olive (about 500 kg per ton olive).
  - Wastewater: process water (1 m^3 / ton olive processed) and water resulting from the olives (about 300 kg / ton olive).

Thus, the total OMW estimated for the production rates in 1994 = 100 000 m^3/season. This figure has increased as a result of the increase in production rates of oil. It may reach 200000 m^3 at present.

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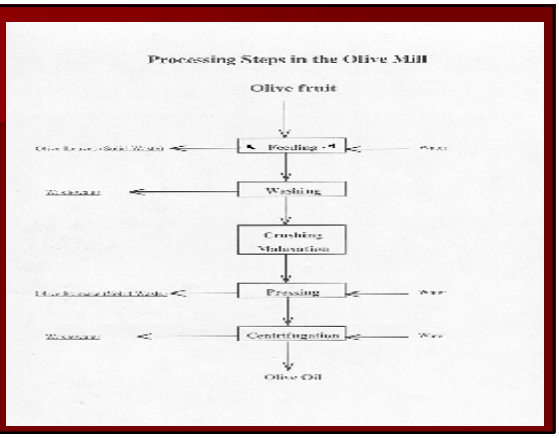

CHARACTERIZATION OF OLIVE MILLS WASTEWATER

- Samples of OMW were taken from 22 olive mills.
- Standard Methods for the Examination of Water and Wastewater were adopted.
- The results of the major parameters are summarized below.

CHARACTERIZATION OF OLIVE MILLS WASTEWATER

- The analysis showed that OMW is acidic and contains high concentration of total dissolved solids (TDS up to 80355 mg/l) and total suspended solids (TSS up to 46188 mg/l).
- The organic content is characterized by a high concentration of chemical oxygen demand (COD up to 160096 mg/l) and biochemical oxygen demand (BOD_5 up to 63271 mg/l), in addition to a very high concentration of fat, oil and grease (FOG up to 13118 mg/l).
- These characteristics make OMW unsuitable for disposal neither to the sewer system nor to wadis and streams according to the Jordanian standards and regulations.

OMW Characteristics and Jordanian Standards

Parameter	Average reading	Maximum Allowable Limit		
		Disposal to Wadis & Rivers	Reuse for irrigation	Discharge to sanitary sewer system
pH *	5.67	6.5-9.0	6.5-8.4	5.5-9.5
TDS	39,000	3,000	2,000	-
TSS	29,000	50	1,000	1,000
COD	117,000	150	-	2,100
BOD	38,000	50	-	800
FOG	7,000	5	5	50

*: All the unit in mg/L except pH (SU).

-: Undetermined.

TREATMENT METHOD

Many treatment experiments were undertaken at RSS. It was found that anaerobic treatment is favored for such wastewater. The technique of Up-flow Anaerobic Sludge Blanket Reactor (UASB) was seen the most appropriate.

ANAEROBIC TREATMENT

- It is favored for strong wastewater; high organic content.
- Low chemicals and energy requirement.
- Energy producer; methane gas is generated.
- Low production of sludge from the treatment.
- Less space is required.
- Simple equipment are used.

TREATMENT METHOD UASB REACTOR

- It is a tank partly filled with anaerobic sludge which has good settling properties. The influent is fed into the bottom of the tank where it comes in contact with the sludge.
  - Feed distribution.
  - Sludge bed.
  - Three-phase separator.

TREATMENT SCHEME

The adopted treatment was based on the fact that the scheme should be applicable at large scale at individual olive mills or at a central treatment units, thus simple treatment method was selected, the scheme also assumed that the effluent can be discharged to domestic wastewater treatment plants for post treatment so as to keep the cost of specialized treatment of OMW as low as possible.

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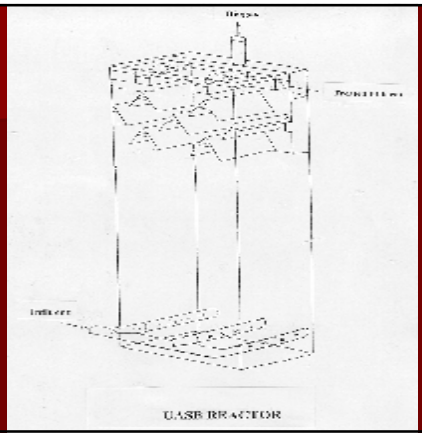

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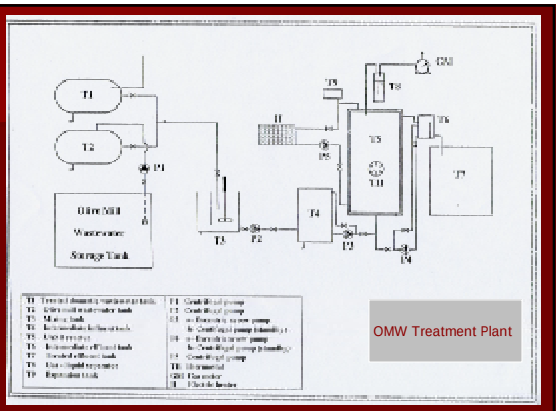

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UASB REACTOR

- Two UASB reactor were investigated:
  - Laboratory 15 & 28 liter (cylindrical and conical).
  - Pilot 2 m^3

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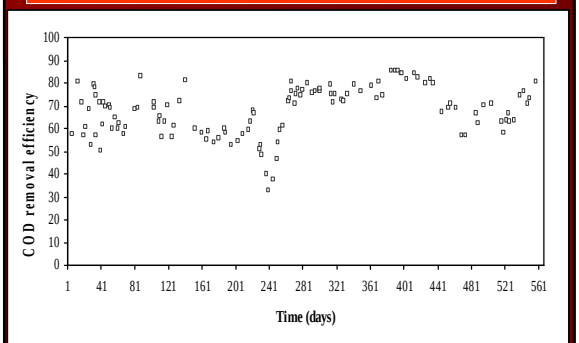
RESULTS OF UASB1 – LAB SCALE



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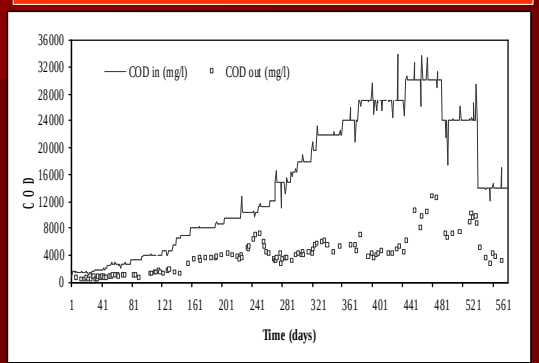
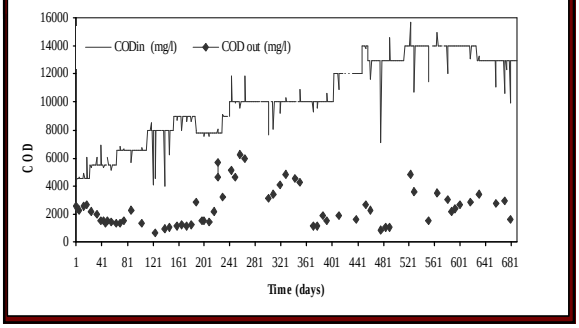


RESULTS OF UASB2 – PILOT PLANT



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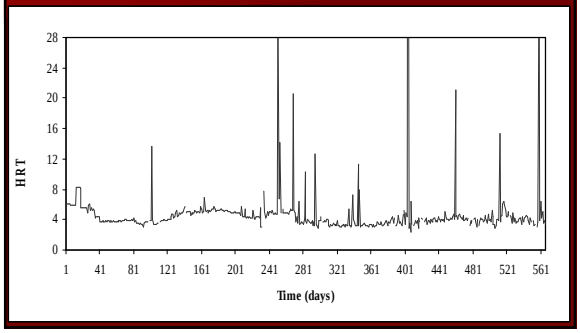

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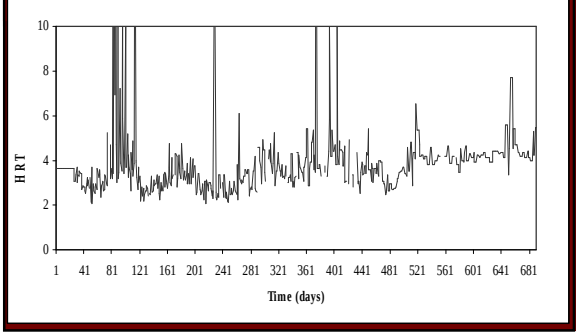

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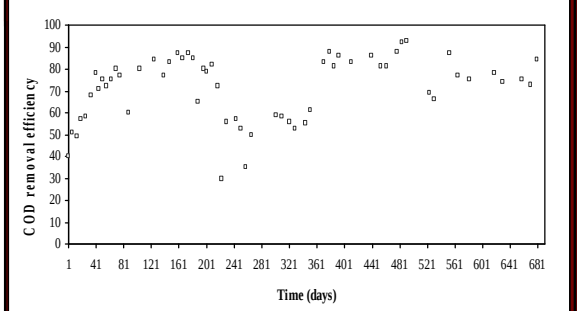

METHANE GAS PRODUCTION

- Anaerobic treatment processes are net energy producers with the methane gas being generated.
- The amount of methane gas that can be produced from the treatment of OMW in Jordan is estimated at 6.15×10^6 m^3 (given the quantity of OMW = 2000000 m^3 / season, COD = 117 kg/m^3 (average), anaerobic biodegradation of 1 kg COD yields 0.35 m^3 CH4 and the treatment efficiency = 75%). This amount of gas can generate 10.26×10^6 kwh electric power

RESULTS

- COD removal efficiency = 75%
- Biogas analysis:
  - CH_4 = 79.6%.
  - CO2 = 17.5%.
- Drawbacks of the UASB
  - Need post treatment.
  - Long start-up stage.

CONCLUSIONS

- It is necessary to treat OMW before disposal.
- The treatment utilizing UASB reactors is a viable option that can be used in Jordan.
- UASB reactors are easy to operate at relatively low cost.
- The biogas produced by the anaerobic degradation can be utilized to heat the reactor, or alternatively to generate electricity.

PROJECT RESULTS

- Constructing 9 central treatment plants (CTPs) in the different areas.
- The effluent of the 9 CTPs is to be discharged to the existing domestic wastewater treatment plants (DWTP) for further treatment.
- The effluent of DWTP is currently used directly or indirectly for irrigation, thus introducing the treated OMW to DWTP is seen positive for allowing the reuse of OMW or discharge safely to the environment.

THANK YOU

CONCLUSIONS *cont.*

- Another viable option is to enhance the adoption of cleaner production techniques at mills i.e. by using low water consumption technologies (ecological decanters). This is seen most important at high capacity olive mills.