Bellingham + Stanley Technical Bulletin

Bulletin No: **R024**
Title: RFM800 Series 'user scale' to assistant in interpretation of results as part of ASTM D 2140

Background Information:
The test method is useful for determining the carbon-type composition of electrical insulating oils of the types commonly used in electric power transformers and transmission cables. It is primarily intended for use with new oils, either inhibited or uninhibited.

ASTM D 2140 may be used to determine the carbon-type composition of mineral insulating oils by correlation with basic physical properties. For routine analytical purposes it eliminates the necessity for complex fractional separation and purification procedures. The test method is applicable to oils having average molecular weights from 200 to above 600, and 0 to 50 aromatic carbon atoms.

Carbon-type composition is expressed as percentage of aromatic carbons, percentage of naphthenic carbons, and percentage of paraffinic carbons. These values can be obtained from a correlation chart (available from ASTM) if both the viscosity-gravity constant (VGC) and refractivity intercept (r_1) of the oil are known. Viscosity, density and relative density (specific gravity), and refractive index are the only experimental data required for use of this test method.

RFM800 software:
ASTM D 2140 requires measurement of its viscosity, density, relative density (specific gravity) and refractive index in order to calculate the viscosity-gravity constant (VGC) and refractivity intercept (r_i) prior to using a three dimensional correlation graph to determine carbon-type composition of insulating oils.

The use of a correlation graph is likely to lead to some variation, caused by operator error visually interpreting the results.

Software installed in RFM800 type refractometers from September 2006, allows input of viscosity, density and relative density (SG) at the specified measurement temperatures, and carries out the calculations instantly providing a report of results, without the need for visual interpretation.

Advantages:
1. Use of a digital refractometer will give better repeatability in obtaining refractive index values compared to visual Abbe refractometers.

2. Use of software within the RFM800 series refractometer will offer more precise interpretation of results, especially between different operators, compared to visual use of the correlation table.

Use of the RFM800 Software to determine results in accordance with ASTM D 2140:

The RFM800 incorporates a user scale that enables automatic calculation of:

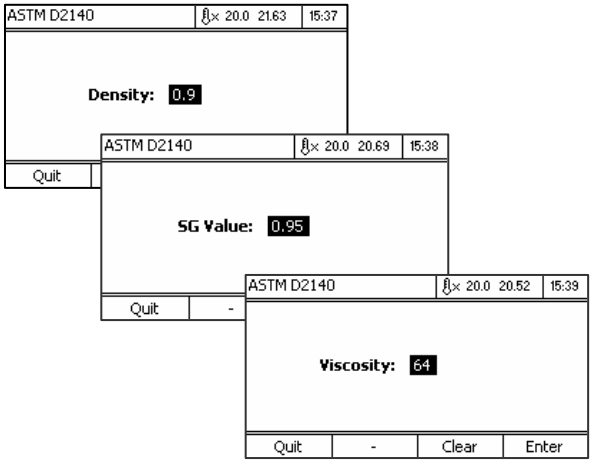
% Aromatic Carbons
% Naphthenic Carbons
% Paraffinic Chain Carbons

The scale is available from the scale library within the instrument

Scale Name: ASTM D 2140
Scale ID: ad

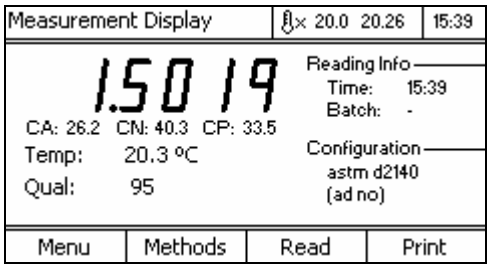
If a measurement is taken with the 'ASTM D 2140' scale, the instrument will request a number of measurements to be input prior to measuring the sample applied to the prism:

Value	Measurement Specification
Density	at 20°C
Relative density	SG at 15.6°C
Viscosity	cSt at 37.8°C



Results:

When the measurement has been completed the result will be displayed. The RI of the sample will be displayed in the large characters, and the special ASTM D 2140 values appear below the RI measurement.



Notes & Recommendations:

1. *This document is intended as an introduction to the software of the RFM800 series refractometers and provides a brief summary of the test method. It is **NOT** designed to be a replacement or actual test method.*
2. *Users of the method should consult with ASTM and obtain an original copy of the method in order to ascertain suitability.*
3. *Although B+S Ltd. has done everything possible to ensure that results obtained match those from the published method, no responsibility is taken for the calculated results or indeed the source data taken from the method itself.*
4. *B+S Ltd. recommend that users adopting the RFM800 'user scale method' continue to carryout infrequent checks by way of original method to prove results as part of GLP.*
5. *The RFM800 series complies with additional ASTM methods including ASTM D 5006, 1747 and 1218 (annex 2).*
6. *All copyright acknowledged.*