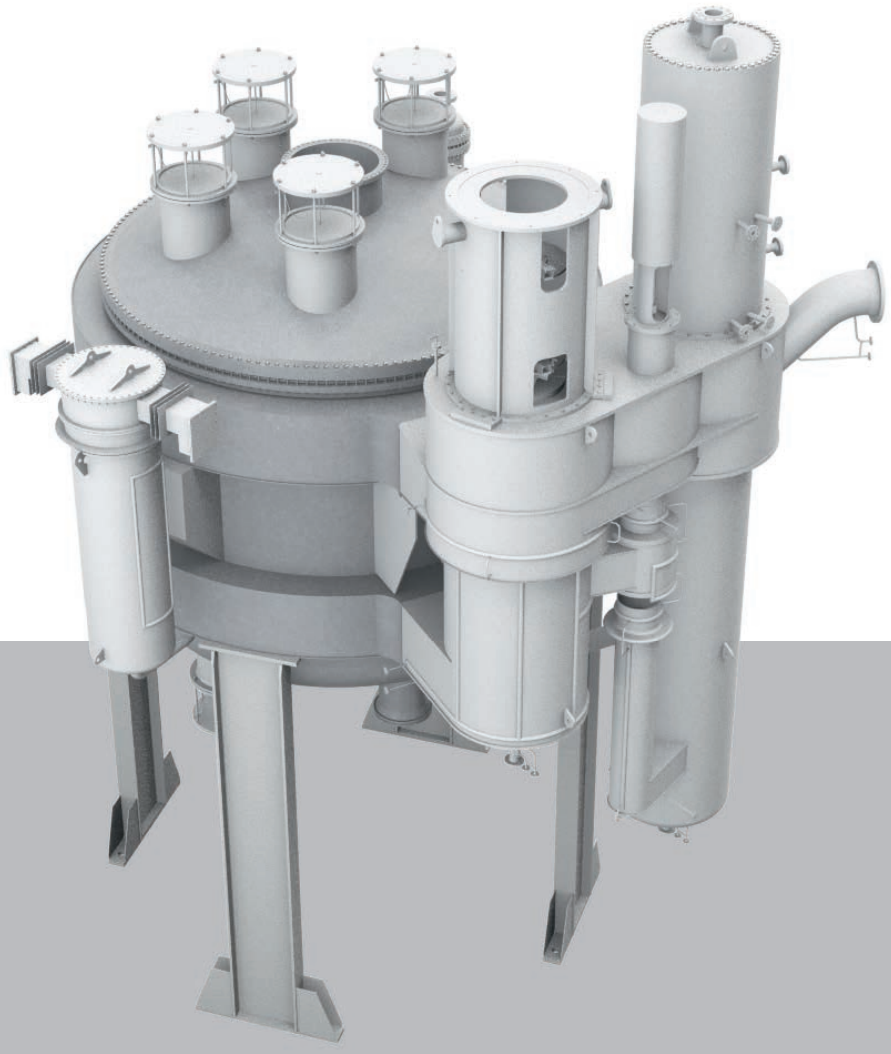
MAN Energy Solutions
Future in the making

Salt operated reactors

Phthalic Anhydrid



DWE® – global no. 1 in tubular reactors

- First reactor in 1955
- More than 750 contracts
- Up to 45,000 tubes
- Heat removal up to 40 MW
- Salt flow up to 11,000 m³/h
- More than 750 catalytic gas phase tubular reactors for 54 products and use of 77 different processes
- 28 containment design reactors
- Up-scale from pilot test (1-2 tube) to commercial reactor size with same salt temperature conditions

Phthalic Anhydrid (PA)

Technical data

Pressure and temperature

Design data	Design	Operating
Pressure tube side	2.0 barg (0.95 – 0.99 barg for China)	0.5 barg – 0.7 barg
Temperature tube side	420 °C – 450 °C	340 °C – 390 °C
Pressure shell side	static + pump	static + pump
Temperatur shell side	420 °C – 450 °C	340 °C – 390 °C
Pressure heating	20 barg – 45 barg	16 barg – 25 barg
Temperature heating	420 °C – 450 °C	201 °C – 224 °C

Comparison: O-Xylene versus Naphtalene

Feed	O-Xylene	Naphthalene
Design load	100 – 110 g/Nm³ at 4 Nm³ air/h x tube	80 – 90 g/Nm³ at 4 Nm³ air/h x tube
Operation load	90 – 100 g/Nm³ at 4 Nm³ air/h x tube	70 – 80 g/Nm³ at 4 Nm³ air/h x tube
Tube diameter x wall thickness	ø 30 x 2.5 mm	ø 30 x 2.5 mm
Tube length over tube sheets	approx. 3,700 – 3,800 mm	approx. 3,700 – 3,800 mm
Tube length between tube sheets	approx. 3,500 mm	approx. 3,500 mm
Amount of heat to salt per tube	approx. 1,300 W (at 100 g/Nm³ at 4 Nm³ air/h x tube)	approx. 1,150 W (at 80 g/Nm³ at 4 Nm³ air/h x tube)
Yield	112 % – 116 %	100 % – 105 %
Lower explosion limit	44 g/Nm³	50 g/Nm³
PA per tube and hour	0.44 kg (at 100 g/Nm³ at 4 Nm³ air/h x tube)	0. 31 kg (at 80 g/Nm³ at 4 Nm³ air/h x tube)
Max. tube number per reactor	30,000	30,000

Design code

- AD2000
- ASME-Code
- Sec. VIII/1

Catalyst manufaturer

- BASF
- Clariant
- Polynth
- Dragon Wings

Feed

- O-Xylene
- Naphthalene

Max. design load

- O-Xylene:
  - 110 g/Nm³ at 4 Nm³ air/h x tube
- Naphthalene:
  - 90 g/Nm³ at 4 Nm³ air/h x tube

Market leader for PA reactors

- 300+ reactor systems manufactured until today
- PA via O-Xylene or Naphthalene feasible
- Highest loadings
- O-Xylene 110 grams
- Naphthalene 90 grams
- Unique DWE® NAPA-N process for high quality PA via Naphthalene
- Biggest tube number: up to 30,000


MAN
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