In the fast-growing area of low moisture carpet cleaning, the Low Moisture Carpet Cleaners Association (LMCCA) realized an inherent dilemma: There were no formal definitions of low moisture carpet cleaning.

We prepared this paper to quantify the definition of low moisture carpet cleaning so as to better determine which systems actually qualify as "low moisture systems."

Additionally, we elected to scrutinize the make-up of many carpet fibers to help skilled professionals understand the short-term and long-term impact of carpet cleaning systems on the carpet fibers.

This paper represents the views of the LMCCA as expressed by the many people involved with its creation.

Technical white paper on Low moisture cleaning

Defining the basics of low moisture cleaning

Carpet cleaning technologies are changing rapidly as advances in chemicals and equipment continue to improve.

Many new testing programs and technologies are now available to test cleaning methods, chemicals and procedures to determine the efficiency of the methods' ability to remove soil and enhance carpet appearance.

For more information:

Visit **www.cleanfax.com** and type in keywords: **Low moisture.**

For more information on related products, visit **www.cleanfax.com**, select Supplier Search from the site menu, and enter keywords: **Carpet cleaning.**

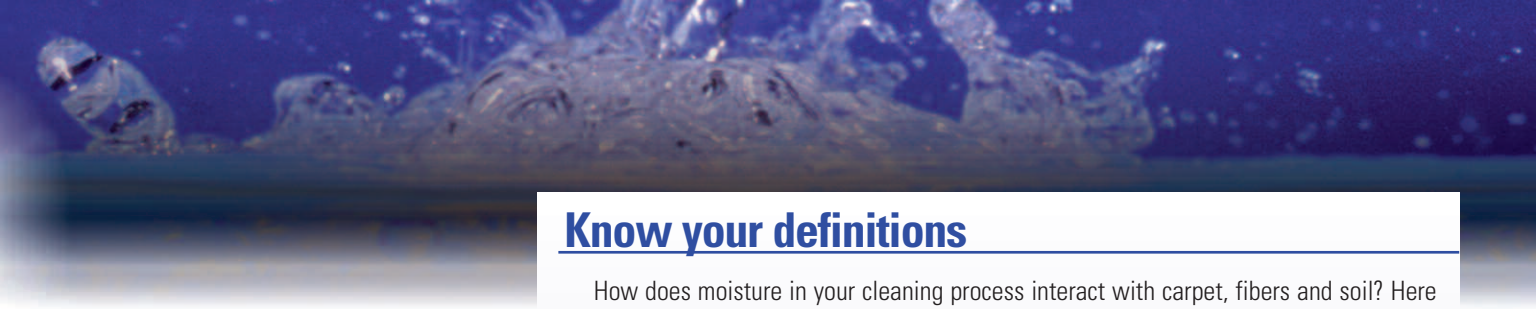
The Institute of Inspection, Cleaning and Restoration Certification *S100 Standard and Reference Guide for Professional Carpet Cleaning* recognizes the importance of using low moisture cleaning to maintain the carpets appearance at its highest levels.

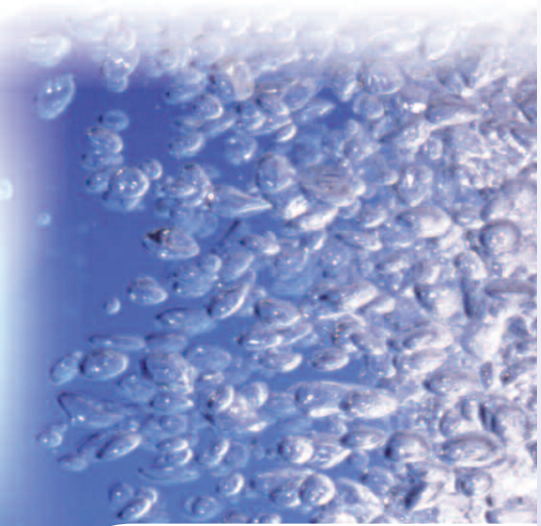
Additional research and testing will continue to improve the ability of professional cleaning and the usage of low moisture cleaning procedures.

This document is designed to define the basics of "low moisture cleaning," to educate the cleaning industry and to lay the groundwork for assisting skilled technicians in decisions regarding low moisture cleaning methods and procedures.

Every carpet exists in a unique environment, including variations in construction, installation, substrates, traffic, soil levels, soil types, temperature, humidity and location.

One system is not optimal in all environments; yet all systems can excel when used by a *skilled operator* in the appropriate specification.





What is low moisture cleaning?

Low moisture cleaning is methods and/or procedures that allow any fibers to dry to its natural state in two hours or less.

For the purposes of standardizing criteria variables, we used 65 percent relative humidity (Rh) and 70 degrees Fahrenheit.

This can be accomplished by using less moisture to clean, by using absorbent mediums, higher efficiency vacuums that efficiently extract water from the carpet, by increasing the evaporation rate of the carpet by lowering the relative humidity of the cleaning environment and by the use of air-movers. (See "Know your definitions", right.)

Moisture and carpet fibers

The "dry" state of a fiber is the level of moisture retention in its normal environment.

Each fiber type must contain a certain amount of moisture in its natural dry state to maintain its structure.

The resource materials in this white paper are important to the general understanding of fiber moisture content.

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Know your definitions

How does moisture in your cleaning process interact with carpet, fibers and soil? Here are some definitions you should know.

- **Hydrophobic:** From the Greek (hydro) "water" and (phobo) "fear." The hydrophobic effect is the entropy driven force that causes oil to separate from water. It is notoriously strong, though not as strong as covalent forces (chemical bonding). This force is one of the main determinants of the structure of globular protein molecules, since the hydrophilic (water loving) parts of the molecule tend to surround the hydrophobic parts that cluster in the center, away from the aqueous (polar) solvent.
- **Hydrophilic:** From the Greek (hydro) "water" and (philia) "friendship," refers to a physical property of a molecule that can transiently bond with water (H_2O) through hydrogen bonding. This is thermodynamically favorable, and makes these molecules soluble not only in water, but also in other polar solvents.
- A **hydrophilic molecule** or portion of a molecule is one that is typically charge polarized and capable of hydrogen bonding, enabling it to dissolve more readily in water than in oil or other hydrophobic solvents. Hydrophilic and hydrophobic molecules are also known as polar molecules and non-polar molecules, respectively.
- **Polar solvent:** A compound, such as water or liquid ammonia that is composed of polar molecules. Polar solvents can dissolve ionic compounds or covalent compounds that ionize. Non-polar solvents, such as benzene, will only dissolve non-polar covalent compounds.

Applying the information

Utilizing the terms as defined, the fibers we clean can be either hydrophobic or hydrophilic when you compare one to the other.

A fiber that is hydrophobic wets out faster than a fiber that is hydrophilic. This is due to the hydrophobic fiber's inability to retain water.

Water and oil (either petroleum or food based) do not naturally mix unless you add additional components.

Emulsions are a process whereby water and oil is mixed through a reaction process.

Hydrophobic fibers have a natural attraction to oils; conversely, hydrophilic fibers have a natural repulsion to oils.

The reverse is also true with water; hydrophobic fibers have a natural repulsion to water and hydrophilic fibers have a natural attraction to water.

When water is used in the cleaning process, fibers that exhibit a higher affinity to water require less water to clean than fibers that exhibit a higher affinity to oil.

Conversely, fibers that exhibit a greater affinity for oil require more water to clean than fibers that exhibit a low affinity for oil.

Hydrophobic		Hydrophilic	
Fiber Type	**Greatest to Least**	**Fiber Type**	**Greatest to Least**
Polypropylene	1	Wool	1
Polyester	2	Cotton	2
Acrylic	3	Rayon	3
Nylon 6,6	4	Acetate	4
Nylon 6	5	Nylon 6	5
Acetate	6	Nylon 6,6	6
Rayon	7	Acrylic	7
Cotton	8	Polyester	8
Wool	9	Polypropylene	9

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When the resources are utilized by a skilled operator, it can assist the operator in determining if a system/method is low moisture for the fiber type.

Physical makeup of carpet

Tufted carpet is constructed using various face fibers and primarily polypropylene backing materials. (See "Proper carpet and installation specs" on page 37.)

The face fibers are primarily made of nylon, olefin (polypropylene), polyester, wool and some blends.

Nylon fibers still dominate the market in usage.

Woven carpet is constructed using primarily wool and nylon for face fibers.

The backing materials are almost always synthetic except in some high-end residential and commercial products, where jute is occasionally used.

Backing materials will use either synthetic fibers using polypropylene or natural fibers of jute and cotton. Special care should be taken when cleaning woven products that use natural fibers in the backing — this helps to prevent shrinkage or damage.

There are many variables that should be considered when prescribing cleaning processes and in many cases more then one cleaning technique may be used.

These variables include, but are not limited, to:

- The environment: Indoor temperature, air circulation, relative humidity
- Traffic levels, soil levels and frequency of cleaning
- Proper or improper carpet specification
- Carpet construction: Fiber type, backing system, stitch rate, pile height, denier, cut or loop pile designs, patterns
- Installation: Above or below grade, slab, wood, other substrate, computer floors, pad, loose lay, direct glue down
- Cleaning/drying timeline: How long the cleaning process takes, versus how long it actually takes for the process to take place
- Customer expectation

Moisture regain measured as a percentage of weight at 70 degrees Fahrenheit (Dry State)

Fiber Type	At 65% Relative Humidity	At 95% Relative Humidity
Synthetic Fiber		
Nylon 6	2.8 – 5%	3.5 – 8.5%
Nylon 6,6	4 – 4.5%	6.1 – 8%
Acrylic	1 – 2.5%	2 – 5%
Polyester	0.4%	0.6%
Polypropylene	0.01%	0.1%
Man-Made		
Rayon	11 – 12.5%	11 – 27%
Acetate	6.3 – 6.5%	6.3 – 14%
Natural		
Wool	15 – 20%	30%
Cotton	8.5 – 15%	20%

The job site

The indoor environment should be considered when making decisions about which process to use for carpet maintenance.

Inspection of the facility should include the indoor temperature, air circulation and the control system for relative humidity.

Also, it should be determined if the air handling systems are left on all the time, or if they are turned off at night during the cleaning process.

This will have an affect on the drying process and the indoor air quality.

Traffic levels and patterns should be evaluated, determined and broken down into ratings (i.e., high, medium, low).

These ratings can be used then to determine the soil and spot levels in the carpet, and the need for various frequencies of cleaning according to the breakdown of traffic patterns.

The overall maintenance system should be carefully programmed so that adequate time is allowed for the cleaning processes.

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In commercial facilities, proper coordination should be accomplished with the janitorial company to not compete for the same areas or to cause problems with the carpet being walked on, vacuumed or used while it is still wet.

When addressing the fiber cleaning process, it is vital that an understanding is developed as to how each fiber responds to the process being applied.

All of the variables listed here — and others — will determine which process is best applicable to the fiber in question.

All processes should be evaluated to determine if they will work when applied properly.

Proper training of cleaning personnel and understanding of all cleaning processes and procedures is very important or the process could fail when misapplied.

The technical information and tables here should be used as resources as you form your opinions about using various cleaning methods for different fibers and constructions of carpet.

Please review them and apply them to the previous information and the sidebars in this technical white paper.

In addition, system manufacturers and carpet mills can be a valuable source of information.

When does a fiber become wet? All fibers as discussed above absorb water to some degree.

The fiber has reached its saturation point when the fiber cannot absorb more water.

Just like a sponge, the fiber can only hold so much water. Once that point is reached, the fiber — just like the sponge — loses the excess water.

Fiber saturation point: Defined as the point at which the cell wall is saturated with bound water, and at which no free water is present.

Absorbency rate: Affected by the fiber 's mechanical and surface properties, structure of the fabric and the type of fluids.

Moisture gain to saturation point

Fiber Type	At 65% Relative Humidity	Absorbency Rate	Saturation Point
Wool	15 – 20%	430 – 435%	450%
Cotton	8.5 – 15%	2,685 – 2,691.5%	2,400 – 2,700%
Rayon	11 – 12.5%	2,687.5 – 2,689%	2,400 – 2,700%
Acetate	6.3 – 6.5%	23.5 – 23.7%	30%
Nylon 6	2.8 – 5%	22 – 24.2%	27%
Nylon 6,6	4 – 4.5%	22.5 – 23%	27%
Acrylic	1 – 2.5%	6.5 – 8%	9%
Polyester	0.4%	2.6%	3%
Polypropylene	0.01%	0.99%	1%

Basic Cleaning Systems

Base Method	Square Foot Coverage per Gallon Water	Gallon Use per Square Foot	Gallon Use per Square Yard	Pounds of Water per Square Yard
HWE	50	0.02 gal	0.180 gal	1.44 pounds
Pre-spray	200	0.005 gal	0.045 gal	0.36 pounds
Rotary Brush	200	0.005 gal	0.045 gal	0.36 pounds
Mist	500	0.002 gal	0.018 gal	0.14 pounds
Dry Extraction	1,000	0.0014 gal	0.0126 gal	0.9 pounds

Cleaning versus fiber saturation point at 65% Rh

Carpet Example	Saturation Point Water per SY	Cleaning Methodology	Water Use in Square Yard	Excess Water in Pounds
100% Polypropylene Unitary Backed				
	.025 lb.	HWE	1.44 pounds	1.415
	.025 lb.	Pre-spray	0.36 pounds	0.335
	.025 lb.	Rotary Brush	0.36 pounds	0.335
	.025 lb.	Mist	0.14 pounds	0.115
	.025 lb.	Dry Extraction	0.0126 pounds	-0.0124
100% Woven Wool				
	10.75 – 10.875 lb.	HWE	1.44 pounds	- 9.435
	10.75 – 10.875 lb	Pre-spray	0.36 pounds	-10.515
	10.75 – 10.875 lb	Rotary Brush	0.36 pounds	-10.515
	10.75 – 10.875 lb	Mist	0.14 pounds	-10.735
	10.75 – 10.875 lb	Dry Extraction	0.0126 pounds	-10.734

Special thanks to Aviesx Fibers Inc., 1996 McGraw Hill, for some of the above information

Proper carpet and installation specs

Proper carpet specification is very important to the life cycle of any carpet installation.

If, for example, the wrong color, fiber, backing system or installation is used, it could affect the life or appearance of the carpet.

This would also affect how well the carpet maintenance system is working.

Specifying the proper carpet construction will extend the life of the product and raise the consumer satisfaction level with the product.

For example: If loop pile yarns made of nylon are used in a main traffic area that, there is a better success ratio of product appearance holding up as opposed to using an olefin cut pile product installed in the same area.

Installation specifications and procedures need to be carefully evaluated as they will have an affect on the overall wear of the carpet.

Using the proper foundation pad, or determining that direct glue-down installation may be more appropriate, are some of the considerations that should be addressed.

Proper carpet specification will address customer expectations.

If they are unwilling to plan properly, they need to be informed that there are potential difficulties that will have to be overcome.

Additional cleaning frequencies may be necessary if the wrong specifications are used.

All things equal out in the end.

Practical application

We have established the following:

- Fibers in the dry state have some level of moisture content.
- The moisture content changes as the relative humidity increases or decreases.
- The dry state moisture content determines the hydrophobic/hydrophilic property of the fiber.
- Fibers absorb moisture at different rates to the saturation point

Comparison of two carpets and moisture used to saturation point at 65 percent Rh, all other conditions remain constant.

Unitary back 100 percent polypropylene fiber, 40 ounce face weight

- 1 square yard contains 2.5 pounds of face yarn and .00025 pounds of moisture.
- Saturation point of 1 square yard equals .025 pounds of water.

Woven 100 percent wool (foundation and face yarn), 40 ounce face weight

- 1 square yard contains 2.5 pounds of face yarn and .375 to 0.5 pounds of moisture.
- Saturation point of 1 square yard equals 10.75 to 10.875 pounds of water.

Conclusion

Proper specification of the products and systems will enhance the satisfaction with a carpet installation.

The use of low moisture cleaning can increase the performance and appearance of the carpet and extend the useful life of the product.

Low moisture cleaning is a tool that will enhance the industry's ability to service carpet and minimize the downtime of the products.

This is a tool that should be considered for carpet maintenance systems. □