Foul Condensate Stripping
2008 Kraft Recovery Short Course

Ben Lin, P.Eng.
A. H. Lundberg Systems Limited
Vancouver, B.C., Canada

Agenda

1. Introduction
2. Stripping Basics
3. Stripping Equipment
4. Stripper Integration
5. Stripper Operation
1. Introduction

Introduction

Most Kraft mills have Foul Condensate Strippers in order to reduce Hazardous Air Pollutants under the Cluster Rule
**Stripping System Objectives**

1. Meet environmental regulations
2. Reduce TRS emissions in effluent treatment systems
3. Produce a gas stream suitable for incineration
4. Produce relatively clean condensate suitable for reuse in the mill

**Pollution Control**

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<th>(Lb/ton)</th>
<th>(Kg/tonne)</th>
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<tbody>
<tr>
<td>BOD</td>
<td>14 to 20</td>
<td>7 to 10</td>
</tr>
<tr>
<td>Toxicity (turpenes and red oils)</td>
<td>2 to 4</td>
<td>1 to 2</td>
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<tr>
<td>Odour (TRS)</td>
<td>2 to 4</td>
<td>1 to 2</td>
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Cluster Rule

- Reduce HAP by 92%
- Bleached mill
  - 10.2 lb HAP per ODTP
  - 330 ppm HAP in stripped condensate
- Unbleached mill
  - 6.6 lb HAP per ODTP
  - 210 ppm HAP in stripped condensate
- Methanol can be used as a surrogate for total HAPs

2. Stripping Basics
Benefits of FC Stripping

- Reduced effluent and air pollutants
  - Remove 98+% of TRS and 95+% of methanol from foul condensate

- Reduced mill water usage
  - Stripped condensate is relatively clean and can be reused elsewhere in the mill

- Reduced fossil fuel usage
  - Concentrate SOG to 50 wt% methanol and deliver to incineration point for thermal destruction

Alternatives

- Hard piping to biological treatment
- Re-using the condensates in a process where the vents are collected and incinerated
- Any other process that can meet the required removal efficiencies
Typical Condensate Sources

- Condensed batch blow steam
- Condensed batch digester relief steam
- Condensed continuous digester liquor flash steam
- Turpentine decanter underflow
- Evaporator combined condensates
- NCG system condensates

Foul condensate stripping

- Contaminants are removed from foul condensate by the process of steam distillation

- Most abundant and most difficult to remove is methanol, thus process is modelled as binary distillation process between methanol and water
3. Stripping Equipment
Stripping System Equipment

- Foul condensate tank
- Condensate fiber filter
- Condensate pre-heaters
- Stripping column
- Reboiler (optional)
- Reflux condenser
- SOG RD, ME, FA, firing nozzle

Stripper Feed Tank

- The bigger the better
- 30 minutes retention time minimum
- Several hours better
- 300 series stainless steel
- Must be vented to CNCG
Foul Condensate Pump

Condensate Fiber Filter

Used to prevent plugging in downstream process equipment
Condensate Preheater

- Standard is shell and tube, with 300 series stainless steel tubes
- Clean condensate on tube side, foul on the shell side
- Spirals may be better
- Plate type plugs quickly unless designed for white water service
- Must heat condensate to within 20 °F (10 °C) of column temperature
Foul Condensate Preheater

Foul condensate is fed through preheaters counter-current to stripped condensate to recover heat

Spiral Preheater
Condensate Preheater

Stripping Column
Stripping Column

Stripping column has two sections of trays, the bottom “stripping” and top “enriching” section

- Foul condensate is introduced between the enriching and stripping sections
- Steam is introduced below the bottom section
- Steam flows countercurrent to condensate flow down, thus “stripping” of methanol and other volatile contaminants
Stripping Column

- Steam passes up through “valves” in the trays, partially reboiling the liquid as it passes down
- Boiling the liquid will preferentially vapourize methanol and other volatiles

For 1000 tpd mill, (300 gpm, 1150 Lpm)

- Column 6’ diameter (2 m)
- Column 60’ tall (18 m)
- Operates at 10 psig (170 kPag)
- Uses 20 valve trays
- 5 trays in top section
- 15 trays in bottom section
- 300 series stainless steel
Stripping Column
Reboiler

SOV line from stripper
SOV line from stripper

Reflex Condenser

- Overhead vapour is condensed in the reflux condenser and returned to the top of the column for “enriching” of the methanol content
- A small amount of product, Stripper Off Gas, SOG, is bled off at the reflux condenser
- A reflux condensate temperature 30 °F less than the underflow temperature will give 50 wt%
Reflux Condenser

- Shell and tube heat exchanger
- All 300 series stainless steel
- Installed horizontally or vertically
- Coolant through tubes
- Uses water or weak black liquor for cooling
Steam Requirement

- Normally use steam ratio of 0.2 pounds of steam per pound of condensate
- For 300 gpm (1150 l/m), this is 30,000 lb/hr (13,600 kg/hr) steam
- Require effective steam ratio of 0.16 to 0.18 for good efficiency

Steam Requirement

Some steam is condensed to bring the incoming condensate up to the column operating temperature

What is left is the EFFECTIVE STEAM
Compliance Monitoring

- Must show that the stripper is operating with enough effective steam to ensure adequate methanol removal
- For each stripper, develop a curve for desired efficiency at various steam ratios and delta T
- Operate below the curve

Compliance Monitoring

![Graph showing the relationship between ΔT and Steam/Condensate Ratio. The graph indicates that the system must operate below the curve for compliance.](image-url)
Compliance Monitoring

Simple alternate method

Always operate with enough steam that you are in compliance regardless of the heat exchanger

4. Stripper Integration
Integrated Columns

**Advantages**
- Lower Capital Cost
- Lower Operating Cost

**Disadvantages**
- Loss of Evaporator Efficiency

For every K Cal lost due to integration, two or more K Cal are returned as usable fuel.
Partially Integrated Column

Operating Problems

- Foaming
- Unstable Operation
- Steam Collapse
- Reflux Control
- Fiber
- Plugged Heat Exchanger
- Turpentine in Storage Tank
5. Stripper Operation

**Reflux Control**

Simple

- **Stripper**
- **Reflux**
- **Condenser**
- **To Incineration**
- **Cooling Water**
Reflux Control
Better

Condenser

Cooling Water

To incineration

Vapor

Liquid

Reflux Tank

Stripper

Reflux

Stripper Gas System

Vent

Insulated Line

Make up Steam

Purge Steam

To Incineration

Reflux Condenser

PC

FC
Liquid Methanol

- Cluster Rule now approves
- Many Advantages
- Higher Stripper uptime
  - Store MeOH as a liquid fuel
  - Measure MeOH flow for compliance monitoring

Operating Procedures

- Start up on steam
- Add condensate slowly
- Make small step changes
Emergency Shutdown

- Close pressure control valve
- Stop condensate flow
- Leave steam on

Conclusion

Stripping is a good method of meeting the Cluster Rules