



MEASURING AIR VELOCITY
 Wednesday Feb. 28
 2:00 PM - 3:00 PM CST

(and why it is important)

kice.com Wednesday, February 28, 2018
 Presented by Lonnie Glen, Kice Technical Sales
 and Quickship Manager

© Kice Industries, Inc. All rights reserved.

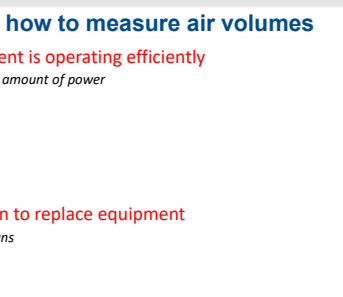


KICE

Applications for "Air"

- **Air Activated Processing**
 - Grinders
 - Granulators
 - Hammermills
 - Aspirators
- **Pneumatic Conveying**
 - Positive Pressure
 - Vacuum
 - (limited to non-fluctuating loads)
- **Dust Control**
- **Drying/Cooling**

© Kice Industries, Inc. All rights reserved.

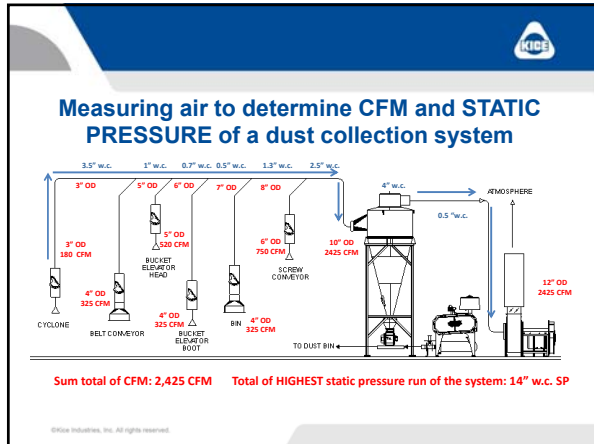


KICE

Reasons to know how to measure air volumes

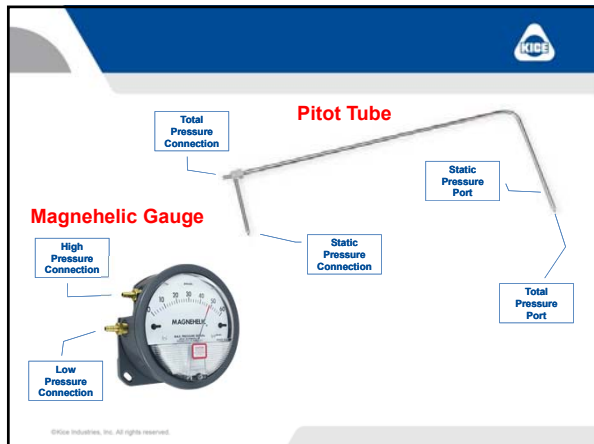
- **To know if your equipment is operating efficiently**
 - Best operation for the least amount of power
- **Sizing new equipment**
 - Dust Collection
 - Aspiration
 - Conveying
- **Important to know when to replace equipment**
 - Blowers, Cyclone, Filters, Fans
- **Record-keeping**
 - Plant operations
 - Government agencies

© Kice Industries, Inc. All rights reserved.



-
- Common terms used in measuring air**
- Pitot Tube**
 - Device used to measure static and velocity pressure
 - Air Measuring Kit**
 - Tool set containing components to measure air, including Pitot tube, Magnehelic gauge(s), tubing, drill bits, charts, calculator, etc....
 - Pressure Differential Gauge**
 - Magnehelic Gauge, Manometer, Spring Gauge, Analog, or Digital device/gauge use to measure pressure differential
 - Velocity**
 - Speed of air, measured as "Feet per Minute" (FPM)
 - Volumetric Air Flow Rate**
 - Amount of air typically being moved through the system, measured as "Cubic Feet per Minute" (CFM)
 - Duct Velocity**
 - How fast the air, dust or product "flies" through the duct, measured in FPM
 - Grain dust typically has minimum of 3400 FPM. Wheat typically conveys at 4200 FPM
- ©Kice Industries, Inc. All rights reserved.





Common terms used in measuring air


- **Static Pressure**
 - Pressure used to overcome the resistance to flow or....
 - The amount of resistance of friction (including the hood, ducting, product and all other components)
 - And....the energy used to move the product from Point A to Point B
 - Usually the longest, smallest diameter run, but not always
- **Velocity Pressure**
 - Pressure required to accelerate the mass of air from rest to its' existing velocity or....
 - Air traveling at a given velocity or....
 - Way to calculate velocity
- **Total Pressure**
 - Sum total of static and velocity pressures
- **Area**
 - Measurement of the inside of a duct
 - Measured in square feet

Vector representation of SP, VP, and TP

Pressure Inside of a Duct

FIGURE 3-3. SP, VP, and TP at a point
Reprinted from Industrial Ventilation: A Manual of Recommended Practice for Design, 27th Edition, published by the American Conference of Governmental Industrial Hygienists

TP (total pressure) = SP (static pressure) + VP (velocity pressure)




Common Terms

- Air-to-Cloth Ratio**
 - Establishes design capacity of a baghouse filter
 - Ratio between the total amount of CFM and total area of the filter bags
 - 15,000 CFM / 1,555 sq ft of filter area = 9.65:1 Air-to-Cloth Ratio
 - Rule of Thumb
 - 7-10:1 for Elevator, Cleaning House, and General Suction
 - 7:1 for Secondary Collectors and High Humidity Air Systems
 - 5:1 for Filter/Receiver, Centro-Vacs, and Bin Vents
- Can Velocity**
 - Velocity measured inside the filter (in the open space below the bags)

Bulk Density (lbs/cu ft)	Filter Can Velocity (fpm)
30-50	300-360
<30	300
<20	180-240
- Interstitial Velocity**
 - Velocity measured inside the filter (between the filter bags)

Bulk Density (lbs/cu ft)	Filter Can Velocity (fpm)
<10	120-180
<5	60-120
<1	<60

©Kice Industries, Inc. All rights reserved.



Basic Formula to determine CFM


$$Q = VA$$

Q = ACFM (Volume of Air)
V = Velocity (in feet per minute)
A = Tube internal cross-section area (in square feet)

Follow a few basic principles

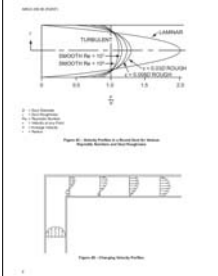
- Obtain the Velocity of the Air
- Obtain the Area of the duct/tube/pipe at the point of measurement
- Multiply Velocity x Area to determine volumetric flow rate

©Kice Industries, Inc. All rights reserved.



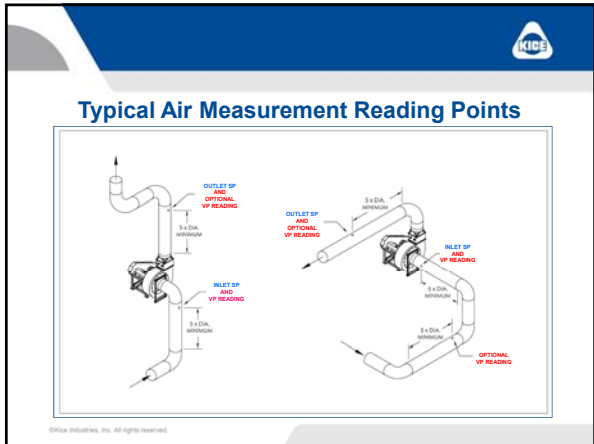
Why "5 + pipe diameters downstream" of fitting?

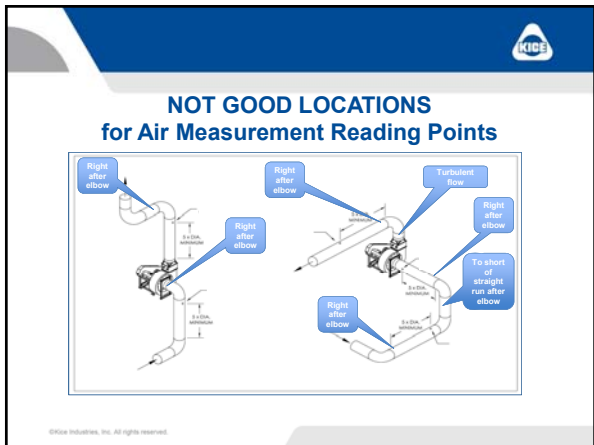
- Air after an elbow, fitting, damper, etc.... becomes turbulent
- Allows air to become "laminar" or more "even" inside the tubing/ducting/pipe
- Makes measurements more accurate

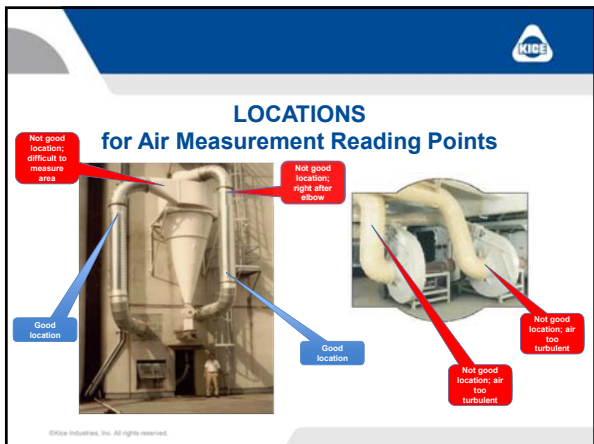


Reprinted from Publication 200-95 (R2007) Air Systems, published by the Air Movement and Control Association International, Inc.

©Kice Industries, Inc. All rights reserved.









“By the Book” Method of Measuring Air for accurate air flow measurements

- Safety First
- Select location 10 pipe diameters, if possible, away from dampers, branches, elbows, etc....
- Drill 2 holes 90-degrees apart to allow insertion of Pitot tube
- Connect Pitot tube static and/or total pressure connections to gauge
- Need to record temperature and absolute pressure
- Traverse the tube, recording SP (“ w.c.) and VP (“ w.c.) readings at published insertion depths
- Take readings in both planes
- Calculate velocities using each VP reading
- Average the velocities to determine Average Velocity (V_{avg}) in FPM
- Calculate the Tube Area in square feet at the plane the measurements were taken
- Multiply Velocity by the Tube Area to get CFM

©Kice Industries, Inc. All rights reserved.



“Reality” Method of Measuring Air for ESTIMATED STATIC PRESSURE

- Safety First
- Select location 5+ pipe diameters, if possible, away from dampers, branches, elbows, etc....
- Drill hole to allow insertion of Pitot tube
- Connect Pitot tube SP port to gauge or
 - ... Put hose perpendicular to the flow over the hole
- If using Pitot tube, center the tube inside the duct
- Record the reading on the gauge


©Kice Industries, Inc. All rights reserved.



“Reality” Method of Measuring Air for ESTIMATED air flow measurements

- Safety First
- Select location 5+ pipe diameters, if possible, away from dampers, branches, elbows, etc....
- Drill hole to allow insertion of Pitot tube
- Connect Pitot tube static and total pressure ports to gauge
- Record the VP at the center of the duct using the Pitot tube
- Convert Velocity Pressure (V_p) reading to Velocity (V) FPM
 - Refer to chart for Velocity or calculate $4005 \times \sqrt{VP}$ (at STP)
- Multiply the velocity by .9 for 6" OD and smaller duct or by .95 for ducts 8"OD and larger to ESTIMATE Average Velocity (V_{avg})
- Determine Tube Area in Square Feet
 - In Feet: Area of circle = $3.14 \times R^2$ or $.7854 \times \text{Diameter}^2$
 - In Inches: Area of circle = $3.14 \times R^2/144$ or $.7854 \times \text{Diameter}^2/144$
 - (144 square inches = 1 square foot)
- Multiply Velocity by the Tube Area to get CFM

©Kice Industries, Inc. All rights reserved.



Finding Velocity

Example 1:

- VP reading = 1.1
- Velocity = 4200 FPM

Example 2:


- VP reading = 1.75
- Velocity = 5298 FPM

Example 3:

- VP reading = 3.60
- Velocity = 7599 FPM

Calculation: Velocity = 4005 x √VP (at STP)

Duct Size		Area		Velocity		CFM	
in.	ft.	sq. ft.	sq. in.	fpm	cfm	fpm	cfm
1.0	0.083	0.0054	0.16	100	0.54	100	0.54
1.5	0.125	0.0122	0.31	100	1.22	100	1.22
2.0	0.167	0.0217	0.56	100	2.17	100	2.17
2.5	0.208	0.0344	0.88	100	3.44	100	3.44
3.0	0.250	0.0509	1.27	100	5.09	100	5.09
3.5	0.292	0.0712	1.74	100	7.12	100	7.12
4.0	0.333	0.0952	2.31	100	9.52	100	9.52
4.5	0.375	0.1329	3.14	100	13.29	100	13.29
5.0	0.417	0.1754	4.24	100	17.54	100	17.54
5.5	0.458	0.2227	5.61	100	22.27	100	22.27
6.0	0.500	0.2748	7.26	100	27.48	100	27.48
6.5	0.542	0.3317	9.21	100	33.17	100	33.17
7.0	0.583	0.3934	11.46	100	39.34	100	39.34
7.5	0.625	0.4600	14.01	100	46.00	100	46.00
8.0	0.667	0.5314	16.86	100	53.14	100	53.14
8.5	0.708	0.6076	19.99	100	60.76	100	60.76
9.0	0.750	0.6887	23.40	100	68.87	100	68.87
9.5	0.792	0.7748	27.09	100	77.48	100	77.48
10.0	0.833	0.8659	31.06	100	86.59	100	86.59
10.5	0.875	0.9620	35.31	100	96.20	100	96.20
11.0	0.917	0.1062	39.84	100	106.20	100	106.20
11.5	0.958	0.1115	44.65	100	111.50	100	111.50
12.0	1.000	0.1179	49.75	100	117.90	100	117.90
12.5	1.042	0.1254	55.14	100	125.40	100	125.40
13.0	1.083	0.1339	60.81	100	133.90	100	133.90
13.5	1.125	0.1434	66.76	100	143.40	100	143.40
14.0	1.167	0.1539	72.99	100	153.90	100	153.90
14.5	1.208	0.1654	79.50	100	165.40	100	165.40
15.0	1.250	0.1779	86.29	100	177.90	100	177.90
15.5	1.292	0.1914	93.36	100	191.40	100	191.40
16.0	1.333	0.2059	100.71	100	205.90	100	205.90
16.5	1.375	0.2214	108.34	100	221.40	100	221.40
17.0	1.417	0.2379	116.25	100	237.90	100	237.90
17.5	1.458	0.2554	124.44	100	255.40	100	255.40
18.0	1.500	0.2739	132.91	100	273.90	100	273.90
18.5	1.542	0.2934	141.66	100	293.40	100	293.40
19.0	1.583	0.3139	150.69	100	313.90	100	313.90
19.5	1.625	0.3354	159.99	100	335.40	100	335.40
20.0	1.667	0.3579	169.56	100	357.90	100	357.90
20.5	1.708	0.3814	179.41	100	381.40	100	381.40
21.0	1.750	0.4059	189.54	100	405.90	100	405.90
21.5	1.792	0.4314	199.95	100	431.40	100	431.40
22.0	1.833	0.4579	210.64	100	457.90	100	457.90
22.5	1.875	0.4854	221.61	100	485.40	100	485.40
23.0	1.917	0.5139	232.86	100	513.90	100	513.90
23.5	1.958	0.5434	244.39	100	543.40	100	543.40
24.0	2.000	0.5739	256.19	100	573.90	100	573.90
24.5	2.042	0.6054	268.26	100	605.40	100	605.40
25.0	2.083	0.6379	280.61	100	637.90	100	637.90
25.5	2.125	0.6714	293.24	100	671.40	100	671.40
26.0	2.167	0.7059	306.15	100	705.90	100	705.90
26.5	2.208	0.7414	319.34	100	741.40	100	741.40
27.0	2.250	0.7779	332.81	100	777.90	100	777.90
27.5	2.292	0.8154	346.56	100	815.40	100	815.40
28.0	2.333	0.8539	360.59	100	853.90	100	853.90
28.5	2.375	0.8934	374.90	100	893.40	100	893.40
29.0	2.417	0.9339	389.49	100	933.90	100	933.90
29.5	2.458	0.9754	404.36	100	975.40	100	975.40
30.0	2.500	1.0179	419.51	100	1017.90	100	1017.90
30.5	2.542	1.0614	434.94	100	1061.40	100	1061.40
31.0	2.583	1.1059	450.65	100	1105.90	100	1105.90
31.5	2.625	1.1514	466.64	100	1151.40	100	1151.40
32.0	2.667	1.1979	482.91	100	1197.90	100	1197.90
32.5	2.708	1.2454	499.46	100	1245.40	100	1245.40
33.0	2.750	1.2939	516.29	100	1293.90	100	1293.90
33.5	2.792	1.3434	533.40	100	1343.40	100	1343.40
34.0	2.833	1.3939	550.79	100	1393.90	100	1393.90
34.5	2.875	1.4454	568.46	100	1445.40	100	1445.40
35.0	2.917	1.4979	586.41	100	1497.90	100	1497.90
35.5	2.958	1.5514	604.64	100	1551.40	100	1551.40
36.0	3.000	1.6059	623.15	100	1605.90	100	1605.90
36.5	3.042	1.6614	641.94	100	1661.40	100	1661.40
37.0	3.083	1.7179	660.99	100	1717.90	100	1717.90
37.5	3.125	1.7754	680.30	100	1775.40	100	1775.40
38.0	3.167	1.8339	699.87	100	1833.90	100	1833.90
38.5	3.208	1.8934	719.70	100	1893.40	100	1893.40
39.0	3.250	1.9539	739.79	100	1953.90	100	1953.90
39.5	3.292	2.0154	760.14	100	2015.40	100	2015.40
40.0	3.333	2.0779	780.75	100	2077.90	100	2077.90
40.5	3.375	2.1414	801.62	100	2141.40	100	2141.40
41.0	3.417	2.2059	822.75	100	2205.90	100	2205.90
41.5	3.458	2.2714	844.14	100	2271.40	100	2271.40
42.0	3.500	2.3379	865.79	100	2337.90	100	2337.90
42.5	3.542	2.4054	887.70	100	2405.40	100	2405.40
43.0	3.583	2.4739	909.87	100	2473.90	100	2473.90
43.5	3.625	2.5434	932.30	100	2543.40	100	2543.40
44.0	3.667	2.6139	954.99	100	2613.90	100	2613.90
44.5	3.708	2.6854	977.94	100	2685.40	100	2685.40
45.0	3.750	2.7579	1001.15	100	2757.90	100	2757.90
45.5	3.792	2.8314	1024.62	100	2831.40	100	2831.40
46.0	3.833	2.9059	1048.35	100	2905.90	100	2905.90
46.5	3.875	2.9814	1072.34	100	2981.40	100	2981.40
47.0	3.917	3.0579	1096.59	100	3057.90	100	3057.90
47.5	3.958	3.1354	1121.10	100	3135.40	100	3135.40
48.0	4.000	3.2139	1145.87	100	3213.90	100	3213.90
48.5	4.042	3.2934	1170.90	100	3293.40	100	3293.40
49.0	4.083	3.3739	1196.19	100	3373.90	100	3373.90
49.5	4.125	3.4554	1221.74	100	3455.40	100	3455.40
50.0	4.167	3.5379	1247.55	100	3537.90	100	3537.90
50.5	4.208	3.6214	1273.62	100	3621.40	100	3621.40
51.0	4.250	3.7059	1300.05	100	3705.90	100	3705.90
51.5	4.292	3.7914	1326.74	100	3791.40	100	3791.40
52.0	4.333	3.8779	1353.69	100	3877.90	100	3877.90
52.5	4.375	3.9654	1380.90	100	3965.40	100	3965.40
53.0	4.417	4.0539	1408.37	100	4053.90	100	4053.90
53.5	4.458	4.1434	1436.10	100	4143.40	100	4143.40
54.0	4.500	4.2339	1464.09	100	4233.90	100	4233.90
54.5	4.542	4.3254	1492.34	100	4325.40	100	4325.40
55.0	4.583	4.4179	1520.85	100	4417.90	100	4417.90
55.5	4.625	4.5114	1549.62	100	4511.40	100	4511.40
56.0	4.667	4.6059	1578.65	100	4605.90	100	4605.90
56.5	4.708	4.7014	1607.94	100	4701.40	100	4701.40
57.0	4.750	4.7979	1637.49	100	4797.90	100	4797.90
57.5	4.792	4.8954	1667.30	100	4895.40	100	4895.40
58.0	4.833	4.9939	1697.37	100	4993.90	100	4993.90
58.5	4.875	5.0934	1727.70	100	5093.40	100	5093.40
59.0	4.917	5.1939	1758.29	100	5193.90	100	5193.90
59.5	4.958	5.2954	1789.14	100	5295.40	100	5295.40
60.0	5.000	5.3979	1820.25	100	5397.90	100	5397.90
60.5	5.042	5.5014	1851.62	100	5501.40	100	5501.40
61.0	5.083	5.6059	1883.25	100	5605.90	100	5605.90
61.5	5.125	5.7114	1915.14	100	5711.40	100	5711.40
62.0	5.167	5.8179	1947.29	100	5817.90	100	5817.90
62.5	5.208	5.9254	1979.70	100	5925.40	100	5925.40
63.0	5.250	6.0339	2012.37	100	6033.90	100	6033.90
63.5	5.292	6.1434	2045.30	100	6143.40	100	6143.40
64.0	5.333	6.2539	2078.49	100	6253.90	100	6253.90
64.5	5.375	6.3654	2111.94	100	6365.40	100	6365.40
65.0	5.417	6.4779	2145.65	100	6477.90	100	6477.90
65.5	5.458	6.5914	2179.62	100	6591.40	100	6591.40
66.0	5.500	6.7059	2213.85	100	6705.90	100	6705.90
66.5	5.542	6.8214	2248.34	100	6821.40	100	6821.40
67.0	5.583	6.9379	2283.09	100	6937.90	100	6937.90
67.5	5.625	7.0554	2318.10	100	7055.40	100	7055.40
68.0	5.667	7.1739	2353.37	100	7173.90	100	7173.90
68.5	5.708	7.2934	2388.90	100	7293.40	100	7293.40
69.0	5.750	7.4139	2424.69	100	7413.90	100	7413.90
69.5	5.792	7.5354	2460.74	100	7535.40	100	7535.40
70.0	5.833	7.6579	2497.05	100	7657.90	100	7657.90
70.5	5.875	7.7814	2533.62	100	7781.40	100	7781.40
71.0	5.917	7.9059	2570.45	100	7905.90	1	




Why is this information important in an “Air System”?

- **Make system changes for adequate conveying velocity:**
 - For example, downstream duct area must roughly equal the sum of the area of the upstream ducts. A system tour can reveal duct branches that may have issues.
- **Take proof-of-performance airflow and static pressure measurements:**
 - These will show whether you have adequate conveying velocity in all system branches at startup and provide a reference point to which you can go back if rebalancing is needed.
- **Keep records of recent routine system measurements AND follow up when out of “acceptable”:**
 - Data history may show which parts of the system typically fail first (for example, plugged elbows, blinded filter media, or other component) for corrective action before major events.

Assign trained personnel responsibility for the system:

- Allow your personnel the time, tools, and skills to take the data and complete follow-up actions.


©Kice Industries, Inc. All rights reserved.



General Good Practices

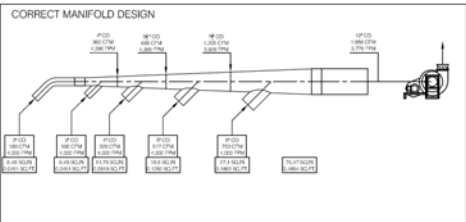
- Increase line size as needed to keep good velocity in the line back to the filter
 - Reduces resistance & keeps dust in suspension.
- Use lockable dampers or slide gates on each connection point AND MARK FOR REFERENCE
 - Use for balancing & lockout to keep from changes being made.
- Allow Free Air into the system
 - Cannot “pull” against a dead head or sealed system & makes use of natural air currents.
- Seal any “leaks” in the system
 - Will rob the dust collection system of suction to remove dust & many small leaks will add up.
- Purchase and learn to use an Air Measuring Kit
 - Will let you measure resistance and static pressure, can use to rebalance a system, and gives you some known data to work with.
- Use care putting Pitot tube in conveying line or heavy dust line.
 - May clog the small ports in the Pitot tube.

©Kice Industries, Inc. All rights reserved.




Good design, Good volume, Good velocity

CORRECT MANIFOLD DESIGN



Dust is in suspension because of correct velocities and velocities are correct to minimize wasting HP.

©Kice Industries, Inc. All rights reserved.



Closing Comments

- It is not difficult to take air measurement reading with the correct tools.
- It can help you in dealing with the manufacturer and minimize any downtime.
- The information the air readings provide can:
 - Benefit product quality*
 - Benefit in product recovery*
 - Extend equipment life*
 - Save energy*
 - Reduce emissions*
 - Reduce housekeeping*
 - Keep the plant running and out of trouble*

©Kice Industries, Inc. All rights reserved.



Thank you for the opportunity to speak today



**MEASURING AIR
VELOCITY**

Wednesday Feb. 28
2:00 PM - 3:00 PM CST

Contact information: Lonnie Glen, lglen@kice.com / Ph: 316-744-7151

©Kice Industries, Inc. All rights reserved.
