DIVIDING WALL COLUMNS
NOVEL APPLICATIONS WITH CASE STUDIES

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Dividing Wall Columns (DWC)

- Potential savings:
  - 20 to 30% CAPEX
  - 20 to 50% energy
Open Questions? Already Closed!

- Revamping a conventional column?
- Leakage flows?
- Liquid split?
- Vapor split?
- Installation of dividing wall?
- Heat flow through the dividing wall?
- Manways on both sides of the dividing wall?
- Thermal expansion?
- Minimum diameter of a dividing wall column?
Case Study 1

Packed DWC
Design Basis

• Recycle of waste stream back into upstream process
• Insecticide products
  • Highly corrosive components
  • MOC: Alloy 59 (Ni-Cr-Mo) & Nickel 201 (>99 % Ni)
  • Temperature sensitive product defined max. system pressure of 45 mbar
• Brownfield installation with max. steel structure 1.5 m x 1.5 m (5 ft x 5 ft)
• Product purity specification
  • Distillate: min. 98.5 wt.-% A
  • Side-stream: min. 99.5 wt.-% B & max. 0.2 wt.-% C
  • Bottom: min. 92.5 wt.-% C & max. 0.01 wt.-% A
• Required scope of supply
  • Concept Engineering & Feasibility Study & 3D installation concept
  • Design and delivery of dividing wall column, FFE, condenser, reflux splitter
  • Installation support and commissioning
Simulation Results & First Design

• Simulation based on $v_{\text{min}}$ method$^1$
  • Hydraulic profile
  • Temperature profile
  • Theoretical stages
• Column diameter 1,200 mm (4 ft)
• Column height 30 m (100 ft)
• Theoretical stages: 76
• High purity requirements
  • Welded or bolted dividing wall
  • No loose dividing wall

Bolted Dividing Wall

- Challenge for small column diameters
  - Very cramped with welded-in dividing wall
  - Installation of internals risky from a safety point of view
- Compensation for thermal expansion
  - Slotted holes allow thermal expansion
  - Significantly less effort for the column manufacturer
Changing Wall Position

- Pressure drop requirements set the wall position
  - Challenge with different vapor loadings
  - Flashing feeds
  - Vapor feeds
  - Vapor side draw-offs
  - Subcooled reflux with condensation
- Changing wall position along the column
  - High knowledge of hydraulic behavior
  - Welded or bolted dividing wall
Liquid & Vapor Split

- External control of liquid split with Montz Reflux Splitter
  - Constant split ratio at any liquid flow rate due to timing control
  - Operating range 0.1 – 50 m³/h
  - Magnetically coupled drive unit

- Vapor distribution controlled by careful design of tower internals
  - Can be indirectly influenced by adjusting the liquid split above the dividing wall
  - No extra device necessary
Design of Internals

- Redistribution Section
- Packing Bed
- Liquid Distributor
- Support Grid
Summary Case Study 1

• Column diameter 1,200 mm (4 ft)
• Column height 30 m (100 ft)
• Theoretical stages: 76
• Packing type: A3-500M (FRI tested)
• Dividing wall: Bolted
• Liquid Split: Montz Reflux Splitter
• Specialties: Different wall positions
• Successful in operation since 2019
  • Purity of side-stream 99.8 wt.-% B
  • Specification: min. 99.5 wt.-% B & max. 0.2 wt.-% C
Case Study 2

Trayed DWC
Xylenes Recovery

• Diameter
  • ~12 ft 6 in top  (3800 mm)
  • ~14 ft 1 in bottom  (4300 mm)

• Scope of Supply
  • Sieve trays
  • Tray blanking above and below dividing wall
  • 51 Trays
  • Liquid splitter tray
  • Flashing feed distributor tray
  • Dividing wall

• Designed for two operational modes
Process Design

- Re-use existing condenser / reboiler & maintain same number of trays
- Design variables:
  - Trays above & below dividing wall
  - Location of feed and draw
  - Liquid split at top and vapor split at bottom of dividing wall
- Draw taken as liquid
  - Saves energy
  - Reduces vapor load
- Economics dictated two very different design cases
- Sensitivity cases also run
  - Effect of wall leakage
  - Effect of errors in assumed tray efficiencies
  - Effect of errors in calculated vapor split
Sensitivity Analysis Results

- Seal of wall only critical around the feed and draw
  - They are directly adjacent to each other
  - Potential for short circuit
- Varying liquid split at top of wall required to operate at all design conditions
  - Also mitigates errors in vapor split
- Reasonable errors in tray efficiency will not jeopardize performance
- Key finding
  - Errors in vapor split prediction can be corrected by varying liquid split
- Case 1: Energy savings of over 50%
- Case 2 operation (higher feed rate): Energy savings of over 25%
Hydraulic Design

- Design not severely challenged by capacity
  - Trays at ~80% flood at the max throughput case
- Operability was primary concern
  - Tray design optimized for each section of column
  - Sieve trays chosen due to extensive data on $\Delta p$
- Offset of dividing wall key to obtaining proper vapor split and balanced floods
  - Perpendicular to downcomers
- Simplicity of design also an issue
  - Re-use of tray rings and downcomer bars
  - Existing trays above and below dividing wall checked and re-used with some blanking
Liquid Split above Dividing Wall

• Hybrid liquid split design at top of wall
  • Internal splitter tray #39 meters the bulk of the liquid flow internally
  • Controlled external gravity bypass used to trim the split

• Adjusting liquid split indirectly controls the vapor split below the dividing wall
  • More liquid flow to ‘A’ side → More vapor flow to ‘B’ side
Mechanical Design

- Dividing wall has a critical mechanical design
  - ~57 ft tall (17 m) / ~8800 lb (~4000 kg)
  - Revamp schedule
    - Needs safe and quick installation
  - Must provide adequate sealing
  - Provides horizontal tray support ledges
  - Includes side downcomer bolting bars
    - Vertical support bars
  - Boxed center downcomers at the dividing wall
    - Simplifies attachments
    - Reduces heat transfer across wall
Mechanical Design

- **Bolt bars** to support dividing wall on each side of the column
- **Cruciform** support members welded between bolt-bars to provide support ledges for trays
- The **Dividing Wall** sections were bolted between the bolt bars and cruciform sections
- Seal welded in vicinity of the feed and draw-off trays
  - Most critical zones where leakage must be minimized
Installation & Operation

• Performed safely and on-schedule by Koch-Glitsch
  • Surrounded by live plant
• Hot work restrictions at times
• Existing energy balance control scheme was retained
  • Temperature control point relocated to below the Dividing Wall

• Column operation was very stable
• Column responded as expected to external bypass
• Test runs confirmed performance goals met at all operating conditions
Conclusions

• Koch-Glitsch / Montz has supplied equipment for over 200 dividing wall columns

• For almost all process and mechanical challenges there are already proven solutions on an industrial scale available

• Dividing Wall Column is a State-of-the-Art Technology
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