



SCRUBBERS & CONDENSERS

Brandon Guillory, PE
The Dow Chemical Company
October 2011

OVERVIEW

- Scrubbers
 - Mass transfer
- Condensers
 - Phase change



CONDENSERS

- Relies on heat exchange to condense VOCs from vapor state to liquid state
- Two main types
 - Contact
 - Non-contact
- Removal efficiency dependent upon constituent characteristics
 - i.e. vapor pressure

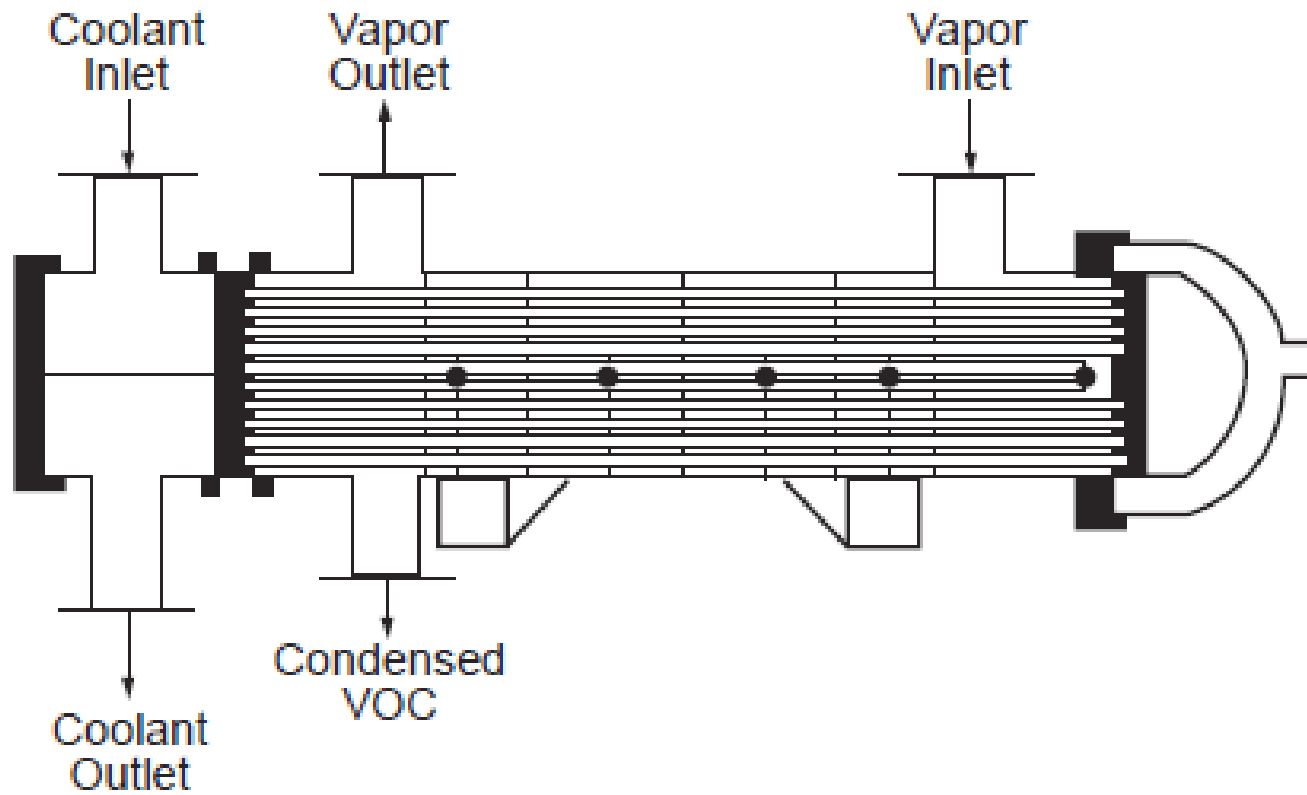


NON-CONTACT CONDENSERS

- No contact between vapor stream and cooling media
- Typical type is shell-and-tube surface condenser
 - Gas on shell side
 - Cooling media on tube side
- Monitoring parameters typically include temperature and condenser performance curve



NON-CONTACT CONDENSERS



SCRUBBERS

○ Dry Scrubbers

- Uses dry sorbent material
- Typically used for acid gasses

○ Wet Scrubbers

- Uses water, caustic, or acid solutions
- Used for:
 - PM
 - SO₂
 - H₂S
 - CL₂
 - NH₃
 - Hydrocarbons

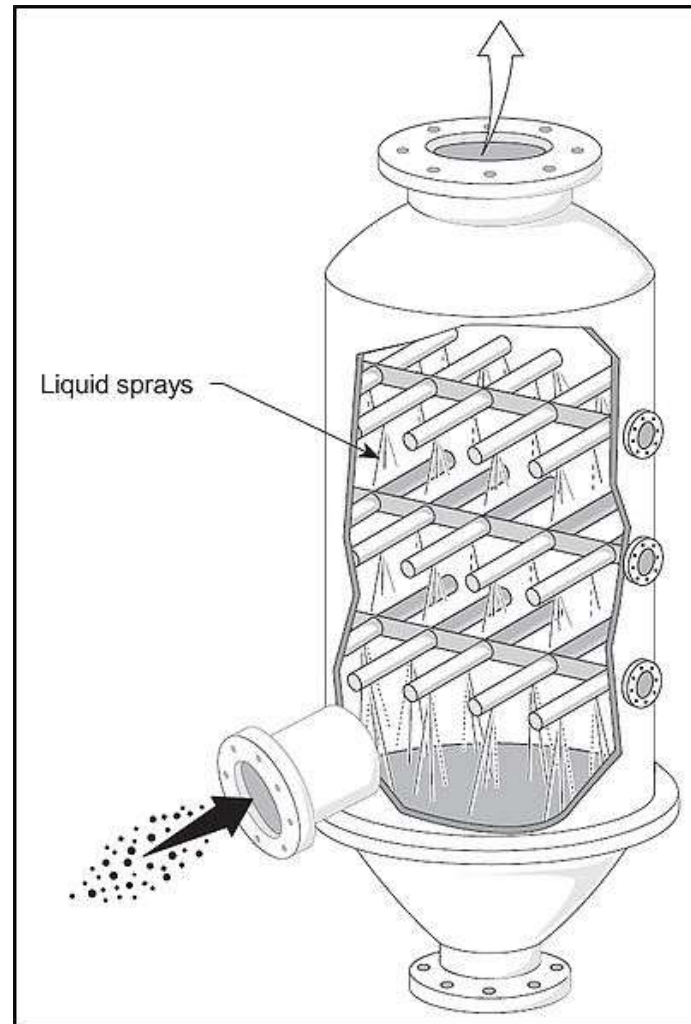


WET SCRUBBERS

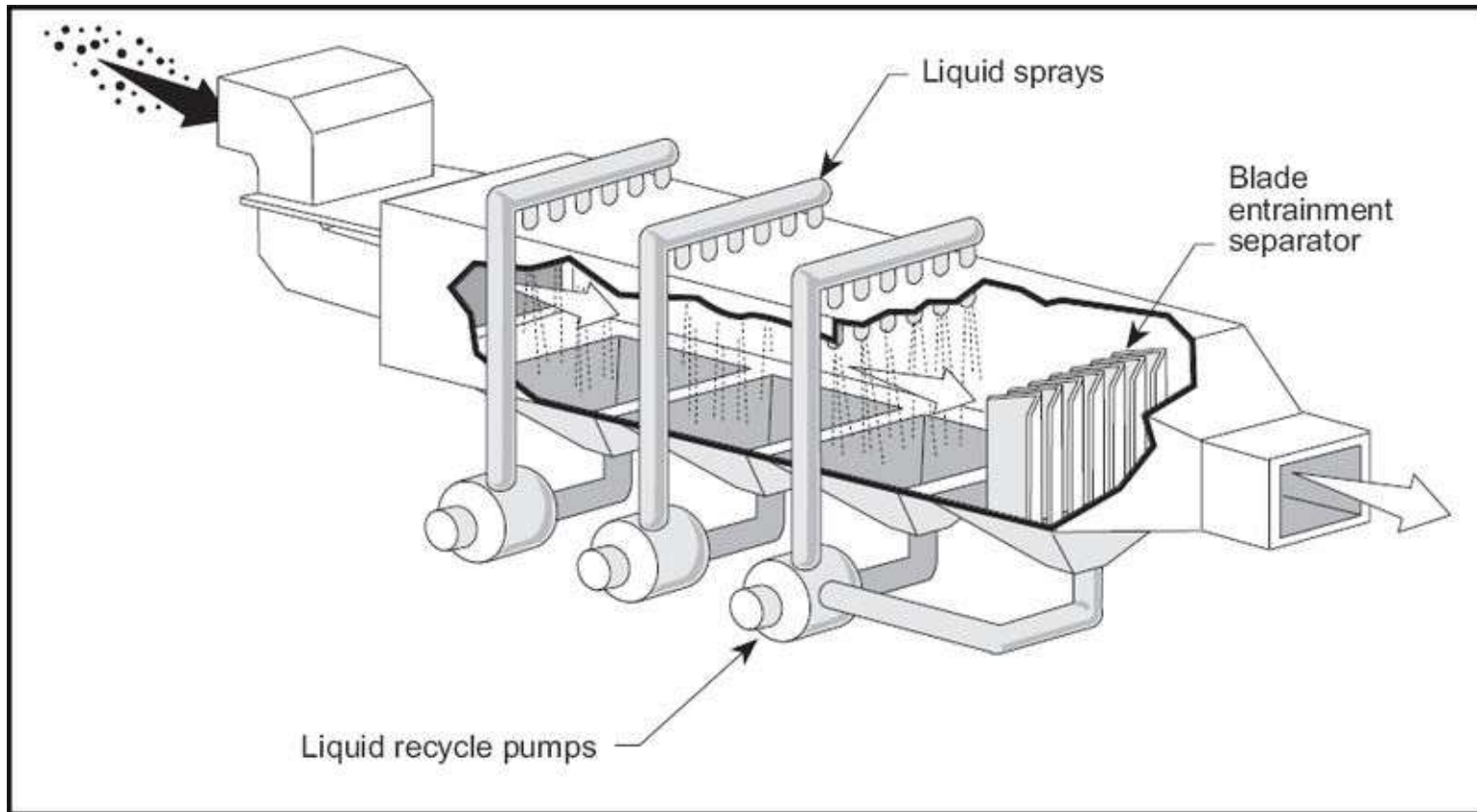
- Wet Scrubber Types
 - Counter Current
 - Cross Current
 - Venturi
 - Packed



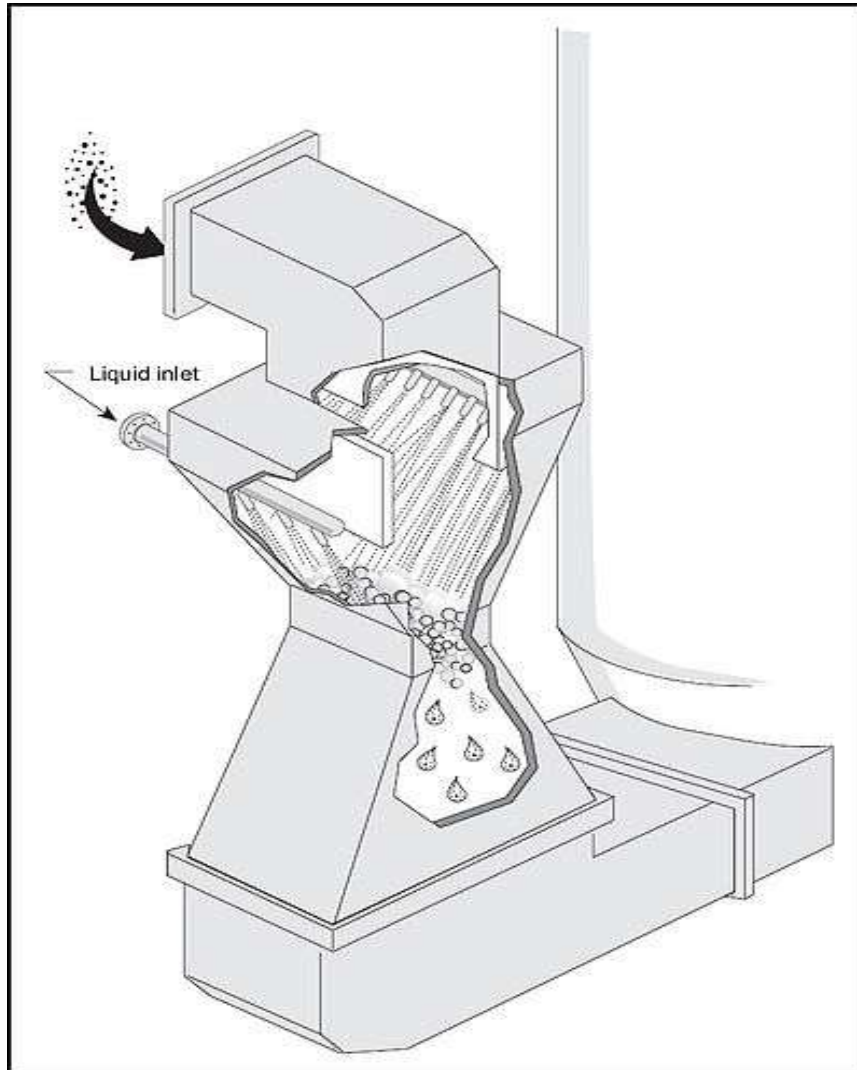
COUNTER FLOW SCRUBBER



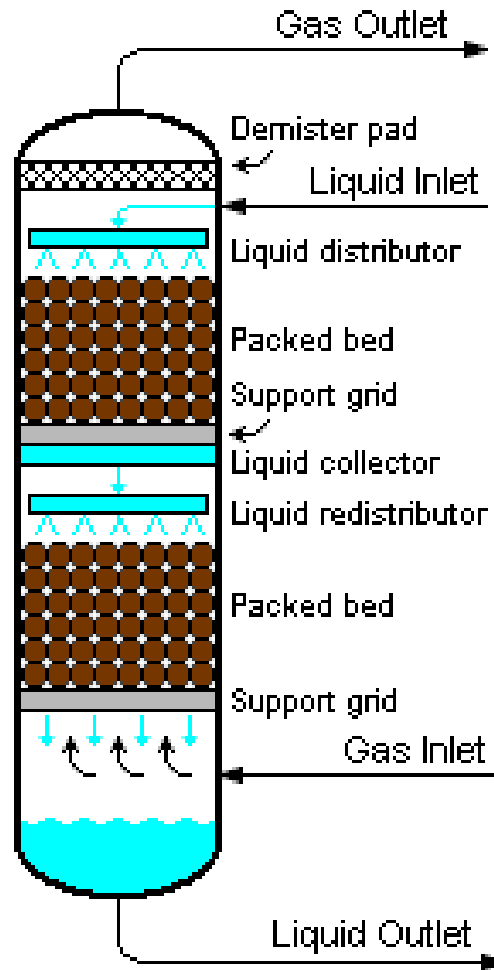
CROSS CURRENT SCRUBBER



VENTURI SCRUBBER



PACKED SCRUBBER



TYPICAL COLUMN PACKING



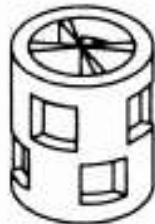
(a) Raschig ring



(c) Berl saddle



(d) Intalox saddle



(b) Pall ring



(e) Tellerette



WET SCRUBBER PROS/CONS

○ Benefits

- Potential for high removal efficiency
- Can treat wide range of gaseous pollutants
- Possibly treat multiple pollutants in one system

○ Drawbacks

- Managing large quantity of wastewater/spent absorbent

○ Common Problems

- Fouling
- Flooding
- Corrosion
- Foaming

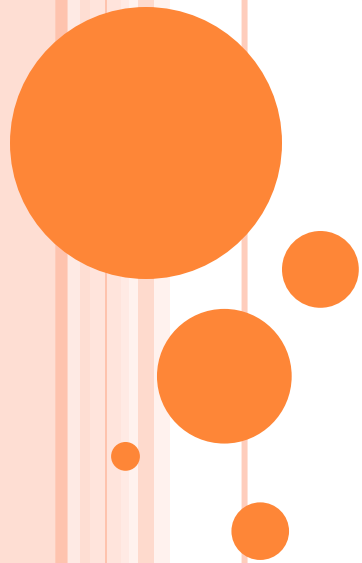


WET SCRUBBER REGS

- Continuous Parameter Monitoring (CPMS)
 - L/g
 - Liquid Flowrate
 - pH
 - Specific Gravity
 - Exhaust Temperature
 - Pressure Drop
 - Others approved by agency



QUESTIONS??



REFERENCES

- Lindeburg, Michael R. (2009). *Environmental Engineering Reference Manual for the PE Exam*. Professional Publications, Inc.
- U.S. EPA. (January 29, 2010). Gaseous Pollutants – Condensation Retrieved October 21, 2011 from <http://www.epa.gov/apti/course422/ce6b3.html>
- U.S. EPA Air Pollution Training Institute in collaboration with North Carolina State University, College of Engineering (NCSU)

