Yankee Shower Design

A New Perspective

Presented by:
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Solenis
Safety First!

Interlock Yankee showers

Showers must not run on a stationary dryer
Some Background

• Before mid 1980’s - Yankee showers uncommon
  – Yankee coating from wet end
  – Poor control
  – Grade dependent

• Yankee showers are now standard
  – Large effort in chemistry – ongoing
  – Little development of showering dynamics
Yankee Coating Objectives

1. Uniformity across dryer
   » Shower geometry
   » Nozzle selection
   » Header pressure

2. Droplet size distribution
   » Nozzle selection
   » Header pressure

3. Water spray volume (condensing load)
   » Nozzle selection
   » Header pressure
Classical Shower Header Design

- Step 1

<table>
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<tr>
<th>Spray Angle at 40 psi</th>
<th>Capacity Size</th>
<th>EQUIV. ORIFICE DIA (in.)</th>
<th>Capacity (gallons per minute)*</th>
<th>Spray Angle (°)*</th>
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\[ D = 2 \cdot h \cdot \tan \left( \frac{\alpha}{2} \right) \]
Single Coverage
Single Coverage
Single Coverage
Double Coverage

D

½ D
Double Coverage
Triple Coverage
Uniform Coverage
Uniform Coverage

Coverage assumption...

Flat Uniform

Exact 1X, 2X, 3X Coverage
Coverage assumption…

Parabolic

Shower Performance

**Parabolic**
Most flat fans are this type. These designs have heavier flow in the center of the pattern which tapers off toward the edges due to the elliptical shape of the orifice. This requires the overlapping on a header to achieve a totally even spray distribution. The diagram shows how the coverage should be overlapped for optimum performance. The 5-15° offset ensures the sprays won’t collide. Parabolic distribution nozzle series are indicated by this symbol:
Shower Performance

Yankee Coating Shower Spray Pattern

Double Coverage

Spray Delivery Rate (GPH) in 1/4" Wide Increments at Indicated Position

Yankee Dryer Face Position (Inches)
Shower Performance

Yankee Coating Shower Spray Pattern

Spray Delivery Rate (GPH) in 1/4" Wide Increments at Indicated Position

Yankee Dryer Face Position (Inches)

Triple Coverage
Shower Performance

Coverage assumption…

Normal Distribution
Shower Performance

Yankee Coating Shower Spray Pattern

Double Coverage
Shower Performance

Yankee Coating Shower Spray Pattern

Spray Delivery Rate (GPH) in 1/4" Wide Increments at Indicated Position

Yankee Dryer Face Position (Inches)

Triple Coverage
Patternation
Patternator Test Results

Spray Flow Distribution Data

- Mfg. Curve, 10" to Target, 3 Bar (43.5 PSI)
- Test Curve, 7" to Target, 60 PSI
- Test Curve, 7" to Target, 40 PSI

Target Position - Millimeters from Centerline

Spray Volume Percent
Yankee Nozzle Survey
Shower Performance – 11001, 60 psi, 6-inches

Coverage assumption...

Actual
Per Spraying Systems
Test Number 2009T12
Double Coverage

10” centers
Shower Performance – 11001 - DOUBLE

Yankee Coating Shower Spray Pattern

Yankee Dryer Face Position (Inches)

Spray Delivery Rate (GPH)
in 1/4” Wide Increments at Indicated Position

Yankee Coating Shower Spray Pattern
Triple Coverage

6.7” centers
Shower Performance – 11001 - TRIPLE

Yankee Coating Shower Spray Pattern

Spray Delivery Rate (GPH) in 1/4" Wide Increments at Indicated Position

Yankee Dryer Face Position (Inches)
Optimized Coverage

5.7” centers
Shower Performance – 11001 - OPTIMIZED
Case Study

Old shower graph

New shower graph
## Case Study

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<td>Coating Flow</td>
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Coefficient of Variance

Yankee Coating Shower Spray Pattern

Spray Delivery Rate (GPH) in 1/4" Wide Increments at Indicated Position

Standard Deviation
Average
Shower Performance – $C_v$ Curve

Coefficient of Variance ($C_v$)
for Nozzle type - 11001 at 6" Spacing

Coefficient of Variance (%)
Distance from Nozzle Tip to Yankee Surface (inches)
# Shower Performance – \( C_v \) Map

## \( C_v \) Table for 1100067 nozzles at 40 psig

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- **Number of Nozzles Required**:
  - 48
  - 41
  - 37
  - 34
  - 31
  - 29
  - 27
  - 25
  - 24
  - 22
  - 20
  - 19

- **Total Shower Flow (gpm)**:
  - 3.19
  - 2.73
  - 2.47
  - 2.27
  - 2.07
  - 1.93
  - 1.80
  - 1.67
  - 1.60
  - 1.47
  - 1.33
  - 1.27
Oscillation

- Proper spray distribution – no oscillation needed
- Poor spray distribution – oscillation may help … or hurt
- To compensate for poor spray:
  - Stroke = ½ nozzle spacing
  - Linear oscillator, not sinusoidal “crank arm”
Shower Performance
6-inch nozzle spacing

Yankee Coating Shower Assessment

Spray Delivery Rate (GPH)
in ~0.14" Wide Increments at Indicated Position

Yankee Dryer Face Position (Inches)
Shower Performance
6-inch nozzle spacing  4-inch oscillation

Yankee Coating Shower Assessment

Spray Delivery Rate (GPH)
in ~0.14" Wide Increments at Indicated Position

Yankee Dryer Face Position (Inches)
Shower Performance

6-inch nozzle spacing 3-inch oscillation

Yankee Coating Shower Assessment

Spray Delivery Rate (GPH) in ~0.14" Wide Increments at Indicated Position

Yankee Dryer Face Position (Inches)
Summary

• Safety first! – Interlock Yankee showers
• Single, Double, Triple coverage ≠ good coverage
• Optimization requires patternation
• Optimization means minimization of \( C_v \)
• Oscillation is not necessary for an optimized shower
Yankee Shower Design
a New Perspective

Thank you

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