

CHAPTER 3 : TEST AT STEADY SPEEDS OVER THE FULL-LOAD CURVE

1 Scope :

This Chapter describes the method of determining emissions of visible pollutants at different steady speeds over the full load curve to be carried out either on an engine or on a vehicle, as defined in para 5.2.4 of Chapter 1 of this Part.

2 Measurement Principle :

2.1 The opacity of the exhaust gases produced by the engine shall be measured with the engine running under full-load and at steady speed.

2.2 A sufficient number of measurements will be carried out ranging between the maximum rated speed and the minimum rated speed. The extreme points of measurement shall be situated at the limits of interval defined above and one point of measurement will coincide with the speed at which the engine develops its maximum power and the speed at which it develops maximum torque.

3 Test Conditions :

3.1 Vehicle or engine :

3.1.1 The engine or the vehicle shall be submitted in good mechanical condition. The engine/vehicle shall have been run in as recommended by the manufacturer.

3.1.2 The engine shall be tested with the equipment prescribed in Chapter 6 of this Part.

3.1.3 The settings of the engine shall be those prescribed by the manufacturer and shown in Chapter 2 of this Part.

3.1.4 In the case of a test on an engine the power of the engine shall be measured in accordance with Chapter 6 of this Part and it should meet the requirements of para 5.2.2 of Chapter 1 of this Part. In the case of a test on a vehicle, it should be established that the fuel flow is not less than that declared by the manufacturer.

3.1.5 The exhaust device shall not have any orifice through which the gases emitted by the engine might be diluted. In cases where an engine has several exhaust outlets, these shall be connected to a single outlet in which the opacity measurement shall be made.

3.1.6 The engine shall be in the normal working condition prescribed by the manufacturer. In particular, the cooling water and the oil shall each be at the normal temperature prescribed by the manufacturer.

- 3.2 Fuel : The fuel used shall be the reference fuel as specified in the gazette notification.

3.3 Test Laboratory :

The absolute temperature T of the air (The test may be carried out in air-conditioned test rooms where the atmospheric conditions may be controlled) at the inlet to the engine measured within 0,15 m upstream of the point of entry to the air cleaner, or if no air cleaner is used, within 0,15 m of the air inlet manifold expressed in degrees Kelvin, and the atmospheric pressure Ps, expressed in Kilopascals, shall be measured, and the atmospheric factor F shall be determined as give below : Naturally aspirated and mechanically super charged engines :-

$$F = (99/P_s) * (T/298)^{0.7}$$

Turbo super charge engines with or without cooling of inlet air

$$F = (99/P_s)^{0.7} * (T/298)^{1.5}$$

- 3.3.1 From the date 1-4-96 , as per the notification, F shall be such that - it is between 0.98 and 1.02.

- 3.4 Sampling and measuring apparatus : The light-absorption coefficient of the exhaust gases shall be measured with an opacimeter satisfying the conditions laid down in Chapter 7 of this Part and installed in conformity with the conditions laid down therein.

4 Evaluation of the Absorption Coefficient :

- 4.1 For each of the six engine speeds at which the absorption coefficient is measured pursuant to Paragraph 2.2 above, the nominal gas flow shall be calculated by means of the following formulae :

for two-stroke engines $G = V * n/60$

for four-stroke engines $G = V * n/120$

where -

G - nominal gas flow, in liters per second, (l/s)

V - cylinder capacity of the engine, in liters, (l)

n - engine speed, in revolutions per minute (rpm),

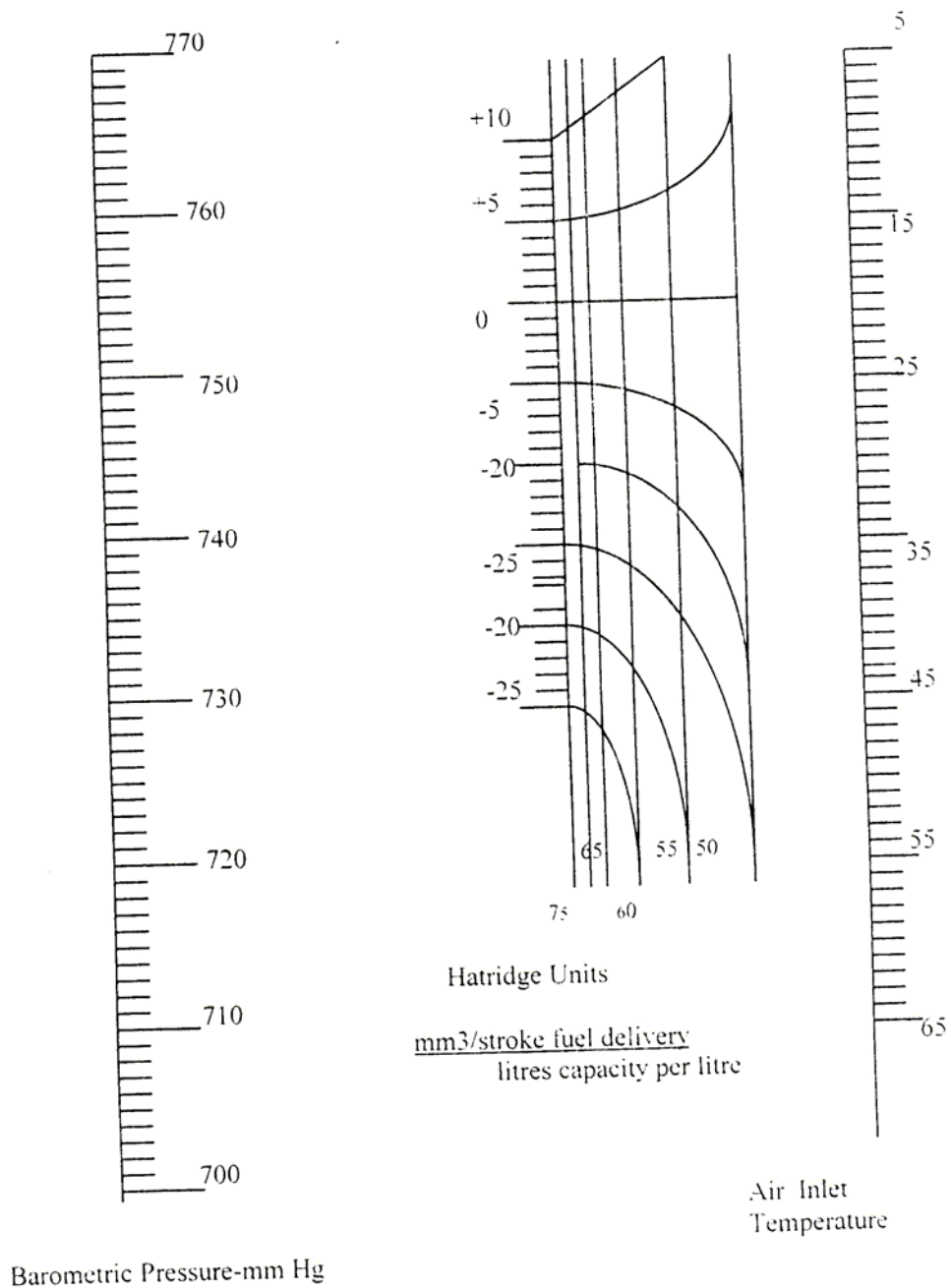
- 4.2 Correction of Exhaust gas opacity: For the correction factor description please refer paras 4.2.1 to 4.2.5. This is not applicable since 01.04.96.

- 4.2.1 The smoke density should be corrected to reference atmospheric conditions of 100 kpa and 298K.

- 4.2.2 Correction data exist only for certain proprietary instruments. The light obscuration smoke meter for which correction data is given in Fig.2, is the Hartridge opacimeter with an effective exhaust gas column length of approximately 0.43 m and applicable for Four stroke naturally aspirated engines only. The correction shall be applied as follows :

Corrected exhaust gas opacity = observed exhaust gas opacity \pm Opacity correction

- 4.2.3 For test atmospheric conditions outside the limits covered by the nomogram given in Fig.2, the maximum possible correction factor from the nomogram will be applied.
- 4.2.4 For engines other than Four-stroke naturally aspirated engines, no correction shall be applied, but if the inlet air density (ignoring humidity) is more than 5 % different from that given by the standard conditions, mention shall be made of it but no values are specified at present as there is insufficient data for such engines. This will be supplemented at a later stage.
- 4.2.5 When the exhaust gas opacity is less than 20 or greater than 80 Hartridge smoke units, no correction shall be applied, and the observed readings shall be stated. If the corrected exhaust gas opacity shall be stated 'as less than 20' or 'greater than 80' Hartridge smoke units, as appropriate.
- 4.3 Where the value of the nominal flow is not one of those given in the table in Chapter 1 of this Part, the limit value applicable shall be obtained by interpolation on the principle of proportional parts.
- 4.4 Fig.1 of chapter 1 shows the correlation between light absorption coefficient expressed in m^{-1} , % opacity, Hartridge Smoke Units (HSU) and Bosch Smoke Units (BSU).



(fig. not to the scale)

FIG2. Correlation For Hartridge Smoke(Four -Stroke Naturally Aspirated Engines) At Steady State Conditions (Pl.Ref. Para. 4.2.3 Of Chapt. 3 Of Part Iv)