



#### Solid bowl decanter

# SUSTAINABLE SOLID/LIQUID SEPARATION IN MINING AND MINERAL INDUSTRY

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- Introduction to Alfa Laval
- Technology development of solid bowl decanter centrifuge
- Operational examples from the mining and mineral world
- Results obtained in Alumina industry
- Conclusions and discussions

### Our corporate mission

To optimize the performance of our customers' processes. Time and time again.



#### The processes we are in

We help customers to heat, cool, separate and transport products such as oil, water, chemicals, beverages, foodstuff, starch and pharmaceuticals.



#### We serve most industries

#### **Biofuels**

Biotech and pharmaceutical Chemicals Engine and transport Fluid power Food and beverages HVAC Industrial fermentation Latex Machinery Marine and diesel



Metal working Mining and mineral processing Oil and gas Oil refinery Power Pulp and paper Refrigeration and air-conditioning Semiconductor systems Steel and coke oven gas Sugar Wastewater treatment

# Gustaf de Laval (1845-1913)



#### "The man of high speed"

- 200 projects and inventions
- 92 patents, including the milk separator (1878) and the steam turbine (1883)
- Started 37 companies

# Key technologies

Our key technologies are adapted to each customer segment and offered separately or combined into optimized solutions.





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# Where it all begins – Stokes' law



Sir George Gabriel Stokes, 1st Baronet (1819–1903)

 $\frac{d^2(\rho_p \cdot \rho_l)g}{18\eta}$  $V_g =$ 



High Liquid Viscosity

- $V_g$  = gravitational settling velocity
- d = particle diameter
- $\rho_p$  = particle density
- $P_{l}$  = liquid phase density
- $\eta$  = liquid phase viscosity
- g = gravitational acceleration



Particle Density Low Liquid Viscosity



Particle Size

#### Based on the concept of a clarifier



# **Technology development**

#### Solid bowl decanter centrifuge

- Sigma [Σ] historical use to define separation efficiency
- Have some limitations but most decanter centrifuge suppliers are using it in some format
- In real life solids handling is often the limiting factor



### What is a decanter centrifuge?



### What is a decanter centrifuge?



# Parameters influencing separation

Process parameters

- Feed rate (Q)
- Particle size (polymer addition)
- Viscosity (heating)

Decanter design

- Bowl speed (g-force)
- Conveyor differential (\_n)
- Pond depth (R-r)



# What is a mining decanter centrifuge?

- A decanter designed to handle large capacity, highly erosive feed, catch of fine particle, lower energy consumption
- Capable of handling up to 350 m<sup>3</sup>/h
  @ 100 t DS / h per unit
- Highly dry cake, easy to stack and more water for recovery



# Solid/liquid separation

#### **Technologies used today**



# New for mining and mineral industry

#### Deep pond technology

- Allows to handle exceptional amounts of solids
- Enhances separation and catch the finest
- Powers power consumption – less kinetic energy is lost from the system





# Enhanced scrolling capacity



Solids restriction puts hydro-static pressure on the solids

Helps the solids out of the decanter

Optimized cone angle facilitates scrolling of highly dense cake

### Erosion protection – more than usual

- Fully protected from inlet to outlet
- Tungsten Carbide widly used





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# Example from mining & mineral world

- Separation of tailings from a saturated borate solution
- Solids: dolomite, clay, quartz
- 96°C, pH= 9–10
- D<sub>50</sub> solids: 14 micron
- Solids specific gravity: ~2.45 kg/dm<sup>3</sup>
- Feed: ~20% w/w
- Cake: ~70% w/w



# Example from mining & mineral world

- Dewatering of fine coal tailings from a coal washing plant
- Solids: coal solids, slime, clay
- Particle size: 5–50 micron
- Solids specific gravity: ~ 1.55 kg/dm<sup>3</sup>
- Feed: ~35–40% w/w
- Cake: ~65–70% w/w
- Several conventional dewatering technologies were tested.



# Example from mining & mineral world

- Mature fine tailings: clays, quartz (sand), bitumen and water
- Solids specific gravity: ~ 2.65 kg/dm<sup>3</sup>
- Solids: kaolinite, illinite and quartz
- D<sub>50</sub> solids = 10 micron
- Feed: ~30% w/w
- Cake: ~55% w/w
- Tests proved that the resulting cake is stackable





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### **Red mud separation**



- Red mud, named after its color, is the main by-product of making alumina by the Bayer process
- The red mud is separated from the pregnant liquor (sodium aluminate remains in solution) via sedimentation in a clarifier
- The amount of red mud (as dry matter) varies from 0.4 ton to 2 ton per ton of alumina product, depending on the quality of the bauxite feedstock and digestion process conditions
- Estimated worldwide production: 120 million tons/year

# Current dewatering technology

#### (1) Deep Cone Washers

 typical solids content of the underflow in the last washer is 50% w/w

#### (2) Vacuum Drum Filter

- solids content of the cake: 50-65% w/w
- filter cake consistency: sticky mud









# Current dewatering technology

#### (3) Filter Press

- solids content of the cake: 70%w w/w
- stackable cake
- questionable if filtrate is sufficient quality in all cases



### Test conducted

- Pilot test in alumina plant in Australia
- Red mud dewatering/Caustic recovery
- Feed SG: ~1.55-1.65
- Solids SG: 3.30
- pH: > 14
- Temp: 70 80 °C
- Particle D<sub>50</sub>= 30 microns



### Test conducted

- Caustic soda recovery (20 g/L)
- Water recovery
- Cake: 70 75% w/w
- Produce stackable cake (eliminate installation of new pond)



### Test conducted

- Pilot test in alumina plant in Brazil
- Red mud dewatering
- Washer underflow (booster to washer)



#### Test conducted – 3 different feeds



# Results – test (1)

Cake dryness vs. recovery





### Results – test (2)

#### Cake dryness vs. recovery



# Test to be done -(3)

- Booster to current washer step (1 and 2)
- Objective to improve uptime of washer stage – e.g. from heavy scaling
- Other benefits to be defined





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# Benefits of decanter centrifuges

- Competitive CAPEX and OPEX, and short payback time
- Capable of handling a wide range of solidliquid separation duties
- Handles everything from ultrafine to coarse tailings
- Water can be recovered by having a decanter centrifuge operating in parallel with a tailings pond
- Valuable chemicals and minerals can be recovered
- Attractive alternative to filtering technology
- A complement or alternative to tailing dams



# Summary

- Dewatering of red mud can be done in a decanter
- Cake dryness in the range of 70% 75% can be achieved
- Recovery in the range of 95 99% can be achieved
- Correct polymer have major impact on performance
- Further test will define
  - Polymer optimization (type, dosing, concentration, etc.)
  - Machine settings (exact scale up)
  - Potential further modification for even better results in respect of cake dryness and/or recovery
  - Other applications i.e. booster to one or more of washer stages

# Thank you



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