Carpet Preconditioning: Its Impact on Cleaning

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INTRODUCTION

Since the Institute of Inspection, Cleaning and Restoration Certification (IICRC) wrote the first carpet cleaning standard[1] in 1991, preconditioning carpet to maximize soil suspension prior to soil removal has been an industry-accepted practice. However, not until The Carpet and Rug Institute (CRI) implemented its Seal of Approval (SOA) program, which included spectrophotometer measurement of light reflected from cleaned carpet using the Association of Textile Chemists and Colorists (AATCC) gray scale to develop comparative ΔE values, did the carpet manufacturing and cleaning industries understand the importance of preconditioning.

IMPORTANT DEFINITIONS

soil: unwanted substance that is deposited on a surface or material, usually as a result of traffic, use, and environmental conditions. There are three general categories of soil: insoluble particles and fibers (e.g., protein, cellulosic or synthetic); water soluble (e.g. food, sugar, salt), and oils (e.g., animal, vegetable, petroleum).

cleaning: removing unwanted substances from a surface or material. Cleaning involves locating, identifying, containing, removing and properly disposing soil.

principles of cleaning: procedural steps involved in cleaning. Carpet cleaning principles include: dry soil removal, soil suspension, suspended-soil removal, grooming as necessary, and drying.

fundamentals of soil suspension: the sequential steps involved in maximizing the soil suspension principle of cleaning. The fundamentals of soil suspension are: chemical (detergent) application; using heat or temperature to increase chemical activity; agitation for uniform chemical distribution and maximum contact with soil, and sufficient dwell time for chemicals to function in the soil suspension process.

preconditioning: applying properly formulated detergent solutions to soiled carpet to maximize soil suspension or separation from individual fibers comprising pile yarns, or the wear surface of the carpet.

agitation: distributing detergents uniformly throughout carpet pile yarns using manual or mechanical action.

hot water extraction (HWE): cleaning method in which pressurized hot water is spray-injected into carpet pile yarns, and almost immediately thereafter, injected water is vacuum-extracted to flush and physically remove soils and excess moisture from the carpet pile.

[1] *IICRC S100 Standard and Reference Guide for Professional Carpet Cleaning*; Institute of Inspection, Cleaning and Restoration Certification, Vancouver, WA, 1991 (revised 2002).

ΔE_{cmc}: a single number defining the total difference in CMC units of a trial from a standard.[2]

method 1 : a procedure or process for attaining an object; as . . . **b.** (1) : a way, technique or process of or for doing something; ***syn*** METHOD, MODE, MANNER, WAY, FASHION, SYSTEM mean the means taken or procedure followed in achieving an end. METHOD implies an orderly, logical, effective arrangement usu. in steps . . . SYSTEM suggests a fully developed or carefully formulated method often emphasizing the idea of rational orderliness . . .[3]

system 1 : a regularly interacting or interdependent group of items forming a united whole; as **a. (1)**; a group of interacting bodies under the influence of related forces **. . . 3 a :** an organized or established procedure . . . ***syn*** see METHOD[4]

SCOPE

This industry white paper applies to testing of a residential 25-ounce untreated nylon tufted carpet. Testing was accomplished using hot water extraction systems only, since, according to industry magazine surveys of professional cleaners, portable or truck-mounted hot water extraction is used as the primary cleaning method by 84.6% of those polled.[5] Preconditioning may be applicable using other cleaning systems as well; e.g., absorbent compound.

PURPOSE

The purpose of this industry white paper is to demonstrate, through laboratory testing and statistical analysis, the affect of the preconditioning process on overall carpet cleaning results.

EXECUTIVE SUMMARY

CRI SOA spectrophotometer (ΔE) analysis of soil removal demonstrates that in-tank application of cleaning detergent during hot water extraction cleaning produces comparative soil removal using average ΔE values 4.6% over flushing with plain hot water. When preconditioner is applied to carpet before attempting soil removal using industry-accepted hot water extraction cleaning techniques, analysis of comparative soil removal using ΔE values increased to an average of 16.3% over hot water with detergent flushing alone.

Overall, cleaning with chemicals used exclusively in the solution tanks of hot water extraction units produced soil removal only slightly better than flushing with plain water; whereas, chemicals pre-applied in the preconditioning process, followed by hot water rinsing, cleaned significantly better than chemicals applied through in-tank solutions in the course of HWE.

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[2] American Association of Textile Chemists and Colorists (AATCC) *Technical Manual.* p. 415, 2007.
[3] *Merriam Webster's Collegiate Dictionary*, Tenth Edition, p. 732; Merriam-Webster, Incorporated, Springfield, MA, USA 1994.
[4] *Merriam Webster's Collegiate Dictionary*, Tenth Edition, p. 1197; Merriam-Webster, Incorporated, Springfield, MA, USA 1994.
[5] *Cleanfax Magazine*, 2007 carpet cleaning benchmark survey report.

APPLICATION

To understand the relationship between the preconditioning process in overall cleaning, it is prudent to discuss this process within the context of hot water extraction cleaning principles. The ***IICRC S100 Standard and Reference Guide for Professional Carpet Cleaning*** sets forth five *"principles" of cleaning*, at least four of which apply to all carpet cleaning efforts, if soil suspension and removal are to be maximized. They are:

- dry soil removal,
- soil suspension,
- suspended soil removal,
- grooming, as necessary, and
- drying.

The principles of cleaning incorporate the use of two media for soil removal: air and liquids. Chemicals - properly formulated, mixed and applied when using liquid media - enhance soil suspension, and ultimately, the suspended soil's physical removal from carpet.

A. Dry Soil Removal

This is the first *principle* of cleaning, according to the IICRC S100. According to industry surveys conducted by the DuPont Company and others, some 74-79% of carpet soil is particulate, or protein and cellulosic fiber. These soils not only have the potential to be removed with dry vacuuming, but if not so removed, when wetted during chemical application or in the course of being flushed from pile yarns, they increase in weight and become more difficult to remove.

B. Soil Suspension

Once dry particle soil has been removed from a carpet to the extent practical, cleaners should begin *soil suspension* (preconditioning) procedures. Soil suspension, or separation of fine particle, water-soluble and oily soils from fiber surfaces, is a critical step in state-of-the-art, professional cleaning.

The goal of *soil suspension* is to separate soil from fiber surfaces and hold it in suspension until physical removal can take place. This goal should be achieved using properly formulated, mixed and applied cleaning chemicals (detergents). Preconditioning, or applying proper chemicals before attempting physical soil removal, is an essential step in achieving that goal.

There are four **fundamental** activities to be accomplished under the **soil suspension principle**. These are known as the "*fundamentals of soil suspension*." They include **chemical** action, **heat or temperature**, **agitation** and **time**; or by the industry-coined acronym, **"CHAT."**

1. **Chemical action** acknowledges the fact that, without chemicals in the form of detergents and their associated additives, the best efforts at cleaning only results in

the physical erosion of some soil from fiber surfaces. Chemical activity is employed in two distinct phases of the cleaning process.

Foremost, chemicals are used to prepare carpet for cleaning by reducing the surface tension of water, and by suspending, sequestering, emulsifying and saponifying the various types of soil. This procedure is referred to as *"**preconditioning** the carpet"* – an essential step for thorough cleaning and the subject of this paper. It is unreasonable to suggest that soils that have been ground into carpet, along with oily films that have had months or years to oxidize or dry out, can be suspended adequately in the few seconds that elapse between the injection and extraction phases employed in the hot water extraction cleaning method.

Normally, preconditioning detergents are applied in one of three ways:

- through hand-pump (three-gallon *minimum* capacity) or electrically powered sprayers.
- through an in-line preconditioning device that automatically meters chemical concentrate into the solution line of a hot water extraction unit, or
- by means of rotary or cylindrical brush agitators.

The second phase of chemical activity occurs when chemicals are mixed or metered into *rinse solutions* to suspend light (usually atmospheric) soils that settle on and accumulate in non-trafficked areas along baseboards or under furniture.

To summarize, chemicals applied during preconditioning are essential for quality, state-of-the-art cleaning.

2. **Heat or Temperature** - The temperature fundamental that relates to soil suspension simply acknowledges the fact that heat *reduces the surface tension of water,* enabling it to clean faster and more efficiently than cold water. It is merely a matter of thermodynamics, or the ability of heat to *accelerate the activity of the chemicals* employed in the course of cleaning.

   The **temperature fundamental** in soil suspension is addressed in two phases of the extraction cleaning process:

   a. First, preconditioners can be mixed in spray-application equipment with hot water to increase activity, insofar as is practical. High-pressure, in-line preconditioning units, which are often used with portable or truck-mounted cleaning equipment, help maximize the temperature principle by providing water at 120-210^{o}F (49-99^{o}C), into which chemicals are metered automatically. Of course, the efficiency of preconditioners used with other methods also can be increased somewhat by mixing them with hot water.

   b. Second, the temperature fundamental is maximized to the greatest extent during the injection/extraction phase of hot water extraction.

   Because of the amount of chemical applied, because agitation is normally limited, and because of the limited time chemicals have to work before they are extracted, increasing chemical activity using temperature becomes an important factor in achieving state-of-the-art cleaning. However, from a practical standpoint,

200°F/93°C temperature *at the machine,* using state-of-the-art truck-mounted HWE cleaning plants, results in a temperature *on the carpet* of some 160-165°F/71-74°C - and then only for a relatively brief period. Typically, the problem in most professional cleaning applications, is one of generating enough temperature, rather than too much.

3. **Agitation** - The agitation fundamental in some form is required basically to accomplish uniform chemical distribution. Without this important function, soil suspension can be superficial and non-uniform, perhaps even resulting in soil streaks after drying.

   Agitation for uniform preconditioner distribution normally in accomplished in one of two primary ways: *manual* agitation using a brush or groomer, or *mechanical* agitation using rotary or cylindrical brush agitation during or following preconditioner application.

4. **Time Fundamental** - Time is the last fundamental under the soil suspension principle, and it probably is the least considered. Residential carpet that is cleaned with any regularity (over and above routine vacuuming) may be cleaned on an average of once every 12 to 24 months. No other textile fabric receives as much heavy, ground-in soil with so little regular cleaning. Of the soils that are deposited over this period, none are more difficult to suspend and remove than oils that have dried out or "oxidized."

   Oxidized oils form a yellowish, lacquer-like film on fiber surfaces and, they can serve as strong binders for other soils. Oxidized oils in traffic areas require pre-application of cleaning chemicals and "dwell time" to ensure maximum removal. This is where the time fundamental becomes so important. Failing to take advantage of chemical "dwell" time before extraction results in dingy entry and traffic areas, which manifests itself beyond the physical distortion caused by abrading, fading and wear - not to mention streaking that can result from incomplete soil suspension.

   With the preconditioning chemicals made by reputable formulators today, only 10-15 minutes of dwell time are needed for chemicals - *properly formulated, mixed, applied and distributed to all areas through agitation* - to suspend most soils for optimum removal.

Summary: To summarize the four **fundamentals** included under the second **principle** of cleaning - *soil suspension*: First, there is *chemical action*, which emphasizes the importance of chemicals, if efficient cleaning is to result. Second, is *heat or temperature* used to reduce the surface energy of water and excite chemicals, thereby suspending soils faster and more efficiently. Third, *agitation* is required to distribute chemicals uniformly, while flexing and massaging fibers to accelerate the action of chemicals on all soil types. Finally, the *time* factor gives chemicals the dwell time required to dissolve, suspend and emulsify soils, particularly oxidized oils.

Note that each of the soil suspension fundamentals revolves around the proper use of cleaning *chemicals*; i.e., adding heat *excites* chemicals, agitation *distributes* them for maximum soil contact, and *dwell time* allows chemicals to dissolve, suspend or emulsify soils on fibers. Variables, such as chemical quality, solution temperature, application

rate, agitation (manual or mechanical), dwell time, extractor type and components, and others, can have a bearing on total cleaning efficacy.

C. Suspended Soil Removal Principle

By definition soil is unwanted substance foreign to the construction of carpet. At this point in employing cleaning principles, soils that could not be removed using dry vacuuming have been dissolved, emulsified, separated or suspended from fiber surfaces. In addition, the soil that was evenly spread out causing the carpet to look grey and dingy, has now been reduced to fewer, larger (though still less visible) masses of particles, and the carpet may even look relatively "clean." However, to achieve state-of-the-art cleaning, this soil still must be removed physically (extracted or rinsed) as completely as possible from the carpet's pile.

Physical soil removal (wet or dry) should be accomplished in a number of other ways including:

- absorption,
- wet vacuuming,
- rinsing, or
- dry vacuuming.

D. Finishing (Grooming) Principle

The term "finishing" refers to any procedure used to enhance the appearance of the carpet beyond the physical soil removal process. Generally, pile setting or grooming, using appropriate brushes or combs, should be performed in this context, especially on residential carpet styles with higher pile height. Grooming carpet is important for several reasons:

- First, it can be used on residential carpet as a *pre-cleaning technique* to separate tufts prior to vacuuming to increase dry soil removal.
- Grooming evenly distributes after-cleaning treatments efficiently and effectively.
- *Post-cleaning*, grooming is important to leave the carpet in its most pleasing appearance for customer viewing.
- Following cleaning, from a more practical standpoint, grooming untangles yarns, eliminates cleaning tool patterns, and breaks up distortion that might be interpreted as matting, crushing or wear and generate complaints for carpet manufacturers.

E. Drying Principle

A cleaning project is not complete until provisions are made to return carpet to its intended use. Effort to dry carpet as expeditiously as practical, should be made for several reasons: First, it is required to return the carpet to use by customers as soon as practical. Second, drying carpet essentially eliminates slip-fall hazards, especially in areas where carpet transitions to wood, laminate, linoleum, VCT, sheet vinyl, tile or stone flooring. Third, rapid drying eliminates musty odors that may be associated with prolonged dampness. Moreover, it eliminates the potential for microbial germination, growth, amplification and dissemination, along with real or perceived IEQ or health concerns that may arise if carpet stays damp too long.

DATA ANALYSIS

Laboratory testing using industry-accepted procedures and evaluations has demonstrated that maximum application of the IICRC S100 Principles of Cleaning results in increased soil removal, as measured by a spectrophotometer that produces ΔE values related to the AATCC Gray Scale. In this standard test procedure, carpet samples are soiled to approximately a 7± ΔE value. Next, each carpet sample is cleaned with a specified medium, and spectrophotometer readings are taken from ten spots, in the same location on each test sample. The ten readings are averaged for each sample to provide a reliable ΔE value for that sample.

In testing conducted by Professional Testing Laboratories in Dalton, Georgia, cleaning product manufacturer directions for product dilution and application rate were followed. Testing produced the following data sets and comparative results:

Item (Test#)	Application Rate	Application Means	Soiled ΔE	Cleaned ΔE	Change in ΔE	Change in ΔE	Improved over H_2O
7957-058 H_2O A		control	7.23	5.22	2.01	27.8%	
7957-058 H_2O B		control	6.48	4.50	1.98	30.6%	
Average			6.855	4.860	1.995	**29.1%**	
79058 1A	3 gal/200 ft²	In-tank	7.05	3.92	3.130	44.4%	
79058 1B	3 gal/200 ft²	In-tank	6.66	3.75	2.910	43.7%	
79058 2A	3 gal/200 ft²	In-tank	6.44	3.03	3.410	53.0%	
79058 2B	3 gal/200 ft²	In-tank	6.77	3.44	3.330	49.2%	
79058 5A	3 gal/200 ft²	In-tank	6.63	4.40	2.230	33.6%	
79058 5B	3 gal/200 ft²	In-tank	6.78	4.94	1.840	27.1%	
79058 9A	3 gal/200 ft²	In-tank	7.11	5.11	2.000	28.1%	
79058 9B	3 gal/200 ft²	In-tank	7.23	5.02	2.210	30.6%	
79058 11A	3 gal/200 ft²	In-tank	7.44	5.24	2.200	29.6%	
79058 11B	3 gal/200 ft²	In-tank	7.13	4.89	2.240	31.4%	
79058 12A	3 gal/200 ft²	In-tank	7.33	4.87	2.460	33.6%	
79058 12B	3 gal/200 ft²	In-tank	7.15	5.15	2.000	28.0%	
79058 13A	3 gal/200 ft²	In-tank	7.02	5.16	1.860	26.5%	
79058 13B	3 gal/200 ft²	In-tank	7.25	4.78	2.470	34.1%	
79058 14A	3 gal/200 ft²	In-tank	7.09	5.13	1.960	27.6%	
79058 14B	3 gal/200 ft²	In-tank	7.03	4.89	2.140	30.4%	
79058 15A	3 gal/200 ft²	In-tank	7.13	4.94	2.190	30.7%	
79058 15B	3 gal/200 ft²	In-tank	6.73	4.46	2.270	33.7%	
79058 16A	3 gal/200 ft²	In-tank	6.73	4.35	2.380	35.4%	
79058 16B	3 gal/200 ft²	In-tank	7.00	4.71	2.290	32.7%	
79058 18A	3 gal/200 ft²	In-tank	6.76	4.71	2.050	30.3%	
79058 18B	3 gal/200 ft²	In-tank	6.93	4.83	2.100	30.3%	
79058 19A	3 gal/200 ft²	In-tank	7.28	5.06	2.220	30.5%	
79058 19B	3 gal/200 ft²	In-tank	7.44	4.55	2.890	38.8%	
79058 21A	3 gal/200 ft²	In-tank	6.59	4.61	1.980	30.0%	
79058 21B	3 gal/200 ft²	In-tank	6.97	4.54	2.430	34.9%	
Average			6.99	4.634	**2.353**	**33.7%**	**4.6%**

79057 3A	1 gal/200 ft²	Presprayed	7.33	3.54	3.790	51.7%	
79057 3B	1 gal/200 ft²	Presprayed	6.65	3.23	3.420	51.4%	
79057 4A	1 gal/200 ft²	Presprayed	6.95	3.97	2.980	42.9%	
79057 4B	1 gal/200 ft²	Presprayed	7.06	4.07	2.990	42.4%	
79057 6A	1 gal/200 ft²	Presprayed	7.18	3.67	3.510	48.9%	
79057 6B	1 gal/200 ft²	Presprayed	6.96	3.78	3.180	45.7%	
79057 7A	1 gal/200 ft²	Presprayed	7.48	4.10	3.380	45.2%	
79057 7B	1 gal/200 ft²	Presprayed	7.42	4.45	2.970	40.0%	
79057 8A	1 gal/200 ft²	Presprayed	6.68	4.06	2.620	39.2%	
79057 8B	1 gal/200 ft²	Presprayed	7.09	4.35	2.740	38.6%	
79057 10A	1 gal/200 ft²	Presprayed	7.40	3.58	3.820	51.6%	
79057 10B	1 gal/200 ft²	Presprayed	7.40	3.85	3.550	48.0%	
79057 17A	1 gal/200 ft²	Presprayed	7.15	4.08	3.070	42.9%	
79057 17B	1 gal/200 ft²	Presprayed	6.80	3.99	2.810	41.3%	
79057 20A	1 gal/200 ft²	Presprayed	6.72	3.37	3.350	49.9%	
79057 20B	1 gal/200 ft²	Presprayed	6.84	3.61	3.230	47.2%	
Average			7.07	3.856	3.213	**45.5%**	**16.3%**
					Prespray over tank-applied improvement		**71.99%**

- The carpet tested was a 25-ounce cut-pile tufted nylon.
- All chemicals, whether in-tank or presprayed, were diluted according to product formulator label directions. When a dilution range was specified for preconditioner, the lowest dilution was used by the laboratory; i.e., when 6-12 oz/gal were specified, 12 ounces were used.
- Preconditioners were agitated with a Grandi-Groomer® (comb) in a fixed position with four passes at one foot per second.
- Preconditioners were provided dwell time of 10 minutes for soil suspension.
- The extraction cleaning sequence was one wet and two dry passes, at one foot-per-second.

CONCLUSIONS

As the data in this paper shows, hot water extraction cleaning with in-tank-applied chemicals improves ΔE values 4.6% better than flushing soiled carpet with water only. Prespraying preconditioning chemicals, followed by plain water rinsing, improves ΔE values by 16.3%, or 3.54 times (71.99%) compared to in-tank-only application of chemicals in the course of cleaning. However, this percentage of soil removal does not necessarily correlate to a comparable percentage of visual improvement in carpet appearance.

REFERENCES:

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