SISSG
SOCIETÀ ITALIANA PER LO STUDIO DELLE SOSTANZE GRASSE

Congresso SISSG 2022

"OLI E GRASSI ALIMENTARI: INNOVAZIONE E SOSTENIBILITA' NELLA PRODUZIONE E NEL CONTROLLO"

Innovazione nella filtrazione degli oli vegetali

"Innovation in vegetable oils filtration"

RELATORE:
Dott. Alessio Tessitori

OIL FILTRATION AND STATE OF THE ART :

DEFINITION:

- Operation consisting in the separation of a heterogeneous solid-liquid mixture.

- The filtration of vegetable oils also follows adsorption processes(H_20).

THE TYPES OF FILRATION ARE DIFFERENT BASED ON :

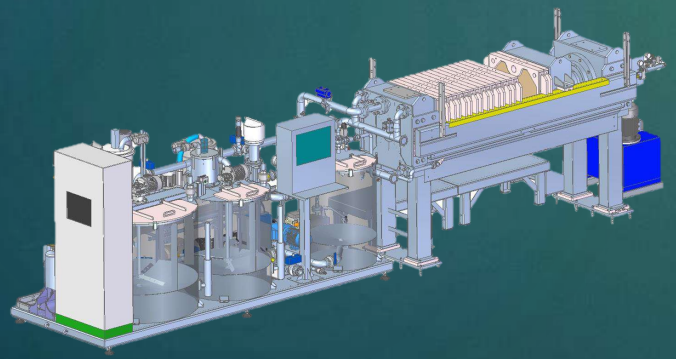
- MECHANISM OF ACTION :
  - SIEVE ACTION (surface filtration)
  - DEEP ACTION (multiple mechanisms)
  - ADSORBENT ACTION (physico - chemical)
- DIRECTING FORCE APPLIED TO THE FLUID :
  - BY PRESSURE
  - WITH VACUUM
- FEATURES OF THE FILTER MEDIA:
  - WITH FILTERING MASS
  - WITH FILTERING PAPERS
  - WITH CLOTH
  - WITH MEMBRANE
- OPERATION
  - CONTINUOUS
  - DISCONTINUOUS

MAIN TYPES OF FILTERS IN THE VEGETABLE OIL SECTOR:

FILTERPRESS

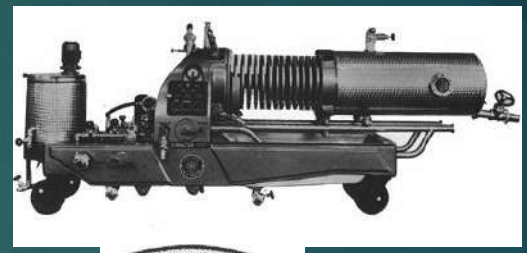
- **PAPER FILTERS (finishing)**

- **FLOOD FILTERS**

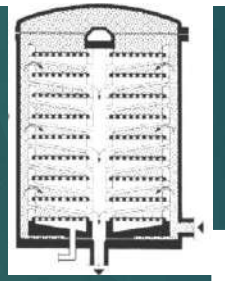


PRESSURE CHAMBER

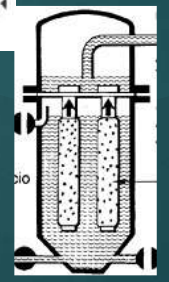
- WITH VERTICAL DISCS



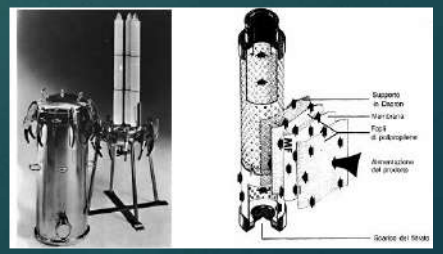
- WITH ORIZONTAL DISCS



- CANDLE FILTERS



- CARTRIDGE FILTERS



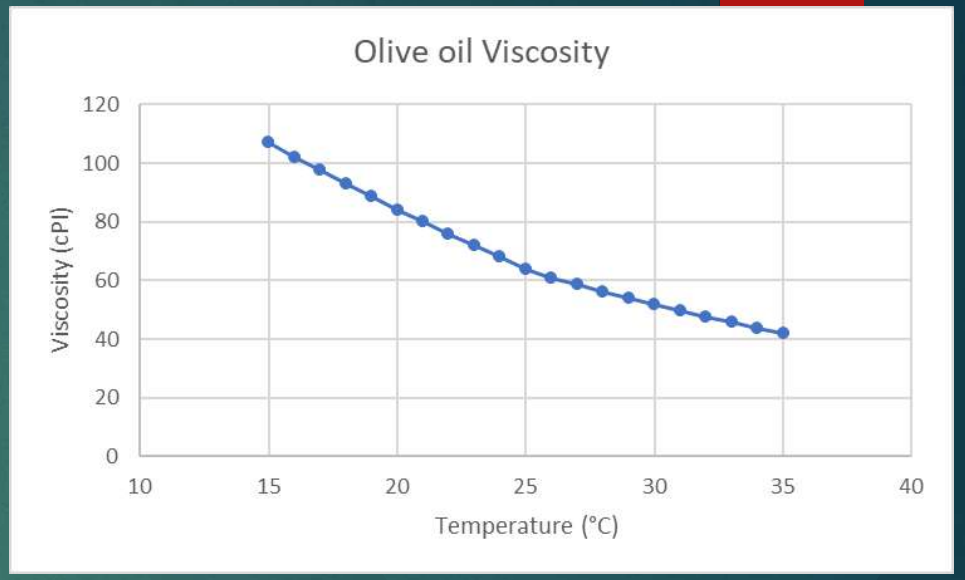
FILTRATION AND DARCY'S LAW :

$$\phi = \frac{dV}{dt} = \frac{A \cdot \Delta P}{\mu \cdot (R_d + R_{sf})}$$

- ϕ= the flow of permeate through the septum at a time t
- A= filtration surface
- ΔP= pressure difference between the two sides of the filter media
- μ = fluid viscosity coefficient
- R_d= deposit resistance
- R_{sf}= filter media resistance

μ = FLUID VISCOSITY COEFFICIENT

- **THE VISCOSITY OF VEGETABLE OIL MAINLY DEPENDS ON :**
- TEMPERATURE
- CONTENT AND TYPES of WAXES
- FATTY ACID COMPOSITION
  - Degree of unsaturation
  - Carbon chain length
  - Cis / trans configuration
  - Eutectic phenomena



Fatty acid	Configuration	Molecular weight	Melting point (°C)
Caprylic acid	8:0	144.2	16.50
Methyl ester	8:0	158.2	–
Capric acid	10:0	172.3	31.5
Methyl ester	10:0	186.3	–
Lauric acid	12:0	200.3	44
Methyl ester	12:0	214.3	5
Myristic acid	14:0	228.4	58
Methyl ester	14:0	242.4	18.5
Palmitic acid	16:0	256.4	63
Methyl ester	16:0	270.4	30.5
Stearic acid	18:0	284.5	71
Methyl ester	18:0	298.5	39
Oleic acid	18:1	282.5	16
Methyl ester	18:1	296.5	−20
Linoleic acid	18:2	280.5	−5
Methyl ester	18:2	294.5	−35
Linolenic acid	18:3	278.4	−11
Methyl ester	18:3	292.5	−57/−52

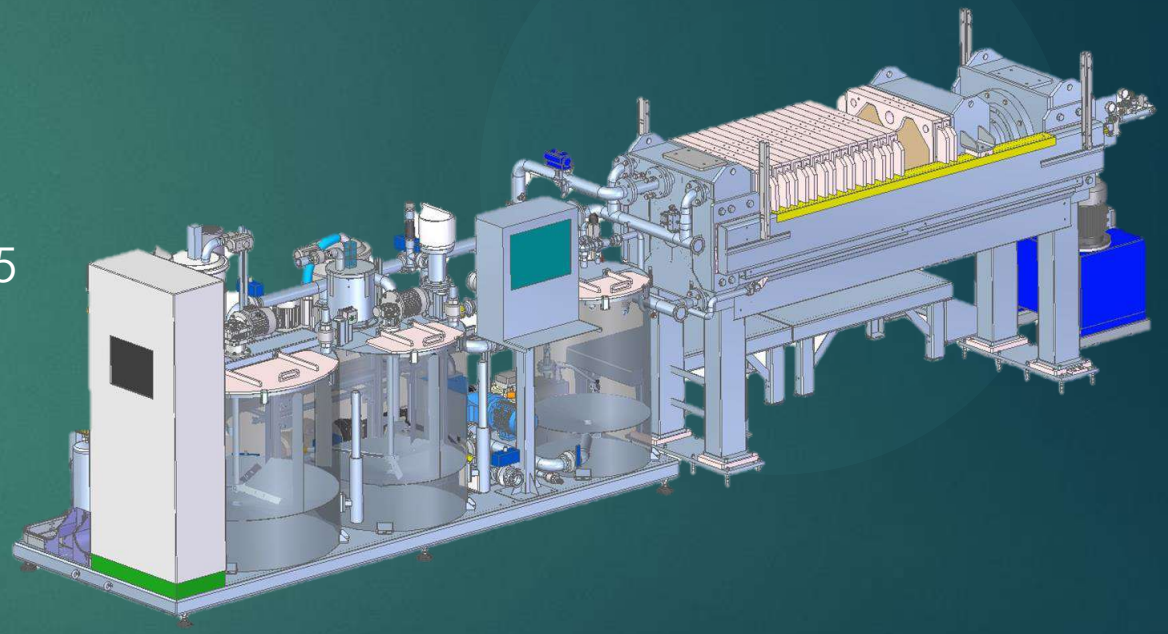
CRITICAL POINTS of the filtration process:

- **Rapid filling** with oils rich in solid dispersions or in strong emulsion with water which can cause a strong increase in the resistance of the filter medium and / or poor filtration quality;
- Difficulty in **draining and cleaning the filter**;
- **High oil losses in the filter material** (> 40% by weight of the used adjuvants);
- **Poor automation** and **poor process control**;
- **Low achievable ΔP**, do not allow the indiscriminate use of low permeability adjuvants necessary for excellent polishing;
- Risk of the presence of **adjuvants in the filtered oil**.
- **Inability to pause filtration** due to breakage of the filter panel (adjuvant filters).
- Request of large quantities of compressed air for drying the used adjuvants.
- **Quick replacement of paper filter or cartridges**.

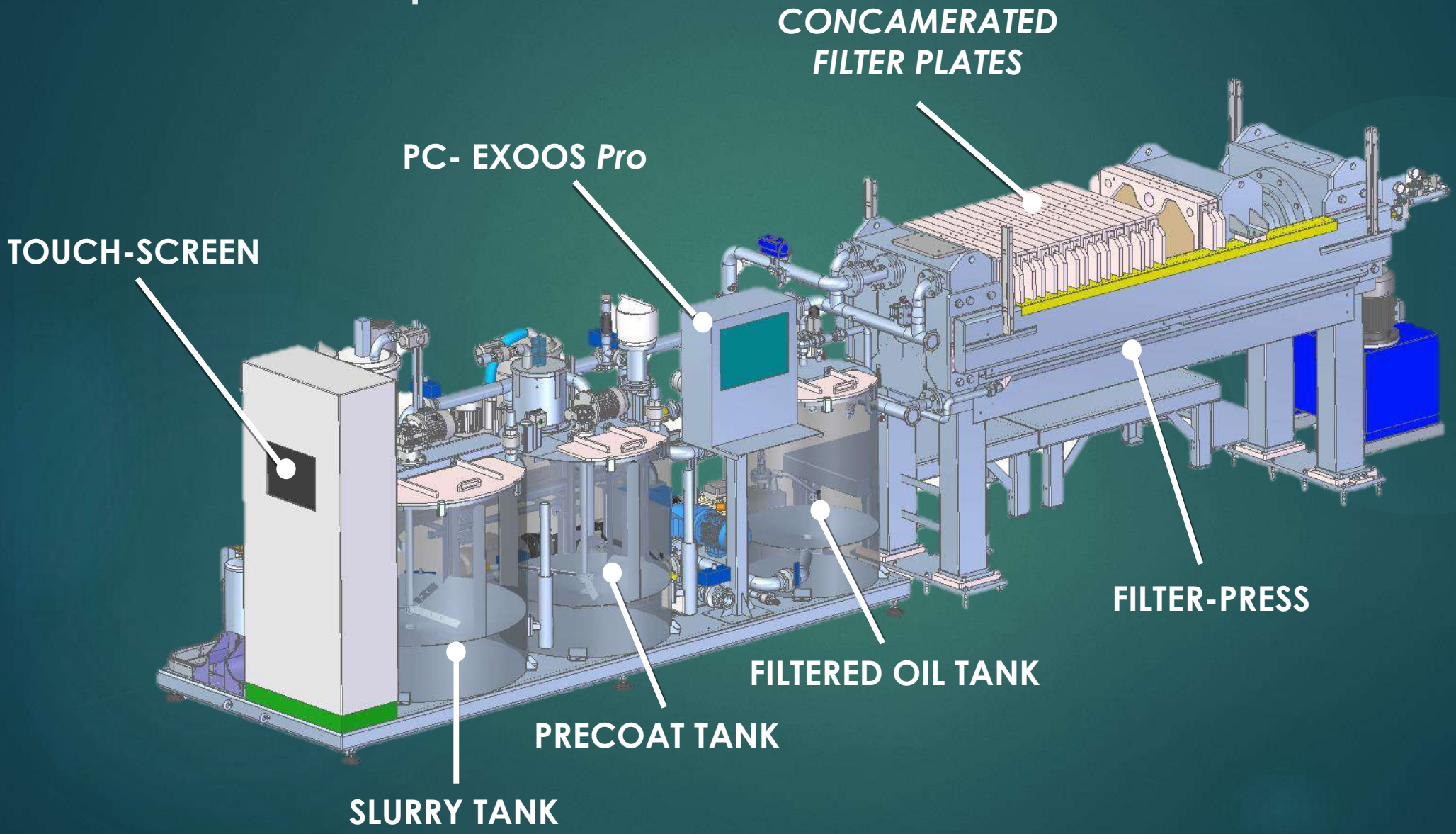
EXOOS FILTER AND INNOVATION:

MAIN INNOVATIONS

- FILTRATION UP TO HIGH DELTA P (12 Bar)
- HIGH PRESSURE SQUEEZING SYSTEM of adjuvants (40Bar) which guarantees almost total oil recovery and an extremely rapid drain / cleaning pause. (45 min)
- TOTAL AUTOMATION OF THE FILTRATION PROCESS
- PREPARATION FOR INDUSTRY 4.0



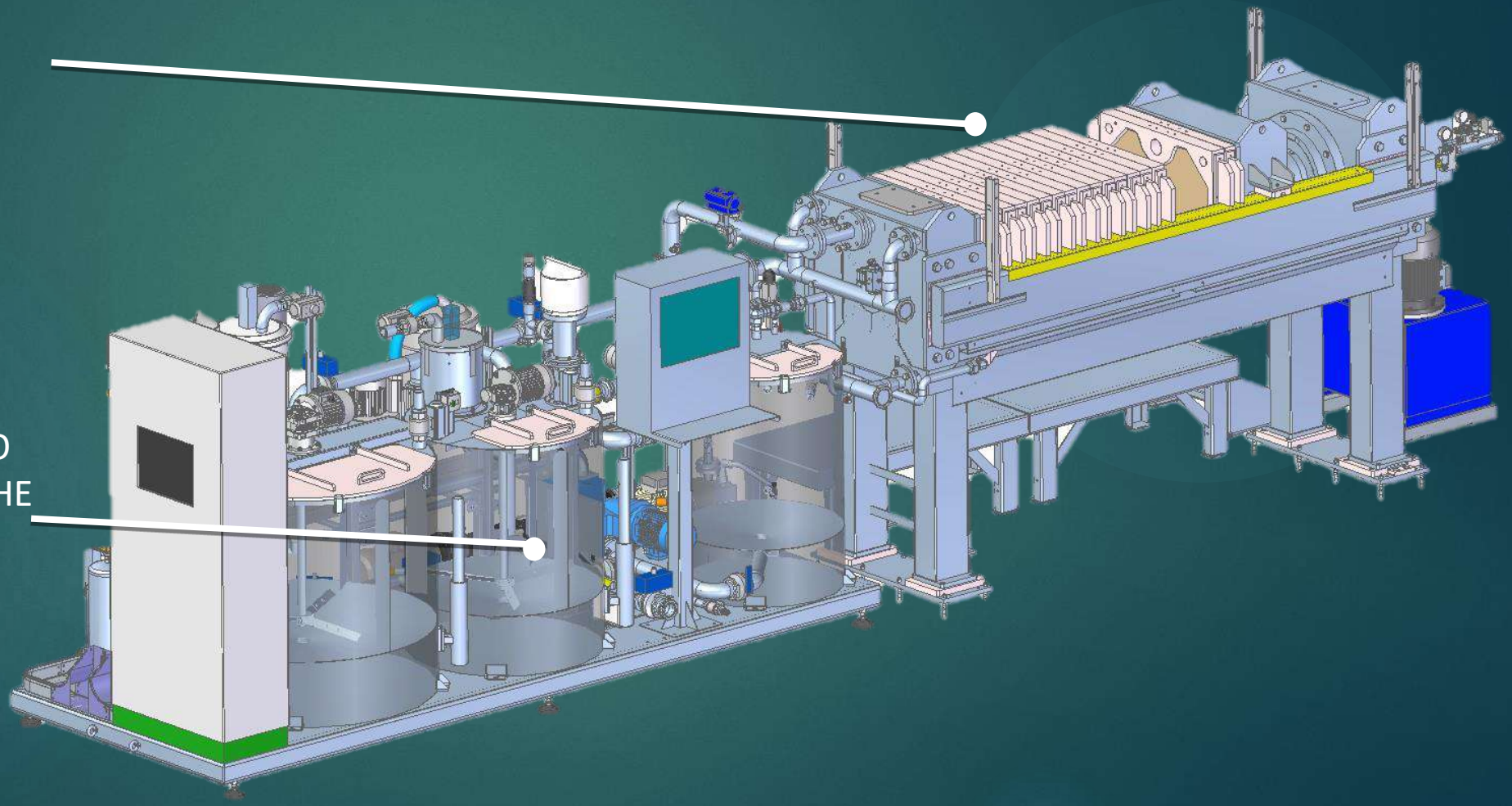
EXOOS plant :


CONCAMERATED FILTER PLATES
PC- EXOOS *Pro*
TOUCH-SCREEN
FILTER-PRESS
FILTERED OIL TANK
PRECOAT TANK
SLURRY TANK

EXOOS Filtration Cycle :

THE FILTRATION CYCLE BEGINS WITH THE DEPOSITION OF THE PRECOAT ON THE FILTER PLATES CLOTHS

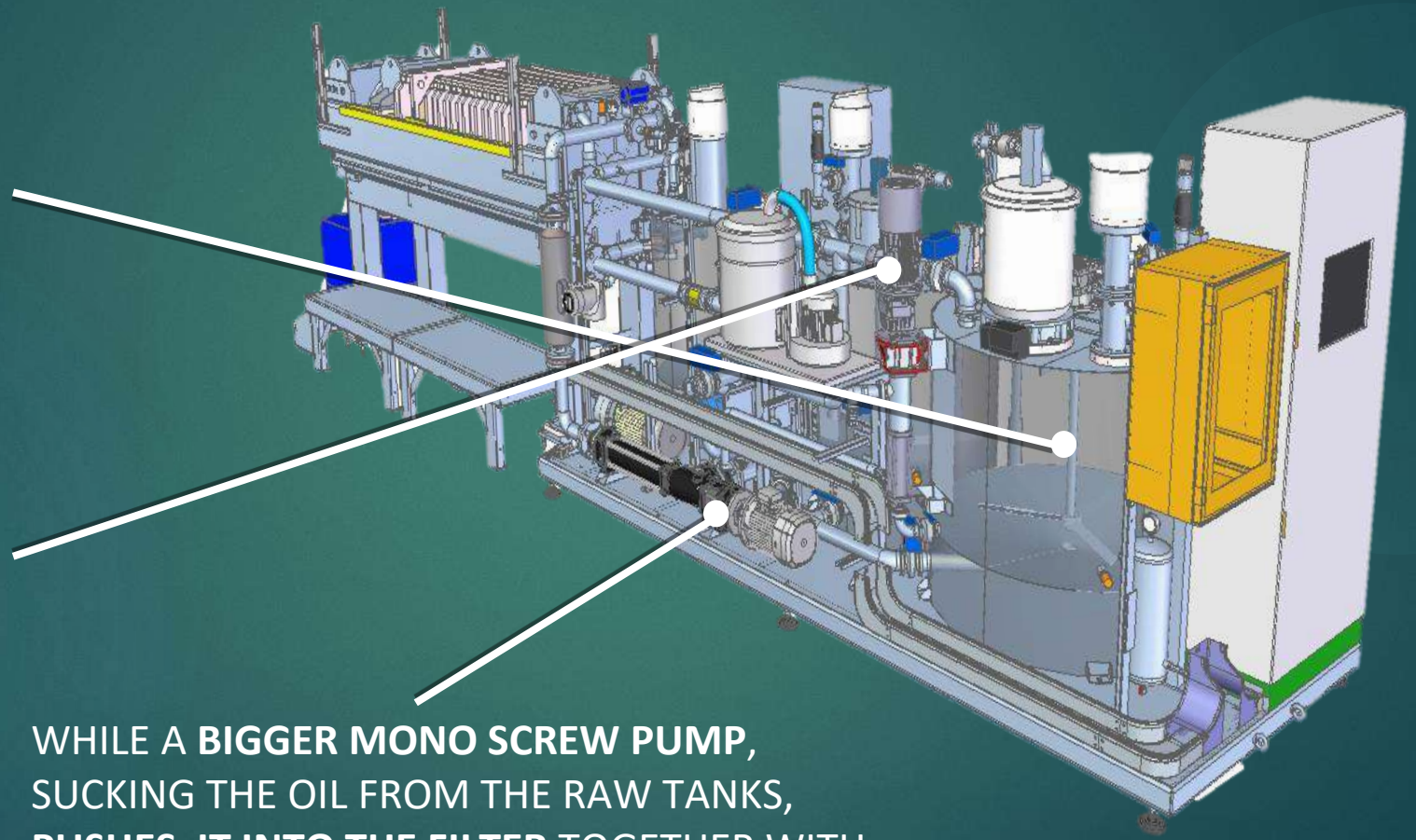
THIS HAPPENS THANKS TO THE RECIRCULATION IN THE FILTERPRESS OF THE MIXTURE OF OIL AND ADJUVANTS PRESENT IN THE PRECOAT TANK.



EXOOS Filtration Cycle :

AT THE SAME TIME, **ADJUVANTS** AND **OIL ARE COMBINED** IN THE **SLURRY TANK**

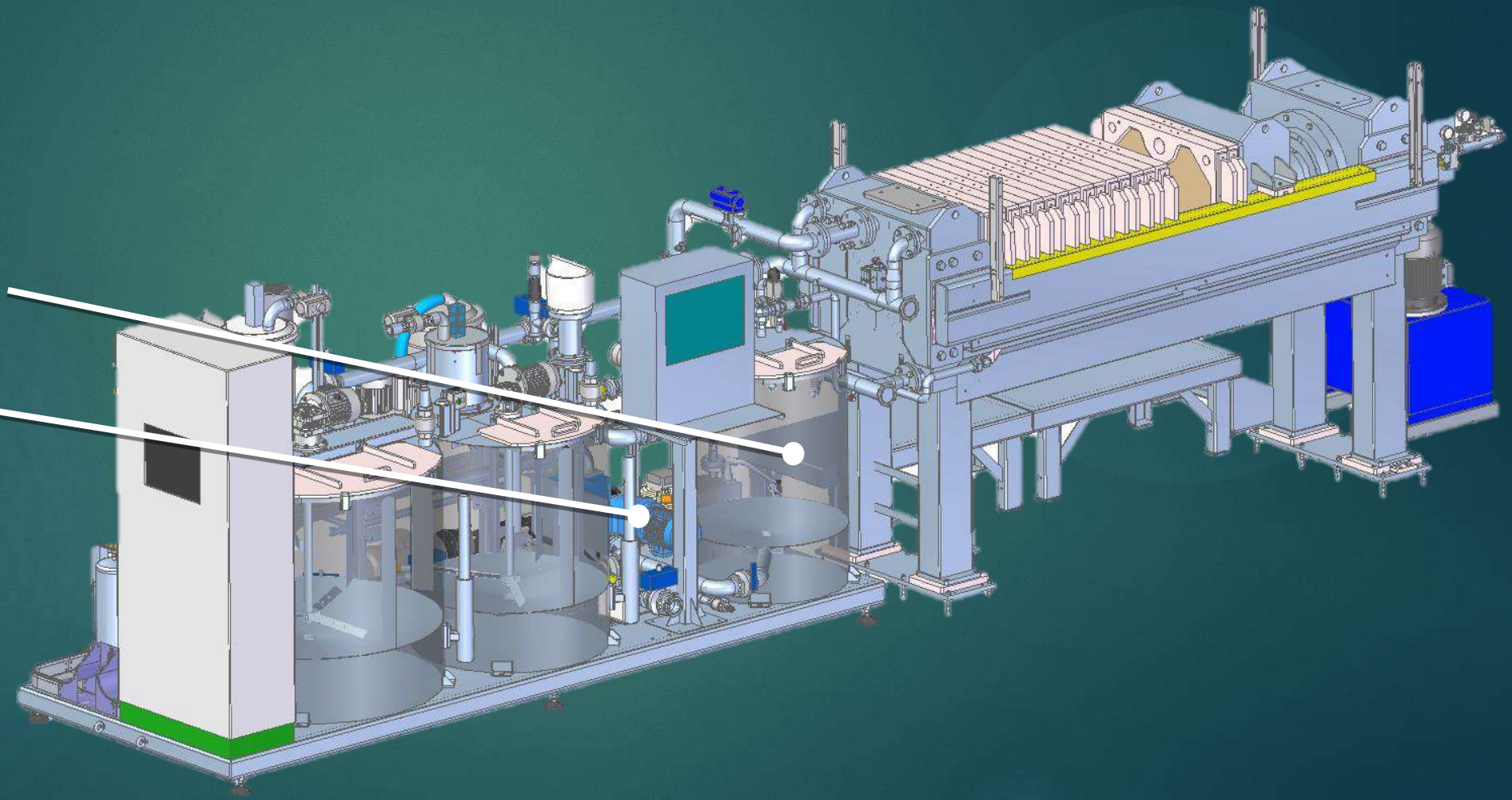
THIS MIX CALLED SLURRY IS **DOSED ONLINE** FROM A **SMALL MONO PUMP WITH CERAMIC ROTOR**



WHILE A **BIGGER MONO SCREW PUMP**, SUCKING THE OIL FROM THE RAW TANKS, **PUSHES IT INTO THE FILTER** TOGETHER WITH THE SLURRY MIXTURE

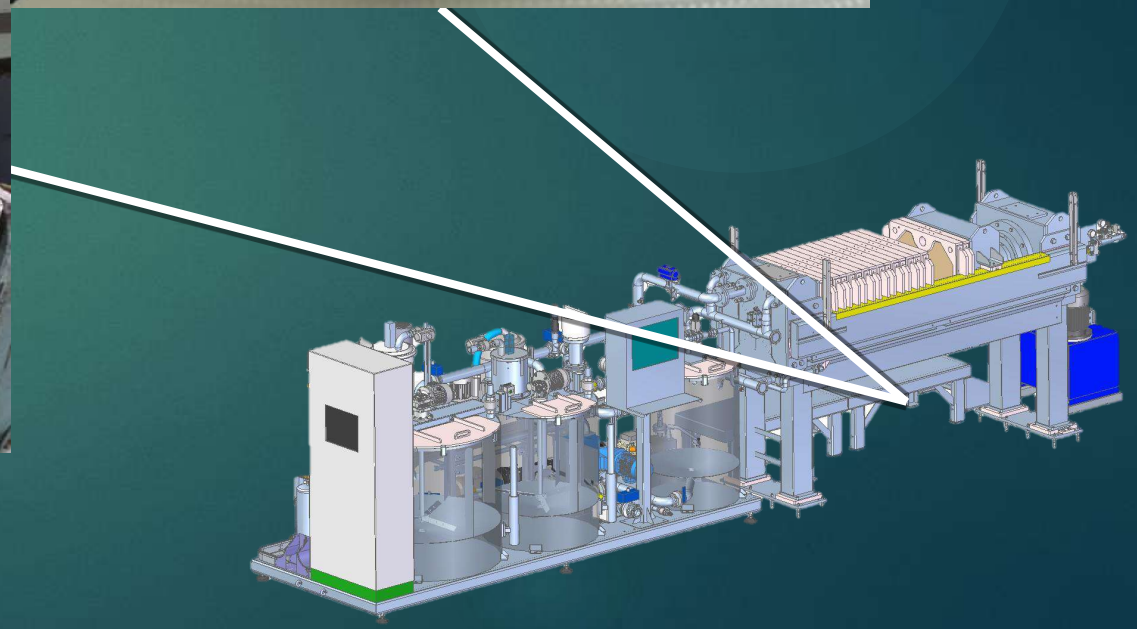
EXOOS Filtration Cycle :

FILTERED OIL IS COLLECTED IN THE **FILTERED TANK** FROM WHERE A **VOLUMETRIC PUMP WILL TRANSFER** IT TOWARDS THE FILTER STORAGE TANKS

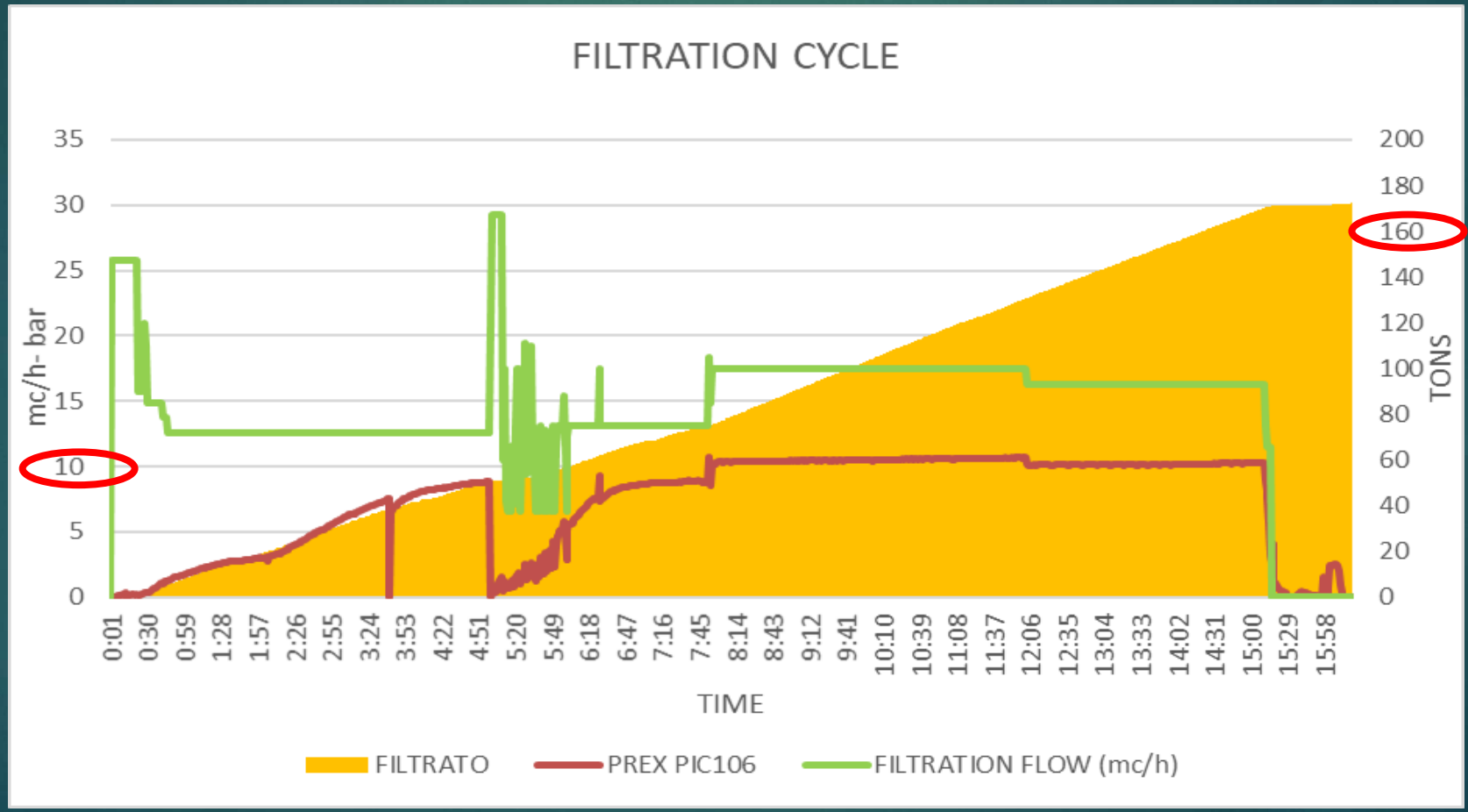


EXOOS Filtration Cycle :

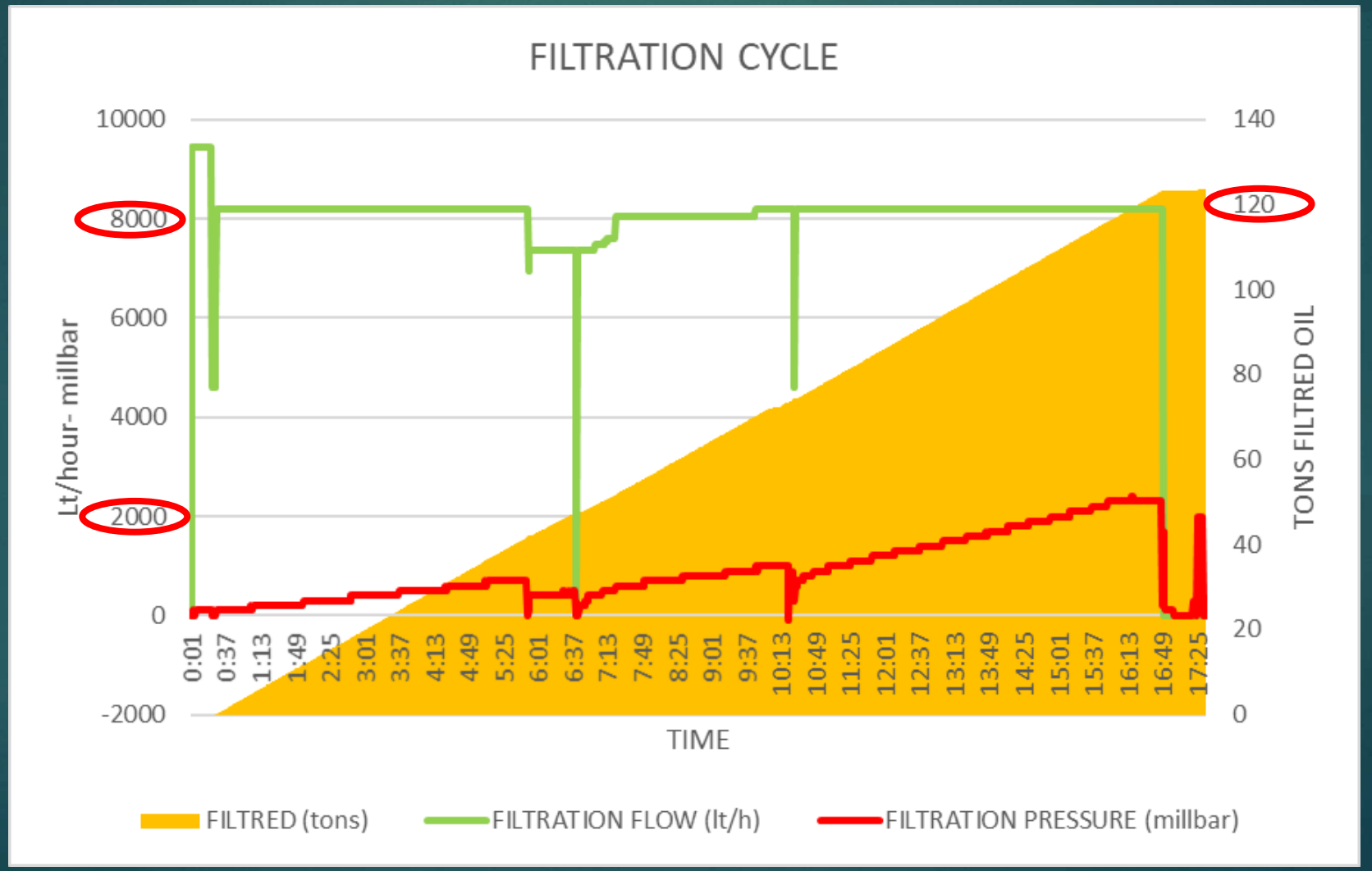
EXOOS is **THE ONLY FILTRATION SYSTEM** EQUIPPED **WITH THE SQUEEZING SYSTEM** (PRESSING ADJUVANTS AT 40 Bar)



EXAMPLE CYCLE (With Difficult Oil), **EXOOS FILTER 70sqm** (In Harvesting season)



EXAMPLE CYCLE (With medium Oil), **EXOOS FILTER 30sqm** (In Harvesting season)



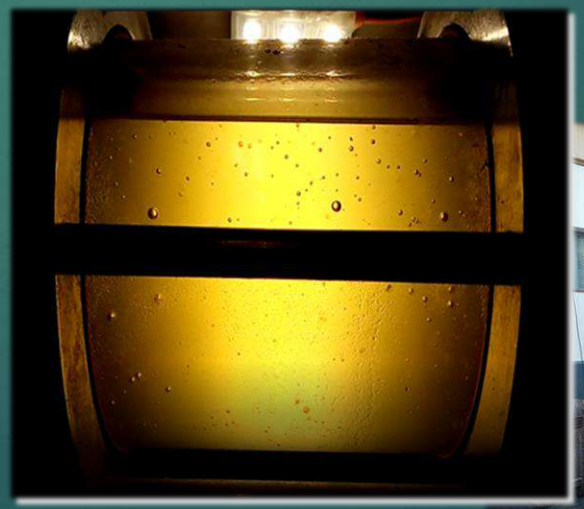
FILTRATION OF OPAQUE REFINED OLIVE OILS :

- THE CASE STUDY : **ACEITES BORGES**

Filtration of refined olive oil that it presents

turbidity defects due to a wax content > 350 mg /kg

- ***T°** in filtration: **14° C***
- *Average production per hour : **180 lt/sqm***
- *Average filtration cycle duration with 20 sqm filter : **25 ton***
- ***Adjuvants**: Dosage of **0.36%** using **Lignin in precoat** and **diatom in filtration** or a mix of **cellulose and perlite** in precoat and **diatom in filtration**.*



FUTURE PROSPECTS:

Possible introduction of the **HIGH PRESSURE FILTRATION PROCESS** in the **BLEACHING PHASE OF REFINED OILS** with the aim of:

- **Simplification of the process** often carried out with multiple stages and filtration techniques.
- **Process yield improvement**.
- **Improvement of the quality of the filtrate** with reduction of traces of the bleaching earths, with positive effects on the subsequent phases of deodorization and/or physical neutralization.

THANKS FOR YOUR ATTENTION

FOCUS EXTRACTION PRESSURES:

- RPM: 2900
- Diameter: 575 mm
- ρ: 958 kg/m3
- Maximum pressure exerted on the fluid : >20 bar
- $F = m \cdot \omega^2 \cdot r$
- $m = \rho \cdot V = \rho \cdot [(r_1^2 \cdot \pi) - (r_2^4 \pi)]/100 = 1{,}55$ Kg
- $\omega = \frac{2900}{60} \cdot 2\Pi = 303{,}5$ rad/s
- $F = 1/55 \cdot (303{,}5)^2 \cdot 0{,}287 = k_g \cdot \left(\frac{rad}{s}\right)^2 \cdot m =$ 41.008 N
- $P = \frac{F}{s} = \frac{41.000}{0{,}018} = \frac{N}{m^2} = 2{,}27 \cdot 10^6 = 22{,}7\ Bar$