BioSFerA
Biofuel for biotravels

ENVIRONMENT PARK Parco Scientifico Tecnologico per l'Ambiente

BIOfuels production from Syngas FERmentation for Aviation and maritime use

Waste as Resources: Innovative technologies for recycling and recovery

The production of biofuels for aircrafts and ships from waste and discards

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Grant Agreement 884208

The BioSFerA project

Funded by the Hotizon 2020 Framework Programme of the European Union

Context Aviation and marine transport have a direct effect on global greenhouse gas emissions and air quality. BioSferA project mitigates this impact through the development of innovative and high performing biofuels.

3% of Global GHG

BioSFerA is a research project, funded by the European Union's Horizon 2020 program.

It aims to validate a **combined thermochemical – biochemical pathway** to develop a cost-effective interdisciplinary technology to produce sustainable aviation and maritime fuels.

At the end of the project next generation aviation and maritime biofuels, completely derived from second generation biomass, will be produced and validated by industrial partners at pilot scale.

4 years (2020-2024)
€5 mln budget
H2020 funds

> 40% GHG reduction

> 22% Land Use reduction

> 70% Tot Carbon conversion

Up to 60% reduction of production cost

BioSFerA concept description

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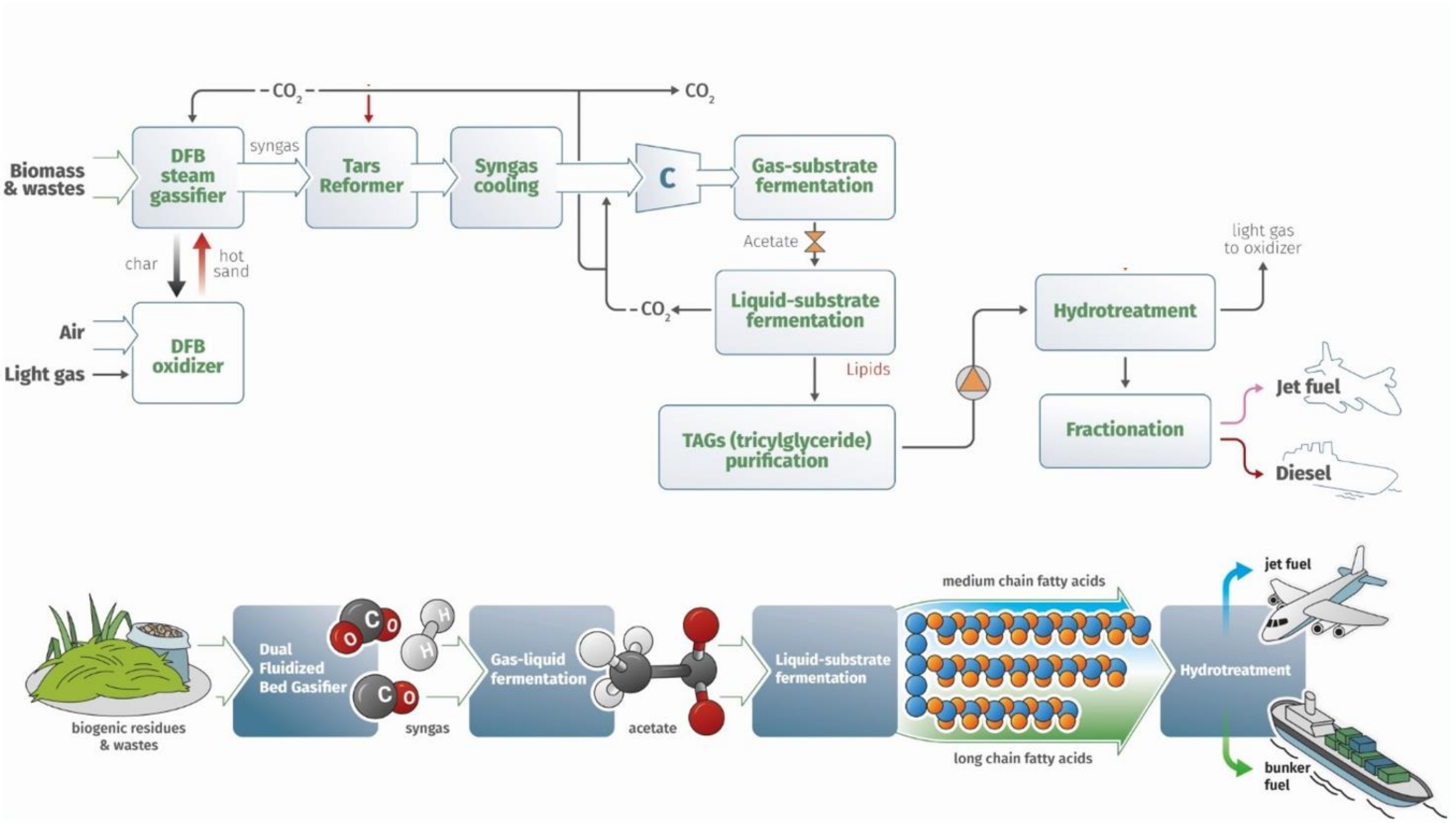
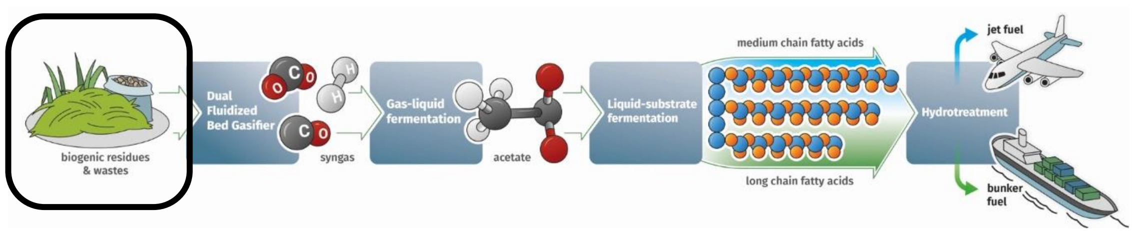


BioSFerA concept description



Feedstock selection

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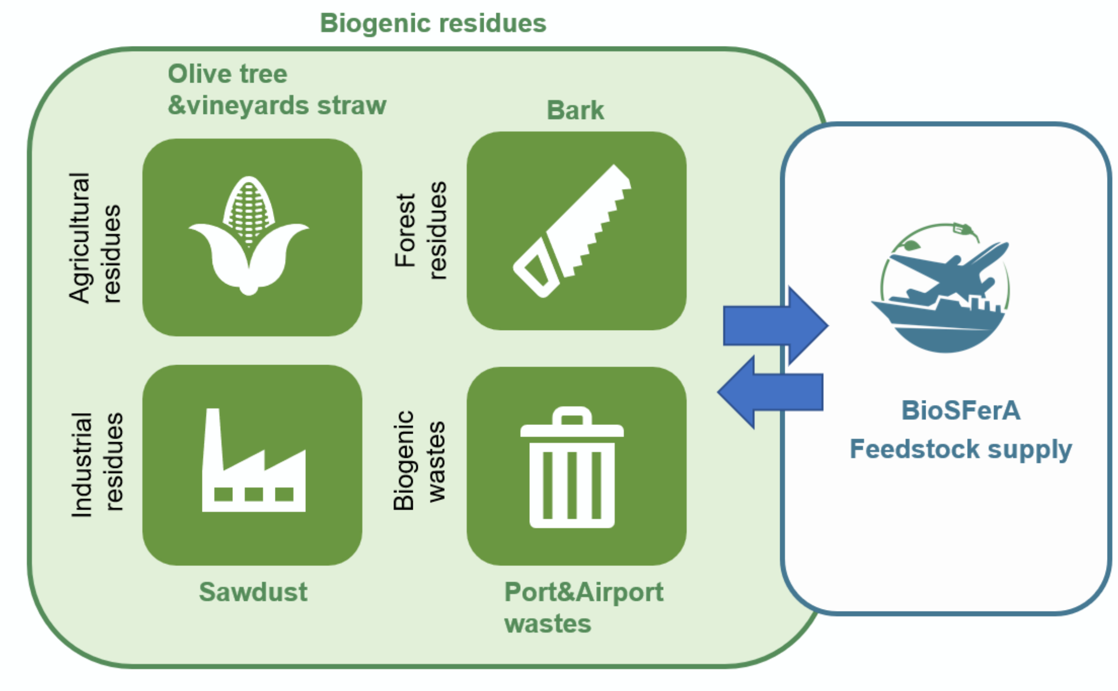
1. Feedstocks selection

Selected feedstocks:

- Olive and vineyard prunings (Greece, Spain respectively)
- Cereal straw (Italy)
- Logging residues / wood residues (Finland)
- Airports & ports biogenic wastes (All around Europe)



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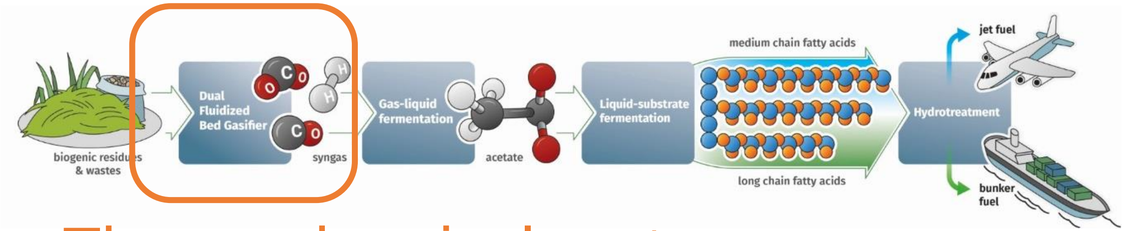

Thermochemical part

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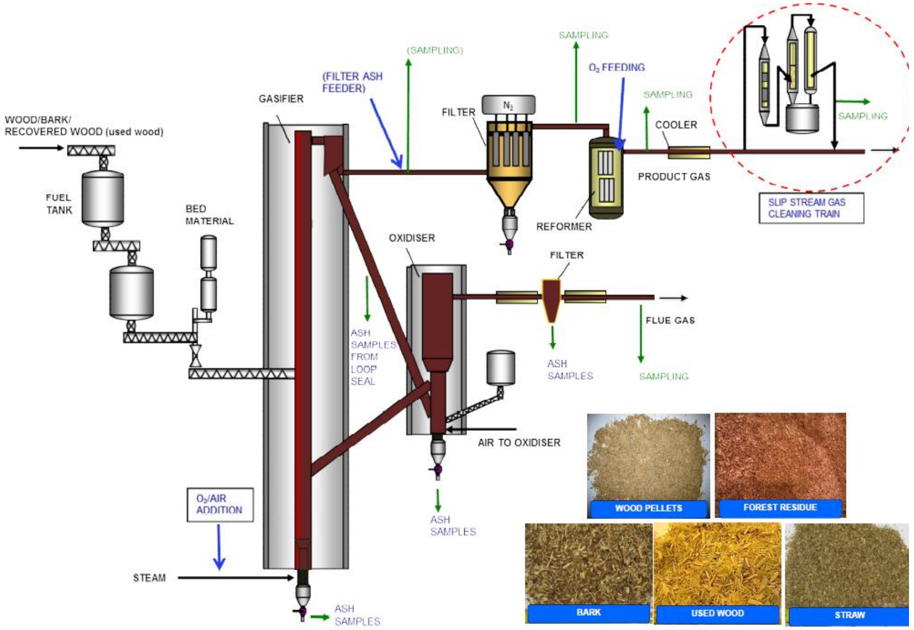
2. Gasification step

Dual Fluidized Bed Gasifier:

- gasifier
- oxidizer

The char produced is transported to the combustor where react with air to produce heat. The hotter bed material returns to the gasifier, serving as an external heat source for the endothermic pyrolysis and steam gasification reactions, leading to higher carbon conversion rate and thermal efficiency



BioSFerA concept description

Wild type selection:

- Moorella – acetogenic bacteria for acetate production
- Yarrowia lipolytica – oleaginous yeast for TAGs lipids production

3. Syngas fermentation

- 2-stage fermentation
- Gas phase → acetate
- 1-10 bar

4. Acetate fermentation

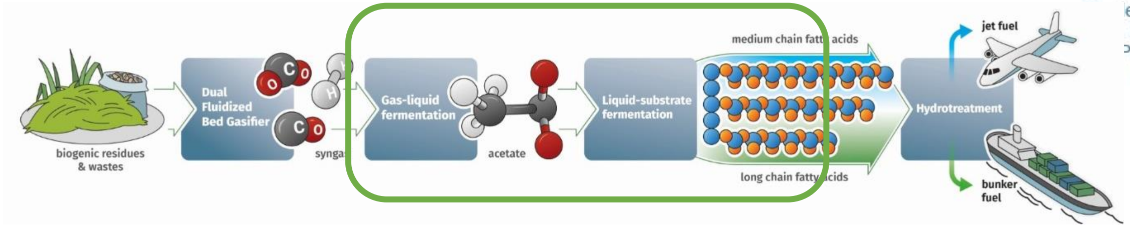
- Liquid phase → lipids

5. TAGs Purification

- catalytic hydrotreatment process: conversion to straight chain alkanes by saturation of double bonds plus removal of hetero atoms

- Dewatering
- Steam explosion
- Enzymatic treatment

Biological part



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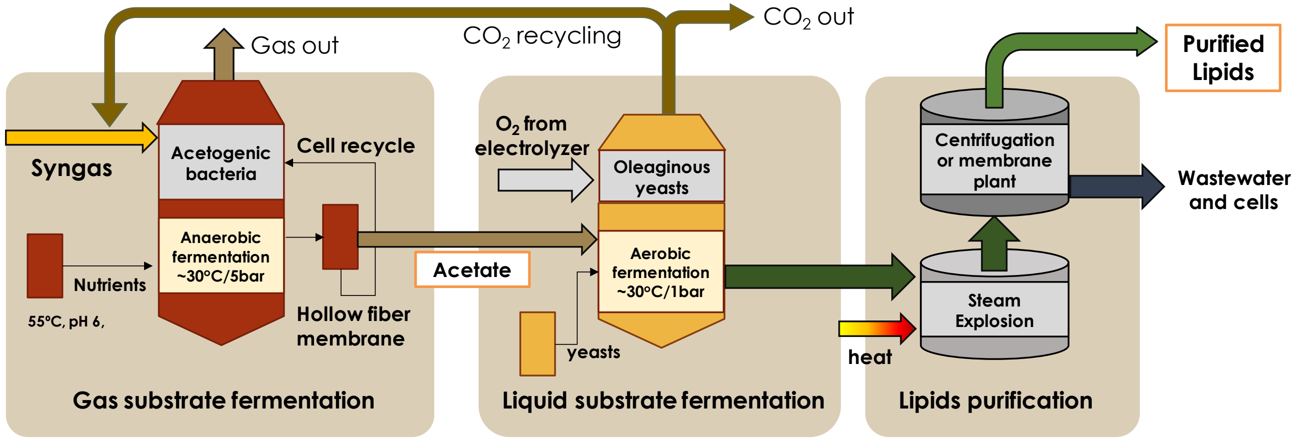

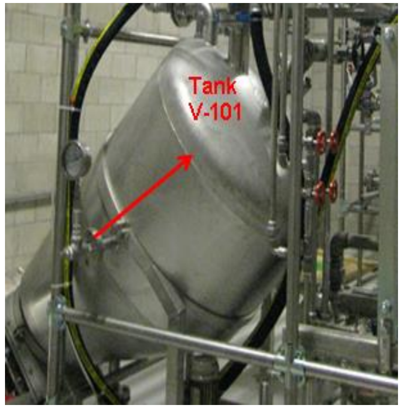

BioSFerA concept description

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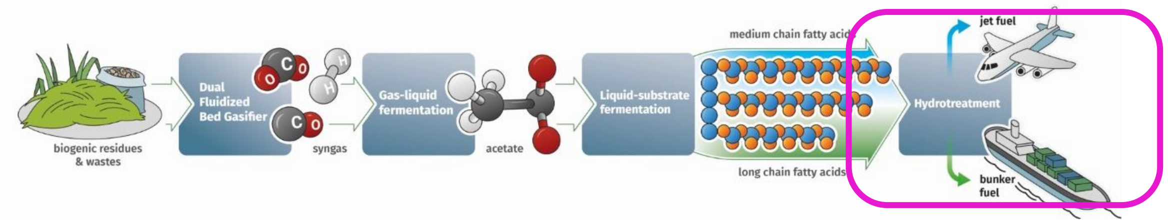
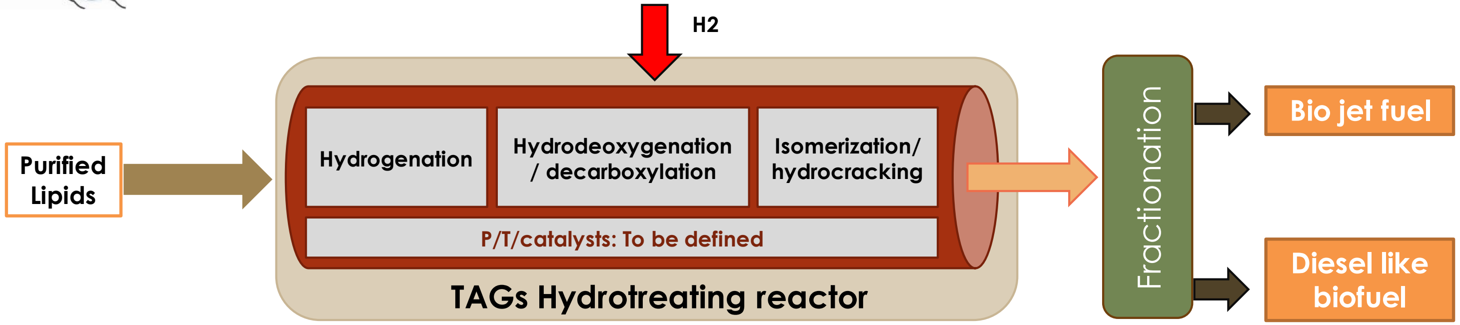
Thermocatalytic part

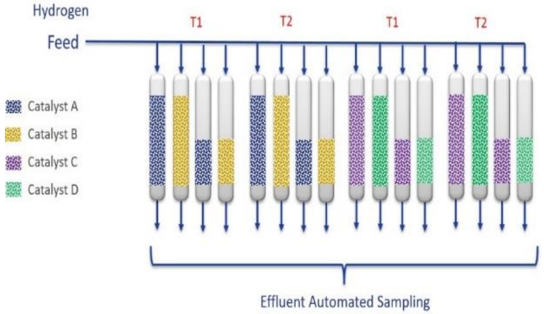


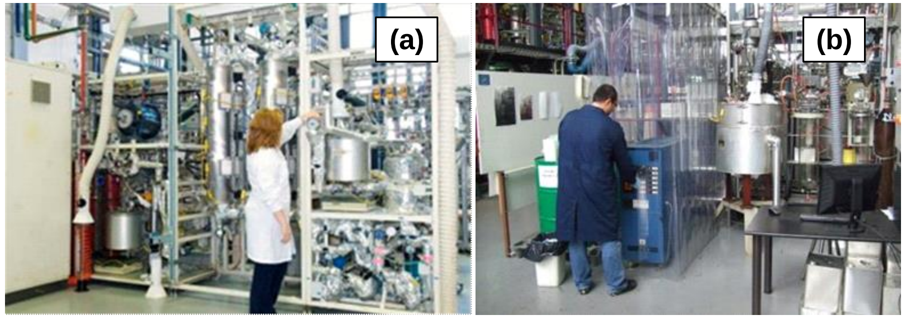
6. TAGs Hydrotreatment

- Pressurized, thermocatalytic
- Deoxygenation
- Hydrocracking
- Isomerization



Develop a proper reaction process using **commercial catalysts** where the desired bioliquids products are produced under certain operating conditions.





First steps – April 2022

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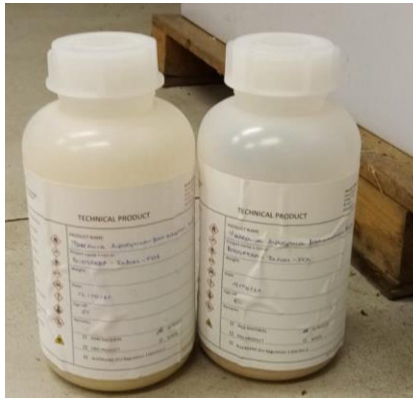

A sample of *Yarrowia Lipolytica* broth that was retrieved from fermentations with the wild-type strain.

2 bottles, each containing around 2 L of fermentation broth

Envipark carried out a first test on the steam explosion pilot plant, determining the process parameters on the basis of literature data and previous experiences on biomass treatment

Steam explosion plant

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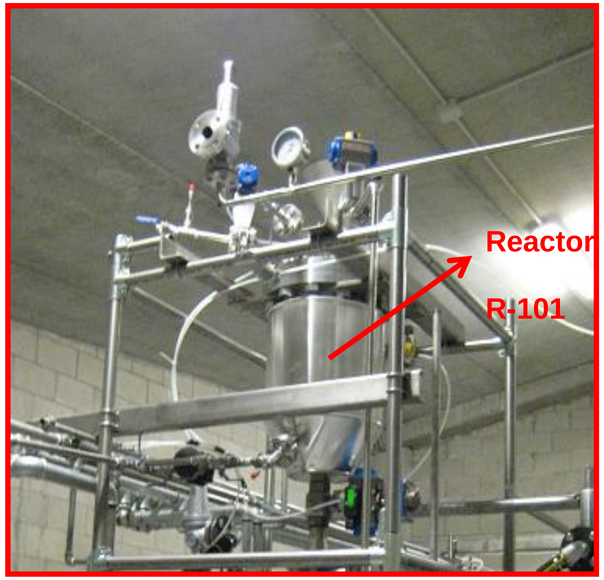
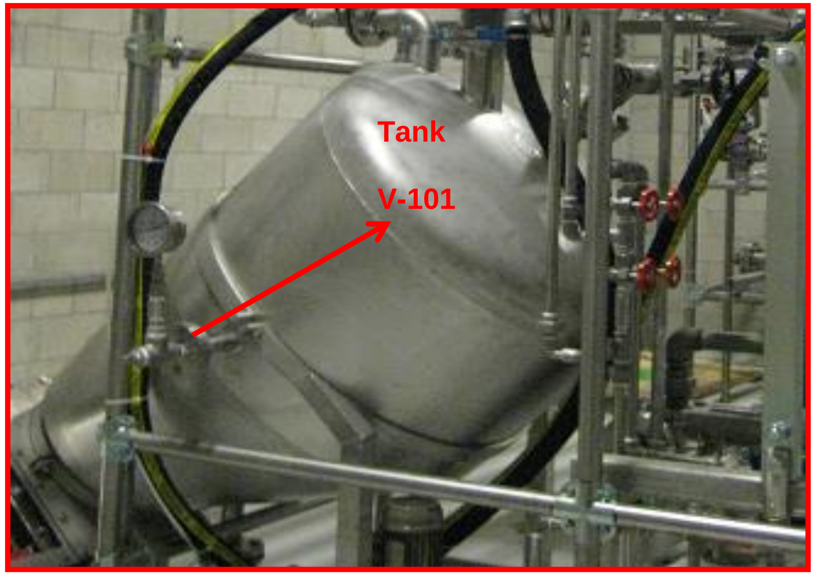


V=22 lt (2 kg of biomass/cycle)
Pmax= 26 bar
Tmax=227 °C
Pre-heating jacket V=10 lt
Temperature and pressure control system



V=300 lt for the expansion
Pmax= 1 bar
Cooling jacket
Hermetic butterfly valve for the recovery of the exploded biomass

- Saturated steam
- Automatic control system for maintaining process conditions
- Isoenthalpic conditions
- Critical pressure jump conditions
- Operator intervention only after the complete depressurization and cooling

Test 1

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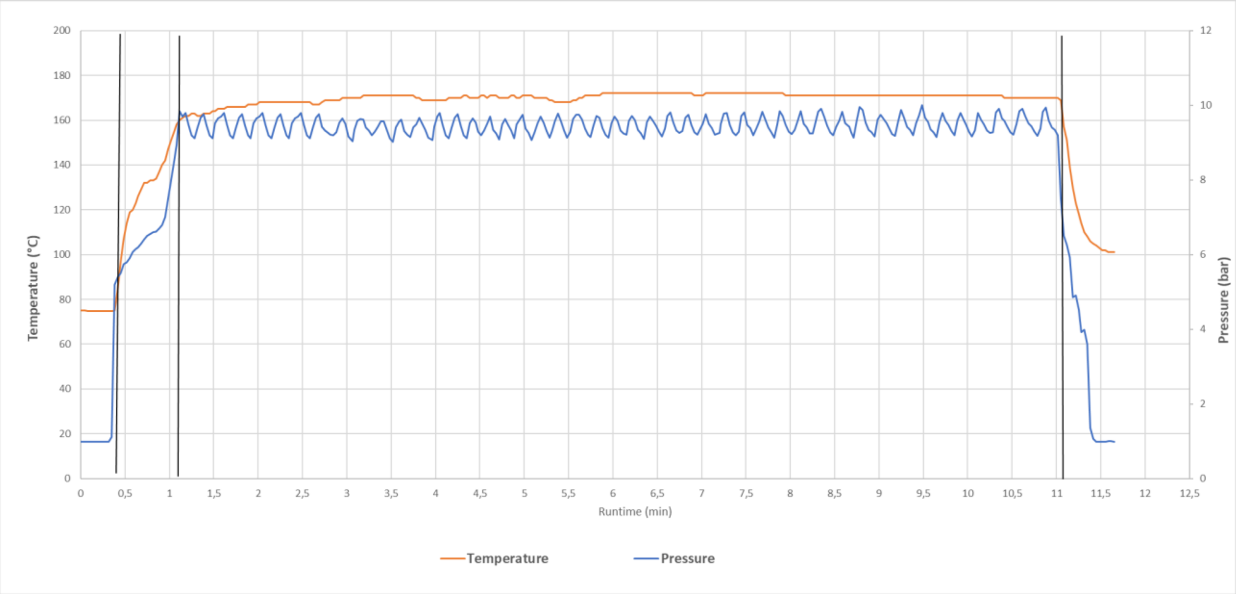
Phase **I**	Feeding Biomass
Phase **II**	Pressurization
Phase **III**	Process conditions maintenance
Phase **IV**	Expansion, cooling, harvesting of hydrolyzed Yarrowia



Working conditions of the process elaborated by severity factor R.

$$R = \int_{t1}^{t2} \exp\left(\frac{T(t) - 100}{14.75}\right) dt$$

$$R = t \cdot \exp\left(\frac{T - 100}{14.75}\right)$$

	Weight kg	pH
Before SE	4	
After SE	18,53	7,44

	Pression bar	T °C
min	9,02	172,22
max	10	176,6
average	9,46	174,2

	Severity min	Time min
PII+PIII	1566	0,93
PIII	1490	10
PIII at average T	1528	10,93

Results ENVIPARK

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Down-stream processing of TAGs

PURIFICATION STEP

Steam exploded samples have been processed in a small pilot plant equipped with different filtration membranes:

1 – spiral wound PVFD (poly vinylidene fluoride) Microfiltration membrane 0,2 µ

2- spiral wound polyamide composite nanofiltration membrane cut off 300 Da

ANALYTICAL RESULTS

Samples were shipped to a specialized analytical laboratory for the quantification of C16-C18 fatty acids

Results ENVIPARK

Down-stream processing of TAGs

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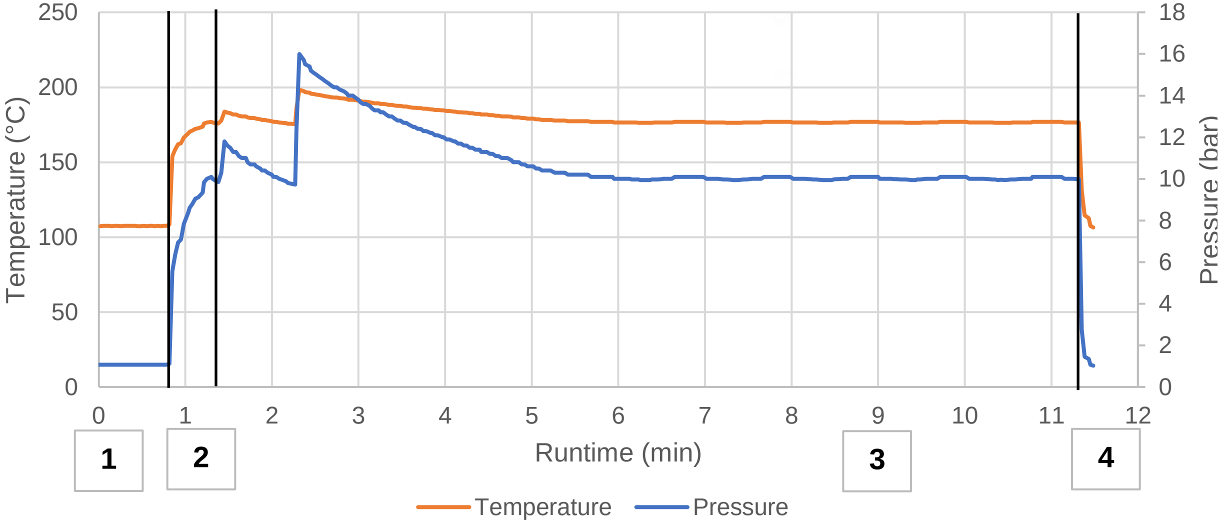
Acids	Feed (mg/l)	MF permeate (mg/l)	MF retentate (mg/l)	NF permeate (mg/l)	NF retentate (mg/l)
Myristic Acid	0,1	0,023	1,1	0,010	0,3
Palmitic Acid	6,8	1,156	95,1	1,404	36,7
Stearic Acid	3,4	0,264	20,7	0,335	9,7
Oleic Acid	10,4	0,041	159,9	0,054	36,9
Linoleic Acid	13,4	0,163	230,7	0,211	63,4
Linolenic Acid	0,2	0,002	10,8	0,002	1,5
Arachic Acid	0,3	0,015	1,6	0,014	1,2

Test 2

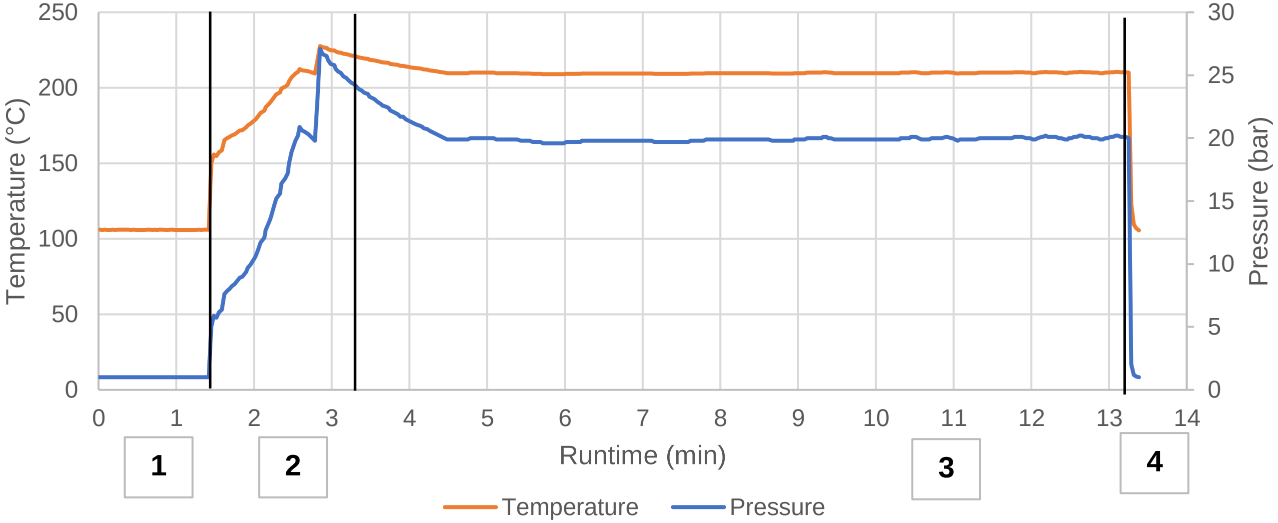


	Weight kg	pH
Before SE	18	
After SE	24,6	2,71

	Pression bar	T °C
min	9,73	175,38
max	16,00	198,34
average	10,82	179,74

	Severity min	Time min
PII+PIII	2472,18	0,47
PIII	2415,36	10,00
PIII at average T	2227,90	10,47

Test 3



	Weight kg	pH
Before SE	18	
After SE	25,3	3,08

	Pression bar	T °C
min	19,60	208,97
max	24,40	221,40
average	20,16	210,48

	Severity min	Time min
PII+PIII	21090,08	1,77
PIII	18197,24	10,00
PIII at average T	17898,89	11,77

Results ENVIPARK

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Down-stream processing of TAGs

FUTURE STEPS

Chemical analysis will be carried out aimed at quantifying TAGs (instead of just fatty acids) in order to make the evaluation of process yields more precise and proficient.

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Thank you for your attention!

Check for more information and updates at:

www.biosfera-project.eu

BioSFerA
Biofuels production from **S**yngas **Fer**mentation for **A**viation and maritime use

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