MEMBRANE & ION EXCHANGE TECHNOLOGIES FOR PURIFICATION of COPRODUCT IN AGRO INDUSTRIES

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Summary

- Introduction
- Dairy Industries: whey demineralization plant
- Sugar Industries: decolorization line in sugar refineries
- Wine Industries: wine tartaric stabilization
- Agro-Industries: Production of 2G Sugars – Coffee pulp valorization
- Conclusions - Perspectives
DAIRY INDUSTRIES
Whey demineralization plant
WHEY = A VALUABLE RAW MATERIAL

Cow milk (dry matter)

- 29.20% Fat
- 26.20% Proteins
- 37.70% Lactose
- 6.90% Ash (+ vitamins)

Whey, co-product of milk transformation:
- Whey proteins
- Lactose
- Minerals (+ vitamins)

Fat for Cheese / butter / cream...
Casein for Cheese / Casein production...
FOR WHICH INGREDIENTS WHEY IS USED?

- INFANT FORMULA
  - DM70
  - DM90

- YOGHURT
  - WPC

- BACKERY
  - DM50 up to DM90

- SWEETENER

- ICE CREAM
  - WPC

- ANIMAL FEED
  - DM40

- CANDIES
  - DM50 up to DM90

- BEVERAGE
  - Lactose.DM70
EURODIA is combining part or all technologies to demineralize, function of physico-chemical composition.
Dairy Industry – Whey Demineralization

- Liquid sweet whey
  - Ion exchange
    - Nanofiltration
      - Electrodialysis
        - Acid pasteurization
          - Ion exchange
            - pH adjustment
              - Dem90

Water / Chemical recovery process

Effluent to waste water treatment plant (from the complete process line)

Water recovery

Water recovery

Part of regeneration

NF permeate

ED brine
Dairy Industry – Whey Demineralization

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**Water recovery**

- Collected effluents
  - Filtration unit
    - Process water (1)
    - By-product (2)

**Chemical recovery**

- Bipolar ED
  - Acid / Base solutions (3)

**Final effluents**

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1. **Process water**: used for IEX regeneration cycle / ED brine / membrane unit CIP (ED & filtration systems)

   For example on a complete D90 line:
   - Raw whey = liquid whey (6% DS): complete autonomy in water (and even overproduction)
   - Raw whey = RO/NF whey (18-20% DS): recovery of ~ 50% water consumption

2. **By-product** which can be valorized as animal feed (~ 25% lactose + NPN / ~ 75% ash + organic acids)
Acid / Base solutions : used for IEX regeneration cycle

For example on a complete D90 line :
- Raw whey = liquid whey (6% DS) : saving of ~35% HCl consumption / ~60% of NaOH consumption

Reduction of ~ 40% of the effluent BOD released in the waste water treatment plant
Water / chemical recovery solution allows:
- Much lower water consumption
- Recovery of valuable by-products
- Reduction of effluent load
- Reduction of chemical consumption

=> With no significant increase of the whole operating cost

⇒ Perspective:
- 100 % water recovery
- 100 % chemical recovery
- Discharge = “natural” minerals + organics coming from whey becoming a valuable product
SUGAR INDUSTRIES
Decolorization Line in Sugar refinery
White Sugar / Refined Sugar Production Processing

- Hot Water
- A-Sugar
- Mincer
- Remelt Liquor
- Carbonator Tank
- Carbonated Liquor
- Rotary Pressure Filter
- Iron Exchange Resin
- Clear Liquor
- Fine Liquor
- R3/R4 Vacuum Pan
- R3/R4 Crystallizer
- R3/R4 Centrifugal
- R1/R2 Crystallizer
- R1/R2 Centrifugal
- Refine/White Sugar
- Big Grain
- Pre-Dryer
- Dryer/Cooler
- Vibrating Screen
- Warehouse
- Packing
- Metal Detector/Magnet Lattice
- Sugar Sifter
- To Raw Sugar Process

kohkongsugar.com
The use of resins as decolorization method step found a new development when nanofiltration membranes have demonstrated their industrial efficiency by decreasing salt consumption and, as a consequence, helping the treatment of the effluents. Nanofiltration is now considered as a standard for decoloration units.

Based on that knowledge, Eurodia is able to adapt its decolorization process to customer expectation:

- Limit the chloride content in the effluent sent to ponds (Italy)
- Limit water consumption and reduce waste water disposal as much as possible (Middle East)
DECOLORATION RESINS REGENERATION

REGENERATION CONDITIONS

- Basic brine: NaCl 100 g/l + NaOH 5 - 10 g/l
- Regeneration level: 150 – 200 g NaCl/lres, # 2,5 – 3,0 eq/lres
- Temperature: 60 – 80 °C
- pH: 12 -13

REGENERATION MECHANISMS

- Osmotic chock
- Decrease hydrophobic interaction
- Ion exchange Cl capacity: < 0,2 eq/lresin
1- Recoverable water
2- Salty colored water
3- Colored Brine
4- Salty water
5- Recoverable water
OPERATIONS
1. Brine
2. Displacement
3. Rinsing
4. Molasses

EURODIA PATENTED PROCESS

DECOLO ➔ Low salt conc ➔ NF ➔ High salt conc ➔ RO ➔ ED

PERFORMANCES
« No » brine consumption
« No » waste discharge from resins regeneration
« No » water consumption
+/-10 times less energy consumption compared with evaporator option
OPERATIONS

MOLASSES

CLARIFICATION: Solids/Liquid

PURIFICATION: DEMINERALIZATION

FRACTIONATION

SUGAR

BETAINES

ETHANOL

Concentration g/l

betaine

Saccharose

glucose

Others

0,0 0,5 1,0 1,5 2,0

0 50 100 150 200 250 300
WINE INDUSTRIES
Wine tartaric stabilization
WINE STABILIZATION WITH ED  MARKET IS GROWING!

- Over the last 15 years, ED has been extensively used for the Tartarate Stabilization for all types of wines.

- By end 2015, 200 plants in operation with 600 stacks: in France, Italy, Spain, Portugal, Germany, Australia, New Zealand, South Africa, Canada, USA, Russia, Argentina, Brasil

- Total volume of treated wine by ED: 800 million Liters/year (around 3.5% of world-wide production)

- ED (wine stabilization)-EDBM(pH adjustment) = SUBTRACTIVE Technologies: No chemical addition

- ECO-FRIENDLY Method
Wine Industry – Tartaric stabilization

Electrodialysis

Water + Acid

Tart.K

Treated Wine

Wastes = Ktart + Acid

Cooling

Chemicals tartarate

Filtrated Wine

Earth

15 to 30 hL/h

120 to 240 hL/h
- **PROCESS IMPROVEMENT**: Reduction of water consumption
- **ED combined to Reverse Osmosis (RO)**

**Performances of commercialized units**: ED+RO
- 50 to 70 % water recovery
- Consumption: 5.5 L /hL wine including CIP (for a stab. rate of 18%)
Optimized process for wine stabilization: \textit{ED + RO}

- Water consumption: 5.5 L/hL Wine for 18% stabilization
  - 50\% to 70\% water recovery – commercial unit
- Electricity consumption: 0.4 kwh/ hL wine as maximum
  - 8 times lower than cold stabilization
- Waste: RO retentate + CIP
- No wine losses

Perspectives: to reach “zero waste” with high pressure RO.

First results: 98\% water recovery – Tartrate in crystal form – valuable product
AGRO-INDUSTRIES
2G Sugars Production
Biomass Fractionation for BIOCHEMICALS production is different from bioethanol production where mixed C5/C6 can be fermented

Necessity to separate lignin / C5 / C6 (e.g. C6 only has interest for most organic acids, while C5 can lead for instance to the market of Xylitol)
Agro Industry – 2G sugars Production

2G Sugar Solution

- Suspended solids, Macromolecules, Sugars, salts, organics
  - Suspended solids, proteins....
  - Salts, organic acids

Sugars C6+C5+Non-Sugars:
- salts, organic acids, color

Sugars (C6 + C5)

- Sugars C6: Glucose
  - Ethanol
- Sugars C5: Xylose
  - Xylitol; Pentose derived chemicals

CLARIFICATION
Centrifugation, Earth filters, + MF/UF

DEMINERALIZATION
Electrodialysis or ISMB Chromatography

PURIFICATION
ISMB Chromatography + Polishing IEX / GAC
Non Sugar – Xylose (C5)

Glu (C6) – Xylose (C5)
In the process of coffee production various residues are obtained. Biomass residues can be categorised into three main groups:

1) Primary biomass residues, available at the farm; branches, stalks, leaves, prunings, and uprooted crop
2) Secondary residues: seed hulls, pulp, and chaff
3) Tertiary residues: spent coffee grounds SCG.

Secondary residues

The fresh coffee beans are liberated from the fruits releasing coffee pulp (29% dry weight), mucilage (5%) and coffee hulls (12%) in a sequence of wet and dry processing steps. The mucilage is either mechanically removed or through fermentation. The weight percentages may differ depending on the variety of coffee.
Coffee Pulp valorization

Fig 1: Coffee processing
CONCLUSION and PERSPECTIVES

- The key of success:
  - To Know the end value of co-product
  - Combine properly each technologies (process approach)
  - Complex process
  - Next step: give a value to this “natural” molecules
Thank you for your attention!!

www.eurodia.com