Technical Memorandum

To: ASTM D01.34 Naval Stores

From: Mike Pointer

Date: 9th October 1998

Re: Procedure to correlate the USRG (Rosin) Scale to the Gardner Scale.

Introduction

When testing rosin it is historical to use the USRG (Rosin) scale as defined in ASTM D509[1]. Some users, however, prefer to use the Gardner scale as defined by ASTM D1544[2]. This memo describes a method that calculates the Gardner values equivalent to the Rosin standards, as defined in ASTM D509, taking into consideration the different path-lengths used by the two Methods.

The Gardner scale requires the sample to be in a glass tube of inside diameter 10.65 mm: this is usually approximated by a 10 mm square cuvette. The Rosin scale uses a ⅞ inch (22.2 mm) cube of material.

Procedure

The CIE x, y, Y chromaticity coordinates of the 18 steps of the Gardner Scale were obtained from ASTM D1544-89[2].

The spectral transmittance data for the 12 standards of the Rosin scale were taken from ASTM D509-93[1]. To find the equivalent values of transmittance for a 10 mm path-length these values were raised to the power (10.0 / 22.2). The application of this calculation makes the assumption that Beer's Law can be applied to the samples.

The spectral transmittance values for the 3 lighter Rosin scale values, XA, XB and XC, are not published in the ASTM Method. In order that their Gardner equivalents could be found, spectral transmittance values were measured using the actual glass standards from the Tintometer master grading set. These transmittance values were adjusted for path-length as above.

The table below shows the x, y, Y data for the Gardner scale and similar data calculated from the 'corrected' Rosin scale transmittance data.

Gardner D1544				Rosin D509 - corrected			
	x	y	Y		x	y	Y
1	0.3177	0.3303	80.0	XC	0.3249	0.3432	92.62
2	0.3233	0.3352	79.0	XB	0.3436	0.3719	89.22
3	0.3329	0.3452	76.0	XA	0.3646	0.4006	84.84
4	0.3437	0.3644	75.0	X	0.3805	0.4158	79.20
5	0.3558	0.3840	74.0	WW	0.3981	0.4303	73.91
6	0.3767	0.4061	71.0	WG	0.4148	0.4422	69.15
7	0.4044	0.4352	67.0	N	0.4348	0.4539	63.58
8	0.4207	0.4498	64.0	M	0.4566	0.4633	57.02
9	0.4343	0.4640	61.0	K	0.4812	0.4688	49.23
10	0.4503	0.4760	57.0	I	0.5065	0.4675	41.22
11	0.4842	0.4818	45.0	H	0.5326	0.4574	31.84
12	0.5077	0.4638	36.0	G	0.5557	0.4397	24.69
13	0.5392	0.4458	30.0	F	0.6040	0.3954	15.50
14	0.5646	0.4270	22.0	E	0.6297	0.3699	8.36
15	0.5847	0.4089	16.0	D	0.6706	0.3292	2.79
16	0.6047	0.3921	11.0				
17	0.6290	0.3701	6.0				
18	0.6477	0.3521	4.0				

Intermediate points were calculated for the Gardner Scale using linear interpolation to an accuracy of 0.1 scale units: this is equivalent to 9 points between each step defined above.

The nearest point on this expanded Gardner Scale was found for each point on the Rosin Scale by finding the smallest difference in x,y chromaticity space. The resulting Gardner values are tabulated below.

Rosin Scale	Gardner Scale	ΔE		Rosin Scale	Gardner Scale	ΔE
XC	2.5	7.32		K	11.2	6.81
XB	4.3	7.13		I	11.9	6.30
XA	5.6	7.06		H	12.7	8.33
X	6.2	5.59		G	13.5	3.88
WW	6.8	3.51		F	15.9	13.25
WG	7.6	2.22		E	17.0	11.66
N	8.6	3.41		D	18.0	9.17
M	9.9	6.21				

Also shown in the above table are the CIELAB colour differences between the Rosin scale colours and their nearest Gardner equivalents.

The table below gives the CIE coordinates of the Gardner values equivalent to the USRG (Rosin) Scale.

	Gardner	x	y	Y
XC	2.5	0.3281	0.3402	77.5
XB	4.3	0.3473	0.3703	74.7
XA	5.6	0.3683	0.3973	72.2
X	6.2	0.3822	0.4119	70.2
WW	6.8	0.3989	0.4294	67.8
WG	7.6	0.4142	0.4440	65.2
N	8.6	0.4289	0.4583	62.2
M	9.9	0.4487	0.4748	57.4
K	11.2	0.4889	0.4782	43.2
I	11.9	0.5054	0.4656	36.9
H	12.7	0.5298	0.4512	31.8
G	13.5	0.5519	0.4364	26.0
F	15.9	0.6027	0.3938	11.5
E	17.0	0.6290	0.3701	6.0
D	18.0	0.6477	0.3521	4.0

Attached are two graphs of chromaticity diagrams. The first shows a comparison between the two scales with the full spectral locus plotted. The second shows a magnified view of the relevant part of the diagram.

Comments

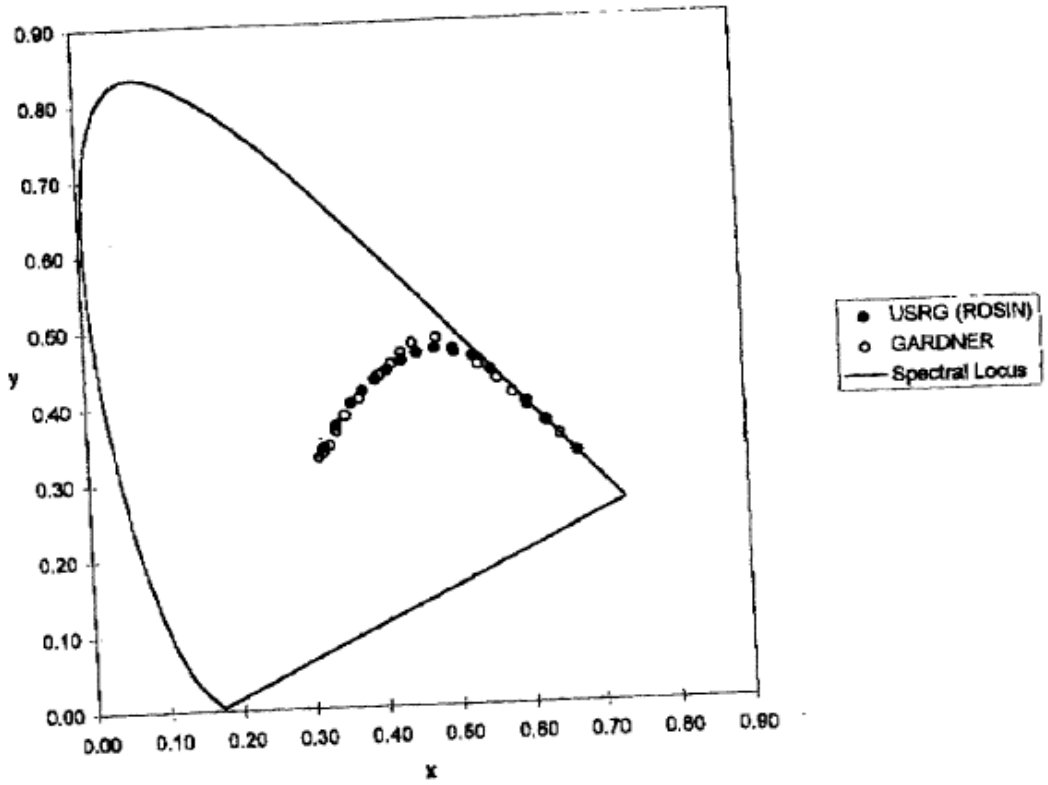
It is possible that a different form of interpolation, e.g. cubic spline or Lagrange, would give slightly different results. However, the difference between these results and those found by linear interpolation, as tabulated above, is likely to be very small.

References

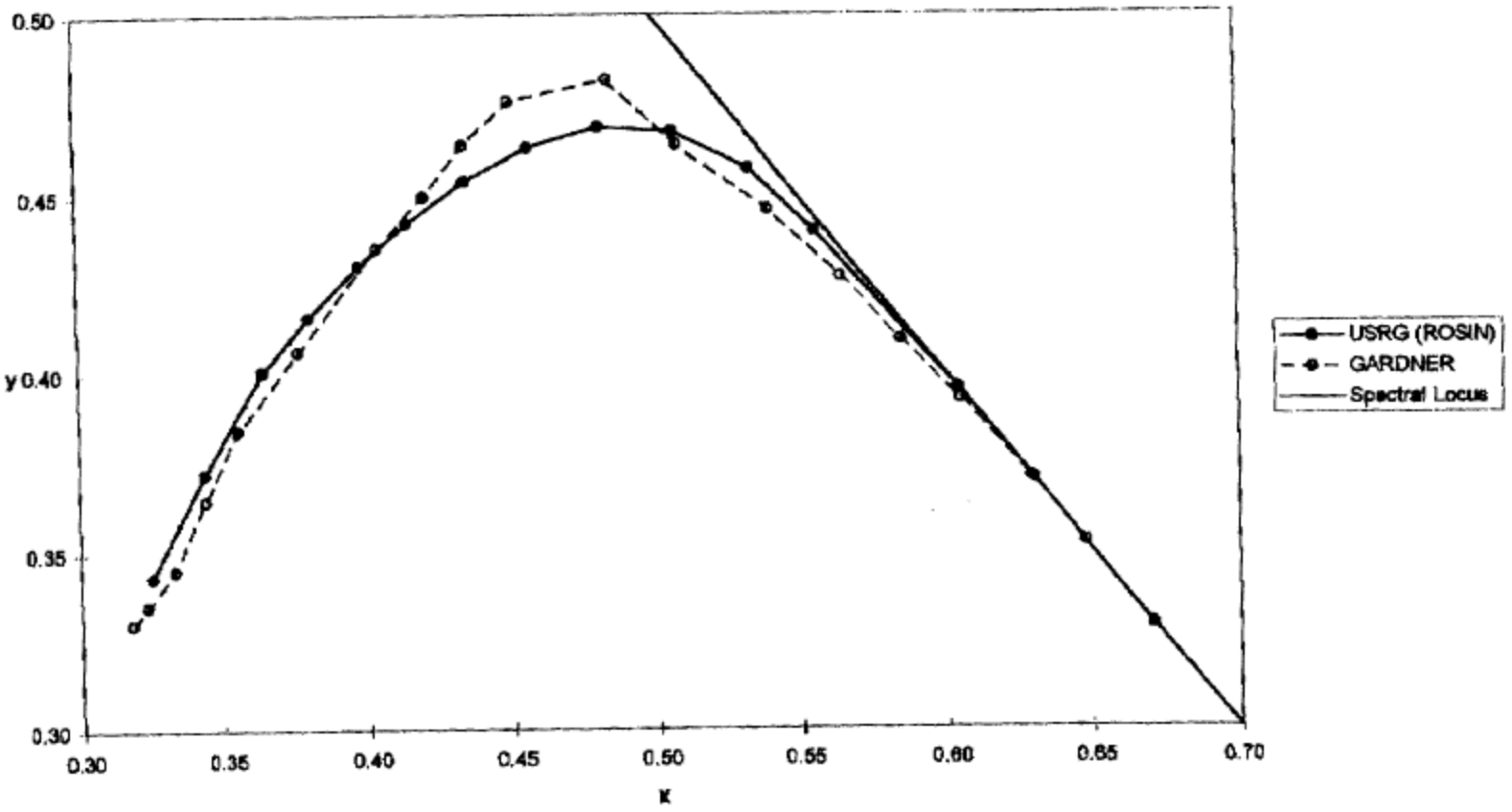
1. ASTM D509-93 *Standard Test Methods of Sampling and Grading Rosin*.

2. ASTM D1544-80 (Re-approved 1989) *Standard Test Methods for Color of Transparent Liquids (Gardner Color Scale)*.

ROSIN SCALE D509 CORRECTED TO GARDNER SCALE D1544



ROSIN SCALE D509 CORRECTED TO GARDNER SCALE D1544



Rosin to Gardner 2.xls

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