Fire in a Cooling Tower

July 1997
Texas, USA
Cooling Tower-Background

- Ammonia and Urea plant.
- Originally constructed in 1968 by M.W. Kellogg.
  - 1000 tons/day ammonia
- Capacity expanded in 1989.
  - 1450 tons/day ammonia
  - 240 tons/day urea
Cooling Tower - Background

- Cooling Tower.
  - 5 cell
  - Induced draft
  - Cross flow
  - Constructed with redwood and steel supports
  - Fill consisted of fiberglass
  - Circulated 50,000 US gpm
Cooling Tower - Background

- **Heat exchanger 124C.**
  - Horizontal, shell and tube heat exchanger
  - Built in 1989
  - Tubes- contained 977 seamless u-tubes designed to MAWP of 2276 psig, 3/4” in diameter, 0.065” thick
  - Shell- designed to MAWP of 250 psig, measured 4’-6” in diameter and 15’- 4” long
Cooling Tower- Events

- July 1997 (All times local)
- Early morning- plant was running smoothly.
- 4:30 a.m.-
  - A common trouble alarm rings for the #4 cooling tower fan
  - Operator proceeds outdoors to investigate and discovers fire
  - Calls fire department and shuts down plant
- Fire extinguished within 2 hours.
Cooling Tower - Outcome

- Fire was limited to the cooling tower only.
  - All pumps and metal piping were unaffected
  - All fans, fan shrouds, top decking and fiberglass piping were destroyed
  - The fiberglass fill and wooden struts were also destroyed

- Source of fuel determined by running water through heat exchangers.
Cooling Tower - Cause

- The source of the fuel was a leak in heat exchanger 124C.
  - Fretting corrosion
- The exact cause of the ignition could not be determined however possibilities are:
  - static electricity
  - Electrical equipment (non-classified in tower)
  - Spark created from separation of riser from tower
Cooling Tower - Lessons Learned

- The heat exchanger should have been analyzed via a hazard analysis model to determine if increased throughputs would affect performance.
Cooling Tower- Damages

✦ All amounts in US dollars (1997)
✦ Amount of loss
  - $1,550,000 physical damage
  - $502,000 loss of profits
  - $2,052,000 Total
✦ Plant was back to 100% output within 55 days
Fire at a Lube Oil Refinery

May 2000
Louisiana, USA
Lube Oil-Background

- Lube Oil Refinery.
- Processes low sulfur (<½%) naphthenic feedstocks.
- Process units (built 1980s onward).
  - Atmospheric crude unit - 10,000 bbls/day
  - 2 vacuum towers in series (E-102 & E-202)
  - Several rerun units (batch stills)
  - Hydrotreater- 4500 bbls/day
  - Sulfur recovery- 2 tons/day
**Vacuum Distillation Tower E-202**

- Operates between \( \frac{1}{2} \) to 1 inch of Hg vacuum
- Temperatures between 727°F (flash zone) and 662°F (column bottom)
- 78 ft tall in total (52.5 ft column on 25 ft tall skirt)
- 6 feet in diameter at base up to cone section (8 ft tall) and 8 feet in diameter above
- Stainless steel liner in upper portion
- Piping into & out of column was carbon steel
- 8000 US gallon liquid (asphalt) hold-up
**Lube Oil- Background**

- **Fire protection system consisted of:**
  - 10,000 US gallon suction tank
  - 1500 US gpm @ 125 centrifugal pump driven by a diesel engine
  - Fire monitors around perimeter of process units
  - Emergency response team trained at LSU and Texas A&M fire schools
  - Full bunker gear for all on Emergency Response Team
Thursday, May 2000 (all times local)

- <11:40 a.m.- Process operating normally at 7500 bbls/day, no process upsets noted
- 11:40 a.m.- Fire noted at 25 ft elevation of the secondary vacuum tower E-202 by operations
- 11:43 a.m.- Controlled shut-down completed
- 11:46 a.m.- Plant fire brigade arrives at fire. Monitors are initially used.
- A total of 15 plant fire brigade members as well as 2 outside volunteer fire departments of 12 people/department are eventually involved
Lube Oil- Events

- 11:50 a.m.- Tower shell drops vertically 1 to 2 feet
- 12:20 p.m.- fire declared extinguished

✨ Fire extinguished within 40 minutes of ignition.
**Lube Oil- Outcome**

- **Tower E-202.**
  - Exposure to heat resulted in the 6 ft diameter lower section of the column to collapse vertically 1 to 2 ft
  - No damage to 8 ft diameter section
  - Exposure to 500 gallon accumulator associated with tower
  - Damage to feed lines into vessel

- **None of the pumps at grade were affected.**
- **No damage to heat exchangers at grade.**
Lube Oil- Cause

Corrosion- entire vessel suffered from uniform corrosion.
- Corrosion was found during a routine internal inspection on a turnaround conducted in 1997
- Existing insurance recommendation on the report
Lube Oil- Lessons Learned

✦ Management needs to determine corrosion allowances more carefully.
Lube Oil- Damages

- All amounts in US dollars (2000)
- Site value: $74,887,000 property
- Amount of loss
  - $800,000 Tower fabrication & delivery
  - $200,000 Peripheral equipment damage
  - $500,000 Installation & other costs
  - $447,532 Loss of profits and extra expense
  - $1,947,500 TOTAL
- Site could batch process product destined for E-202