Testing – Understanding the Proper Testing Processes and Requirements for Electronics, Electronic Components and Printed Circuit Boards

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Abstract
As the need for electronics, electronic components and printed circuit boards becomes more important; the testing of products for these industries becomes a critical component. New materials, new components and new processes all play a vital role in the growth of the electronic and printed circuit board markets. Understanding the industry test guidelines and requirements are essential to product safety and product development. This presentation will give relevant information and guidance to the interconnection industry on what to look for in product testing. We will review industry test requirements and standards along with typical electronic company test standards for their products. Additionally the presentation will cover proper chamber selection, correct testing set up, air flow design and best test practices for the industry. With new markets and products being developed at a rapid pace; industry and company test standards will become part of what each manufacturer must understand. New test standards will be developed to secure both safety and industry guidelines that manufacturers must follow. As manufacturers develop new products for their markets; engineers, R&D managers, quality managers, product managers and product testing personal will need to be educated and knowledgeable of the testing guidelines so they can engineer, specify and build their products around these test standards. This presentation will give them a solid background in awareness of testing, testing requirements and testing standards.

Introduction
Product testing is an important element in the electronics, electronic components and printed circuit board industry. Product testing assures manufactures of safe products, dependability of their products and customer satisfaction. Understanding the various testing specifications, testing chambers, airflow design, test design and testing set up will help achieve better and more accurate test data for your product. Product testing involves many steps from selecting the correct test application, type of chamber, chamber airflow requirements and understanding the test results. The correct test application along with proper test processes is a key component in getting the best test possible. The airflow design used in the test chamber for product testing is critical to get the results that are accurate. Depending on the test specifications required and the device under test (DUT) the airflow you choose is very important. Reviewing and following all the steps needed to get a complete and accurate test gives product manufactures a better, safer and more reliable product for their customers.

Data
In the electronics, electronic components and printed circuit board industry manufactures are required to follow industry guidelines and testing requirements for the products they produce. The industry is covered by many associations that set requirements for product testing. Associations such as the IPC, IEC, ANSI, JEDEC, UL, MIL-SDT all have specifications and guidelines for product manufacturing. These requirements may involve product quality, safety, reliability and performance. Many manufactures also have their own in house test requirements that they have written to a certain performance standard. These standards may come from their own internal requirements or from a customer specific request. In most of these cases a test chamber is required to perform the necessary environmental test that will determine if the product meets these specifications.

In the selection of a test chamber for the product test; a determination will have to be made on type of chamber that is needed. Several categories of chambers are available. The typical test would be a temperature and humidity test requirement. This test requires the chamber to have a temperature range on the low end to a high end. A temperature range could be -40ºC to 180ºC. Humidity ranges from 10% to 98%. Environmental Stress Screen (ESS) chambers have a vertical or horizontal air flow that has fast temperature change rates. ESS chambers are used in many electronics applications with the use of a rake system for multi-product staging.

Thermal shock chambers offer varying temperature and humidity ranges but adds a very aggressive change rate over a short period of time. MIL-STD 883C was developed of adding this method of mechanical stress to electronic components. Thermal shock chambers would move from a very low temperature to an ambient temperature zone then immediately to a very hot temperature zone. AGREE/HALT/HASS all add vibration to the product testing. These tests are used to find the breaking point of a product. Used in the product development process, manufactures conduct HALT (Highly Accelerated Life Test) on products to determine product reliability and for warranty duration. Other chambers include small bench top units for laboratory environments and small product testing. Altitude, salt and corrosion and sand and dust are other type of chambers. Manufactures also may find a need for a custom test chamber for a specific requirement.

Product testing set up is vital to a successful test. Reviewing your requirements for the device under test (DUT) involves reviewing many elements. The first step is reviewing the size of you DUT. An important question to ask would be what additional size DUT may be used in the future? The chamber you need should consider all your product testing and size of these products so you are able to test many different products. The test specification must be understood to perform the proper test with the proper test chamber. The IPC, IEC, UL, MIL-STD or other test requirement must be reviewed so the test can be conducted to meet these standards. As the understanding of the test standard is finalized the chamber then can be selected. Based off the test requirement the chamber airflow, temperature and humidity range would then be selected. Then the tester would need to determine if fixtures for product placement are needed, check to see if the DUT requires dynamic or static load and finally select the analysis tools. Analysis tools typically would be the controller of the test chamber. Many different options and features can be selected for this controller.

With any product testing the airflow that is used in the chamber is very important. The airflow that is selected will have an impact on the outcome of the test. The selection of backwall, sidewall, vertical, horizontal, AGREE or other airflow pattern is necessary to get the best possible testing result.

The use of a backwall or sidewall airflow in the chamber test space will depend on the DUT and the size of the DUT. The objective is to get the best airflow uniformity on the product. Once the product is identified and the size or sizes to be tested; a calculation can be done to select the best airflow. See Figure 1and Figure 2.

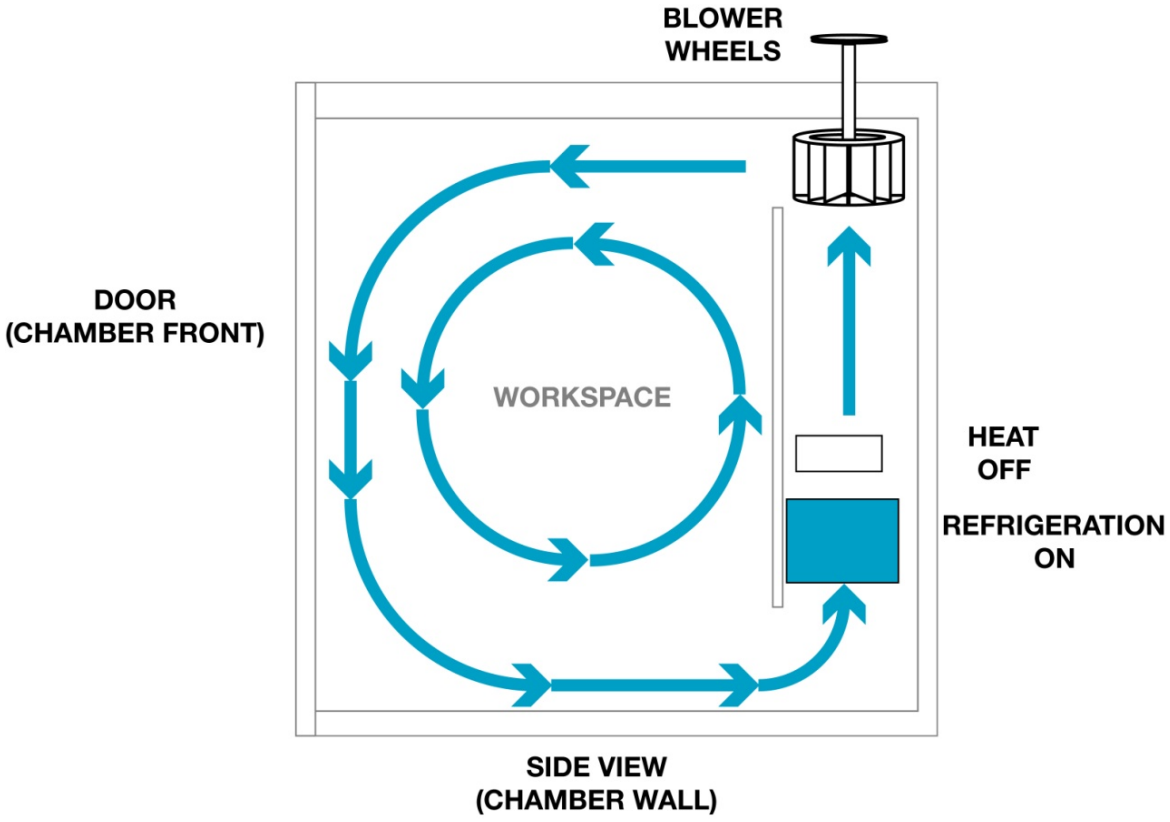


Figure 1

Figure 2

Vertical airflow test chambers are best used for testing products that have dynamic loads (live load) in the chamber workspace and are giving off heat. The vertical air flow provides uniform airflow and temperate in the workspace. Product placement in the chamber workspace is also important to maintain this even temperature. See Figure 3 and Figure 4.

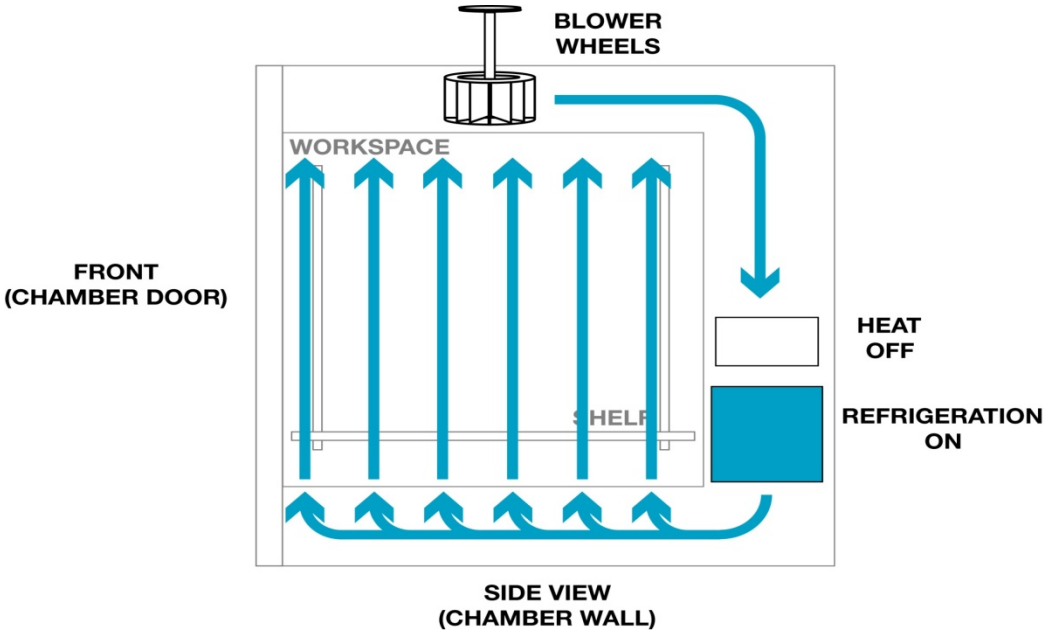


Figure 3

Figure 4

Horizontal airflow test chamber are also used for product testing that has dynamic loads (live loads) in the workspace and are giving off heat. Horizontal airflow allows for maximum workspace usage and is ideal for products that are tested on a rake system. Horizontal also provides uniform airflow within the workspace. See Figure 5 and Figure 6.

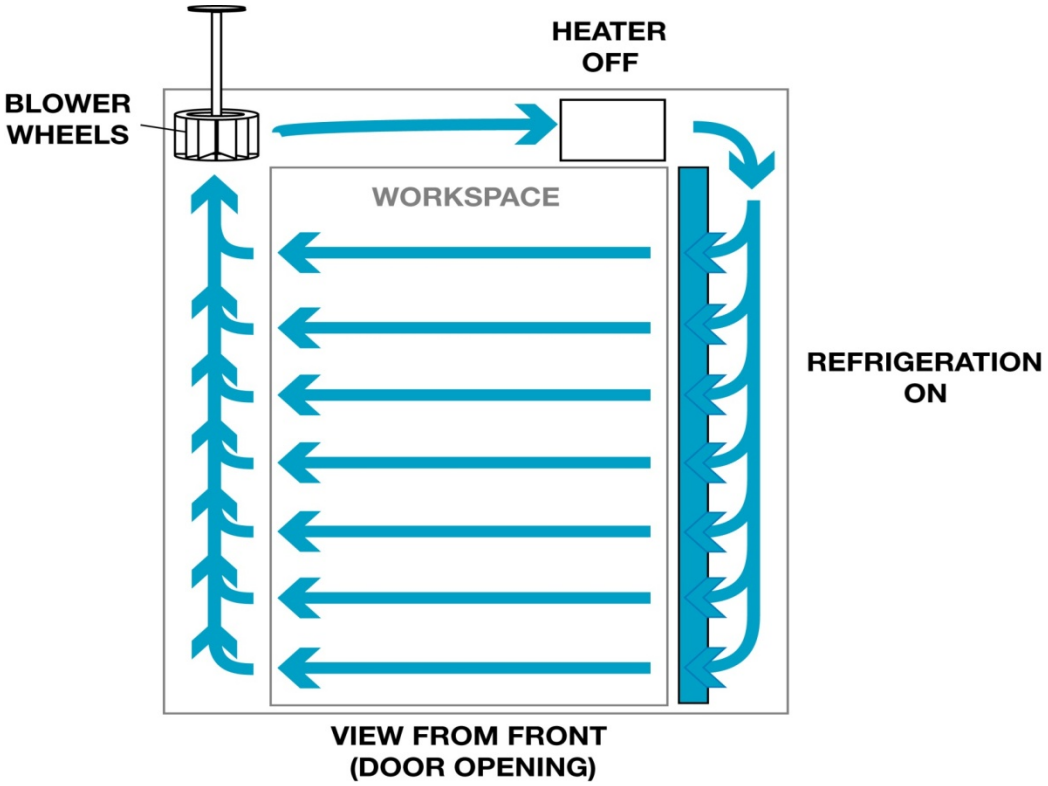


Figure 5

Figure 6

AGREE style airflow test chambers allow for high airflow volume. AGREE test chambers are used in conjunction with vibration testing. You can perform temperature, humidity and vibration testing within the same chamber workspace. AGREE style airflow is used in many MIL-STD tests. See Figure 7 and Figure 8.

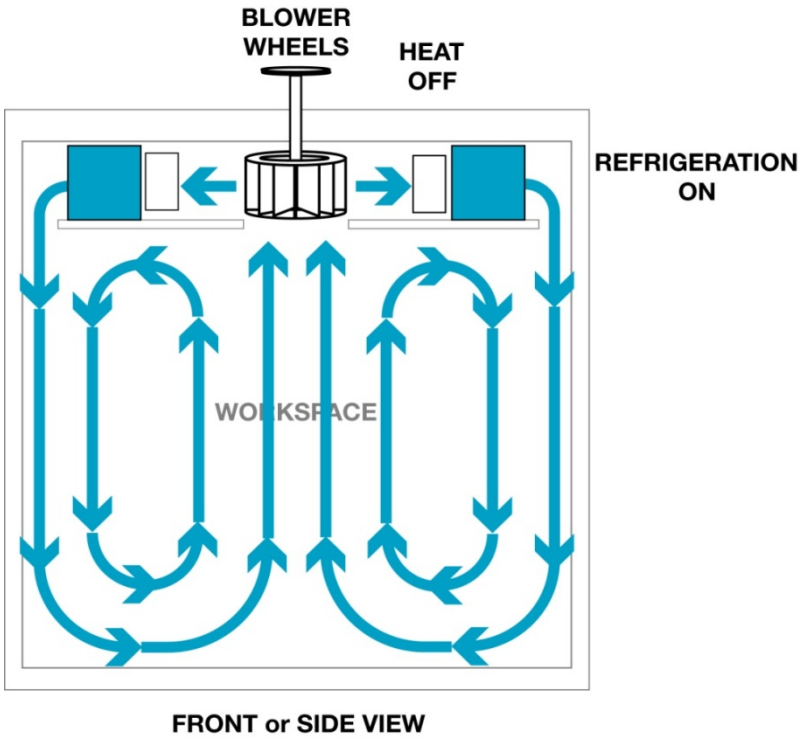
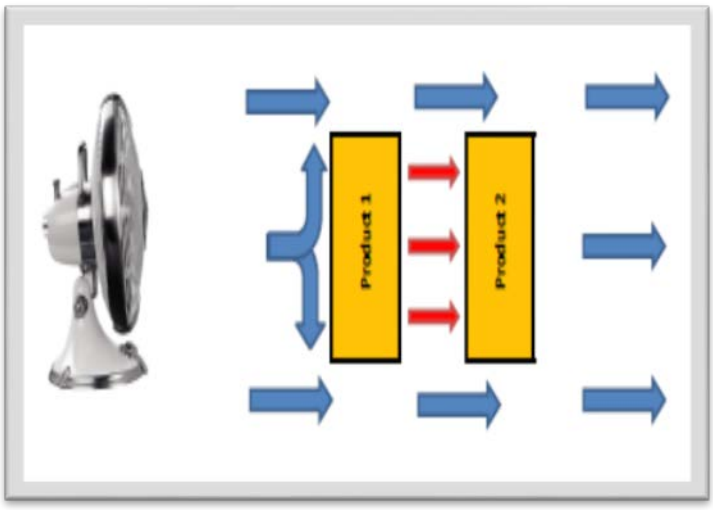


Figure 7

Figure 8

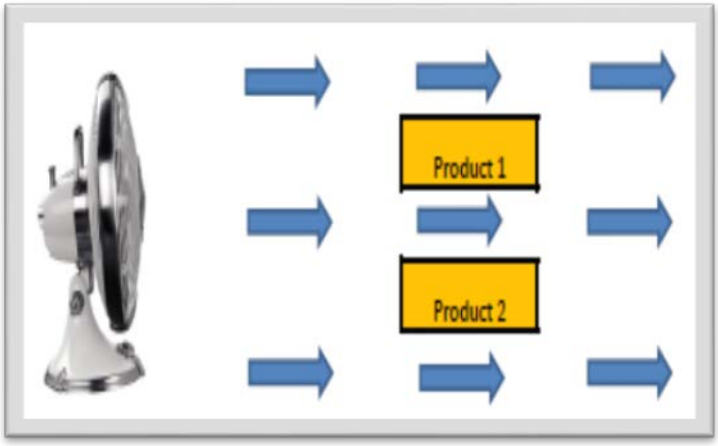
Proper airflow is necessary for a successful product test. The product placement in the test chamber workspace along with proper airflow direction will lead to an accurate and correct test result. See Figure 9 and Figure 10.



Delta-T between Product 1 and 2 is high

- Test conditions are inconsistent
- Hard to determine cause of failures
- Bad temperature distributions
- High failures in the field

Figure 9



Delta-T between Product 1 and 2 is low

- Test conditions are consistent
- Easy to determine cause of failures
- Good temperature distributions
- Less failures in the field

Figure 10

The relationship between air and product temperature is important in product testing. Depending on the test specification; the product temperature or the air temperature will need to be tracked. Understanding the test requirement will determine where you place your test set points. The product and air temperature can vary widely in a test chamber workspace. The place and position you place your sensors; on the DUT or the air is based on what the test requirement calls for. See Figure 11

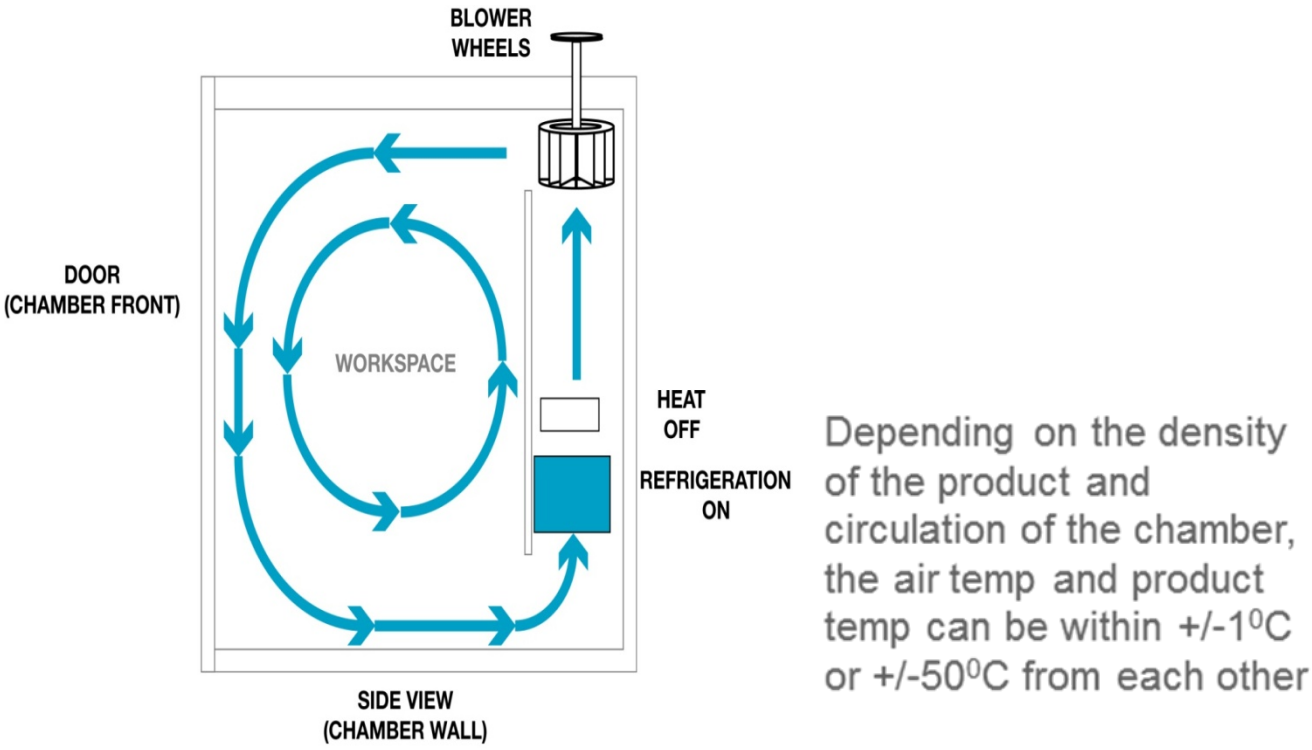


Figure 11

Airflow velocity is also important within the chamber test workspace. Too little airflow will not test your DUT correctly. Product testing involves removing heat from your DUT. Low or slow airflow will not remove head from the product. The product temperature and air temperature will not be in alignment. See Figure 12 and Figure 13.

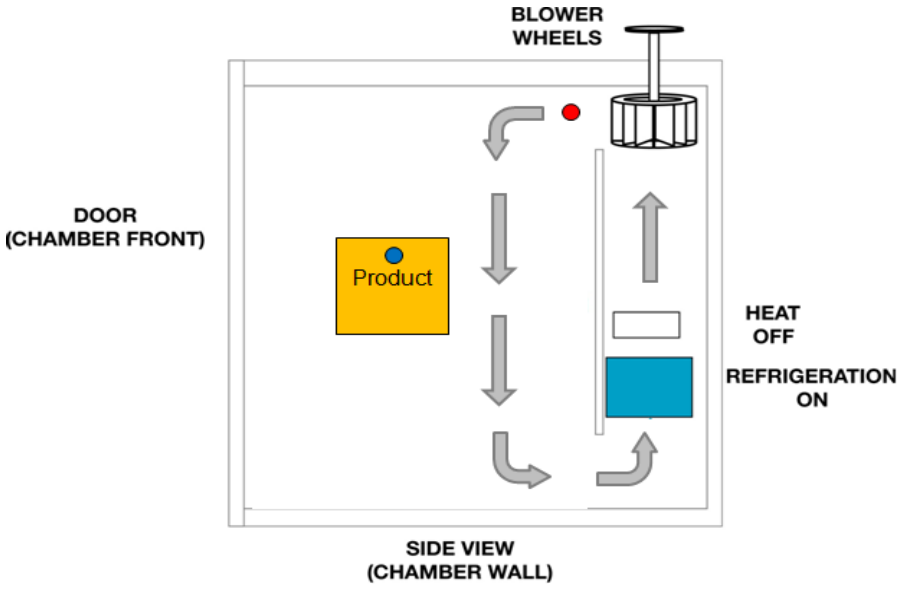


Figure 12

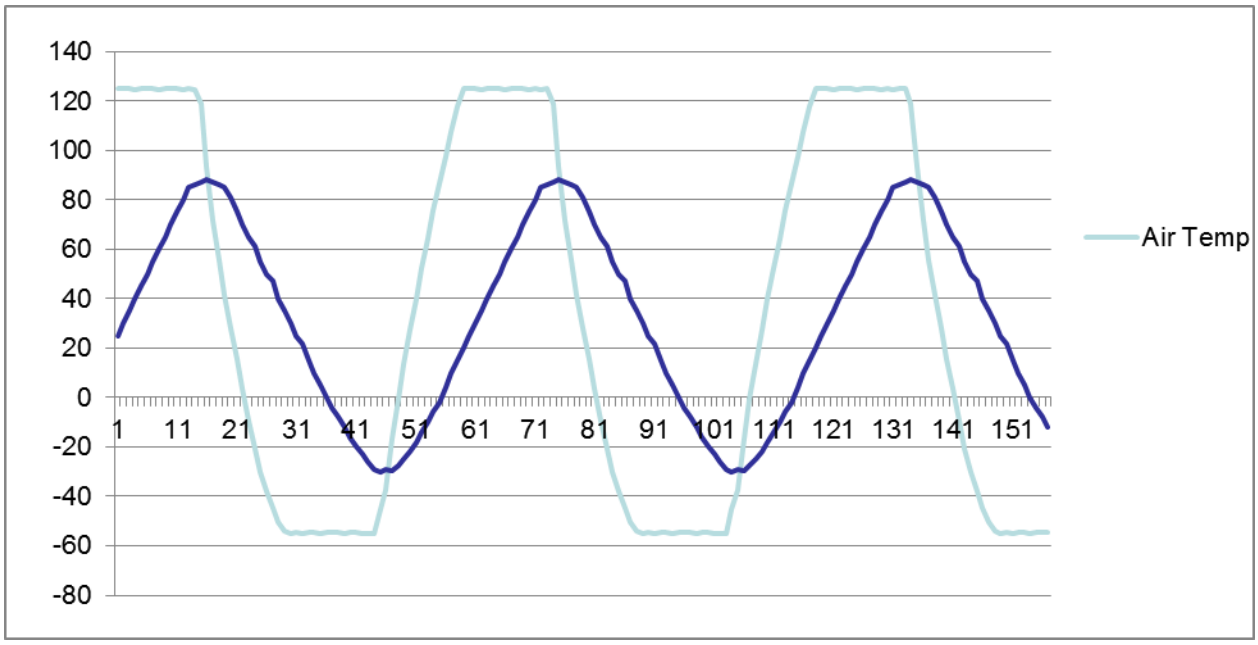


Figure 13

Fast and high airflow velocity will allow your product temperature and air temperature to be in alignment. This allows for better and more accurate test results. One item that must be checked in fast and high airflow velocity is the maximum heat dissipation for the DUT. If you maximum heat dissipation of the DUT is 10ºC per minute then your chamber air rate should be at 10ºC per minute as well. See Figure 14 and Figure 15.

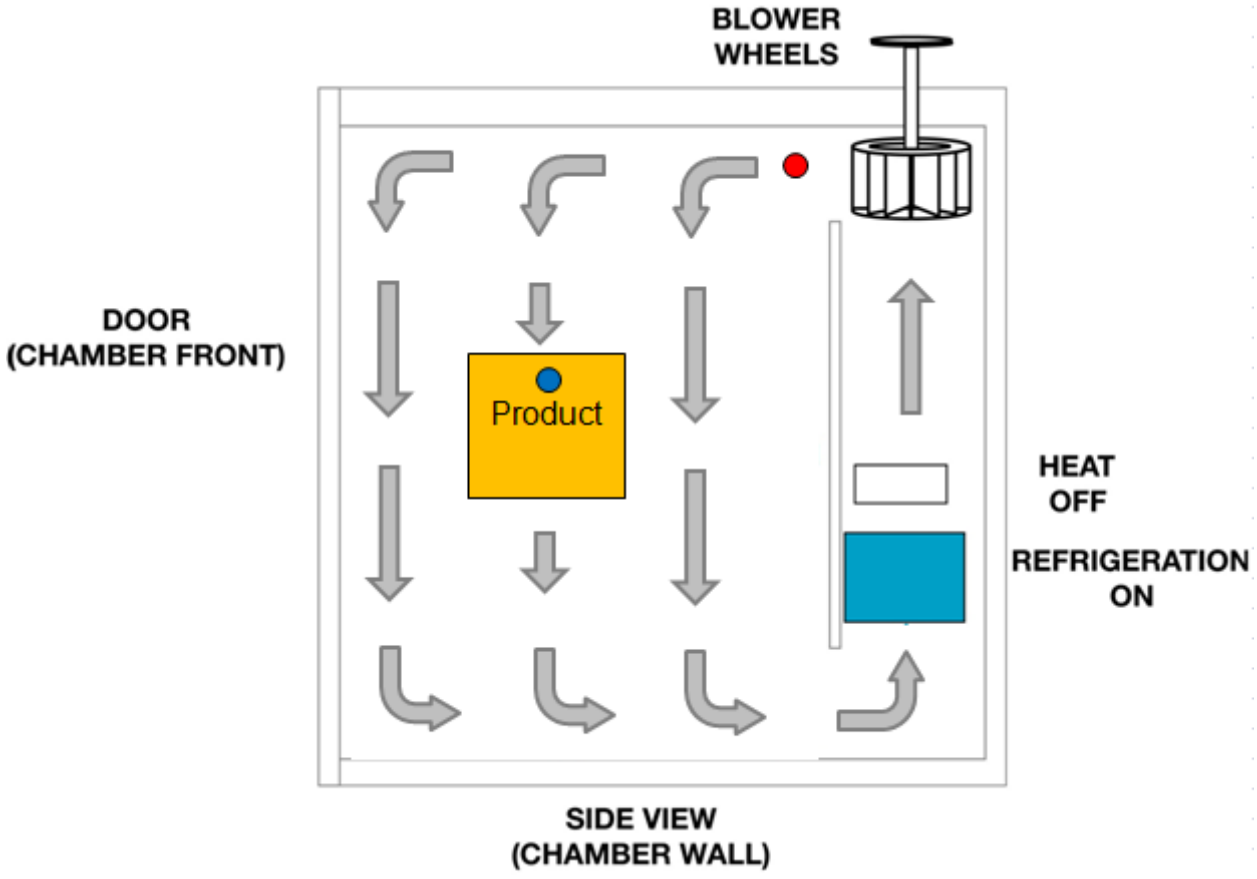


Figure 14

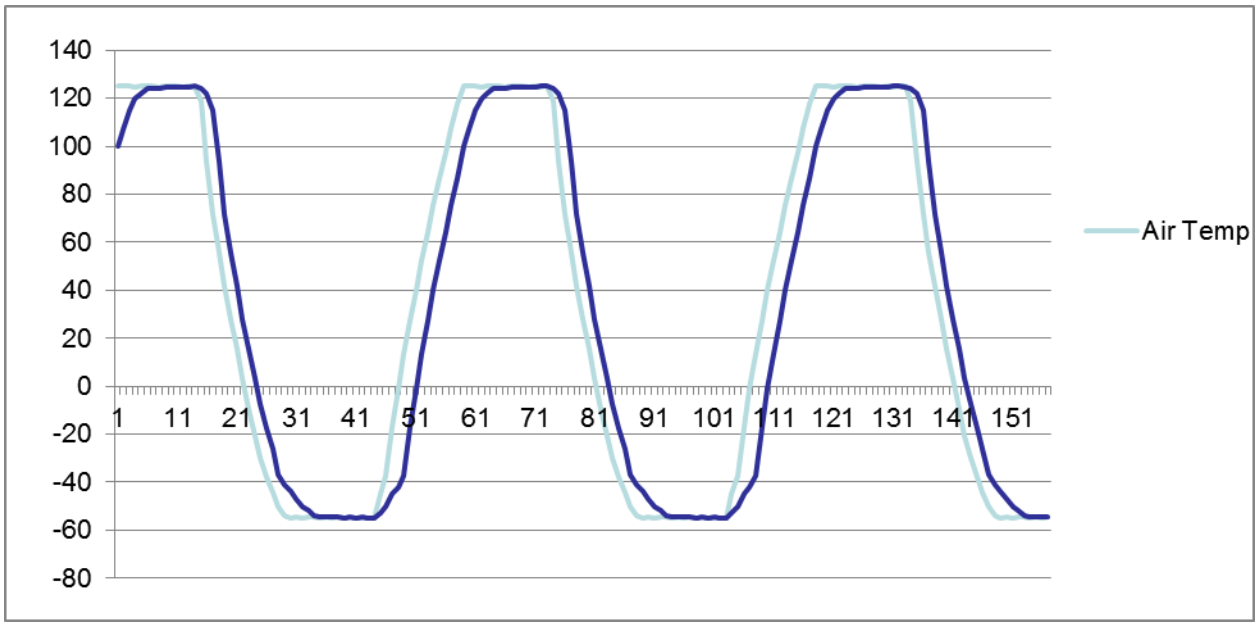


Figure 15

Airflow direction and velocity has a direct impact on the DUT. Airflow must be best utilized to the product in the workspace for best test performance and accurate test results. Improper use of airflow and airflow velocity will give product testing incorrect test results. Understanding your test specifications and gaining knowledge of proper testing processes and various airflow types will help you in achieving the most accurate and trusted results. See Figures 16-20.

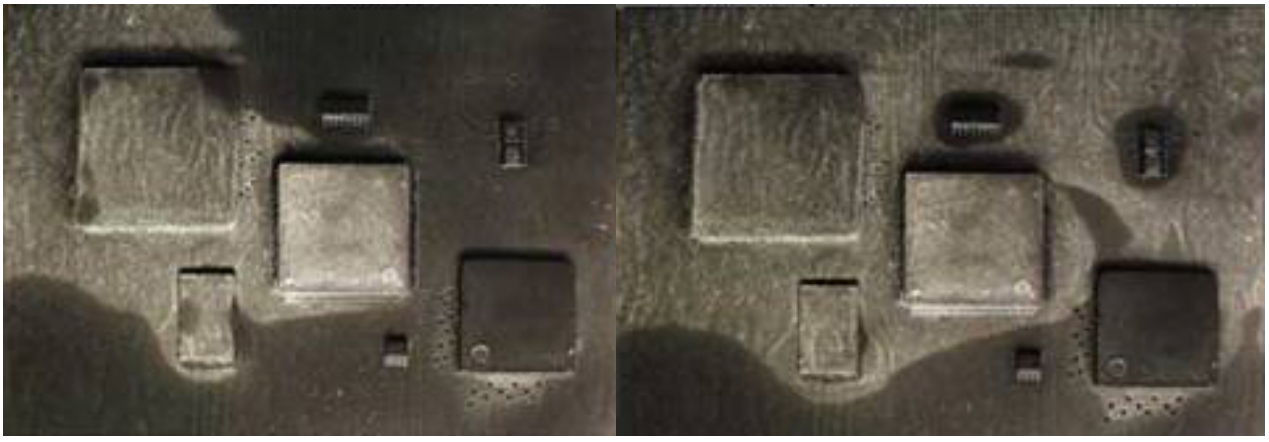


Figure 16

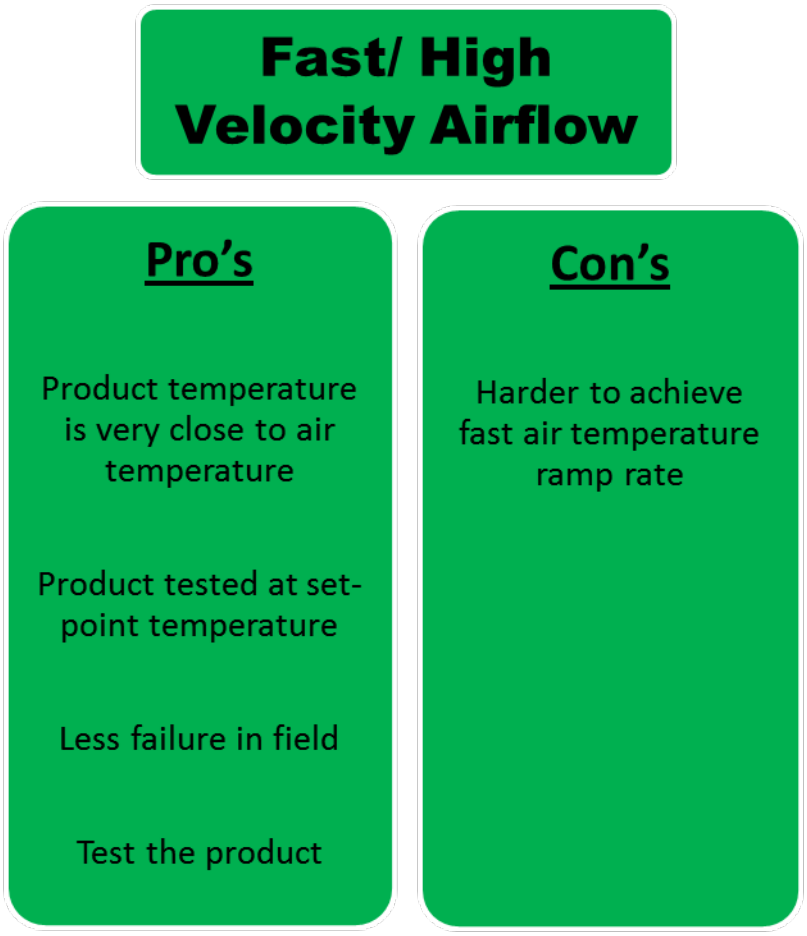

Fast/ High Velocity Airflow
Pro's
Product temperature is very close to air temperature
Product tested at set-point temperature
Less failure in field
Test the product
Con's
Harder to achieve fast air temperature ramp rate

Figure 17

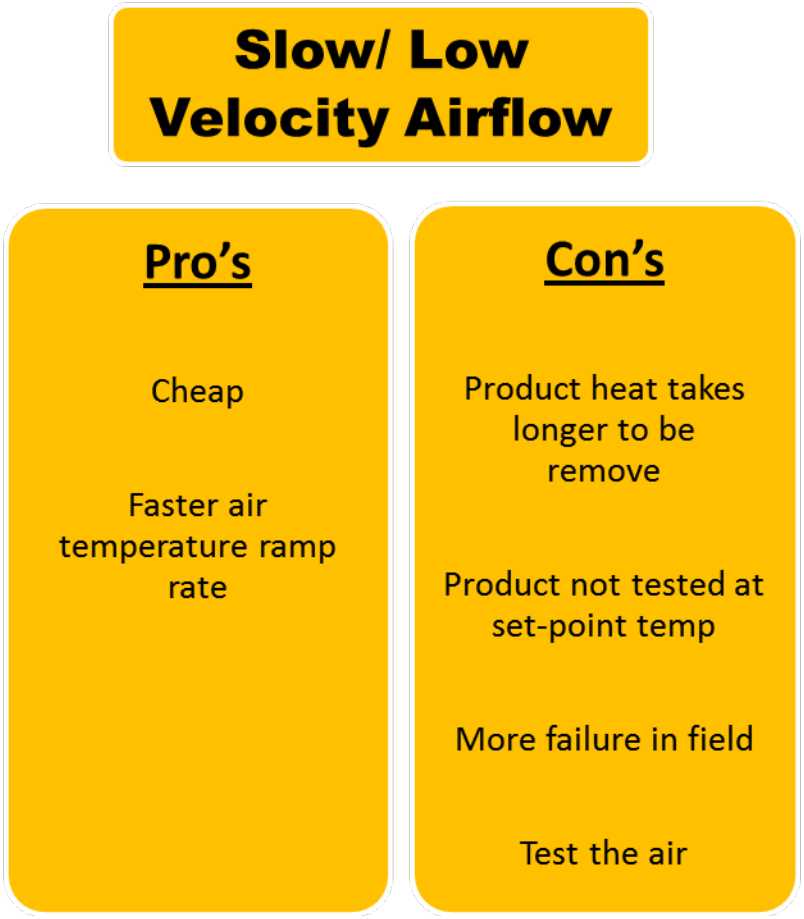

Slow/ Low Velocity Airflow
Pro's
Cheap
Faster air temperature ramp rate
Con's
Product heat takes longer to be remove
Product not tested at set-point temp
More failure in field
Test the air

Figure 18

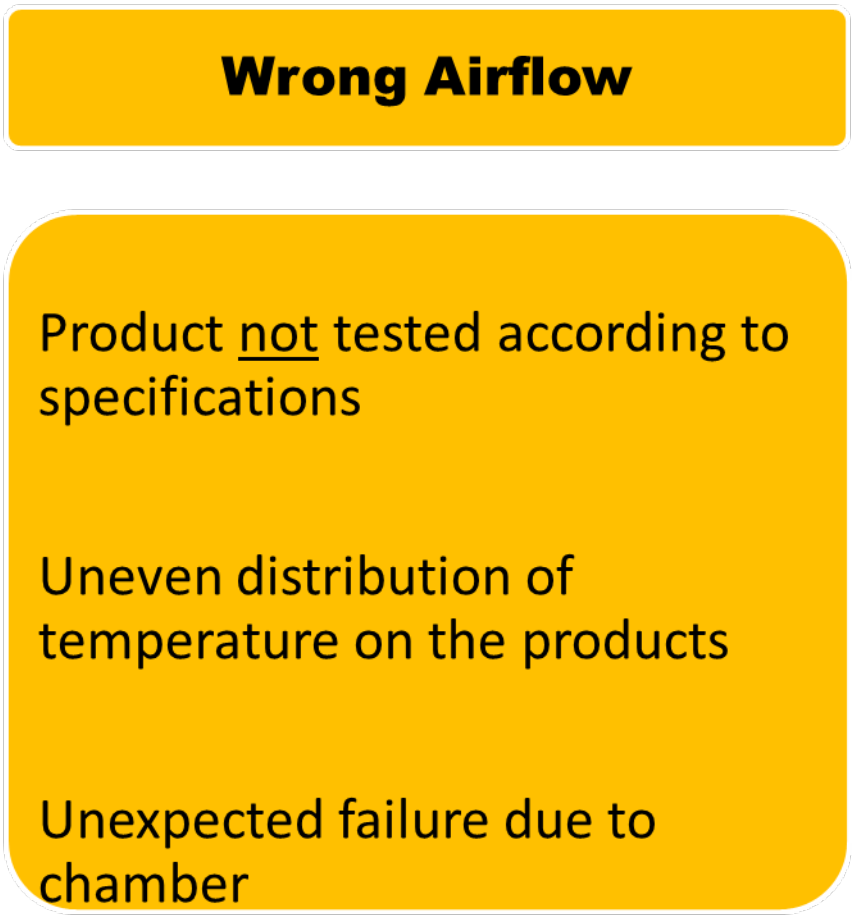

Wrong Airflow
Product not tested according to specifications
Uneven distribution of temperature on the products
Unexpected failure due to chamber

Figure 19

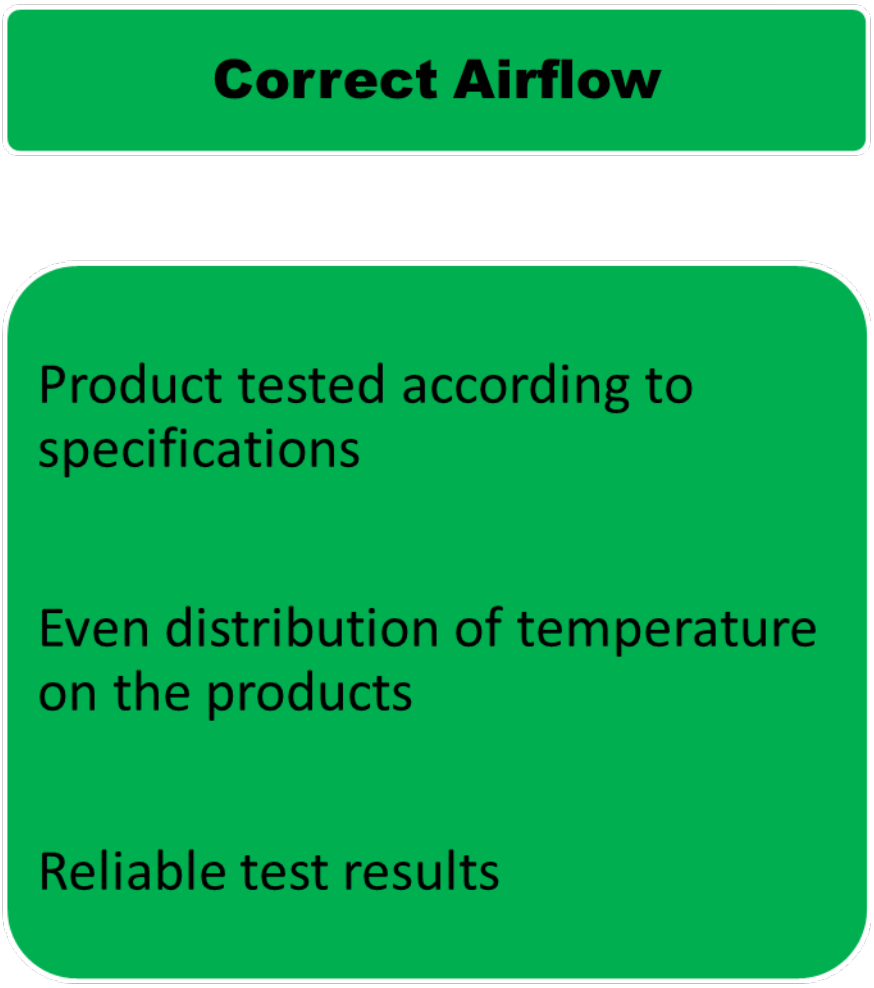


Figure 20

Conclusion

Testing of electronic products is important in the product development process, product safety and in product research and development. Understanding the electronics testing specifications and how to meet these specifications is critical for the electronics industry. Having the knowledge of how these tests are set, administered and concluded results in better products customers. How the tests are set up and how the product is set in relationship to the airflow leads to a successful and accurate test result.

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Testing

Testing & Inspection

Understanding the proper testing processes, equipment and requirements for:

- *Electronics*
- *Electronic components*
- *Printed Circuit Boards*

Agenda

- Industry Testing Requirements
- Chamber Selection
- Product Testing Set-Up
- Chamber Airflow Design
- Questions & Answers

Industry Testing Requirements

- IPC
- IEC
- ANSI
- JEDEC
- UL
- MIL-STD
- In House Test Requirements

Chamber Selection

- Temperature & Humidity
- Environmental Stress Screen
- Thermal Shock
- AGREE
- HALT/HASS
- Benchtop
- Altitude
- Salt Spray/Corrosion
- Sand & Dust
- Custom

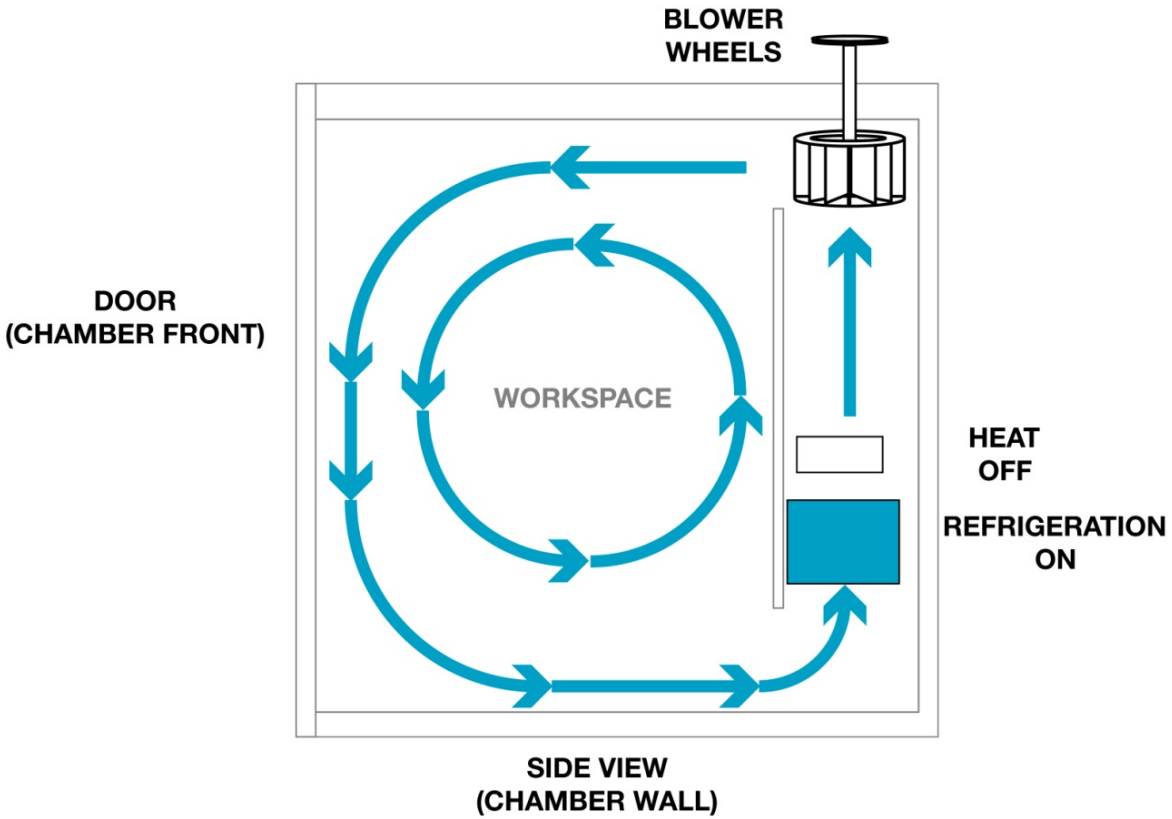
Product Testing Set Up

- Size of DUT (Device Under Test)
- Chamber workspace size
- Test specification
- Type of chamber needed
- Type of airflow needed
- Product or air temperature
- Fixtures
- Dynamic or static DUT
- Analysis tools

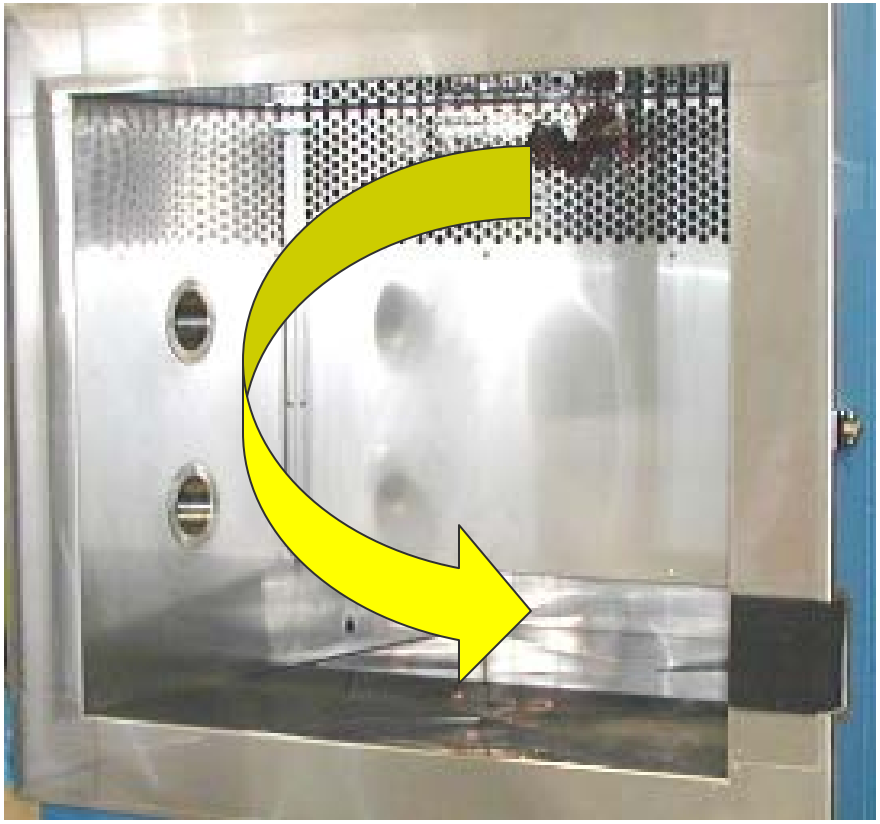
Airflow Effects

Temperature uniformity of DUT
Heat dissipation of DUT
Consistent test results

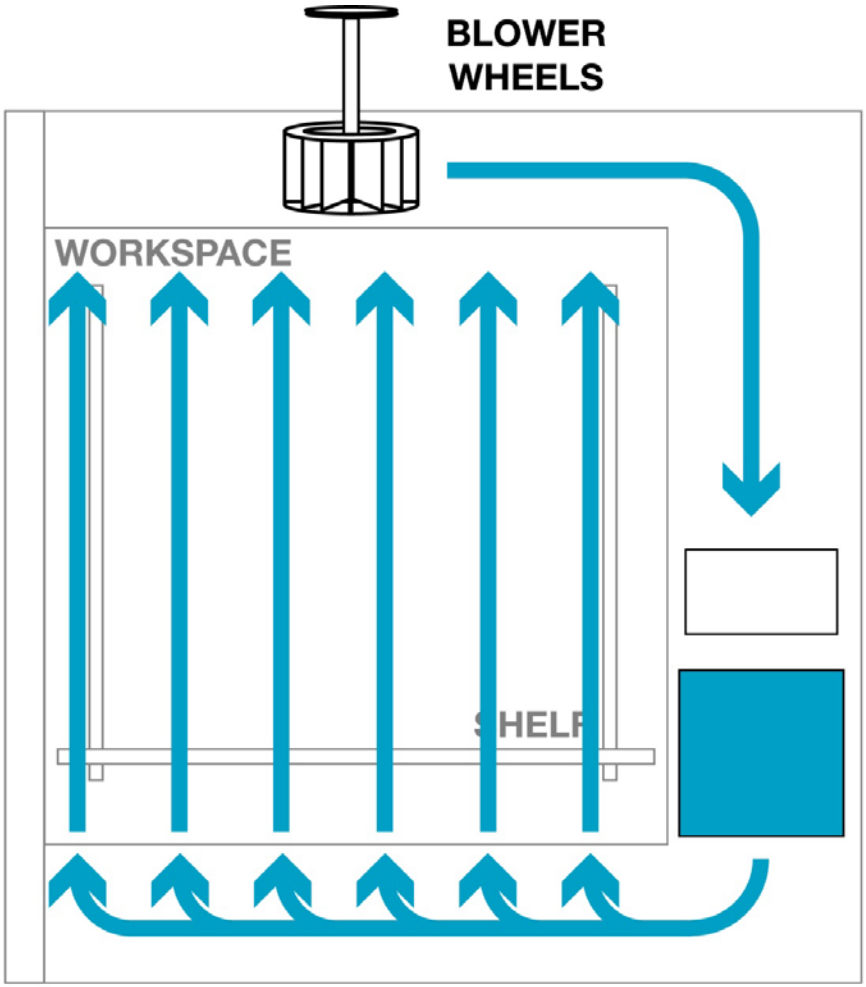
Backwall or Sidewall Airflow



Backwall or Sidewall Airflow

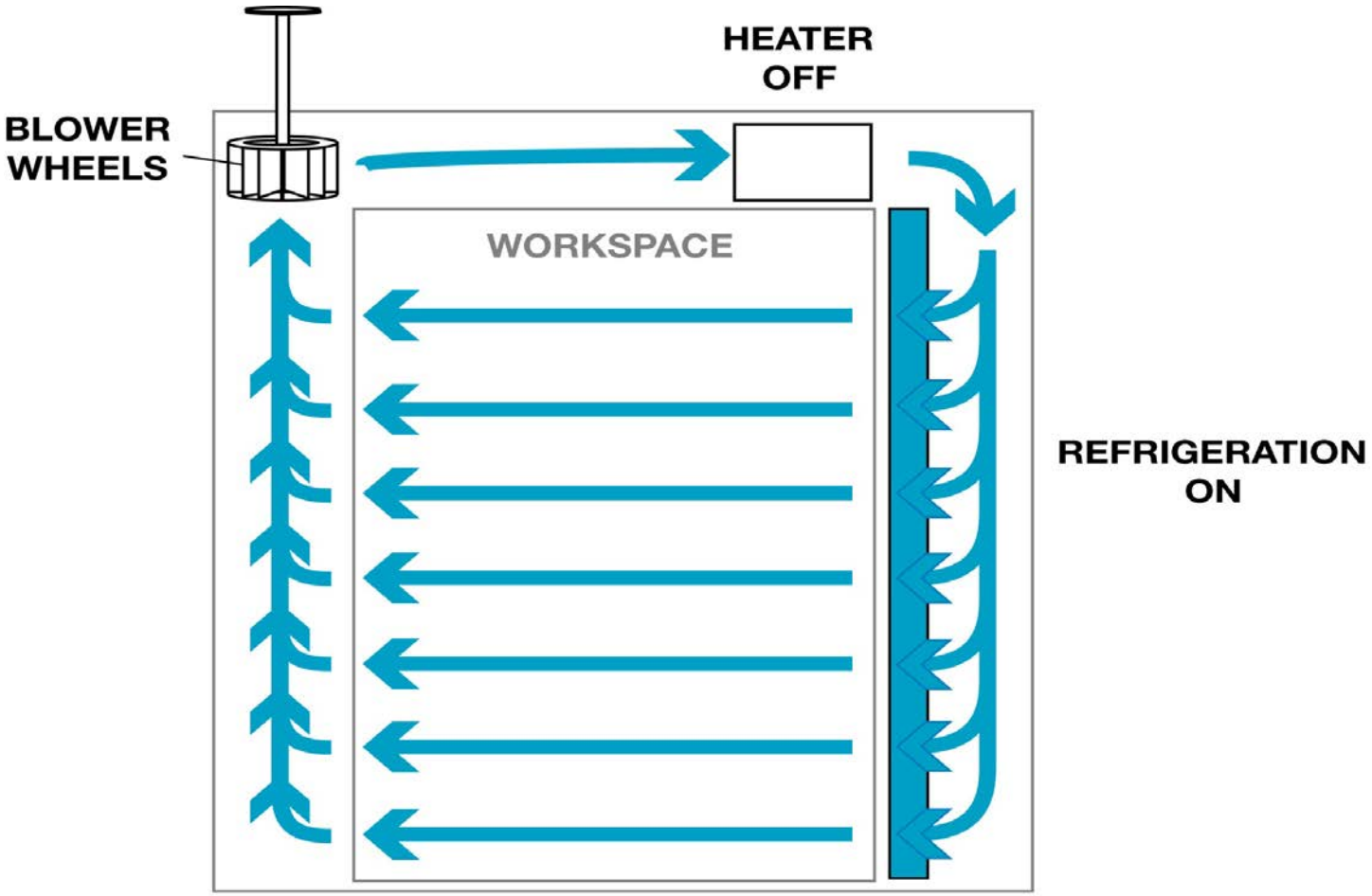


Vertical Airflow

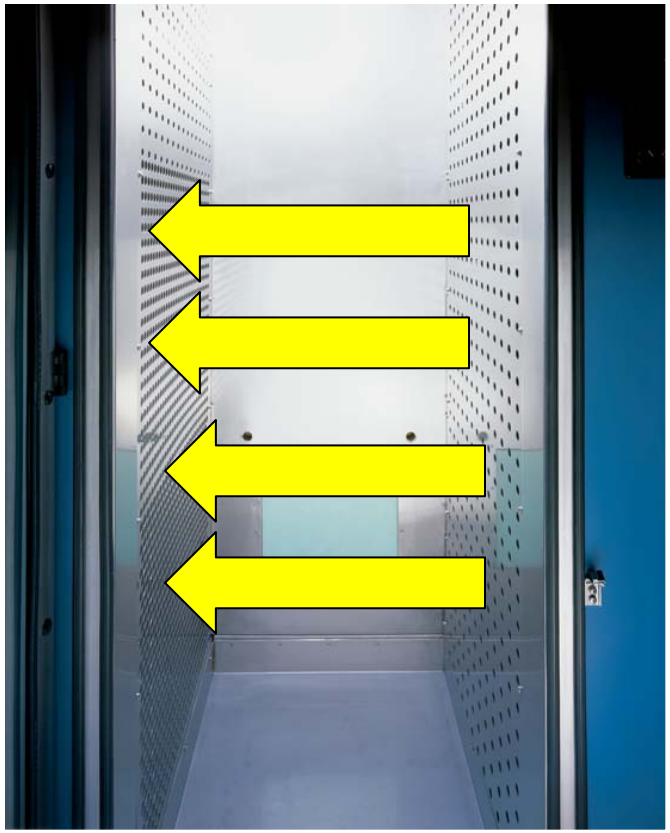


Vertical Airflow (VAF)

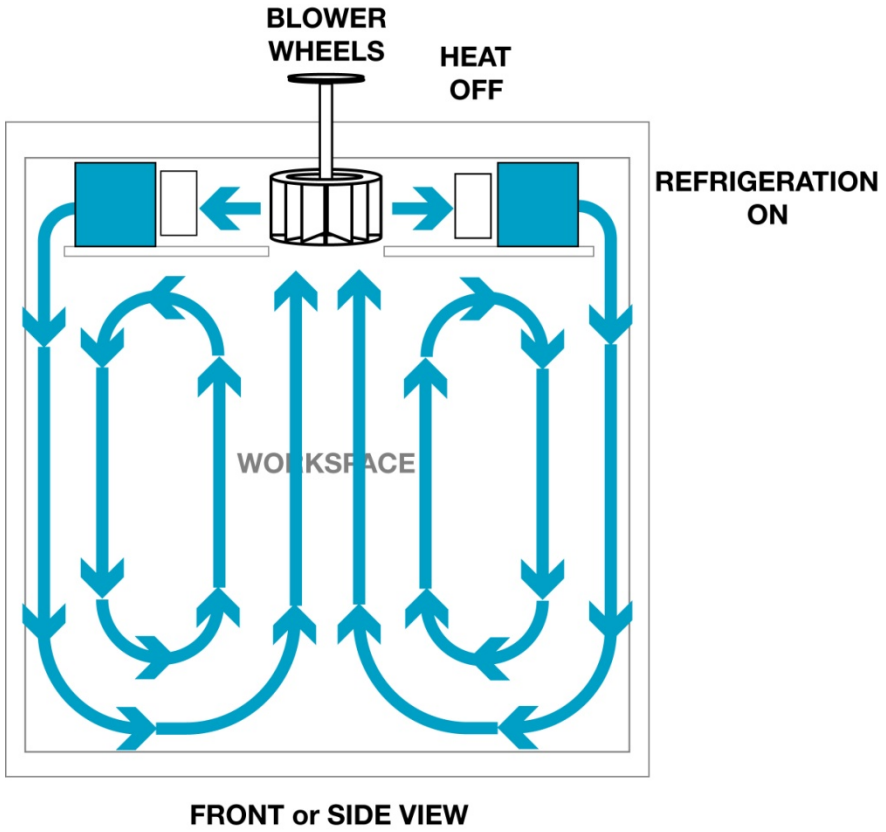
Horizontal Airflow



Horizontal Airflow (HAF)

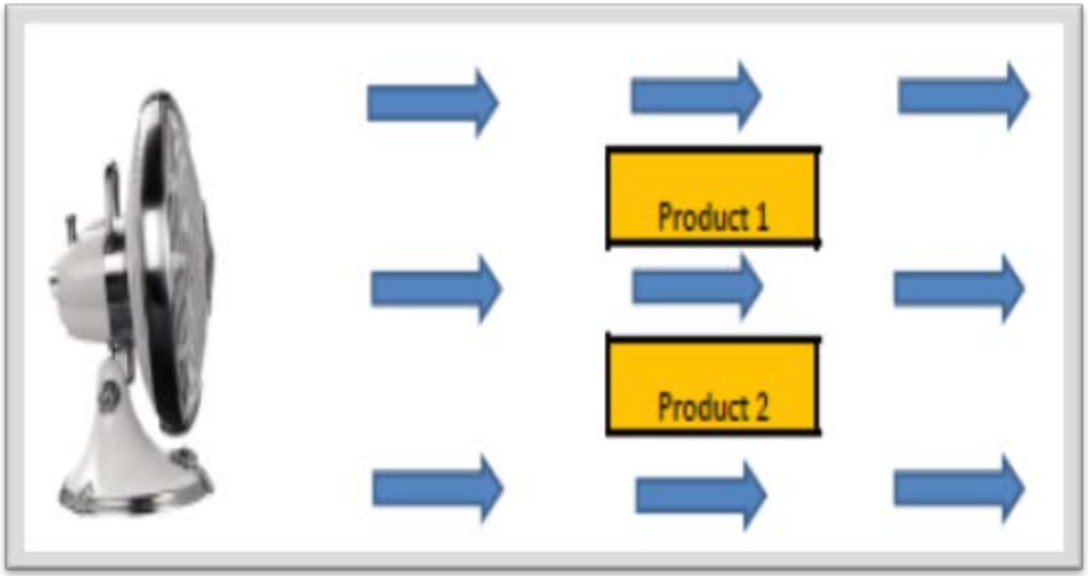


AGREE-Style Airflow



AGREE-Style Airflow

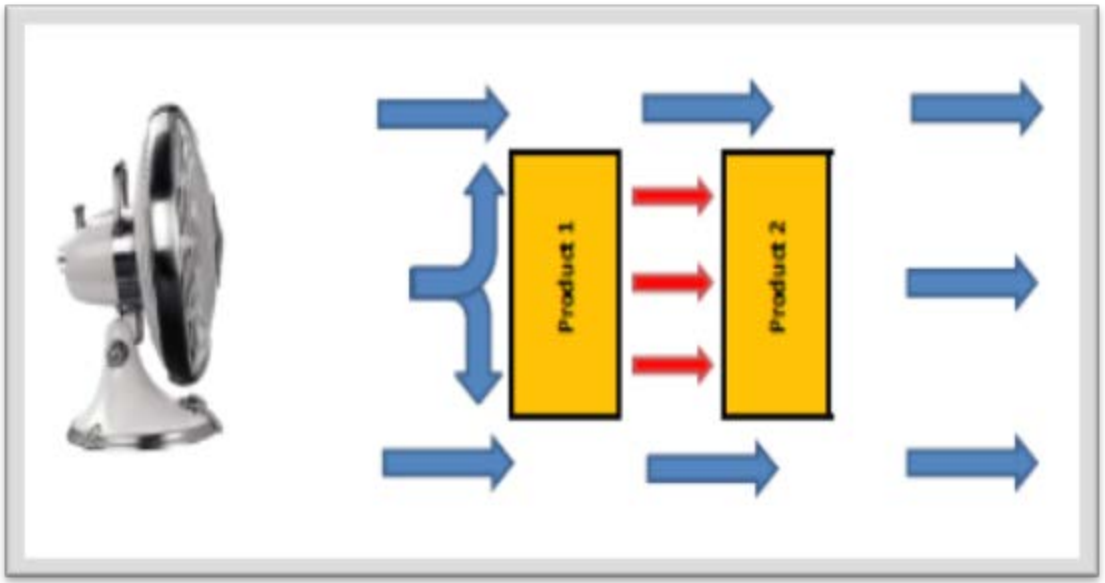
Proper Airflow



Delta-T between Product 1 and 2 is low

- Test conditions are consistent
- Easy to determine cause of failures
- Good temperature distributions
- Less failures in the field

Improper Airflow



Delta-T between Product 1 and 2 is

high

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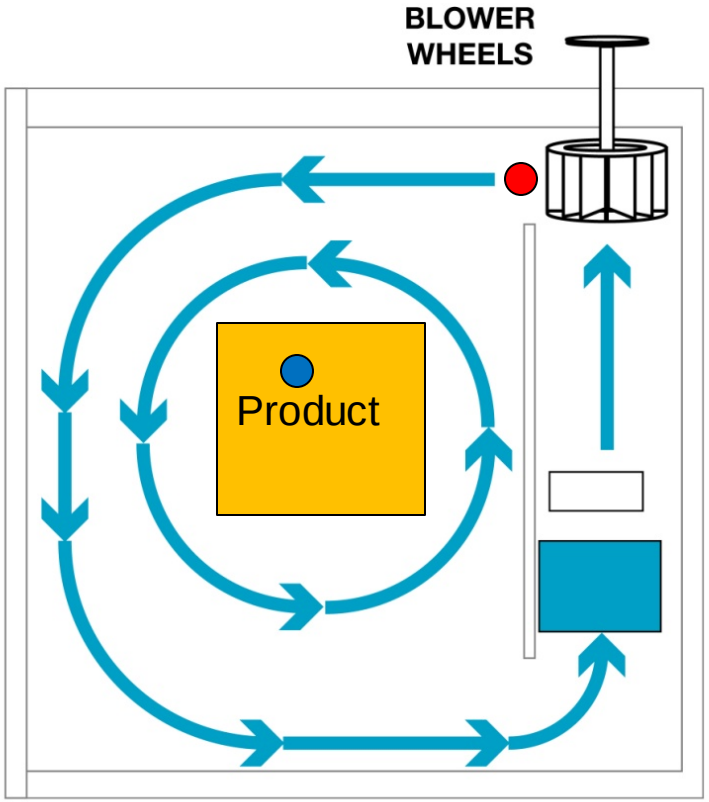
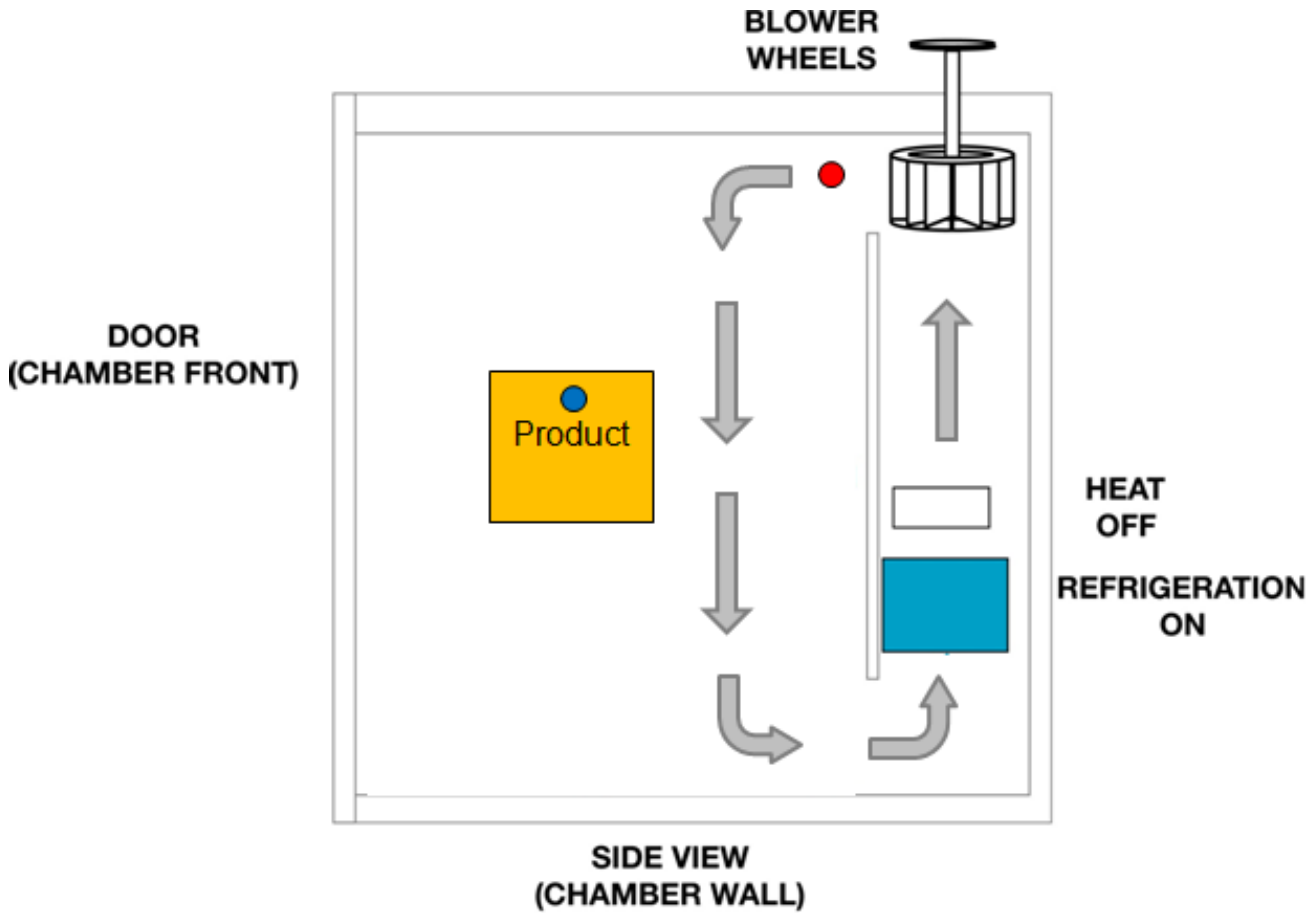
Air and Product Temperature



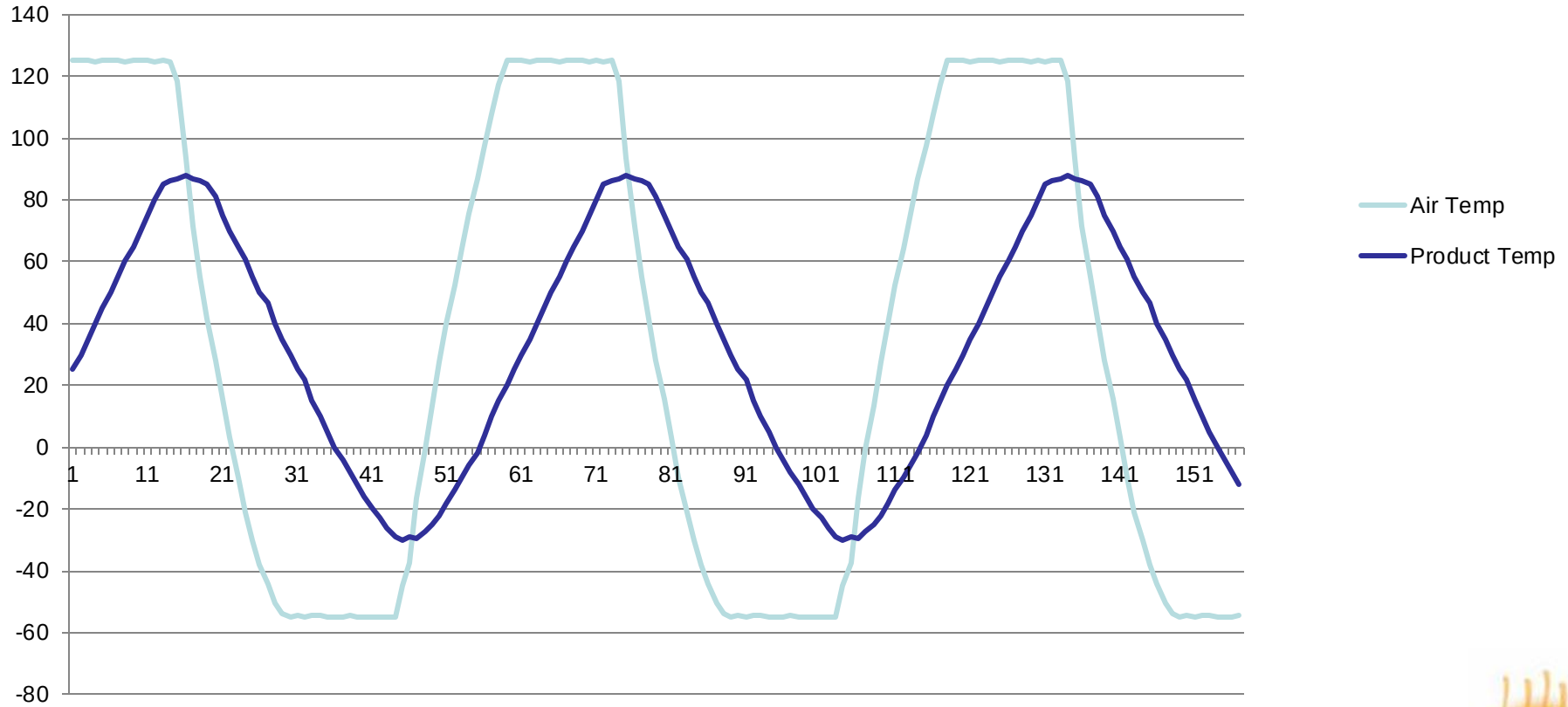
Depending on the density of the product and circulation of the chamber, the air temp and product temp can be within +/-1^{0}C or +/-50^{0}C from each other

= Air Temp
= Product Temp

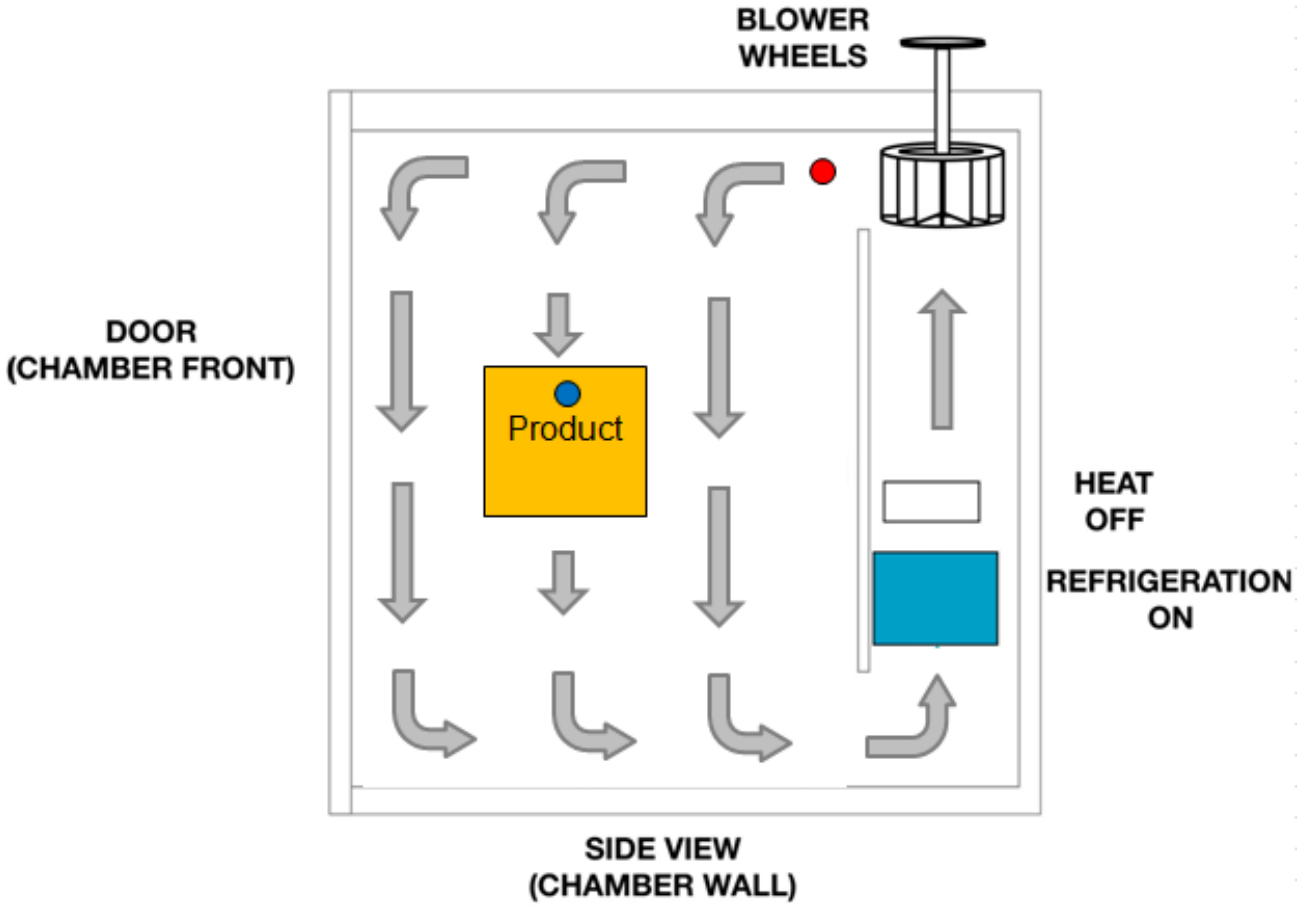
Low/Slow Airflow Velocity



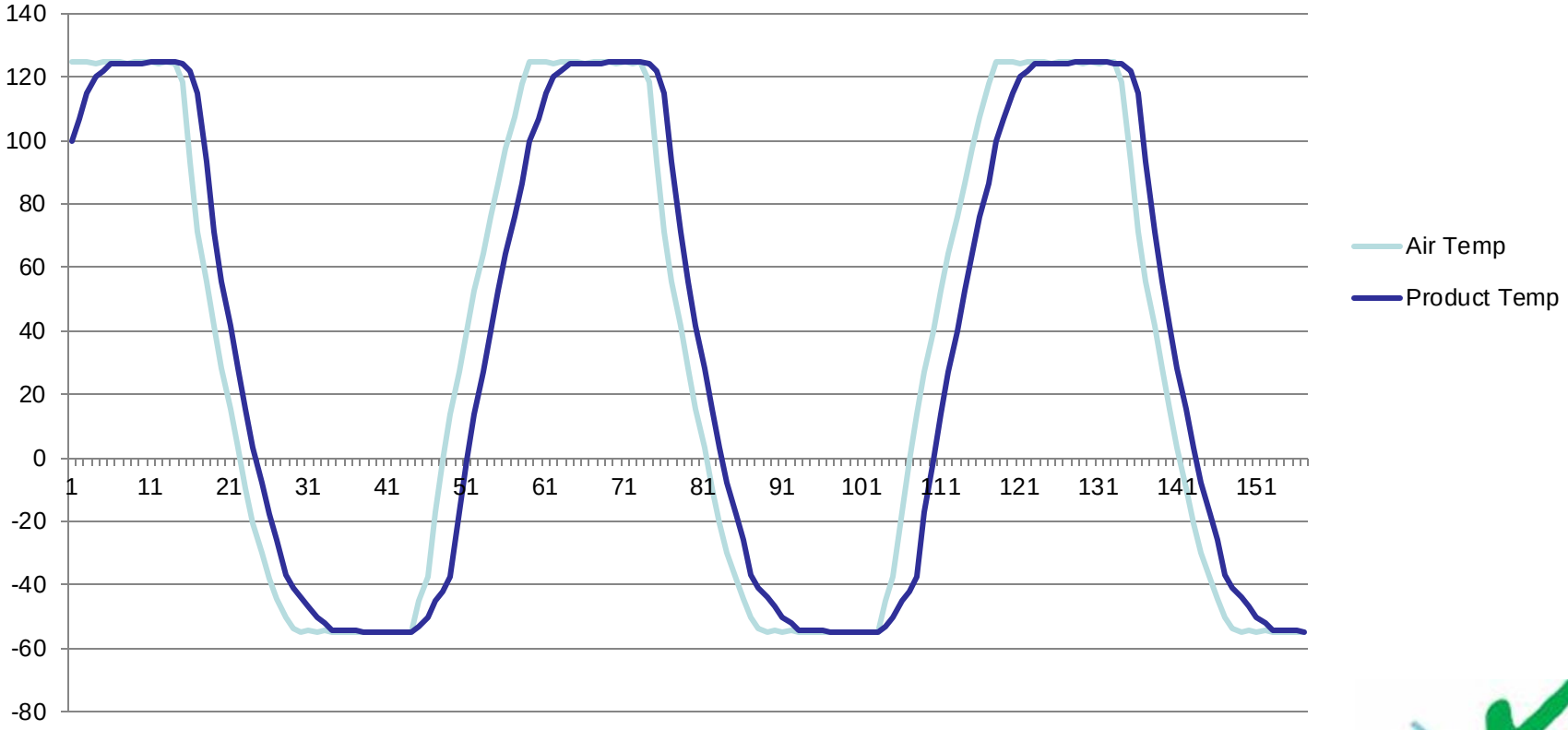
Low/Slow Airflow Velocity



Fast/High Airflow Velocity

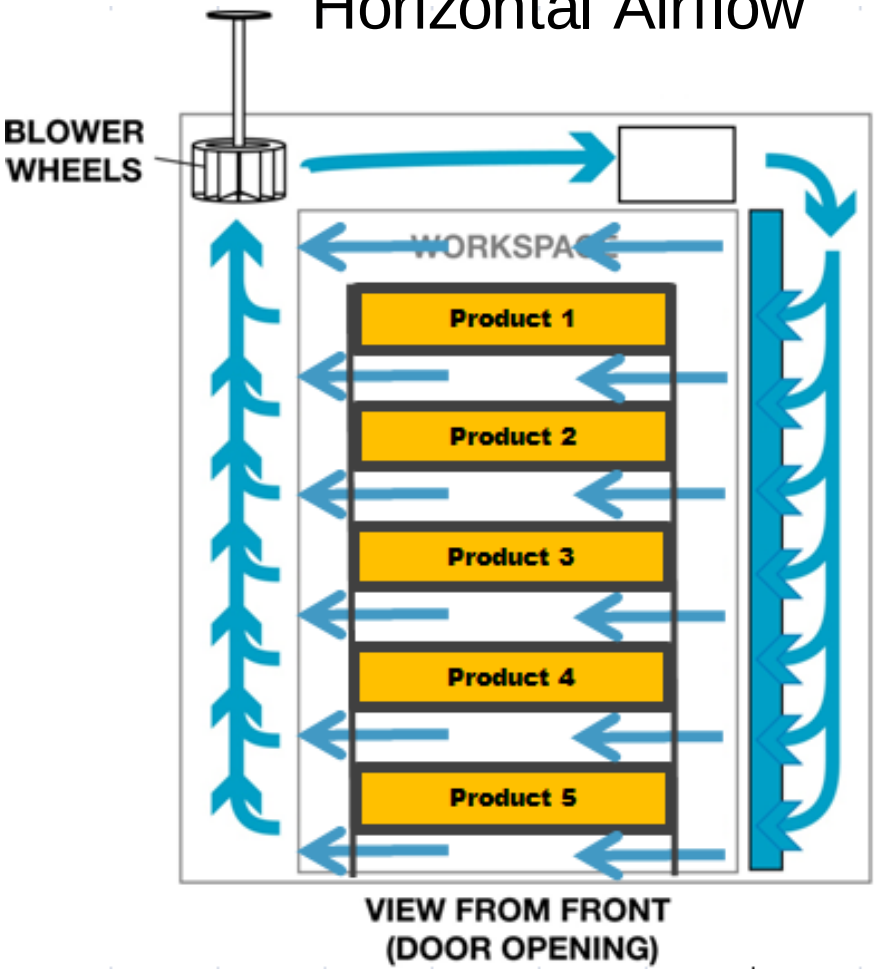


Fast/High Airflow Velocity

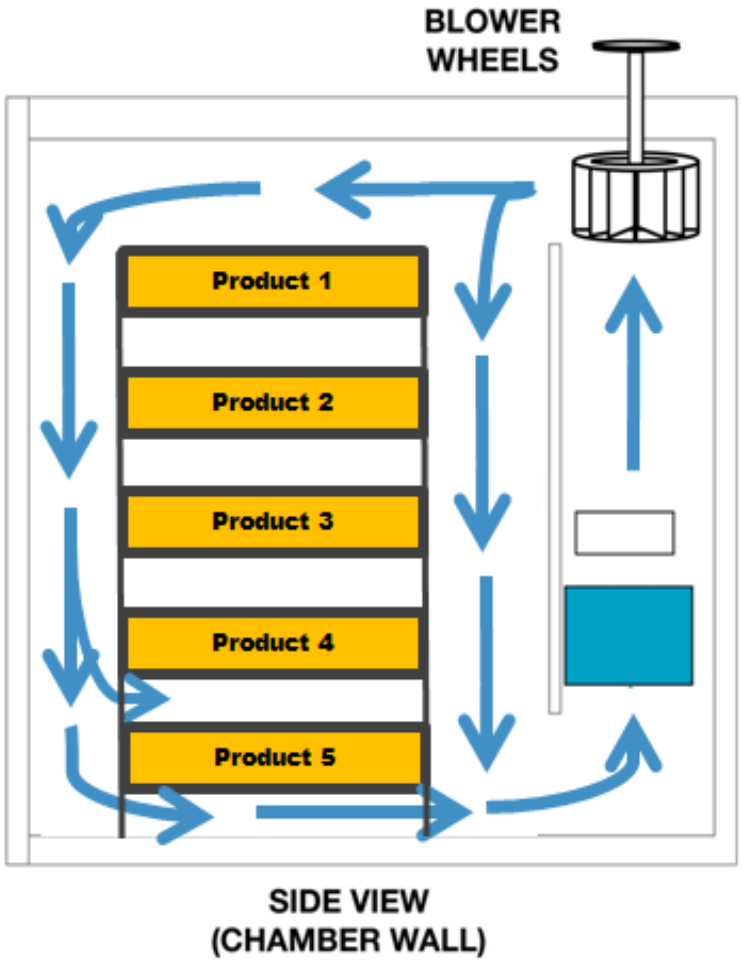


Importance of Airflow Direction

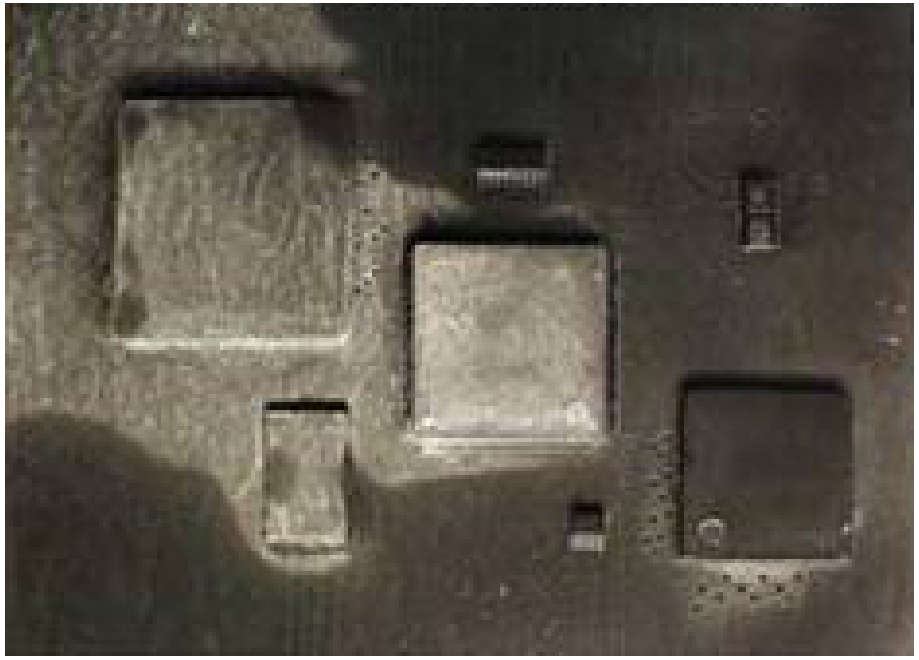
Horizontal Airflow



Backwall Airflow



Slow/Low vs High/Fast Air Velocity



Compare

Slow/ Low Velocity Airflow

Pro's

Cheap

Faster air temperature ramp rate

Con's

Product heat takes longer to be remove

Product not tested at set-point temp

More failure in field

Test the air

Fast/ High Velocity Airflow

Pro's

Product temperature is very close to air temperature

Product tested at set-point temperature

Less failure in field

Test the product

Con's

Harder to achieve fast air temperature ramp rate

Compare

Wrong Airflow	Correct Airflow
Product not tested according to specifications	Product tested according to specifications
Uneven distribution of temperature on the products	Even distribution of temperature on the products
Unexpected failure due to chamber	Reliable test results

Questions & Answers

Thank You

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