



The revision of the colour fastness to rubbing test on leathers (ISO 11640)

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This paper is presented by FILK on behalf of the VGCT Commission "Leather Testing and Assessment". Inter-laboratory tests on the determination of colour fastness of leather to rubbing showed good consistency of results between the participating laboratories. The two evaluation methods that were possible - visual and colorimetric - proved to be equivalent, and both the mean values and variations of the results were almost equal. Results in the limit ranges (rating 4-5 and rating 1) showed good compliance, and differences in felt thicknesses did not affect laboratory procedures.

The testing of fastness to "to-and-fro" rubbing of both leather finishes and colour fastness is part of established leather quality control and is described in ISO 11640⁽¹⁾. In this test the leather is rubbed under defined conditions of pressure and extension with a standardised rubbing material in the form of square pieces of wool felt for a number of cycles.

The staining is then assessed by comparing the test felt with an original one, the colour difference being rated against a grey scale (ISO 105, Part A03⁽²⁾). The felts can be used dry, wetted with water or with artificial perspiration solution. The number of rubbing cycles is specified by the quality requirements of the respective leather type.

The standard could not be considered as state of the art as visual assessment on the basis of grey scales as described was influenced by certain subjectivity. So far, a colorimetric measurement has not been an option, despite the fact that results from historic studies have shown good consistency of both visual and colorimetric assessments⁽³⁾. However, handling techniques and the laboratory apparatus and equipment were not considered at that time.

Over and above any shortcoming within the standard, laboratory testing routine has shown that specific problems arise in conjunction with rub fastness determination. Following discussions between the members of VGCT Commission "Leather Testing and Assessment", the following points were identified as having a potential impact on the test:

- Felt quality (thickness, pH value, tendency to pill, flatness).
- Variations fitting the felt to the finger that provides the "to-and-fro" movement within the test.
- Different handling according to the width of the specimen.
- The quantity of medium - water or perspiration solution - in the felt.
- The procedures used for reference pads. (These require treatment with the medium in the same way as felts used for tests).
- Differing assessment with respect to rates 4-5 and 5 (the least change has to be quoted with rating 4-5).
- Evaluation of the surface of the sample (type of damage and change in gloss).
- The necessity for multiple determinations.

These points were considered in the planning of a new inter-laboratory test. One of the aims of this experiment was to compare the visual and colorimetric evaluation methods, and to remove any ambiguities in handling techniques.

The investigations

INTER-LABORATORY TESTS: THE DETERMINATION OF COLOUR FASTNESS TO RUBBING

A total of 14 laboratories participated in the inter-laboratory tests. This was organised by the VGCT Commission "Leather Testing and Assessment", and samples were provided by both tanneries and the chemical industry.

Sample preparation and distribution were carried out by the Research Institute of Leather and Plastic Sheeting (FILK). On the basis of preliminary tests six different leather types were chosen for the interlaboratory test:

1. upholstery leather, red,
2. automotive leather, brown,
3. shoe upper leather, brown,
4. shoe upper leather, black,
5. garment leather, red,
6. garment leather, black.

The variants included rubbing under dry and wet conditions and with perspiration, but this full range was not applied to all of the leathers. Leathers 3 and 5 were rubbed with dry felt only, and Leathers 4 and 6 were tested with wet and with perspiration-wetted felts.

All the specimens were of the same size (30 mm x 120 mm) and designed for one rub track. For every testing option two independent determinations were performed. The sampling location and distribution of the specimens to the participating laboratories were designed so that any variations due to leather were reduced to a minimum.

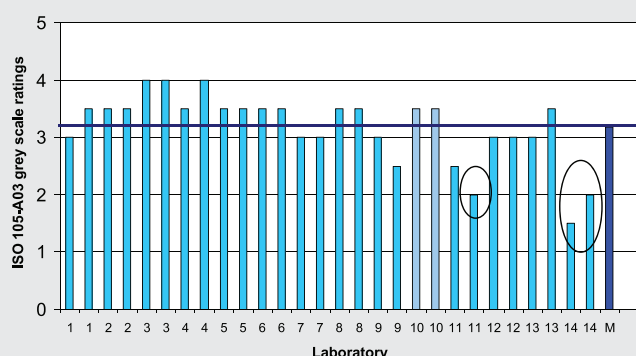
The determination of rub fastness was performed according to ISO 11640 (1998) with felts dry, wetted with water and with artificial perspiration solution. All specimens were extended for 10% after being fixed in the apparatus, and each laboratory used felts from their own sources of supply.

The exact guidelines for both the assessment of the degree of staining of the felt and the colour change of the leather after test were agreed by the participants. In addition, all of the felts used as reference in the wetted felts assessments (water and perspiration) were treated in the same way as the test felts, that is, they also were wetted and dried afterwards.

The assessment of the felts was performed both visually using the grey scale (ISO 105-A03)⁽²⁾, and instrumentally by measuring the difference in colour between the reference and test felt using a suitable device (ISO 105-A04)⁽²⁾.



Panel 1: The visual assessment of Leather 1
100 cycles, pH = 8.0, (felt: pilling / leather: dull)



Grey scale rates were noted as numerical values as accurate as 0.5 (e. g. 3.5 instead of 3-4), and instrumentally measured values as accurate as 0.1. In the case of colorimetric measurements, the aperture setting received particularly close attention. In addition any felt alteration (e. g. pilling) was noted.

The assessment of leather colour changes was also performed by both methods: visually (ISO 105-A02)⁽²⁾ and instrumentally (ISO 105-A05)⁽²⁾. Further visible changes in the surface of the leather (gloss, finish damage, etc.) were documented.

THE EFFECT OF FELT THICKNESS

To detect a potential effect of felt thickness on the test results, the following details were applied:

- Both thin and thick felts out of a standard lot were selected (thin 5.38 – 5.76 mm, thick 6.14 – 6.29 mm).
- Leather samples from the inter-laboratory test were used.
- A staggered sampling procedure was followed.
 - A thin and a thick felt were placed in the rub fastness test apparatus to perform tests in parallel.
 - All the possible test variants (dry, wet, with perspiration) were inspected.
 - Both visual and instrumental assessment was performed for every sample.
 - Quadruple determinations were conducted for every test that was operated.

Findings from the investigations

INTER-LABORATORY TESTS: THE DETERMINATION OF COLOUR FASTNESS TO RUBBING

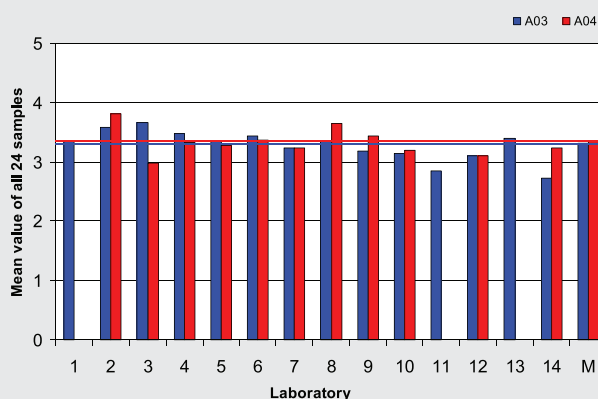
These results reflect a mixture of heterogeneity of leather and the differences between the participating labs. Thereby, variations in leather properties played a subordinated role as the influence of some critical factors (e.g. sampling location and specimen width) was first diminished by precisely defining the sampling and testing conditions.

Results from visual assessment of the felts for the testing variant with perspiration-wetted felts from Leather 1 are given in *Panel 1*. In some cases the deviations between labs are too high as indicated in the chart, but the causes could be clarified to some extent.

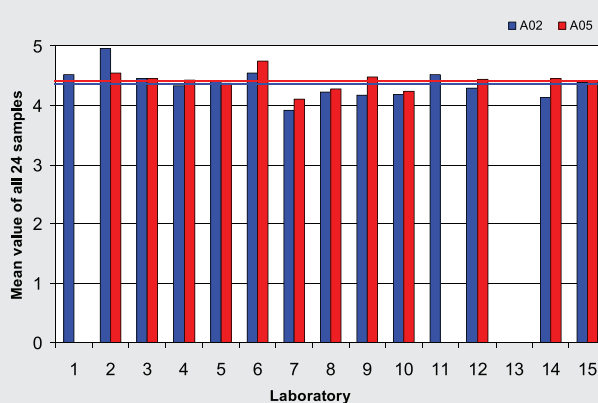
Rubbing with perspiration-wetted felt (pH=8) shows significant deviations from laboratories 11 and 14. The mean value of all numerical values of grey scale rating (M) is marked blue.

The comparison of all results for the assessment of staining of the felts (A03 and A04), and for colour change of the leather

Panel 2: Assessment of staining the felts



Panel 3: Assessment of leather colour changes



(A02 and A05) are shown as *Panels 2* and *3*. On the basis of the statistical evaluation of the inter-laboratory test the results of the visual assessment of leather from laboratory 13 were eliminated from the study.

Panel 2 shows the laboratory comparisons of the visual (A03) and colorimetric (A04) assessment of felts of all samples. The mean values (M) of all numerical values of rating are marked blue for visual assessment and red for colorimetric assessment. It should be noted that no colorimetric data were available from laboratories 1, 11 and 13.

Panel 3 shows laboratory comparisons for the visual (A02) and colorimetric (A05) assessment of leather colour changes of all 24 samples. The identification of mean values is the same as shown in *Panel 2* (blue – visual, red – colorimetric assessment). It should be noted that no colorimetric data was available from laboratories 1, 11 and 13, and that visual assessment data of laboratory 13 was eliminated from the investigation).

The mean values and standard deviations of both evaluation procedures for the felts and leathers are summarised in *Panel 4*. The evaluation of the numerical grey scale ratings for each leather and testing variant resulted in standard deviations of the A03-value (visual) between 0.16 and 0.64. The instrumental assessment did not show any significant differences in scattering of A04-values (colorimetric, 0.15 to 0.67).

The assessment of colour change of each leather resulted in similar observations. The standard deviations for visual assessment (A02-ratings) ranged between 0.24 and 0.69, and those from the colorimetric procedure ranged between 0.10 and 0.54. In comparison to the felt, staining assessment was found to be more difficult, and this is shown as the difference of the mean

**Panel 4: Comparison of the evaluation procedures**

Leather, testing variant		Assessment of staining of the felt			Assessment of change in leather colour		
		A03	A04	A03-A04	A02	A05	A02-A05
Leather 1, dry	Mv	4.45	4.63	-0.19	4.77	4.79	-0.02
	Std	0.16	0.15		0.25	0.20	
Leather 1, wet	Mv	2.81	2.85	-0.04	4.50	3.88	0.62
	Std	0.60	0.28		0.29	0.43	
Leather 1, pH=8	Mv	3.18	3.38	-0.20	4.65	4.28	0.37
	Std	0.61	0.43		0.24	0.32	
Leather 2, dry	Mv	4.73	4.63	0.10	4.04	3.74	0.30
	Std	0.25	0.57		0.55	0.44	
Leather 2, wet	Mv	3.91	4.04	-0.13	4.65	4.92	-0.27
	Std	0.41	0.47		0.31	0.10	
Leather 2, pH=8	Mv	3.55	3.69	-0.13	4.73	4.92	-0.19
	Std	0.64	0.67		0.32	0.12	
Leather 3, dry	Mv	2.16	2.38	-0.22	4.37	4.25	0.12
	Std	0.41	0.24		0.46	0.34	
Leather 4, wet	Mv	3.82	3.63	0.20	4.64	4.63	0.01
	Std	0.43	0.50		0.33	0.26	
Leather 4, pH=8	Mv	3.45	3.38	0.07	4.31	4.33	-0.03
	Std	0.53	0.62		0.43	0.34	
Leather 5, dry	Mv	3.75	3.96	-0.21	4.54	4.60	-0.06
	Std	0.44	0.29		0.24	0.35	
Leather 6, wet	Mv	2.34	2.23	0.11	3.96	4.55	-0.59
	Std	0.55	0.46		0.68	0.27	
Leather 6, pH=8	Mv	1.21	1.12	0.10	3.42	3.95	-0.53
	Std	0.32	0.30		0.69	0.54	

Mv Mean value of all labs per leather type and test variant
Std Standard deviation

values of the two evaluation procedures. However, no directional tendency could be detected.

The findings from this inter-laboratory test can be summarised as follows:

- In general, the grey scale values of two parallel determinations differed by no more than half a unit. Only in three cases out of 168 testings was the difference rated at a full unit.
- The causes of deviations could be clarified in most cases. For example, diverging results were generated by a different handling of the perspiration-wetted felts, an overly severe visual assessment, or excessive differences between the leathers under test.
- The results show good consistency between the laboratories within limit ranges of the assessment ranges (levels 4-5 and 1). Even if differences for the evaluation of both procedures are low for a given test variant (mean values), in some cases significant deviations of single values were observed. For example, in felt assessment (A03 – A04) differences up to 1.5 units were found. The differences for leather surface changes (A02 – A05) were even higher (up to 2.0).
- The inspection of selected specimens showed that differences can be generated by both the test in principle, and the visual assessment. Both effects can add or compensate for each other.
- A certain tolerance of the “finger” of some rub fastness test apparatus was also observed. This can cause differences of a half unit of grey scale rating in felt assessment.
- Pilling effects on felts were observed in case of Leather 1 and Leather 2, and repeated tests often replicated these effects. However, the assumption that the direction in which the felt is fixed on the finger plays a role (visible by the different drape during flexing the felt) could not be proved.
- The amount of liquid contained in the felts plays a significant role in the test result. It is also of importance to promptly remove the felt from the leather surface after the test is finished.
- The changes found on the leather surface were generally consistent.

Panel 5: Comparison of mean values obtained for thick and thin felts, colorimetric measurement (A04)

Testing variant	Colorimetric values (A04)		Difference
	Thick felt	Thin felt	
Leather 1, 500 cycles, dry	4.50	4.56	-0.06
Leather 1, 250 cycles, wet (experiment 1)	2.37	2.74	-0.37
Leather 1, 250 cycles, wet (experiment 2)	2.51	2.82	-0.31
Leather 4, 20 cycles, pH= 8	4.02	3.63	0.39

THE EFFECT OF FELT THICKNESS

The influence of the thickness of the felts on the test results was minor as shown in *Panel 5*.

Differences in felt thickness will hardly produce an effect in laboratory routine as extreme conditions were deliberately chosen in this experiment. Nevertheless, in serial determinations the felt thickness should be taken in account so that any tendencies might be detected.

Conclusions from the investigation

The findings from the inter-laboratory test evaluation, and the subsequent analysis within the Commission for Leather Testing and Assessment produced the following conclusions:

1. The test results throughout the limit range show very good compliance (levels 4-5 and 1).
2. The assessments of each of the inter-laboratory test participants are consistent overall. Major deviations were found in particular cases, but the causes could generally be identified.
3. The scatter of the results is roughly the same for both visual and colorimetric assessment (half grey scale level).
4. The mean values for both visual and colorimetric assessment differ only marginally. Significant deviations up to 2 grey scale rating levels are possible in single cases, but as yet the causes could not be detected.
5. Differences in felt thickness are not relevant within laboratory routine.
6. The direction that the felt is fixed in the finger of the rub fastness test apparatus has no effect on the appearance of a pilling effect.

The findings from these Inter-laboratory test investigations have been taken into account as part of the revision of ISO 11640. 

Acknowledgement

The Commission thanks all participants of the inter-laboratory test for dedicated cooperation and discussions.

References

- (1) ISO 11640, *Leather – Tests for colour fastness – Colour fastness to cycles of to-and-fro rubbing*, 1998 (old edition), 2012 (new edition).
- (2) ISO 105, *Textiles – Tests for colour fastness – Parts A02, A03, A04 and A05*.
- (3) Hummel, A., Lange, J., Germann, H.-P.: *Untersuchungen über die Anwendung der Farbmessung bei der Beurteilung der Reibechtheit von gefärbten Ledern*, Das Leder 5 (1997), S. 105.