

COMMENTARY TO AG:PT/T161 - DETERMINATION OF DYNAMIC VISCOSITY BY FLOW THROUGH A CAPILLARY TUBE – TEST TUBE SCHEDULE

PREFACE

This test method was prepared by ARRB Group on behalf of Austroads. Representatives of Austroads, ARRB Group and Industry through the Australian Asphalt Pavement Association (AAPA) have been involved in the development and review of this test method.

FOREWORD

This test method was prepared as an adjunct to Australian Standard AS2341.2 and provides a recommended series of Asphalt Institute and Cannon-Manning vacuum capillary test tubes for each of the bitumens specified in AS2008 and multigrade bitumens specified in the Austroads Specification framework for modified binders. The schedule also includes recommendations for rolling thin film oven (RTFO) treated binders produced in accordance with the requirements of these specifications. In this version of the test method, Cannon Manning viscometers have been included to allow laboratories currently equipped with these tubes to continue testing during the working life of these existing viscometers. A future version of this test method will restrict the test to Asphalt Institute type viscometers. For laboratories investing in vacuum capillary viscometers, the Asphalt Institute type tubes listed in this method are recommended. Where Cannon-Manning type tubes reach the end of their service life, replacement with the appropriate Asphalt Institute tubes is recommended.

The tube selection criteria has been based on the specified and estimated viscosity ranges declared in Table 1. Where the specifications for bitumens and multigrade bitumens are further developed resulting in a change in the range of measured viscosities, a revision of the recommended tubes could be required.

Table 1
Viscosities of AS 2008 bitumens and multigrade bitumens (Pa.s)

Binder Grade	Pre RTFO	Post RTFO
C50	40–60	70–135
C170	140–200	240–575
C320	260–380	520–1075
C600	500–700	1050–2050
M500/170	400–600	1500–2800
M1000/320	950–1400	3500–6500

The tube and bulb selection process has been based on three objectives:

- For a specified binder, all laboratories should be using the same tube type, size and timing bulb. This will ensure all test results (for a given binder) are obtained under the same test conditions.

- For paving applications, low rates of strain are considered to be relevant. The Asphalt Institute viscometer has been designed to provide low rates of strain. This contrasts with the Cannon-Manning viscometer where the rates of strain are generally higher and vary significantly between tubes.
- Selected tube/bulb combinations ensure flow time are greater than 60 seconds.

Other than the recommendations presented in this test method for tube and bulb selection, the user must refer to the testing instructions provided in AS2341.2.

Laboratory sample handling for AS2008 bitumens shall be in accordance with AS/NZS 2341.21: *Methods of testing bitumen and related roadmaking products - Sample preparation*. This is an agreed part of the AS2341 series but has not been referenced in the test methods.

Representative samples of multigrade binders shall be obtained in accordance with AG:PT/T101: (formerly MBT 01) *Method of sampling polymer modified binders, polymers and crumb rubber*. The division of these samples into subsamples and test portions prior to testing shall be conducted according to AG:PT/T102 (formerly MBT 02) *Protocol for handling polymer modified binders in the laboratory*

SCOPE

This test method applies to bitumens and multigrade bitumens. Materials are sampled according to the specified protocols to ensure that correct sampling procedures are followed and that test results provide the required information on consignment quality. The purpose of sampling is to enable subsequent testing to:

- (a) represent, as nearly as practicable, an average of a consignment or batch, or
- (b) detect any variation within a consignment or batch.

Further Development

There is no further development of this test method planned.

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1 REFERENCED DOCUMENTS

The following documents are referred to in this method:

AUSTROADS

AG:PT/P101 Method of sampling polymer modified binders, polymers and crumb rubber

AG:PT/P102 Protocol for handling polymer modified binders in the laboratory

AS /NZS

2341.2 Methods of testing bitumen and related roadmaking products - Determination of dynamic (coefficient of shear) viscosity by flow through a capillary tube.

2341.21 Methods of testing bitumen and related roadmaking products - Sample preparation.

2. SAFETY PRECAUTIONS

Strict precautions shall be taken to avoid injury or fire at all times when handling hot bituminous materials, such as bitumens, multigrade bitumens and modified binders. Such precautions include, but are not limited to, the following requirements:

- a. Eye protection, such as safety glasses and/or face shields, shall be worn while sampling.
- b. Heat-resistant gloves, with close-fitting cuffs, and other suitable protective clothing, shall be worn while sampling and sealing containers.
- c. There shall be no smoking while sampling.
- d. Containers shall not be held in the hand while sampling and sealing. Tongs, or some other device, shall be used to hold the containers while the sample is being taken.
- e. The sampler shall, as far as practical, stand above and away from the sampling valve or outlet and on the windward side.
- f. The sample shall be taken slowly and carefully to prevent splashing of the material.
- g. The container shall be placed on a firm, level surface to prevent splashing, spilling or dropping.

3. PRINCIPLE

The time for a fixed volume of the liquid bitumen or multigrade bitumen to be drawn up through a selected capillary tube by means of reduced pressure, under closely controlled conditions of pressure and temperature is measured. The dynamic viscosity is calculated by multiplying the flow time by the viscosity tube calibration factor. This test method introduces a restriction to the type and size of viscometer tube used for each category of binder. While

no precision statement is provided, it can be assumed that the restrictions to tube type and size described in this test method will improve the testing precision declared in AS2341.2 at the time of writing (Repeatability 7 percent, Reproducibility 12 percent).

4. APPARATUS

The following items of apparatus are required, with a choice of two viscometer types.

Asphalt Institute viscometer – available in six sizes covering the range 4 Pa.s to 80,000 Pa.s. For the purpose of this test method, the tubes described in Table 2 are limited by the range of viscosities encountered in AS2008 bitumens and Austroads multigrade bitumens.

Table 2
Standard viscometer sizes and application recommendations
for Asphalt Institute vacuum capillary viscometers

Binder type and condition	AI tube and bulb
C50	50 C
C50 RTFO	100 D
C170	100 C
C170 RTFO	100 B *
C320	100 B *
M500/170	100 B
C600	200 C
C320 RTFO	200 C
M1000/320	400 D
C600 RTFO	400 D
M500/170 RTFO	400 C
M 1000/320 RTFO	400 B

* Also measure bulb C and report time for bulb C if time for bulb B less than 60 s.

Cannon-Manning viscometer – available in eleven sizes covering a range of 0.004 Pa.s to 8,000 Pa.s. For the purpose of this test method, the tubes described in Table 3 are limited by the range of viscosities encountered in AS2008 bitumens. (Note Multigrade bitumens are specified in terms of Asphalt Institute Viscometers. This single viscometer approach to viscosity testing for Multigrade bitumens was the first testing rationalisation of this type initiated by Austroads.)

Table 3
Standard viscometer sizes and application recommendations
for Cannon-Manning vacuum capillary viscometers

Binder type and condition	C-M tube and bulb(*)
C50)	CM-12 C
C50 RTFO	CM-12 C
C170	CM-13 C
C170 RTFO	CM-13 B/C
C320	CM-13 B/C
C600	CM-14 B/C
C320 RTFO	CM-14 B/C
C600 RTFO	CM-14 B

* Tube selected to minimize shear rate.

5. Calibration of Viscometers

Follow the procedure in AS2341.2

6. Procedure

Follow the procedure in AS2341.2

7. Calculation

Follow the procedure in AS2341.2

Note: Table 2 (AS2341.2) contains an error for the Asphalt Institute Tube No 100. Shear constant 120 should read 160.

8. Precision

See AS2341.2 for acceptability criteria for judging results.

9. Reporting

Follow the reporting requirements in AS2341.2

AMENDMENT RECORD

Amendment No.	Clauses amended	Action	Date
1	Draft with Asphalt Institute tubes	New	March 2003
2	Inclusion of Cannon-Manning tubes as an interim measure. First circulated as May 2004 draft version	New	January 2004
3	Revised draft with comments from Test Methods Task group	Substitution	June 2004
4	Commentary Page	New	June 2005
	Footer and header	Format	
	Applied revised test method number	Format	
	Applied new styles	Format	
5	Applied revised test method number	Substitution	March 2006

Key

Format	Change in format
Substitution	Old clause removed and replaced with new clause
New	Insertion of new clause
Removed	Old clauses removed