Reverse Osmosis with Integrated Salt Precipitation Cycle for High BWRO Water Recovery

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Texas Desal 2016
BEST PRACTICES & PUBLIC POLICY

IDE Technologies | Your Water Partners

Who We Are

- Established in 1965
- Technology leaders in desalination, industrial water treatment and waste water reuse
- Large and growing patent portfolio
- Worldwide offices in Israel, China, India, USA, Canada, Chile and Australia
- Unrivalled experience: more than 400 installed units in over 40 countries
- Ownership: ICL and Delek Group

Delivering Excellence 50 YEARS Through Partnership

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A Full Range of Water Project Types

Operation & Maintenance Services

- Engineering
- Procurement
- Construction

EPC / EPS / Turnkey

- Build, operate, transfer (BOT)
- Public private partnership (PPP)
- Build, operate, own (BOO)
- Private finance initiative (PFI)

Water Sales

- Plant operation
- Refurbishment and retrofitting services
- Spare parts services
- Chemical services

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The Incentive behind the Innovation

- Penetrate the industrial water treatment market:
  - Mine effluents
  - Steam assisted gravity drainage (SAGD)
  - Cooling tower blowdown treatment
- Increase production and recovery of thermal units:
  - MED
  - MEVC
- Improve brine management and reduce brine effluent capacity

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The Innovation

Discovering the limitations to our well-known technology (both thermal and RO)

Leveraging our experience in the technologies we know

Pushing the boundaries of conventional solutions and developing more creative designs

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The Proposed Solution

- Be able to works at a very high recovery, and low brine flow
- Can overcome variable change in the feed flow concentration
- Pushes the limits of precipitation of calcium carbonate, calcium sulfate and silica

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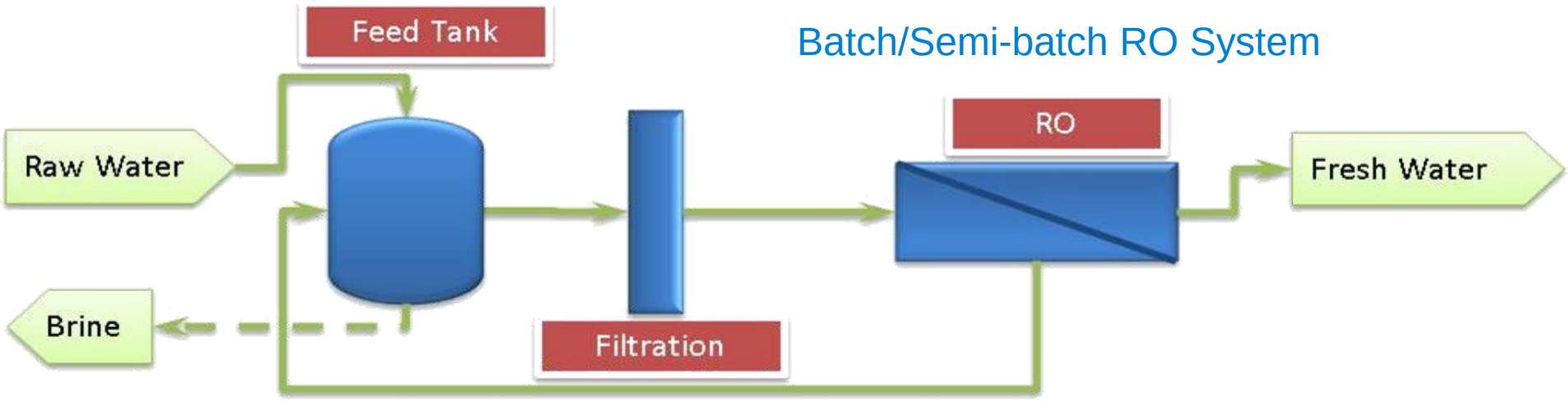
RO System for Brackish Water Design Requirements



- Lowest average system flux
- Lowest lead element flux
- Best flux balance between stages
- Lowest differential pressure for each stage
- Highest cross-flow and concentrate flow velocities
- Control of biological fouling

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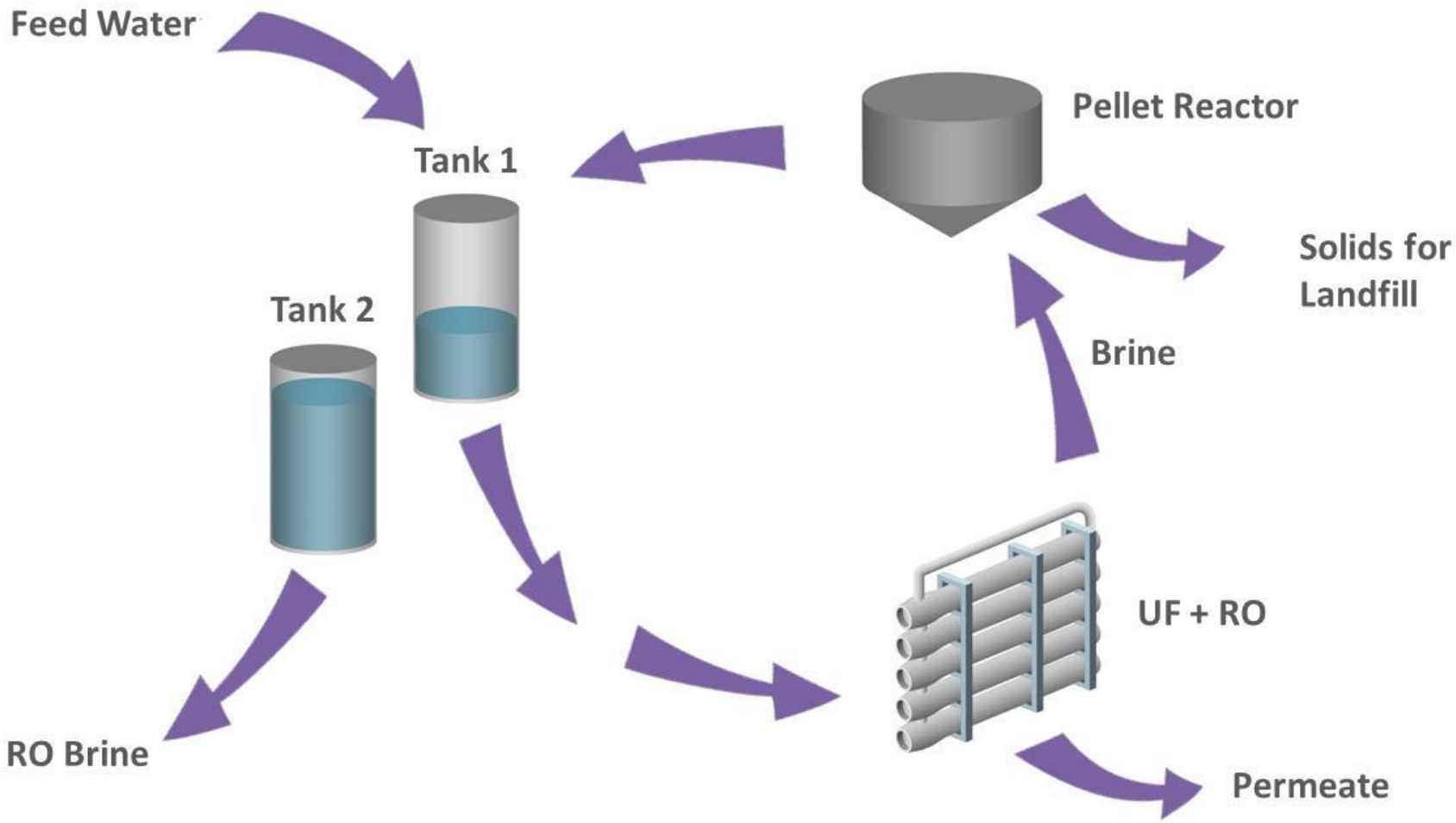
RO System with an Integrated Salt Precipitation Cycle



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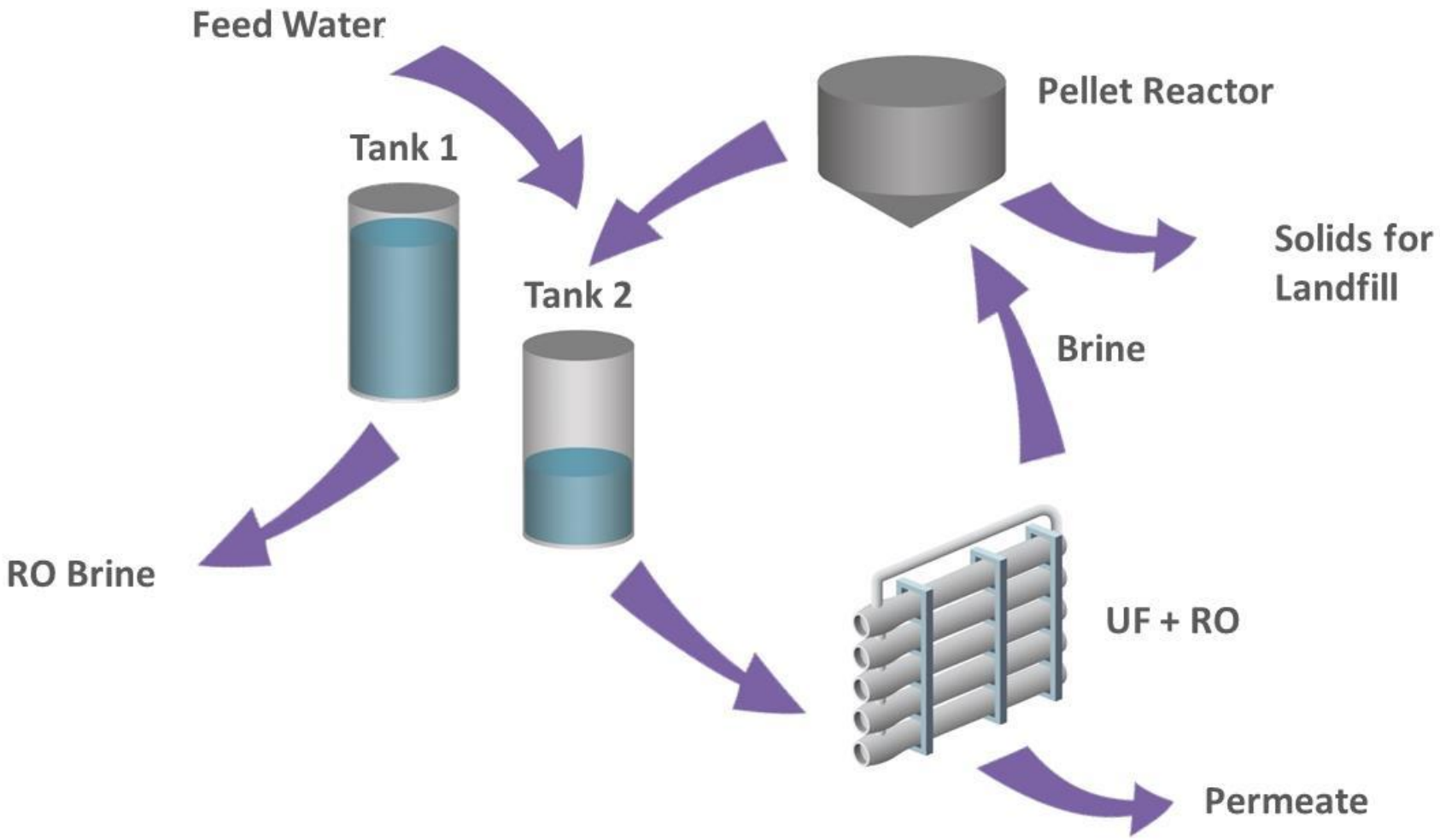

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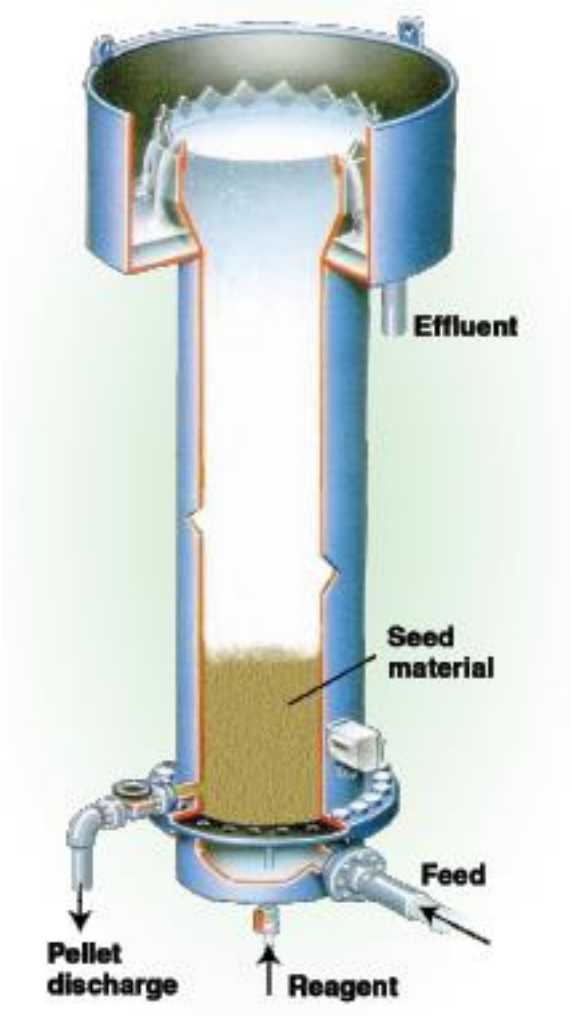
Salt Precipitation Unit – Fluidize Bed Crystallizer

- Able to operate with
  - Variable super-saturation conditions
  - Different sparingly soluble salts
  - Variable TDS levels
- Short residence time
- Small footprint
- Minimum sludge handling
- Low chemical consumption
- Low investment cost



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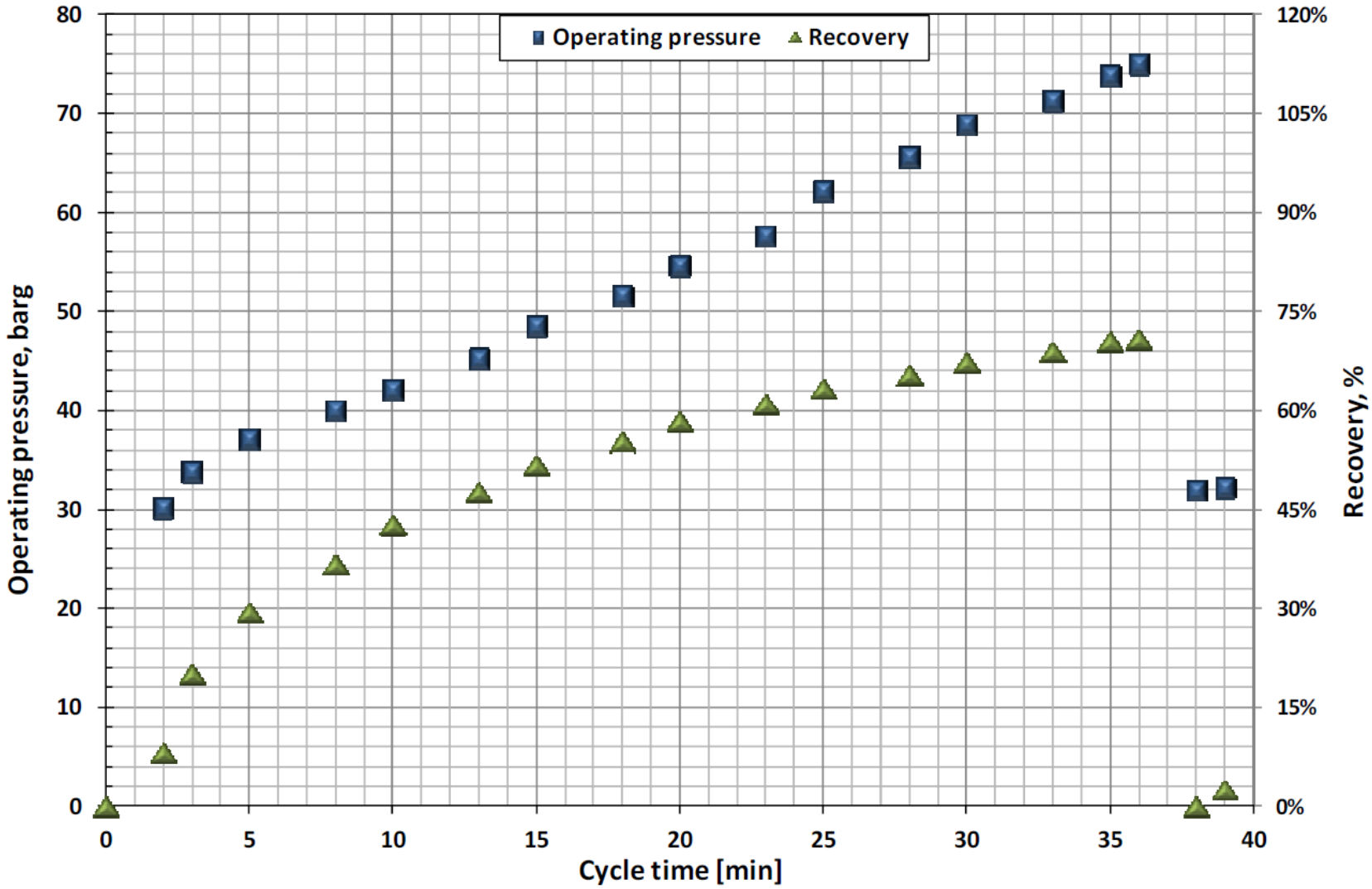
Process Parameter Changes during the Cycle



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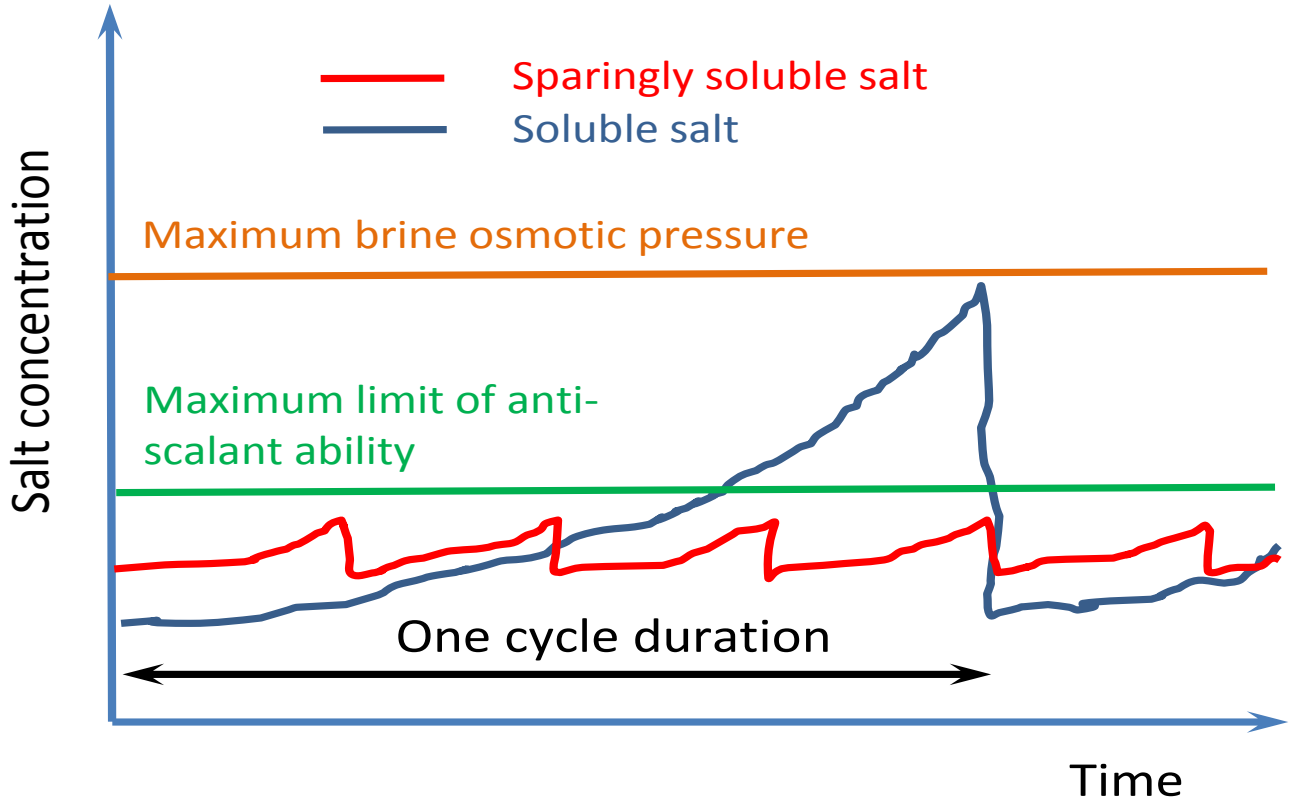

System Advantages

Operation mode	• Semi-batch
Stages	• 1 stage (2-4 elements/PV in each stage)
Instantaneous recovery	• 5-20%
Total recovery	• Variable recovery 5-98%
Flux	• Almost equal in all elements
Residence time	• Low
Feed water TDS	• Can handle different feed TDS levels and adjust recovery accordingly, keeping brine solution constant at highest level
Turbulence	• High (12 m^3/hr/PV at the inlet, 10 m^3/hr/PV at the outlet)
Bio-fouling tendency	• The changes in osmotic pressure of the flowing liquid dramatically reduce tendency for bio-fouling
Scaling tendency	• Entire stream is filtered every cycle and the produced nucleuses are removed • Last element every cycle starts from under saturated conditions

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Fluidized Bed Crystallizer (FBC) – Pilot Pellet Reactor

Fluidized bed crystallizer 50-100 m/hr

Sand filters 10 m/hr

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Next Activities of the Pilot Pellet Reactor

- Running the FBC with calcium sulfate $CaSO_4$
- Running the FBC in high feed temperature of 80°C
- Integrate the FBC in an RO system

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Proprietary Patent-Protected Technology

- Application title:
  Improved Reverse Osmotic Process for Cleaning Water
- Priority date filing:
  UK July 2105
- Paris Convention Treaty (PCT) filing:
  July 2016

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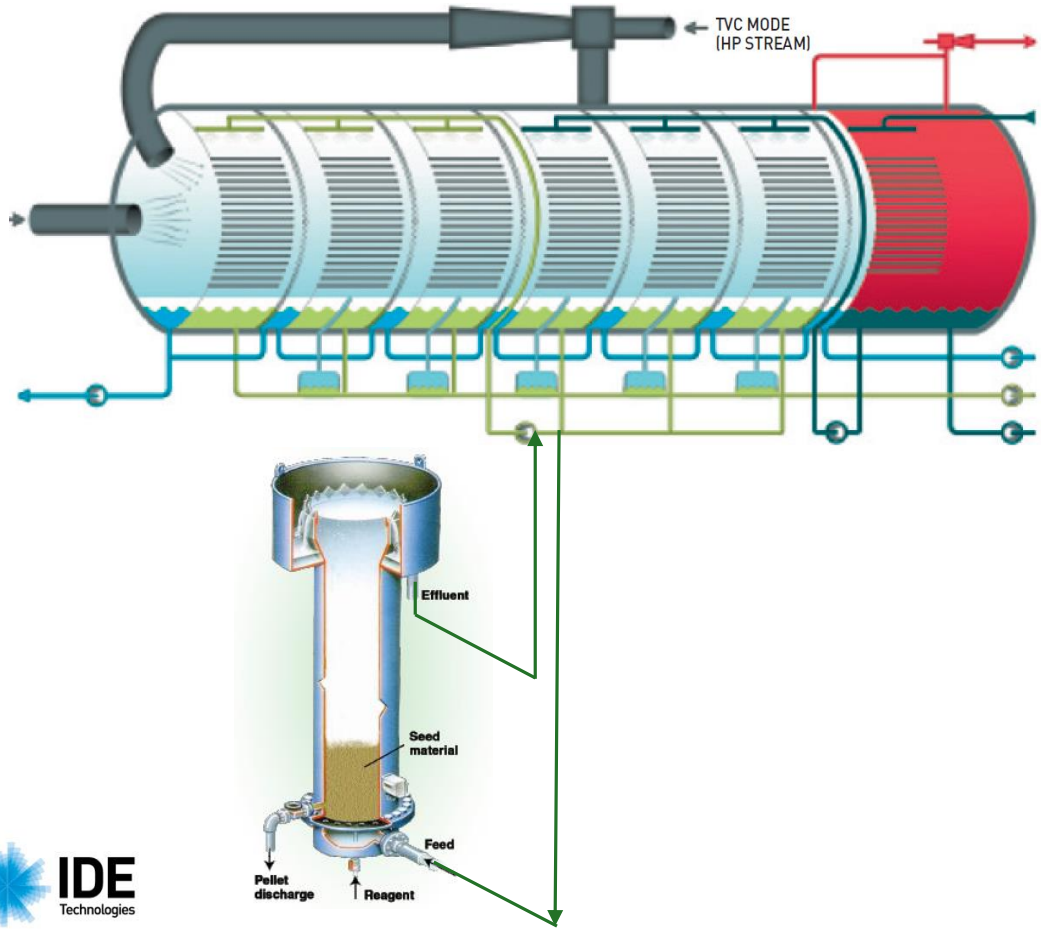
New Opportunities

FBC in thermal units allows:

- Working at higher feed temperature of the hot effects
- Increasing total unit recovery and total production by 37%



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Thank you

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