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The flow rate between each segment on a line is assumed proportional to its length. To calculate the flow rate across a line, follow the following procedure:

— *Step 1* – Sum the flow rate from all filter/coalescers below the line. From this, subtract the flow rate of all separators below the line.

— *Step 2* – For each element on the line, calculate or measure the angle defining the amount of the element that is below the line. For example, choosing element F on line wEFAw, the angle is defined by AFE. This angle (in degrees) divided by 360 is the fraction of flow that flows into or out of the element below the line. Sum the flows from the fraction below the line of all filter/coalescers on the line. Subtract from this the flow rate from the fraction of all separators on the line. Add this to the result from Step 1. This is the total flow rate across the line.

— *Step 3* – Sum the lengths of all segments on the line. The flow rate across each segment is the length of the segment divided by the total length of segments on the line multiplied by the total flow rate across the line.

Starting at a wall region, a series of mass balances can be performed to determine the flow rates of the segments that are not on lines, e.g. segment ED, FD etc. To do this, select a region, e.g. wEDw. Calculate the flow rate into or out of the fraction element in the region using the procedure of Step 2 above. Using the convention that flow into a region is negative and out of a region is positive, add the flow rate of the segments with flow rate leaving the region and flow rate from the fraction of separator(s) in the region. From this subtract the flow rate of the segments with flow entering the region and the flow rate from the fraction of filter/coalescer(s) in the region. The result is the flow rate across the unknown segment. Continue this process until the flow rates across all segments are known.

The velocity for each segment is then calculated as follows:

— *Step 1* – Calculate the area by multiplying the length of the segment by the sum of the lengths of the two elements linked by the segment and divide by 2.

— *Step 2* – Divide the flow rate across the segment by the area calculated in Step 1. (Note: Use consistent units so that velocity results in units of ft/sec.)

The results of these calculations for Figure 6 are given in Table 3.

Table 2 - Lengths of segments

Segment	FC/FC (in.)	Mixed (in.)	S/S (in.)
AB	4,497		
AF	5,407		
AG		0,248	
BC	2,419		
BD	9,556		
BF	3,996		
CD	2,419		
DE	2,419		
DF	3,996		
EF	5,102		
EH		5,982	
EI		2,419	
FG		6,107	
FH		0,250	
GH			2,347
GJ			2,419
HI			2,347
HJ			0,250
IJ			2,419
wA	0,250		
wB	0,250		
wC	0,250		
wD	0,250		
wE	0,250		
wG			0,250
wI			0,250
wJ			0,250

Table 3 - Flow rates and velocities for segments

Segment	Length (in.)	Flow (gpm)	Velocity (ft/sec.)
wE	0,250	10,295	0,540
EF	5,102	210,095	0,378
AF	5,407	222,648	0,378
wA	0,250	10,295	0,540
wD	0,250	4,350	0,228
BD	9,556	166,299	0,160
wB	0,250	4,350	0,228
CD	2,419	58,150	0,220
BC	2,419	58,150	0,220
wI	0,250	16,246	1,490
HI	2,347	152,504	1,490
GH	2,347	152,504	1,490
wG	0,250	16,246	1,490
IJ	2,419	77,504	0,735
GJ	2,419	77,504	0,735
DE	2,419	56,555	0,214
wC	0,250	0,000	0,000
AB	4,497	59,889	0,122
AG	0,248	20,742	1,094
wJ	0,250	0,000	0,000
EI	2,419	21,576	0,117
DF	3,996	103,540	0,238
BF	3,996	112,759	0,259
EH	5,982	175,273	0,384
FH	0,250	-38,541	-2,020
FG	6,107	238,286	0,511
HJ	0,250	0,000	0,000

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FH	0,250	-38,541	-2,020
FG	6,107	238,286	0,511
HJ	0,250	0,000	0,000

Table 5 - Location of separators and filter/coalescers

Separators			Filter/Coalescers		
Element	**Radius (in.)**	**Angle (degrees)**	**Element**	**Radius (in.)**	**Angle (degrees)**
A	6,25	180	A	0	0
B	0	0	B	6,25	18
C	6,25	0	C	6,25	90
D	6,25	90	D	6,25	162
			E	6,25	234
			F	6,25	306

Similar segments and regions are drawn for the filter/coalescers.

Table 6 - Lengths for segments

Filter/Coalescers		Separators	
Segment	**Length (in.)**	**Segment**	**Length (in.)**
wB	0,2500	wC	0,2500
AB	0,2500	BC	0,2500
AD	0,2500	AB	0,2500
wD	0,2500	wA	0,2500
wF	0,2500	CD	2,8388
EF	1,3473	AD	2,8388
wE	0,2500	wB	6,5000
BC	1,3473	wD	0,2500
CD	1,3473	BD	0,2500
BF	1,3473		
DE	1,3473		
AF	0,2500		
AE	0,2500		
wC	0,2500		
AC	0,2500		

B.3 SEGMENT LENGTH AND FLOW RATE

Calculate or measure the length of each segment. For Figure 7, the lengths are shown in Table 6.

The flow rate between each segment on a line is assumed proportional to its length. To calculate the flow rate across a line, follow the following procedure:

Separator Section:

— *Step 1* – Calculate the areas of each region. For regions adjacent to the wall, the area can be calculated by calculating the area of the pie from the centre of the vessel and lines going through the centre of the elements to the wall. This is the angle of the pie divided by 360 and multiplied by the cross-sectional area of the vessel. Subtract the area of the triangle from the centre of the vessel and the centres of the two elements. Finally, subtract the area of the elements within the regions.

— *Step 2* – For each line, calculate the flow across the line. Assuming plug flow across the region between the filter/coalescers and separators, the flow into the region below the line is the total flow for the vessel multiplied by the sum of area in regions below the line divided by the total area of the regions in the separator section. Subtract from that the flow into each separator below the line. Finally, subtract the flow rate per separator multiplied by the fraction of the separator below the line for each separator on the line. This is the flow across the line. For example, for line wCBAw, the flow across the line is:

  Total Flow for the vessel (600 GPM) X ∑(Areas wABw & wCBw) / ∑(Areas wABw, wCBw, wADw, wDCw, CDBC,DABD) – Flow into separators below line (None) – Flow into separators A, B, C below the line (0,5 x 150 + 0,5 x 159 + 0,5 x 150 gpm).

— *Step 3* – Sum the lengths of all segments on the line. The flow rate across each segment is the length of the segment divided by the total length of segments on the line multiplied by the total flow rate across the line.

Starting at a wall region, a series of mass balances can be performed to determine the flow rates of the segments that are not on lines, e.g. segment BD. To do this, select a region, e.g. CBDC. Calculate the flow rate into or out of the fraction of the separator in the region. Using the convention that flow into a region is negative and out of region is positive, add the flow rate of the segments with flow rate leaving the region and flow rate from the fraction of separator(s) in the region. Also, add the total flow multiplied by the area of the region divided by the sum of all regions in the separator section. From this, subtract the flow rate of the segments with flow entering the region. The result is the flow rate across the unknown segment. Continue this process until the flow rates across all segments are known.

The velocity for each segment is then calculated as follows:

Step 1 – Calculate the area by multiplying the length of the segment by the length of a separator.

Step 2 – Divide the flow rate across the segment by the area calculated in Step 1. (Note: Use consistent units so that velocity results in units of ft/sec.)

The results of these calculations for Figure 7 are given in Table 7.

Filter/Coalescer Section:

— *Step 1* – Calculate the areas of each region. For regions adjacent to the wall, the area can be calculated by calculating the area of the pie from the centre of the vessel and lines going through the centre of the elements to the wall. This is the angle of the pie divided by 360 and multiplied by the cross-sectional area of the vessel. Subtract the area of the triangle from the centre of the vessel and the centres of the two elements. Finally, subtract the area of the elements within the regions.

— *Step 2* – For each line, calculate the flow across the line. Add all the flows from filter/coalescers below the line, F_F. Assuming plug flow across the region between the filter/coalescers and separators, the flow from the region below the line is the total flow for the vessel multiplied by the sum of area in regions below the line divided by the total area of the region in the filter/coalescer section. Subtract this from F_F. Finally, add the flow rate per filter/coalescer multiplied by the fraction of the filter/coalescer below the line for each filter/coalescer on the line. This is the flow across the line.

— *Step 3* – Sum the lengths of all segments on the line. The flow rate across each segment is the length of the segment divided by the total length of segments on the line multiplied by the total flow rate across the line.

Starting at a wall region, a series of mass balances can be performed to determine the flow rates of the segments that are not on lines, e.g. segment BF. To do this, select a region, e.g. wBFw. Calculate the flow rate out of the fraction of the filter/coalescers in the region. Using the convention that flow into a region is negative and out of a region is positive, add the flow rate of the segments with flow rate leaving the region and subtract flow leaving the region across segments. Add the total flow multiplied by the area of the region divided by the sum of all regions in the filter/coalescer section. Finally, subtract the flow from the fraction of each filter/coalescer in the region. The result is the flow rate across the unknown segment. Continue this process until the flow rates across all segments are known.

The velocity for each segment is then calculated as follows:

Step 1 – Calculate the area by multiplying the length of the segment by the length of a filter/coalescer.

Step 2 – Divide the flow rate across the segment by the area calculated in Step 1. (Note: Use consistent units so that velocity results in units of ft/sec.)

The results of these calculations for Figure 7 are given in Table 7.

Table 7 - Flow rates and velocities of separator and filter/coalescer sections

Filter/Coalescers			Separators		
Segment	**Flow Rate (gpm)**	**Velocity (ft/sec.)**	**Segment**	**Flow Rate (gpm)**	**Velocity (ft/sec.)**
wB	0,0000	0,0000	wC	31,1920	2,8608
AB	0,0000	0,0000	BC	31,1920	2,8608
AD	0,0000	0,0000	AB	31,1920	2,8608
wD	0,0000	0,0000	wA	31,1920	2,8608
wF	0,0000	0,0000	CD	-24,8180	-0,2004
EF	-26,6170	-0,1812	AD	-24,8180	-0,2004
wE	0,0000	0,0000	wD	0,0000	0,0000
BC	26,617	0,1812	BD	0,0000	0,0000
CD	26,6170	0,1812	wB	0,0000	0,0000
BF	-26,6170	-0,1812			
DE	-26,6170	-0,1812			
AF	0,0000	0,0000			
AE	0,0000	0,0000			
wC	0,0000	0,0000			
AC	0,0000	0,0000			

sum of all regions in the filter/coalescer section. Finally, subtract the flow from the fraction of each filter/coalescer in the region. The result is the flow rate across the unknown segment. Continue this process until the flow rates across all segments are known.

The velocity for each segment is then calculated as follows:

Step 1 – Calculate the area by multiplying the length of the segment by the length of a filter/coalescer.

Step 2 – Divide the flow rate across the segment by the area calculated in Step 1. (Note: Use consistent units so that velocity results in units of ft/sec.)

The results of these calculations for Figure 7 are given in Table 7.

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AD	0,0000	0,0000	AB	31,1920	2,8608
wD	0,0000	0,0000	wA	31,1920	2,8608
wF	0,0000	0,0000	CD	-24,8180	-0,2004
EF	-26,6170	-0,1812	AD	-24,8180	-0,2004
wE	0,0000	0,0000	wD	0,0000	0,0000
BC	26,617	0,1812	BD	0,0000	0,0000
CD	26,6170	0,1812	wB	0,0000	0,0000
BF	-26,6170	-0,1812			
DE	-26,6170	-0,1812			
AF	0,0000	0,0000			
AE	0,0000	0,0000			
wC	0,0000	0,0000			
AC	0,0000	0,0000			