Energy recovery and treatment of wine lees using a compact anaerobic digester

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COMPETITIVENESS AND ENTREPRENEURSHIP OPC II
regions at the centre of development

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GSRT - Management and Implementation Agency for RTD and Innovation Activities

Introduction

R&D Project:

Two goals

- ✓ Winery Wastewater treatment and
- ✓ Waste valorization – Energy recovery

Wine production

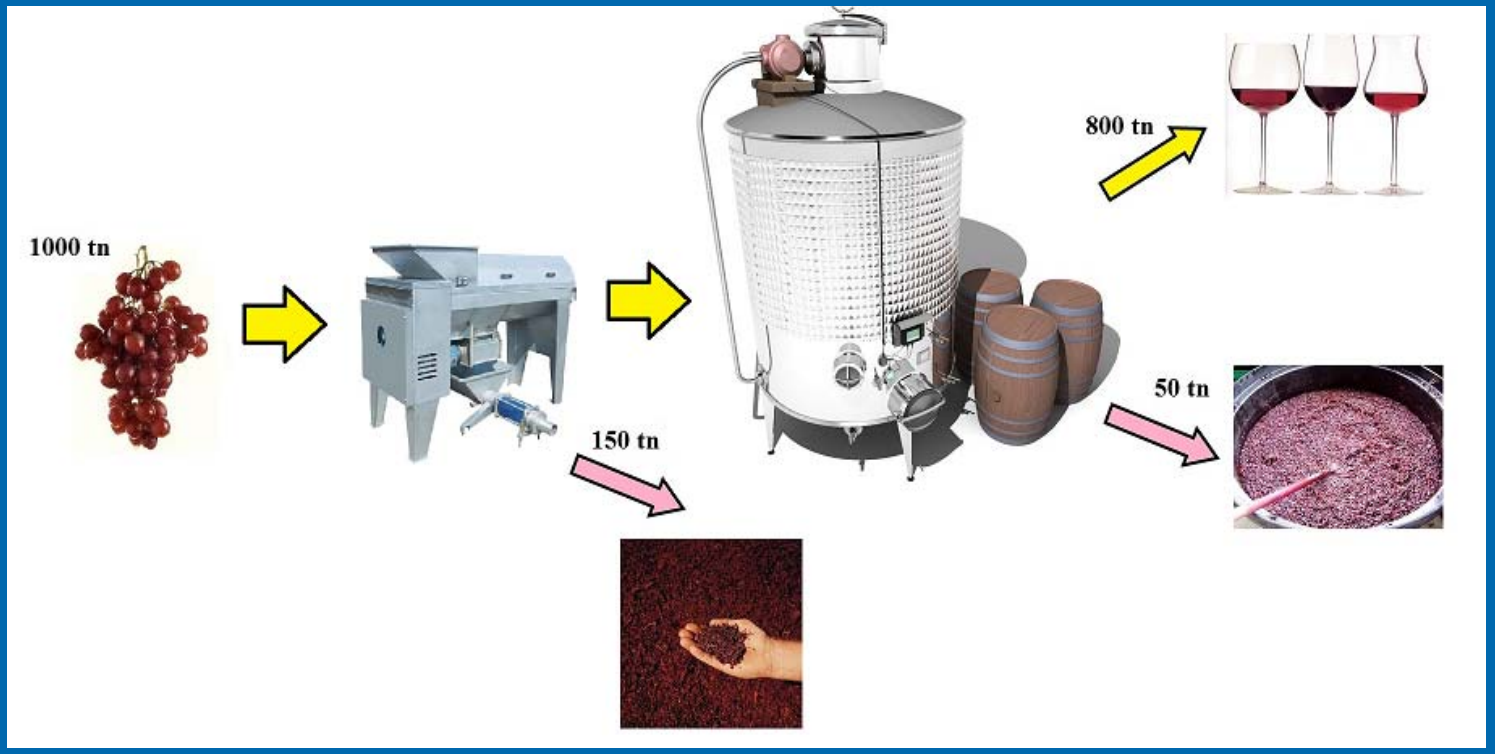
- One of the most important sectors of the Greek industry involving 470,000 tons of grapes per year

- Around 600 wineries
  most of them small or medium sized <1000tn/y
  family business

✓ Wineries present a challenge for wastewater treatment

✓ In Greece there is no common practice for winery waste management
  - Discharge in sewer system
  - WWTP before discharge
  - Grape marcs usually used as fertilizer in fields

Winery by-products



- Grape marcs
- Wine lees
- Process wash water

- ✓ High organic load
- ✓ Most is readily biodegradable (70-80%)
- ✓ Source of energy

Scope of the work

1) Winery Wastewater characterization

2) Laboratory scale anaerobic treatment

3) Pilot plant – Results analysis

5) Cost analysis for a scale up system

6) Proposals for further optimization developments

The final aim is the design of an attractive and sustainable small – medium size system for wide scale application across the Southern Europe market

Anaerobic digestion

- Stabilization of organic wastes
- Simple design and operation
- Mild conditions (pH, T, P)

Laboratory experiments

- 50L and 70L stirred tank reactors
- low mixing velocity
- Temperature: 35 °C
- Inoculum: from anaerobic digester of a dairy industry

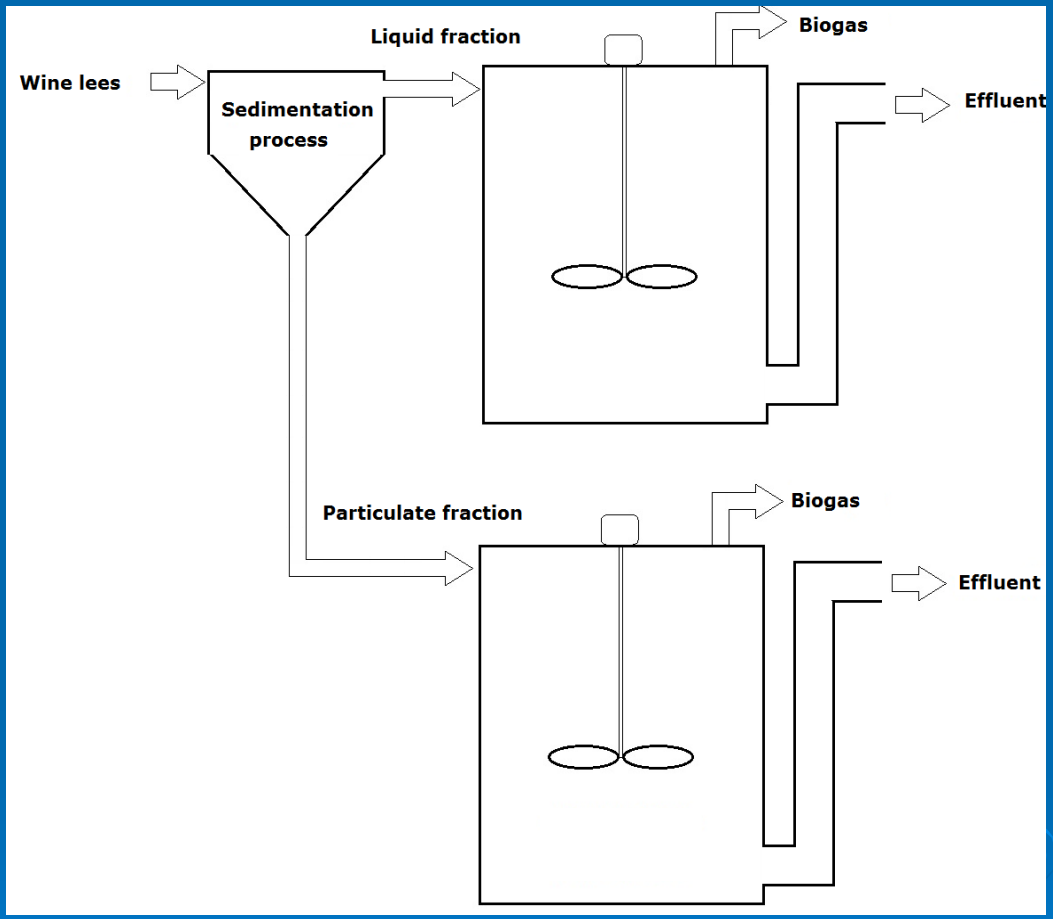
Followed on daily basis
- Biogas production
- pH
- Digester temperature

Measured twice a week
- TSS
- VSS
- Total and soluble COD

Laboratory experiments

Wine lees

- liquid fraction (supernatant)
- particulate fraction

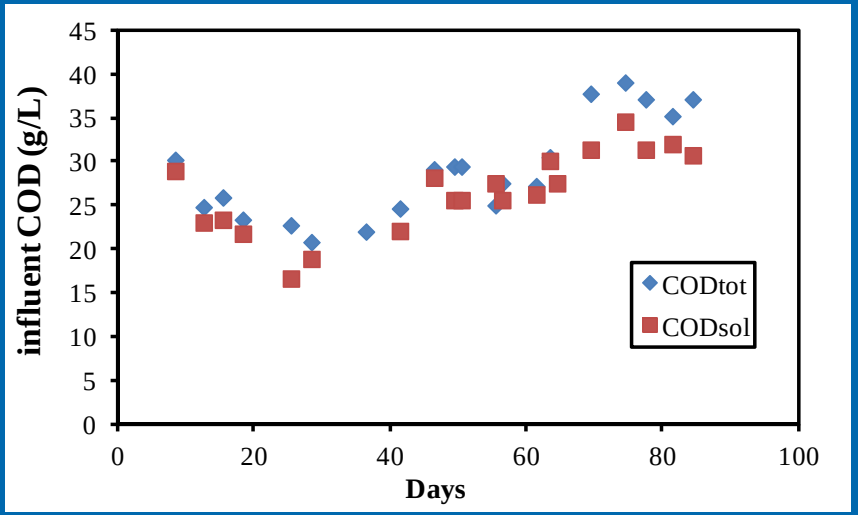


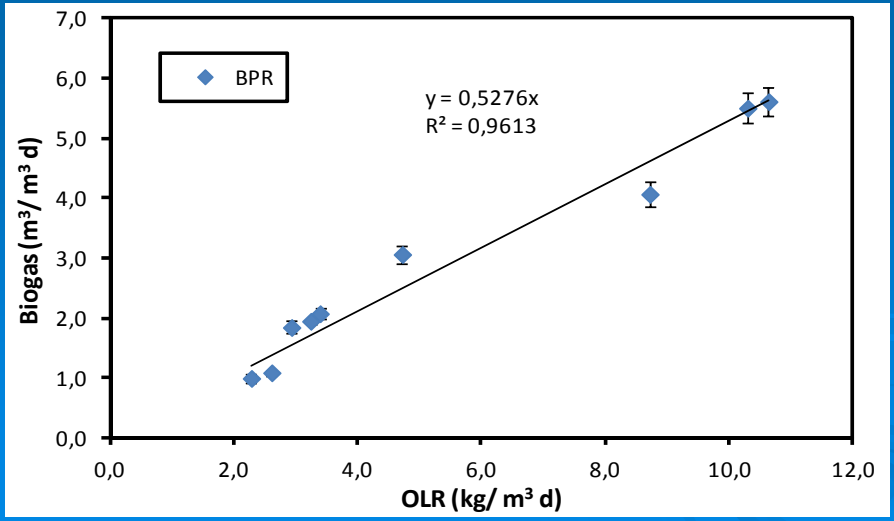
- ✓ Sedimentation process
- ✓ Further dilution with tap water to a COD 20-35 g/L

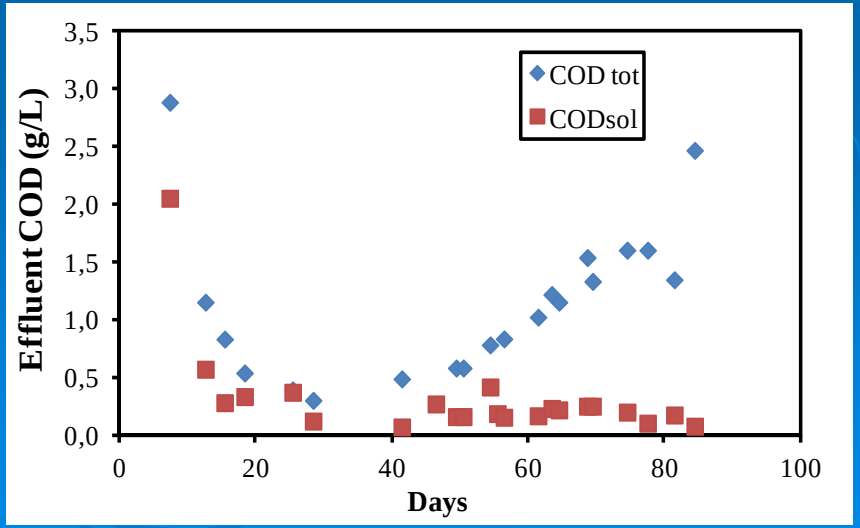
Laboratory results

Wine lees – liquid fraction

- Operation with organic loading rate up to **10** kg/(m³ d)
- Biogas production: **1,0 – 6,0** m³/(m³ d)
- Biogas yield: **0,53** m³/ kg CODın (theoretical 0,50-0,65 m³/kg CODin)
- COD removal rate >**97**%



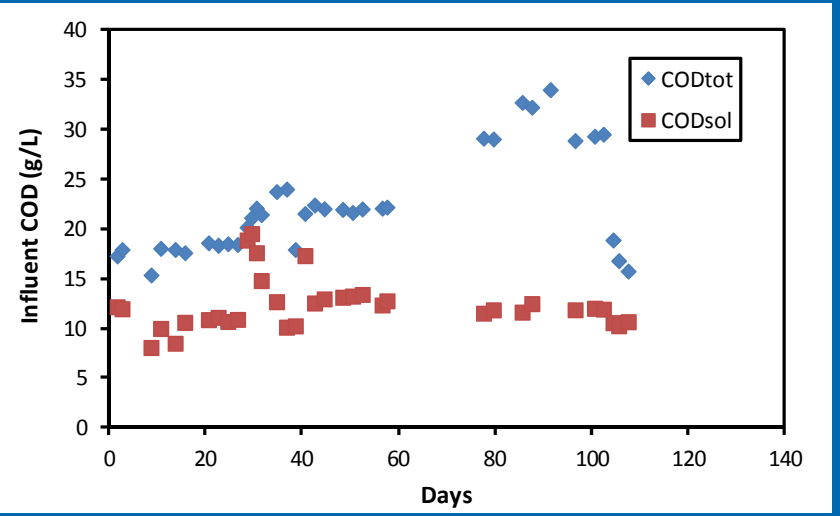


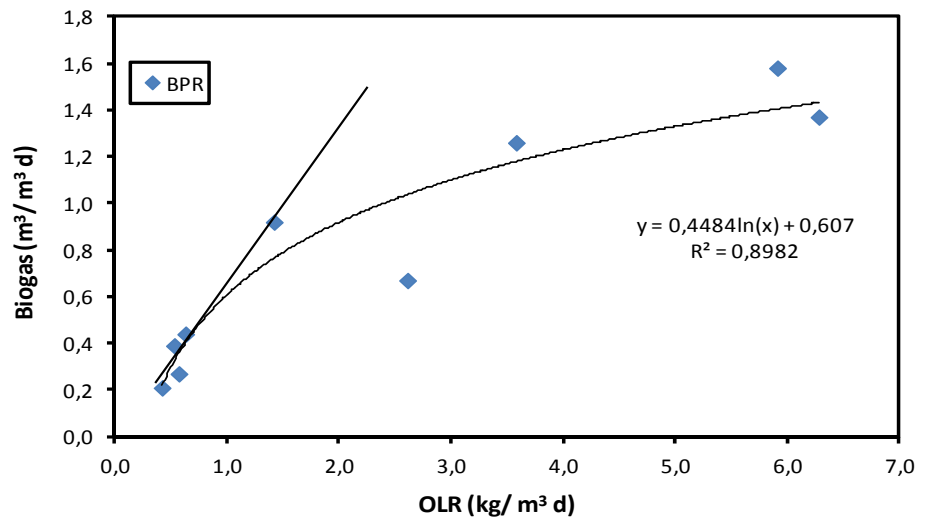


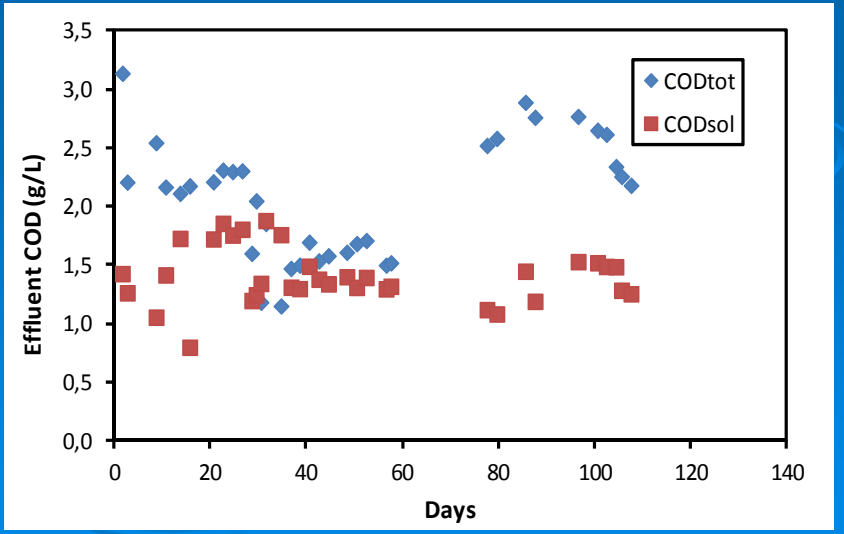
Laboratory results

Wine lees – particulate fraction

- Displays lower degradability compared to liquid fraction
  Up to **2** kg/ (m^3 d)
- Biogas production : **0,2 – 1,7** $m^3/(m^3$ d)
- COD removal rate: **88-90**%



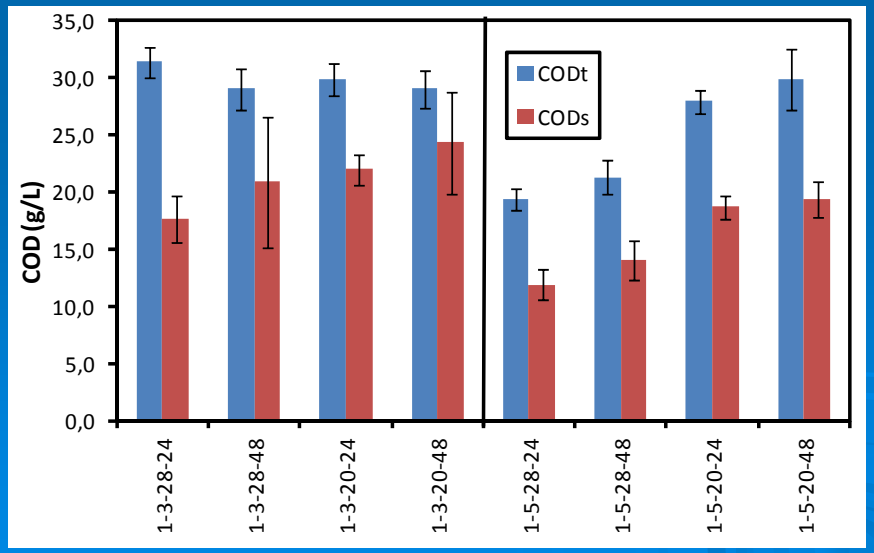




Laboratory results

Grape marc extract

- Solid/liquid: 1/3, T = 20^{0}C, t = 1d
- COD in 30 g/L
- COD removal > 90%
- OLR: 3,5kg/(m^3 d)
- Biogas production: 1,3 m^3/(m^3 d)



Pilot Plant – Kechris winery

- $2m^3$ storage tank - $3m^3$ anaerobic digester
- Mixer motor, electrical resistance for heating, insulation
- pH-controlled feeding system

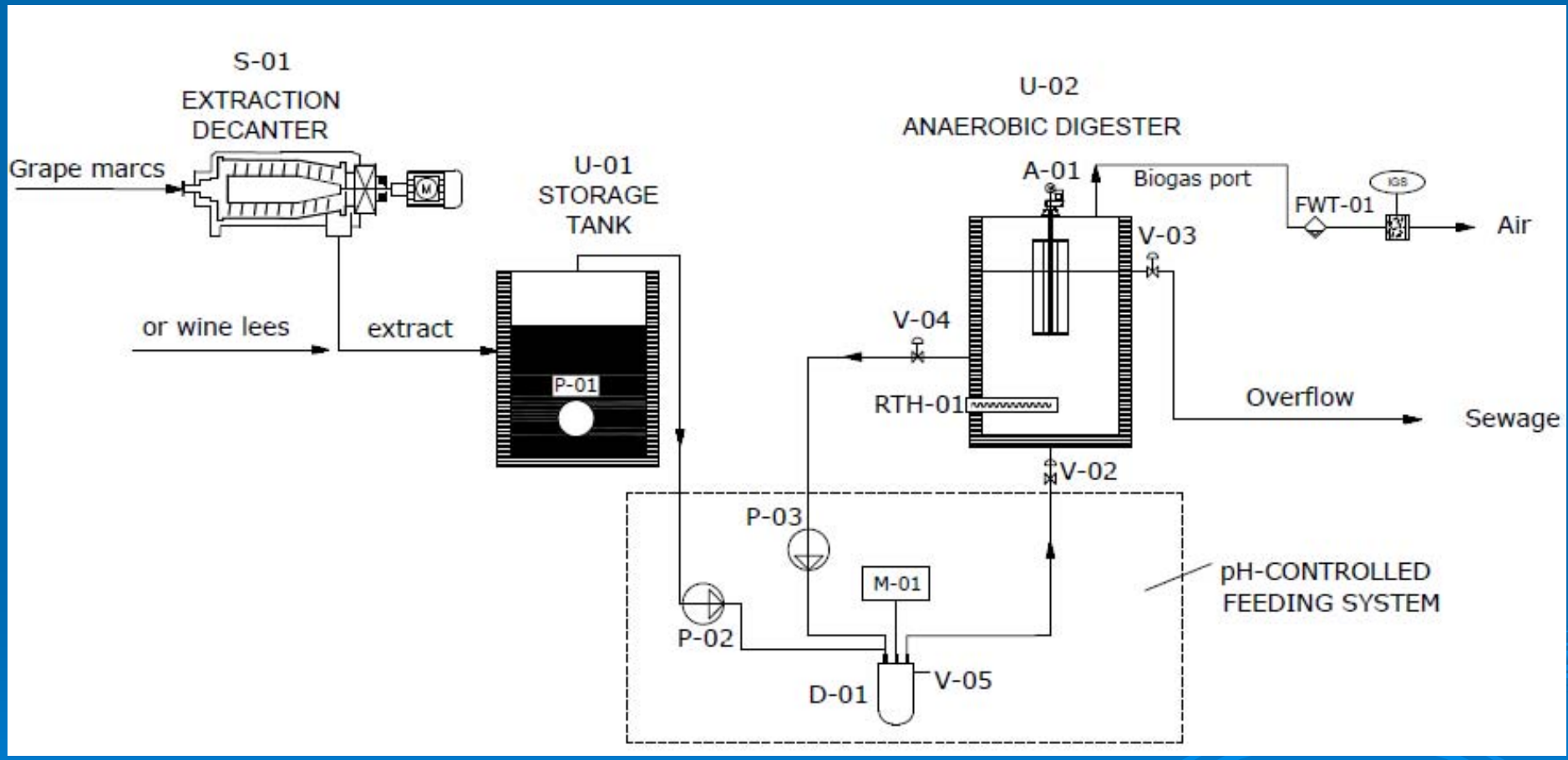
  feed was interrupted as soon as

  the pH fell below a certain value
- Inoculum: from anaerobic digester of a dairy industry

Followed on daily basis
- Biogas production
- pH
- Digester temperature

Measured twice a week
- Total and soluble COD
  inlet – outlet – reactor

Pilot Plant – Flow diagram



Pilot plant

Pilot results

Substrate	Soluble COD concentration (g/L)	Organic Loading Rate (g/l·d)	Biogas yield (m^3/ kg CODin)	COD removal (%)
Wine lees	14-23	0,1-3,6	0,44	95,0
Grape marc extract	21-29	0,3-6,3	0,64	97,0
Process wash water	7-35	0,3-3,6	0,37	97,0

Conclusions

- The Wastewater was treated successfully
- Energy recovery:
  - 15.500 m^3 biogas and 11.500 m^3 methane
  - In CHP: 3,5 kWh_{el}/m^3 CH_4, total 40.000 kWh_{el}
  - Profit of 8.800 € for every winemaking season
- Present and Future development:
  - Optimization of feeding system, automation and control
  - Prototype digester design

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THANK YOU