FILTRATION OF RADIOACTIVE AEROSOLS BY GLASS FIBERS

PART TWO. APPENDICES

BY


TECHNICAL DIVISIONS

APRIL 16, 1951

HANFORD WORKS
RICHLAND, WASHINGTON

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FILTRATION OF RADIOACTIVE AEROSOLS BY GLASS FIBERS
Part Two - Appendices

by

Process Section
Separations Technology Division

April 16, 1951

HANFORD WORKS
RICHLAND, WASHINGTON

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INTRODUCTION

For purposes of convenience, the report entitled "The Filtration of Radioactive Aerosols By Glass Fibers" has been published in two volumes. Part one (HW-20847, 4-16-51) contains the text of the report and describes the development program which led to the design of highly efficient, glass fiber filters. Part two (HW-20847, 4-16-51) is composed of five appendices each of which pertains to a separate phase of the program. Four of the appendices contain experimental data presented in graphical form. The remaining appendix consists of a series of nomographs summarizing the permeability and efficiency characteristics of three types of glass fibers.
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### Figure A-1

SAMPLE CALCULATION OF THE PARTICLE SIZE DISTRIBUTION DETERMINED BY THE MODIFIED CASCADE IMPACTOR

Test Date: 1-10-50
Sample Flow Rate: 0.5 cfm.

<table>
<thead>
<tr>
<th>Stage No.</th>
<th>Stage Median Diameter Microns</th>
<th>Radioactivity Content dpm.</th>
<th>Stage Median Value</th>
<th>Cumulative Per Cent of Activity Less Than the Stage Median Value</th>
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<td>I</td>
<td>7.72</td>
<td>10,900</td>
<td>5,500</td>
<td>99.80</td>
</tr>
<tr>
<td>II</td>
<td>3.24</td>
<td>30,700</td>
<td>15,400</td>
<td>99.02</td>
</tr>
<tr>
<td>III</td>
<td>1.71</td>
<td>188,000</td>
<td>94,000</td>
<td>94.95</td>
</tr>
<tr>
<td>IV</td>
<td>1.14</td>
<td>444,000</td>
<td>222,000</td>
<td>83.17</td>
</tr>
<tr>
<td>V</td>
<td>0.68</td>
<td>2,010,000</td>
<td>1,005,000</td>
<td>37.45</td>
</tr>
</tbody>
</table>
Figure A-2

PARTICLE SIZE DISTRIBUTION FOR THE PROCESS-CELL AIR
AS DETERMINED BY THE MODIFIED CASCADE IMPACTOR

Test Date: 1-10-50
Sample Flow Rate: 0.5 cfm.
Figure A-3

PARTICLE SIZE DISTRIBUTION FOR THE PROCESS-CELL AIR AS DETERMINED BY THE MODIFIED CASCADE IMPACTOR

Test Date: 1-16-50
Sample Flow Rate: 1.0 cfm.
Figure A-4

PARTICLE SIZE DISTRIBUTION FOR THE PROCESS-CELL AIR
AS DETERMINED BY THE MODIFIED CASCADE IMPACTOR

Test Date: 4-11-50
Sample Flow Rate: 1.0 cfm.
Figure A-5

PARTICLE SIZE DISTRIBUTION FOR THE PROCESS-CELL AIR
AS DETERMINED BY THE MODIFIED CASCADE IMPACTOR

Test Date: 4-12-50
Sample Flow Rate: 1.0 cfm.
Figure A-6
PARTICLE SIZE DISTRIBUTION FOR THE PROCESS-CELL AIR
AS DETERMINED BY THE MODIFIED CASCADE IMPACTOR
Test Date: 3-8-50
Sample Flow Rate: 2.5 cfm.
Figure A-7

PARTICLE SIZE DISTRIBUTION FOR THE PROCESS-CELL AIR
AS DETERMINED BY THE MODIFIED CASCADE IMPACTOR

Test Date: 8-8-50
Sample Flow Rate: 2.65 cfm.

Cumulative Per Cent of Activity Less than the Stage Median Value
Figure A-3

PARTICLE SIZE DISTRIBUTION IN THE PROCESS-CELL AIR

An Arithmetic - Probability Graph of Figure A-2

Cumulative Per Cent of Activity less than the Stage Median Value

Particle Diameter - Microns

99.99 99.9 99.8 99.5 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01

99.9 99.8 99.5 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
Figure A-9

PARTICLE SIZE DISTRIBUTION IN THE METHYLENE BLUE SMOKE
AS DETERMINED BY THE MODIFIED CASCADE IMPACTOR

Test Date: 5-31-50
Sample Flow Rate: 2.5 cfm.
Figure A-10

PARTICLE SIZE DISTRIBUTION IN THE METHYLENE BLUE SMOKE
AS DETERMINED BY THE MODIFIED CASCADE IMPACTOR

Test Date: 7-28-50
Sample Flow Rate: 1.7 cfm.
Figure A-11

PARTICLE SIZE DISTRIBUTION IN THE METHYLENE BLUE SMOKE

An Arithmetic - Probability Graph of Figure A-9
Figure B-1

GRAPH OF PRESSURE DROP
VS. SUPERFICIAL VELOCITY

No. 55 Fiberglas, $\rho = 3.0$ pcf.

X - L = 12 inches
O - L = 24 inches

Pressure Drop - Inches of water

Superficial Velocity - fpm.
Figure B-2

GRAPH OF PRESSURE DROP VS. SUPERFICIAL VELOCITY

No. 55 Fiberglas, $\rho_p = 6.0$ pcf.

- □ - $L = 5$ inches
- X - $L = 6$ inches
- △ - $L = 9$ inches
- ○ - $L = 48$ inches
Figure B-3
GRAPH OF PRESSURE DROP VS. SUPERFICIAL VELOCITY

No. 55 Fiberglas, \( \rho_p = 9.0 \) pcf.
- \( O - L = 2 \) inches
- \( \triangle - L = 4 \) inches
- \( \square - L = 6 \) inches

Superficial Velocity - fpm.
Pressure Drop - Inches of water
Figure B-4
CROSS- PLOT OF PRESSURE DROP
VS. BED DEPTH
No. 55 Fiberglas

- O - V = 25 fpm; $\rho_p = 3$ pcf.
- △ - V = 50 fpm; $\rho_p = 3$ pcf.
- □ - V = 25 fpm; $\rho_p = 6$ pcf.
- X - V = 50 fpm; $\rho_p = 6$ pcf.
- ○ - V = 10 fpm; $\rho_p = 9$ pcf.
- □ - V = 30 fpm; $\rho_p = 9$ pcf.
- △ - V = 50 fpm; $\rho_p = 9$ pcf.
Figure B-5
CROSS- PLOT OF PRESSURE DROP
VS. PACKING DENSITY
No. 55 Fiberglas
O - V = 25 fpm, L = 6 inches
Δ - V = 50 fpm, L = 5 inches
X - V = 50 fpm, L = 10 inches

Pressure Drop - Inches of water

Packing Density - pcf.
Figure B-6

GRAPH OF PRESSURE DROP VS. SUPERFICIAL VELOCITY

No. 55 P Fiberglas

O - L = 6 inches; \( \rho_p = 2.0 \) pcf.
X - L = 6 inches; \( \rho_p = 3.0 \) pcf.
Figure B-7
GRAPH OF PRESSURE DROP
VS. SUPERFICIAL VELOCITY

AA Fiberglas, $\rho = 0.6$ pcf.
$\bigcirc - L = 1.5$ inches
$\times - L = 1.0$ inch
$\Delta - L = 0.5$ inch
Figure B-8

GRAPH OF PRESSURE DROP
VS. SUPERFICIAL VELOCITY

AA Fiberglas, \( \rho_p = 1.2 \) pcf.

\( \Theta \) - \( L = 1.00 \) inch
\( X \) - \( L = 0.75 \) inch
\( \square \) - \( L = 0.50 \) inch
\( \Delta \) - \( L = 0.25 \) inch

Pressure Drop - Inches of water

Superficial Velocity - fpm.
Figure B-9
GRAPH OF PRESSURE DROP
VS. SUPERFICIAL VELOCITY
AA Fiberglas, \( \rho = 2.4 \) pcf.
- O - L = 1.00 inch
- X - L = 0.75 inch
- □ - L = 0.50 inch
- Δ - L = 0.25 inch
Figure B-10
CROSS- PLOT OF PRESSURE DROP
VS. BED DEPTH
AA Fiberglas
Ø - V = 50 fpm; \( \rho = 1.2 \text{ pcf.} \)
Δ - V = 10 fpm; \( \rho = 1.2 \text{ pcf.} \)
□ - V = 10 fpm; \( \rho = 0.6 \text{ pcf.} \)
Figure B-11

CROSS- PLOT OF PRESSURE DROP

VS. PACKING DENSITY

AA Fiberglas

- L = 0.25 inch; V = 5 fpm.
- L = 0.25 inch; V = 10 fpm.
- L = 0.50 inch; V = 10 fpm.
- L = 0.50 inch; V = 20 fpm.

Packing Density - pcf.
Figure B-12

GRAPH OF PRESSURE DROP VS. SUPERFICIAL VELOCITY

B Fiberglas

Θ - L = 1.0 inch, $\rho = 1.4$ pcf.
Δ - L = 1.0 inch, $\rho = 0.7$ pcf.

Superficial Velocity - fpm.
Pressure Drop - Inches of water
Figure B-13

GRAPH OF PRESSURE DROP VS. SUPERFICIAL VELOCITY

B (L and R) Fiberglas

\( \varepsilon_p = 3.5 \) pcf.

\( L = 1.0 \) inch

Pressure Drop - Inches of water

Superficial Velocity - fpm.
Figure B-14

GRAPH OF PRESSURE DROP VS. SUPERFICIAL VELOCITY

No. 450 Fiberglas

\( \varphi = 5.7 \) pcf.

\( L = 8 \) inches

Superficial Velocity - fpm.

Pressure Drop - Inches of water
Figure B-15

GRAPH OF PRESSURE DROP
VS. SUPERFICIAL VELOCITY

No. 600 Fiberglas
\( \rho = 5.1 \text{ pcf.} \)
\( L = 7 \text{ inches} \)
Figure B-16

GRAPH OF PRESSURE DROP VS. SUPERFICIAL VELOCITY

No. 800 Fiberglas
\( \phi = 6.6 \text{ pcf.} \)
\( L = 8 \text{ inches} \)

Superficial Velocity - fpm.
Pressure Drop - Inches of water
Figure B-17

GRAPH OF PRESSURE DROP
VS. SUPERFICIAL VELOCITY

No. 115 Fiber, \( \epsilon_f = 3.8 \text{ pcf.} \)

- O - L = 10 inches
- \( \Delta \) - L = 20 inches

Superficial Velocity - fpm.
Figure B-18
GRAPH OF PRESSURE DROP
VS. SUPERFICIAL VELOCITY
No. 115 K Fiberglas

- L = 6 inches, \( \rho_p = 6.0 \text{ pcf.} \)
- L = 12 inches, \( \rho_p = 6.0 \text{ pcf.} \)
- L = 24 inches, \( \rho_p = 6.0 \text{ pcf.} \)
- L = 6 inches, \( \rho_p = 1.5 \text{ pcf.} \)
- L = 12 inches, \( \rho_p = 1.5 \text{ pcf.} \)
- L = 18 inches, \( \rho_p = 1.5 \text{ pcf.} \)

Superficial Velocity - fpm.

Pressure Drop - Inches of water
Figure B-19

GRAPH OF PRESSURE DROP VS. SUPERFICIAL VELOCITY

NO. 115K FIBERGLAS

- □ L = 6 inches \( \rho_p = 9.0 \) pcf.
- ○ L = 12 inches \( \rho_p = 9.0 \) pcf.
- △ L = 6 inches \( \rho_p = 3.0 \) pcf.
- ◊ L = 12 inches \( \rho_p = 3.0 \) pcf.
- X L = 24 inches \( \rho_p = 3.0 \) pcf.

Superficial Velocity - fpm.

Pressure Drop - Inches of Water
Figure B-20

GRAPH OF PRESSURE DROP VS. BED DEPTH

NO. 115K FIBERGLAS

- □ - \( \rho_p = 1.5 \text{ pcf}, \ V = 50 \text{ fpm} \)
- ○ - \( \rho_p = 3.0 \text{ pcf}, \ V = 25 \text{ fpm} \)
- △ - \( \rho_p = 3.0 \text{ pcf}, \ V = 50 \text{ fpm} \)
- ◊ - \( \rho_p = 6.0 \text{ pcf}, \ V = 10 \text{ fpm} \)
- X - \( \rho_p = 6.0 \text{ pcf}, \ V = 25 \text{ fpm} \)
- ▽ - \( \rho_p = 9.0 \text{ pcf}, \ V = 50 \text{ fpm} \)
Figure B-21

GRAPH OF PRESSURE DROP VS. PACKING DENSITY
NO. 115K FIBERGLAS

- □ L = 6 inches, V = 25 fpm.
- ○ L = 12 inches, V = 10 fpm.
- △ L = 12 inches, V = 25 fpm.
- ◊ L = 12 inches, V = 50 fpm.
Figure C-1

GRAPH OF COLLECTION EFFICIENCY
VS. DECONTAMINATION FACTOR
Figure C-2

GRAPH OF DECONTAMINATION FACTOR
VS. SUPERFICIAL VELOCITY

No. 55 Fiberglas, $p = 3.0$ pcf.

$\Theta - L = 12$ inches
$X - L = 24$ inches

Superficial Velocity - fpm.
Figure C-3

GRAPH OF DECONTAMINATION FACTOR
VS. SUPERFICIAL VELOCITY
No. 55 Fiberglas, $\rho_p = 4.5$ pcf.

$L = 6$ inches
Figure C-4

GRAPH OF DECONTAMINATION FACTOR VS. SUPERFICIAL VELOCITY
No. 55 Fiberglas, $\rho_p = 6.0$ pcf.

- $\Theta - L = 5$ inches
- $X - L = 9$ inches

Superficial Velocity - fpm.
Figure C-5

GRAPH OF DECONTAMINATION FACTOR
VS. SUPERFICIAL VELOCITY

No. 55 Fiberglas, $\rho_p = 9.0$ pcf.

- $\Theta - L = 2$ inches
- $X - L = 4$ inches
- $\Delta - L = 6$ inches
Figure C-6

CROSS- PLOT OF DECONTAMINATION FACTOR
VS. BED DEPTH
No. 55 Fiberglass

Δ - \( \rho_p = 3.0 \text{ pcf.}, V = 20 \text{ fpm.} \)  Θ - \( \rho_p = 9.0 \text{ pcf.}, V = 5 \text{ fpm.} \)
∇ - \( \rho_p = 3.0 \text{ pcf.}, V = 50 \text{ fpm.} \)  V - \( \rho_p = 9.0 \text{ pcf.}, V = 30 \text{ fpm.} \)
X - \( \rho_p = 6.0 \text{ pcf.}, V = 30 \text{ fpm.} \)
Figure C-7
CROSS- PLOT OF DECONTAMINATION FACTOR
VS. PACKING DENSITY
No. 55 Fiberglas
○ - L = 6 inches, V = 10 fpm.
X - L = 6 inches, V = 50 fpm.
△ - L = 9 inches, V = 10 fpm.
□ - L = 9 inches, V = 5 fpm.
Figure C-8

GRAPH OF DECONTAMINATION FACTOR
VS. SUPERFICIAL VELOCITY

No. 55P Fiberglass, $\rho_p = 3.0$ pcf.

$\Theta - L = 6$ inches
$X - L = 12$ inches

Superficial Velocity - fpm.
Figure C-9

GRAPH OF DECONTAMINATION FACTOR VS. SUPERFICIAL VELOCITY

AA Fiberglas, \( p = 0.6 \) pcf.

\( \Theta - L = 0.5 \) inch
\( X - L = 1.0 \) inch
\( \Delta - L = 1.5 \) inches
Figure C-10

GRAPH OF DECONTAMINATION FACTOR

VS. SUPERFICIAL VELOCITY

AA FIBERGLAS

\[ \Delta - \rho_p = 1.2 \text{ pcf.; } L = 0.25 \text{ inch} \]
\[ \times - \rho_p = 1.2 \text{ pcf.; } L = 0.50 \text{ inch} \]
\[ \Theta - \rho_p = 1.8 \text{ pcf.; } L = 0.50 \text{ inch} \]
Figure C-11

CROSS-PLT OF DECONTAMINATION FACTOR

VS. BED DEPTH

AA Fiberglass

- $\rho_p = 0.6 \text{ pcf.}, V = 5 \text{ fpm.}$
- $\rho_p = 0.6 \text{ pcf.}, V = 20 \text{ fpm.}$
- $\rho_p = 1.2 \text{ pcf.}, V = 5 \text{ fpm.}$
- $\rho_p = 1.2 \text{ pcf.}, V = 40 \text{ fpm.}$
Figure C-12
CROSS- PLOT OF DECONTAMINATION FACTOR VS. PACKING DENSITY
AA FIBERGLAS
L = 0.5 inch
O - L = 10 fpm.
X - L = 20 fpm.
A - L = 40 fpm.
Figure C-13

GRAPH OF DECONTAMINATION FACTOR VS. SUPERFICIAL VELOCITY

B (L and R) Fiberglas, $\rho = 4.0\text{ pcf}$.

\(X - L = 0.50\text{ inch}\)
\(\Theta - L = 0.25\text{ inch}\)
Figure C-14

GRAPH OF DECONTAMINATION FACTOR

VS. SUPERFICIAL VELOCITY

B Fiberglas, \( \rho_p = 0.7 \text{ pcf.} \)

\( L_e = 1.0 \text{ inch} \)
Figure C-15

GRAPH OF DECONTAMINATION FACTOR
VS. SUPERFICIAL VELOCITY

No. 450 Fiberglas, $\rho_p = 5.7$ pcf.

$L = 8$ inches
Figure C-16

GRAPH OF DECONTAMINATION FACTOR
VS. SUPERFICIAL VELOCITY

No. 600 Fiberglas, \( \rho_p = 5.1 \text{ pcf.} \)

\( L = 7 \text{ inches} \)
Figure C-17

GRAPH OF DECONTAMINATION FACTOR
VS. SUPERFICIAL VELOCITY

No. 800 Fiberglas, \( \rho = 6.6 \text{ pcf.} \)

\( L = 8 \text{ inches} \)

Superficial Velocity - fpm.
Figure C-18

GRAPH OF DECONTAMINATION FACTOR VS. SUPERFICIAL VELOCITY

No. 115 Fiber, \( \rho_p = 3.8 \text{ pcf.} \)

\( \bigcirc - L = 10 \text{ inches} \)
\( \bigtriangleup - L = 20 \text{ inches} \)
Figure C-19

CROSS-PLLOT OF DECONTAMINATION FACTOR
VS. BED DEPTH

No. 115 Fiber $\rho = 3.8$ pcf.

- X - V = 2 fpm.
- $\Theta$ - V = 10 fpm.
- $\Delta$ - V = 25 fpm.
- $\Box$ - V = 50 fpm.

Bed Depth - Inches

Decontamination Factor
Figure C-20

GRAPH OF DECONTAMINATION FACTOR
VS. SUPERFICIAL VELOCITY

No. 115K Fiberglas, $\rho_p = 1.5$ pcf.

- $\Theta$ - $L = 6$ inches
- $X$ - $L = 12$ inches
- $\Delta$ - $L = 18$ inches
Figure C-21

GRAPH OF DECONTAMINATION FACTOR VS. SUPERFICIAL VELOCITY

No. 115K Fiberglas, $\rho_p = 3.0$ pcf.

- $\bigcirc - L = 6$ inches
- $\times - L = 12$ inches
- $\bigtriangleup - L = 18$ inches

Superficial Velocity - fpm.
Figure C-22

GRAPH OF DECONTAMINATION FACTOR
VS. SUPERFICIAL VELOCITY
No. 115K Fiberglas, \( \rho = 6.0 \) pcf.

- \( \Phi \) - \( L = 6 \) inches
- \( X \) - \( L = 12 \) inches
- \( \Delta \) - \( L = 18 \) inches

Decontamination Factor

Superficial Velocity - fpm.
Figure C-23

GRAPH OF DECONTAMINATION FACTOR
VS. SUPERFICIAL VELOCITY

No. 115K Fiberglas, \( \rho_p = 9.0 \) pcf.

\( \Theta \) - L = 6 inches
\( X \) - L = 12 inches

Decontamination Factor

Superficial Velocity - fpm.
Figure C-24

CROSS-Plot of Decontamination Factor vs. Bed Depth

No. 115K Fiberglass

X - $\rho = 1.5$ pcf., $V = 15$ fpm.  \(\square\) - $\rho = 6.0$ pcf., $V = 50$ fpm.
\(\Theta\) - $\rho = 3.0$ pcf., $V = 25$ fpm. \(\nabla\) - $\rho = 9.0$ pcf., $V = 5$ fpm.
\(\Delta\) - $\rho = 6.0$ pcf., $V = 15$ fpm.

Bed Depth - Inches

Decontamination Factor
Figure C-25

CROSS- PLOT OF DECONTAMINATION FACTOR
VS. PACKING DENSITY

No. 115K Fiberglas

- X - L = 6 inches, V = 15 fpm.
- Δ - L = 6 inches, V = 30 fpm.
- ◊ - L = 12 inches, V = 5 fpm.
- ◊ - L = 12 inches, V = 15 fpm.
- ◊ - L = 12 inches, V = 40 fpm.
- □ - L = 18 inches, V = 5 fpm.
Figure D-1

Nomograph of the Permeability Characteristics of No. 55 Fiberglas

\[ \Delta P = K_{55} L V \rho_p^{1.6} \]

Where

- \( \Delta P \) = Pressure Drop, Inches of Water
- \( K_{55} \) = Constant
- \( L \) = Bed Depth, Inches
- \( V \) = Superficial Velocity, fpm
- \( \rho_p \) = Packing Density, pcf
Figure D-2

Nomograph of the Permeability Characteristics of AA Fiberglas

\[
\Delta P = K_{AA} L V \rho_p^{1.5}
\]

where

- \( \Delta P \) = Pressure Drop, Inches of Water
- \( K_{AA} \) = Constant
- \( L \) = Bed Depth, inches
- \( V \) = Superficial Velocity, fpm.
- \( \rho_p \) = Packing Density, pcf.
Nomograph of the Permeability Characteristics of No. 115K Fiberglas

\[ \Delta P = K_{115K} L V \rho_p^{1.5} \]

Where

- \( \Delta P \) = Pressure Drop, Inches of Water
- \( K_{115K} \) = Constant
- \( L \) = Bed Depth, inches
- \( V \) = Superficial Velocity, fpm
- \( \rho_p \) = Packing Density, pcf

Figure D-3

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<th>L - INCHES</th>
<th>( \Delta P )</th>
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\( p = \text{pcf} \)
Nomograph of the Efficiency Characteristics of No. 55 Fiberglas

DF = \( \frac{C_{55} \cdot L^{0.9} \cdot \rho_p^{1.1}}{V^{0.4}} \)

Where
- \( DF \) = Decontamination Factor
- \( C_{55} \) = Constant
- \( L \) = Bed Depth, inches
- \( \rho_p \) = Packing Density pcf.
- \( V \) = Superficial Velocity, fpm.
Figure D-5

Nomograph of the Efficiency Characteristics of AA Fiberglas

DF = \frac{C_{AA} L^{0.8} \rho_p^{1.0}}{V^{0.2}}

Where

DF = Decontamination Factor

C_{AA} = Constant

L = Bed Depth, inches

\rho_p = Packing Density, pcf.

V = Superficial Velocity, fpm.
Figure D-6

Nomograph of the Efficiency Characteristics of No. 115K Fiberglas

DF = \frac{C_{115K} L^{0.9} \rho_p^{0.9}}{V^{0.4}}

Where

DF = Decontamination Factor

C_{115K} = Constant

L = Bed Depth, inches

\rho_p = Packing Density, pcf

V = Superficial Velocity, fpm
Figure E-1

COLLECTION EFFICIENCY
AND PRESSURE DROP
VS. \( \xi \) - FUNCTION

No. 55 Fiberglas

\[ L = 2'' \quad \rho_p = 6.0 \text{ pcf.} \]
\[ V = 25 \text{ fpm.} \]
Figure E-2

COLLECTION EFFICIENCY
AND PRESSURE DROP
VS. - FUNCTION

No. 55 Fiberglas

\[ L = 4'' \quad \rho = 3.0 \text{ pcf.} \]
\[ V = 25 \text{ fpm.} \]
Figure E-3

COLLECTION EFFICIENCY AND PRESSURE DROP

VS. - FUNCTION

No. 115K Fiberglas
L = 2"  \( \rho_p = 6.0 \text{ pcf.} \)
V = 25 fpm.

\( \zeta - \text{Function Grains/ft.}^2 \)
Figure E-4

COLLECTION EFFICIENCY
AND PRESSURE DROP
VS. ∑ FUNCTION

No. 115K Fiberglas

L = 6"
ρ = 6.0 pcf.

V = 25 fpm.
Figure E-5

GRAPH OF PRESSURE DROP

VS. \( \Sigma \) - FUNCTION FOR THE FIRST SAND FILTER TEST UNIT

\( \Theta \) - 2 inches of Type IV Sand
\( \Delta \) - 12 inches of Type V Sand
\( \Box \) - 3 inches of Type VI Sand
\( X \) - Entire filter unit
Figure E-6

GRAPH OF PRESSURE DROP
VS. Σ - FUNCTION
FOR THE SECOND SAND
FILTER TEST UNIT

- - 12 inches of Type II Sand
□ - 12 inches of Type III Sand
△ - 6 inches of Type IV Sand
X - 12 inches of Type V Sand
▽ - 3 inches of Type VI Sand
Θ - Entire filter unit.

Superficial Velocity - 5 fpm.
Figure E-7

GRAPH OF PRESSURE DROP VS. $\Sigma$ - FUNCTION FOR THE THIRD SAND FILTER TEST UNIT

- $\Pi$ - Inches of Type II Sand
- - Types II - III Interface
- • - 10 Inches of Type III Sand
- ▲ - Types III - IV Interface
- ◊ - 4 Inches of Type IV Sand
- ▲ - Types IV - V Interface
- □ - 10 Inches of Type V Sand
- X - Types V - VI Interface
- V - 2 Inches of Type VI Sand
- © - Entire Filter Unit

Superficial Velocity - 5 fpm.

Interfacial layers extended one inch above and one inch below the line of demarcation.
Figure E-8

GRAPH OF THE RADIOACTIVITY DISTRIBUTION
IN A PLANT SAND FILTER

O - Tube No. 1
X - Tube No. 2
Figure E-9

GRAPH OF PRESSURE DROP
VS. $\Sigma$ - FUNCTION

$\Theta$ - 5 inches of No. 55 Fiberglas at 9.0 pcf. Protecting

$\Delta$ - 0.25 inch of AA Fiberglas at 1.2 pcf.

Superficial Velocity - 50 fpm.
Figure E-10

GRAPH OF PRESSURE DROP
VS. ∑ - FUNCTION

○ - 11 inches of No. 55 Fiberglas at 6.0 pcf. Protecting
□ - 0.25 inch of AA Fiberglas at 1.2 pcf.
Superficial Velocity - 50 fpm.
Figure E-11

GRAPH OF PRESSURE DROP

VS. Σ - FUNCTION

○ - 5 inches of No. 55 Fiberglas at 3.0 pcf. Protecting
□ - 11 inches of No. 55 Fiberglas at 6.0 pcf.
Superficial Velocity - 50 fpm.
Figure E-12

GRAPH OF PRESSURE DROP VS. Σ - FUNCTION

- 12 inches of No. 450 Fiberglas at 5.7 pcf. Protecting
- 5 inches of No. 55 Fiberglas at 3.0 pcf.

Superficial Velocity - 50 fpm.
Figure E-13

GRAPH OF PRESSURE DROP
VS. $\Sigma$ - FUNCTION

O - 12 inches of No. 600 Fiberglas at 6.8 pcf. Protecting
□ - 12 inches of No. 450 Fiberglas at 5.7 pcf.
Superficial Velocity - 50 fpm.
Figure E-14
GRAPH OF PRESSURE DROP
VS. \( \Sigma \) - FUNCTION

- 12 inches of No. 800 Fiberglas at 6.6 pcf. Protecting
- 12 inches of No. 600 Fiberglas at 6.8 pcf.
Superficial Velocity - 50 fpm.
Figure E-15
GRAPH OF PRESSURE DROP
VS. Σ - FUNCTION

- 8 inches of No. 55 Fiberglas at 6.0 pcf. Protecting
- 0.25 inch of AA Fiberglas at 1.2 pcf.
Superficial Velocity - 25 fpm.
Figure E-16

GRAPH OF PRESSURE DROP

VS. Σ - FUNCTION

- 5 inches of No. 55 Fiberglas at 3.0 pcf. Protecting
- 8 inches of No. 55 Fiberglas at 6.0 pcf.
Superficial Velocity - 25 fpm.

Σ - Function - grains/ft.²

Pressure Drop - inches of water
Figure - E-17

GRAPH OF PRESSURE DROP

VS. Σ - FUNCTION

☐ - 5 inches of No. 115 Fiber at 3.8 pcf. Protecting
Θ - 5 inches of No. 55 Fiberglas at 3.0 pcf.
Superficial Velocity - 25 fpm.

Pressure Drop - inches of water

Σ - Function - grains/ft.²
Figure E-18

GRAPH OF PRESSURE DROP

VS. $\Sigma$ - FUNCTION

○ - 12 inches of No. 450 Fiberglas at 10 pcf. Protecting
□ - 5 inches of No. 115 Fiber at 3.8 pcf.
Superficial Velocity - 25 fpm.

Pressure Drop - Inches of water

$\Sigma$ - Function - grains/ft.$^2$
Figure E-10

Graph of Pressure Drop

O 14 inches No. 55 Fiberglas at 1.5 pcV. Protecting
& 5 inches No. 55 Fiberglas at 3.0 pcV.
Superficial Velocity - 15 fpm.
Figure E-20

GRAPH OF PRESSURE DROP

VS. $\Sigma$ - FUNCTION

- 12 inches of No. 450 Fiberglas at 10.0 pcf. Protecting
- 14 inches of No. 55 Fiberglas at 1.5 pcf.
Superficial Velocity - 25 fpm.
Figure E-21

GRAPH OF PRESSURE DROP VS. $\Sigma$ - FUNCTION

- 24 inches No. 450 Fiberglas at 5.0 pcf. Protecting
- 14 inches No. 55 Fiberglas at 1.5 pcf.

Superficial Velocity 25 fpm.

Pressur Drop - Inches of water

$\Sigma$ - Function - grains/ft.²
Figure E-II
GRAPH OF PRESSURE DROP
VS. $\Sigma$ - FUNCTION

- 10 inches No. 55 Fiberglas at 1.5 pcf. Protecting
- 5 inches No. 55 Fiberglas at 3.0 pcf.
Superficial Velocity - 25 fpm.
Figure E-23

GRAPH OF PRESSURE DROP VS. Σ FUNCTION

Θ - 24 inches of No. 450 Fiberglas at 2.0 pcf, protecting.
□ - 14 inches of No. 55 Fiberglas at 1.5 pcf.

Superficial Velocity - 25 fpm.
Figure E-24

GRAPH OF PRESSURE DROP VS. $\Sigma$ FUNCTION

$\Theta$ - 24 inches of No. 800 Fiberglas at 5.0 pcf.
Protecting

$Q$ - 14 inches of No. 55 Fiberglas at 1.5 pcf.

Superficial Velocity - 25 fpm.
Figure E-25

GRAPH OF PRESSURE DROP VS. \( \Sigma \) FUNCTION FOR A COMPOSITE UNIT OPERATED AT 50 fpm.

1 - 18 inches of No. 55 Fiberglas at 1.5 pcf.
2 - 6 inches of No. 55 Fiberglas at 3.0 pcf.
3 - 8 inches of No. 55 Fiberglas at 6.0 pcf.
4 - 1 inch of AA Fiberglas at 1.2 pcf.
5 - entire filter unit.
Figure E-26A

GRAPH OF PRESSURE DROP VS. Σ FUNCTION FOR A COMPOSITE

TEST UNIT OPERATED AT 25 fpm.
1 - 1st. inch of No. 55 Fiberglass at 1.5 pcf.
2 - 2nd and 3rd inches of No. 55 Fiberglass at 1.5 pcf.
3 - 1st inch of No. 55 Fiberglass at 3.0 pcf.
Figure E-26 B

GRAPH OF PRESSURE DROP VS. Σ FUNCTION FOR A COMPOSITE
TEST UNIT OPERATED AT 25 fpm

1 - 14 inches of No. 55 Fiberglas at 1.5 pcf.
2 - 8 inches of No. 55 Fiberglas at 3.0 pcf.
3 - 8 inches of No. 55 Fiberglas at 5.0 pcf.
4 - 6.75 inches of AA Fiberglas at 1.2 pcf.
5 - entire filter unit.
Figure E-27

GRAPH OF PRESSURE DROP VS. Σ FUNCTION

- 8 inches of No. 55P Fiberglas at 6.0 pcf protecting
- 0.75 inch of AA Fiberglas at 1.2 pcf.

Superficial Velocity - 25 fpm.
Figure E-28

GRAPH OF PRESSURE DROP VS. $\sum$ FUNCTION

- 6 inches No. 55P Fiberglas at 3.0 pcf. protecting
- 8 inches No. 55P Fiberglas at 6.0 pcf.

Superficial Velocity - 25 fpm.
GRAPH OF PRESSURE DROP VS. $\Sigma$ FUNCTION

- 18 inches of No. 55P Fiberglas at 1.5 pcf. protecting
- 8 inches of No. 55P Fiberglas at 3.0 pcf.
  Superficial Velocity - 25 fpm.
Figure E-30

GRAPH OF PRESSURE DROP VS. Σ FUNCTION

- 8 inches of No. 115K Fiberglas at 9.0 pcf.
- 3/4 inch AA Fiberglas at 1.2 pcf.

Superficial Velocity - 50 fpm.
Figure E-31

GRAPH OF PRESSURE DROP VS. Σ FUNCTION

- 6 inches of No. 115K Fiberglas at 6.0 pcf. protecting.
- 8 inches of No. 115K Fiberglas at 9.0 pcf.
- 1st inch of No. 115K Fiberglas at 6.0 pcf.

Superficial Velocity - 50 fpm.
Figure E-32

GRAPH OF PRESSURE DROP VS. Σ FUNCTION

- 6 inches of No. 115K Fiberglas at 3.0 pcf. protecting.
- 8 inches of No. 115K Fiberglas at 6.0 pcf.

Superficial Velocity - 50 fpm.
GRAPH OF PRESSURE DROP VS. Σ FUNCTION

- 12 inches No. 115K Fiberglas at 1.5 pcf. protecting.
- 6 inches No. 115K Fiberglas at 3.0 pcf.

Superficial velocity - 50 fpm.
Figure E-34

Graph of Pressure Drop vs. Σ Function

- 8 inches No. 115K Fiberglas at 9.0 pcf. protecting.
- 3/4 inch AA Fiberglas at 1.2 pcf.
Superficial Velocity - 25 fpm.

Σ Function - Grains/ft.²
Figure E-35

GRAPH OF PRESSURE DROP VS. Σ FUNCTION

Θ - 6 inches No. 115K Fiberglas at 6.0 pcf. protecting.

□ - 8 inches No. 115K Fiberglas at 9.0 pcf.
Superficial velocity - 25 fpm.
Figure E-36

GRAPH OF PRESSURE DROP VS. Σ FUNCTION

6 inches No. 115K Fiberglas at 6.0 pcf.
Superficial Velocity - 25 fpm.
Figure E-37

GRAPH OF PRESSURE DROP VS. Σ FUNCTION

Θ - 6 inches No. 115K Fiberglas at 3.0 pcf. protecting.

□ - 8 inches No. 115K Fiberglas at 6.0 pcf.

Superficial Velocity - 25 fpm.
Figure E-38

GRAPH OF PRESSURE DROP VS. Σ FUNCTION

Ο - 6 inches No. 115K Fiberglas at 3.0 pcf. protecting.

□ - 8 inches No. 115K Fiberglas at 6.0 pcf.

Superficial Velocity - 25 fpm.
Figure E-39

GRAPH OF PRESSURE DROP VS. Σ FUNCTION

Θ - 3 inches No. 115K Fiberglas at 3.0 pcf. protecting.

□ - 6 inches No. 115K Fiberglas at 6.0 pcf.

Superficial Velocity - 15 fpm.

Σ Function - Grains/ft.²
Figure E-40

GRAPH OF PRESSURE DROP VS. Σ FUNCTION

- First one inch increment of 12 inches No. 115K Fiberglas at 1.5 pcf.
- 12 inches of No. 115K Fiberglas at 1.5 pcf.
- 6 inches of No. 115K Fiberglas at 3.0 pcf.

Superficial Velocity - 25 fps.