KHANSAHEB

spiralite®

energy saving ductwork

Study on the anti-microbial efficacy of SPIRALITE phenolic foam duct

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Impact on indoor air quality and the wellbeing of building occupants

Introduction:

Microbiological growth happens as the Air-Condition (AC) system cools and heats, creating condensation and collecting in small pools. A condensate line, when installed, can remove excess water from the central AC system. However, small amounts of water still manage to creep in, usually collecting around the evaporator coils. As a result, if microbiological growth is present in the evaporator coils, indoor air is exposed to growing microbial.

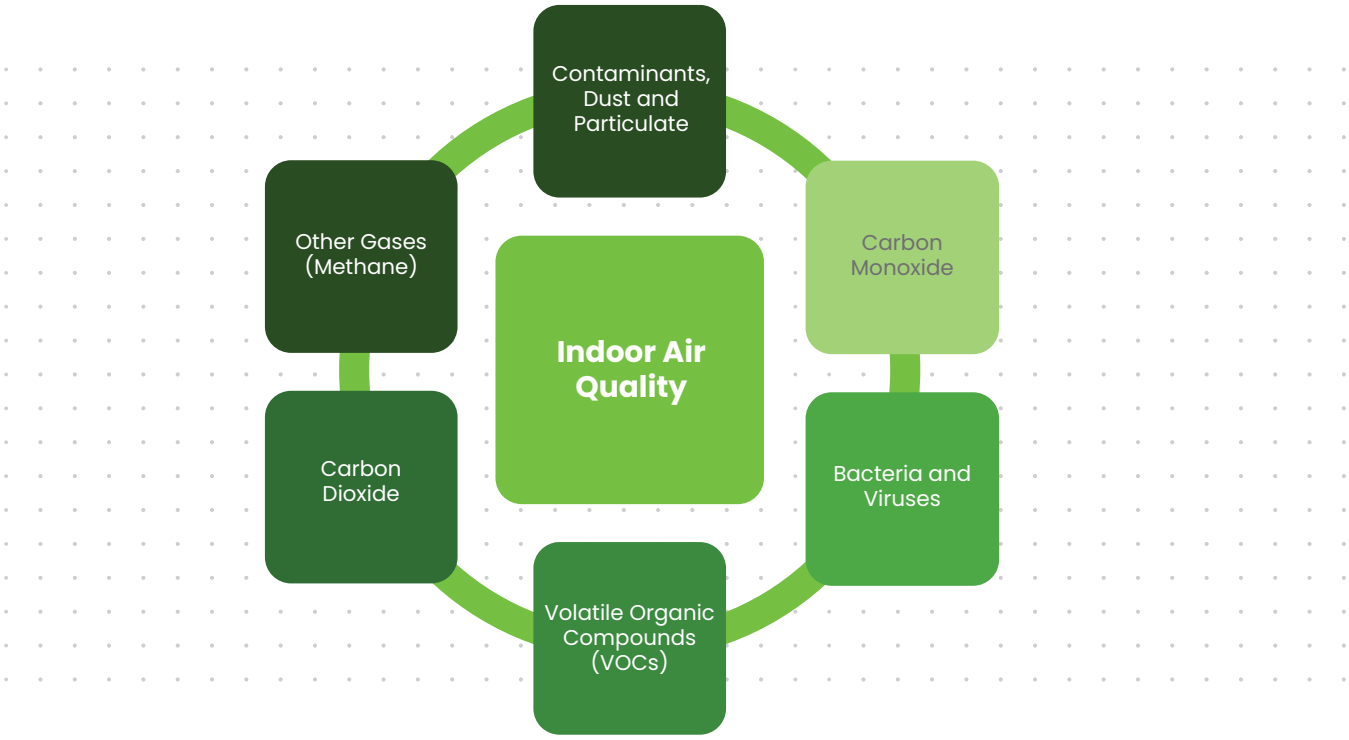
Mold formation inside duct and at grill

All AC systems are at risk for microbiological growth, especially in seashore climates with high humidity. Microbiological growth dirties the central AC system and can alter the indoor air quality to a great extent. Various bio-contaminants are found in the Heating, Ventilation, and Air Condition (HVAC) system. Primary bio-contaminants are fungi and bacteria. Secondary bio-contaminants may include mites, insects, or nematodes.

Bacterial contaminants may produce allergenic proteins, toxins (endotoxins in particular), and bacterial VOCs. Occupants in buildings with a contaminated HVAC system occasionally report musty odours, and these odours often result in the amplification of microbial in the system. In addition, some bacteria, such as Pseudomonas Aeruginosa, may cause opportunistic infections. These bio-contaminants can cause adverse health effects in exposed building occupants.

Critical factors affecting indoor air quality:

- Common pollutants
- Second-hand tobacco smoke
- Indoor combustion
- Radon
- Molds and other allergens
- Carbon monoxide
- Volatile organic compounds
- Legionella
- Other bacteria
- Asbestos Fibers
- Carbon dioxide
- Ozone
- Particulate



It is said, “as a general rule of thumb, regular AC maintenance prevents microbiological growth”. However, in between maintenance calls, increasing the strength of the air filter can improve indoor air quality. Today, HVAC technology has allowed for specialized air filters to protect the central air system and indoor air quality, which is valid to a certain extent.

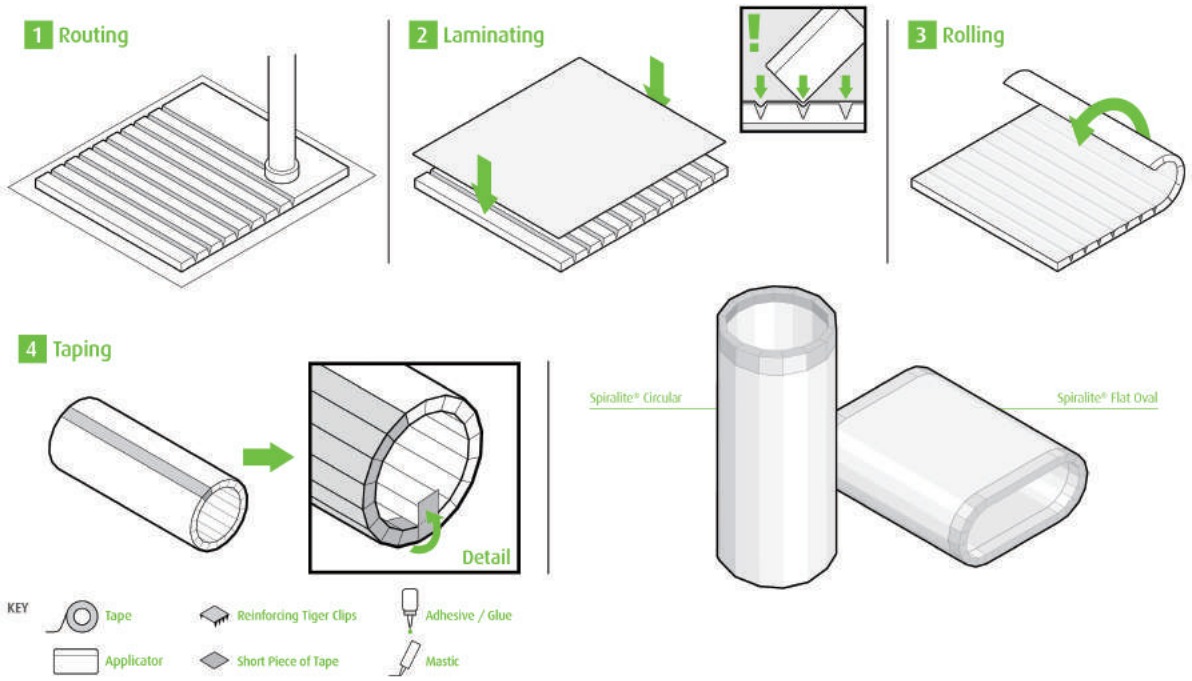
Another way to overcome this problem is to consider UV lamps and bulbs that fit inside the box of evaporator coils. UV emissions neutralize all microbiological growth so that they cannot harm the air supply.

SPIRALITE Duct Work:

Pre-insulated phenolic ducts are typically manufactured in square and rectangular shapes. However, SPIRALITE brand ducts by Khansaheb Industries are produced in the round and flat oval shapes with a unique internal surface. This Internal Surface is designed and manufactured for SPIRALITE products to behave anti-bacteriostatic, which means it has properties that do not allow the growth of fungi, bacteria, and moulds, in addition to many other microbes and allergens.

Microbiological growth is evident among offices, commercial establishments, and home central air systems. We can live in healthy indoor air if the proper ductwork with an internal Surface has been installed in our HVAC systems.

Basic Principles



Spiralite® Manufacturing Guide

SPIRALITE Unique Manufacturing Process

Unique internal Surface does not allow bacteria, moulds, and microbes to stay, reside, and grow on the internal surface of the duct.
Spiralite has conducted a laboratory study on the effectiveness of the duct that has been in use for 2.5 years in comparison to a new duct with the internal Surface based on the BS ISO 22196:2011 standards. The study will demonstrate the efficacy of inner duct surfaces for their anti-microbial properties and the ability to withstand rapid deterioration.

Many fungi and bacteria are saprophytes that are adaptable to the environment if there are organic nutrients and sufficient moisture. Secondary contaminants are often the result of fungal growth. Fungal contaminants produce allergens, mycotoxins; beta-1,3-glucans; and fungal volatile organic chemicals (VOCs).

Fresh Internal Surface

The fresh internal Surface is tested in the laboratory for the value of the antibacterial activity, which shall not be less than 2.0. The ISO 22196:2011 standard provides a means of quantifying the anti-microbial effectiveness of a surface in antibacterial activity. Still, it no longer specifies a value for determining anti-microbial efficacy.

After the exposure of the internal Surface with 2 different bacteria Staphylococcus aureus (Table- I) and Escherichia coli (Table- 2) in the laboratory test for the fresh internal Surface the bacterial counts are obtained (shown as a geometric mean), together with the antibacterial activity (shown as a Log 10 reduction) and the kill rate (shown as a percentage).

Test Sample	Mean Bacterial Count		Antibacterial Activity	% Lethality
	Initial Count	24 Hours Count		
Laboratory Control	2.6×10^7	2.1×10^7	-	-
Internal Surface		2.3×10^2	3.0	>99.98

Table 1: Anti-microbial activity against S. aureus, ATCC: American Type Culture Collection

Test Sample	Mean Bacterial Count		Antibacterial Activity	% Lethality
	Initial Count	24 Hours Count		
Laboratory Control	2.6×10^7	2.1×10^7	-	-
Internal Surface		2.3×10^2	3.0	>99.98

Table 2: Anti-microbial activity against Ecoil (ATCC8739), ATCC: American Type Culture Collection

As a pass/ fail criterion is not defined in the current standard, the laboratory decided to follow the below criteria to interpret the results of the test as given in Table 3.

Antibacterial activity	% Kill	Comment
<1.5	<96.8	poor
1.5-2.0	96.9-99.0	borderline
2.0-3.0	> 99.0-99.9	good
>3.0	>99.98	excellent

Table 3: Anti-microbial Activity on Fresh Internal Surface

It is concluded on the fresh internal Surface sample tested (100mm X 100mm) shows excellent antibacterial/anti-microbial property against tested bacterial cultures.

Internal Surface After 2.5 years

The internal Surface after 2.5 years is similarly tested in the laboratory based on the ISO 22196:2011 standard, Measurement of antibacterial activity on plastics and non-porous surfaces.
After the exposure of the internal Surface after 2.5 years with 2 different bacteria Staphylococcus aureus (Table- 4) and Escherichia coli (Table- 5) in the laboratory test, which was similarly performed for the fresh internal Surface.

Test Sample	Mean Bacterial Count		Antibacterial Activity
	Initial Count	24 Hours Count	
Laboratory Control	4.6×10^4	4.5×10^4	-
Duct Sample	4.5×10^4	2.9×10^2	2.20*

Table 4: Anti-microbial activity against S. aureus (ATCC6538p), ATCC: American Type Culture Collection

Test Sample	Mean Bacterial Count		Antibacterial Activity
	Initial Count	24 Hours Count	
Laboratory Control	4.7×10^4	4.3×10^4	-
Duct Sample	4.3×10^4	2.2×10^2	2.33*

Table 5: Anti-microbial activity against Ecoil (ATCC8739), ATCC: American Type Culture Collection

Like the previous test for fresh internal Surface for this test also a pass/ fail criterion is not defined in the current standard. The laboratory decided to follow the below criteria to interpret the test results given in Table 6.

Antibacterial activity	Comment
<1.5	poor
1.5-2.0	borderline
2.0-3.0	good*
>3.0	excellent

Table 3: Anti-microbial Activity on Fresh Internal Surface

*This is a combined evaluation of the Inner surface (having internal anti-microbial Surface) for a 2.5-year-old duct sample.

Referring to Tables 4 and 5, the 'duct' sample's antibacterial activity was shown to be 2.20 & 2.33 against Staphylococcus aureus and E. coli. Therefore, it is concluded that this sample showed 'Good' antibacterial activity against Staphylococcus aureus and 'Good' * antibacterial activity against E-coli during this study.

Spiralite has also analysed the bacterial count from the duct accumulated in the 2.5-year-old duct using the swab test in the laboratory and following the test method to obtain the yeast count, mould count, and total bacterial count (cfu/swab). The results are shown in Table 6.

Test Name	Units	Result	Method Limit of Detection
Microbiology of SWAB Collected from Site:			
Yeast count$	cfu/swab	Not Detected	1
Mould counts$	cfu/swab	17	1
Total Bacterial count	cfu/swab	11	1
$- Marked analytes are EIAC (formerly DAC) accredited			

Table 6: Swab Test for the Duct

The interpretation of the test results is the below:

1. Overall bacterial Count is 11, which is very good because of average acceptance for bacterial count limit of 15.
2. Mould count is also below 50, and just above 15 is also an indication of resis tance to mould growth after 2.5 years
3. There is zero Yeast count, which indicate surface resistance for yeast grows on the duct surface after 2.5 years.

Conclusion:

From the results and laboratory conclusions, it is evident that the internal surface of SPIRALITE ductwork has excellent anti-microbial properties. These properties will not allow the growth of primary and secondary microbial on the inner surface of the duct, which is always in contact with conditioned or returned air, making it very safe for building occupants.

If we look at the results after 2.5 years, the inner surfaces of the duct demonstrate good anti-microbial characteristics. So, results of both tests reveal that the efficacy of the SPIRALITE duct's anti-microbial properties is very good.

Also, the following points can be taken into consideration along with the scope of this laboratory evaluation.

1. SPIRALITE ducts require less frequent cleaning for commercial/residential spaces, i.e., no repeated internal surface cleaning. However, it is recommended to pre-deter mine a cleaning schedule for the ducts to take care of particulate contaminants.
2. SPIRALITE ductwork is the ductwork having very good anti-microbial properties making it most suitable for rooms to live with good indoor quality.
3. It will also reduce the filtration load on HEPA filters and the usage of UV light.

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