

CHAPTER 4 : TEST UNDER FREE ACCELERATION

- 0 1 Scope : This Chapter describes the method of determining the emissions of visible pollutants during the free acceleration test as defined in para 5.3 of Chapter 1 of this Part. This is applicable for naturally aspirated and supercharged (turbocharged) engine/vehicles.
- 2 Test Conditions :
- 2.1 The test shall be carried out on an engine installed on a test bench or on a vehicle.
- 2.1.1 If the engine test is a bench test it shall be carried out as soon as possible after the test for measurement of opacity under full load at steady speed. In particular, the cooling water and the oil shall be at the normal temperatures stated by the manufacturer.
- 2.1.2 If the test is carried out on a stationary vehicle the engine shall first be brought to normal operating conditions during a road run or on a dynamic test. The test shall be carried out as soon as possible after completion of this warming up period.
- 2.2 The combustion chamber shall not have been cooled or fouled by a prolonged period of idling preceding the test.
- 2.3 The test conditions prescribed in Paragraph 3.1, 3.2 and 3.3 of Chapter 3 of this Part shall apply.
- 2.4 The conditions prescribed with regard to the sampling and measuring apparatus in para 3.4 of Chapter 3 of this Part shall apply.
- 3 Test Methods :
- 3.1 The visible pollutants during free acceleration shall be measured with the engine in the maximum rated speed and maximum power condition.
- 3.2 At the request of the manufacturer, measurements shall also be made over a matrix of up to five other power/speed combinations for the engines de-rated for speed/power to cover the range of speed and power allowed for in Para 5.3.4 of Chapter 1 of this Part covering the modification of an engine type. In this case the steady state visible pollutants will also be measured with the engine rated at these other points, by the method described in Chapter 3 of this Part, to enable the free acceleration absorption coefficient to be corrected in accordance with Paragraph 4 below. These values shall be recorded in the approval certificate.

- 3.3 The Table and diagram below shows the six possible measuring points of the matrix and the range of power and speed governed by each point.

% of maximum rated speed	% of maximum torque at that speed
100	100
90	100
100	90
90	90
100	80
90	80

- 3.4 Each measuring points governs the power and speed area to the left of and below that point and is the measuring point for any engine rated in that area. For example the measuring point at "A" which is for the 90% full load line and 100% rated speed applies to the rated power/speed area bounded by ABCD on the diagram (Dia -1 of chapter 4 , part 4)
- 3.5 If the test is a bench test, the engine shall be disconnected from the brake, the latter being replaced either by the rotating parts driven when no gear is engaged or by an inertia substantially equivalent to that of the said parts.
- 3.6 If the test is carried out on a vehicle, the gear-change control shall be set in the neutral position and the drive between engine and gear-box engaged.
- 3.7 With the engine idling, the accelerator control shall be operated quickly, but not violently, so as to obtain maximum delivery from the injection pump. This position shall be maintained until maximum engine speed is reached and the governor comes into action. As soon as this speed is reached the accelerator shall be released until the engine resumes its idling speed and the opacimeter reverts to the corresponding conditions.
- 3.7.1 The sequence mentioned in para 3.7 for complete cycle for measurement can be defined based on time.
- 1) Acceleration time from idle to fly up speed :- 5 sec (max)
 - 2) Stabilising time at maximum speed :- 2 sec (max)
 - 3) De-acceleration Phase :- Engine comes back to idle speed by its own natural time
 - 4) Idling Phase :- Operator to start next acceleration within 5 to 20 secs.
 - 5) Repeat 1) to 4) above.
- 3.8 The operation described in Para 3.6 above shall be repeated not less than six times in order to clear the exhaust system and to allow for any necessary adjustment of the apparatus. The maximum opacity values read in each successive acceleration shall be noted until stabilised values are obtained. No account shall be taken of the values read while, after each acceleration, the engine is idling. The values read

shall be regarded as stabilised when four of them consecutively are situated within a band width of 25% of the arithmetic mean of these four readings or within a band width of 0.25K whichever is higher and do not form a decreasing sequence. The absorption coefficient X_M to be recorded shall be the arithmetical mean of these four values.

- 3.9 In cases where the engine has several exhaust outlets. the tests shall be carried out with all the outlets joined in an adequate device ensuring mixture of the gases and ending in a single orifice. Free acceleration tests, however, may be carried out on each outlet. In this case the value to be used for calculating the correction to the absorption coefficient shall be the arithmetical mean of the values recorded at each outlet, and the test shall be regarded as valid only if the extreme values measured do not differ by more than 0.15 m^{-1} .

- 4 Determination of the Corrected Value of the Absorption Coefficient :
Applicable where steady speed absorption coefficient has been effectively established on the same engine derivative.

- 4.1 Notation :

X_M - value of the absorption coefficient under free acceleration measured as prescribed in Paragraph 3.8 above;

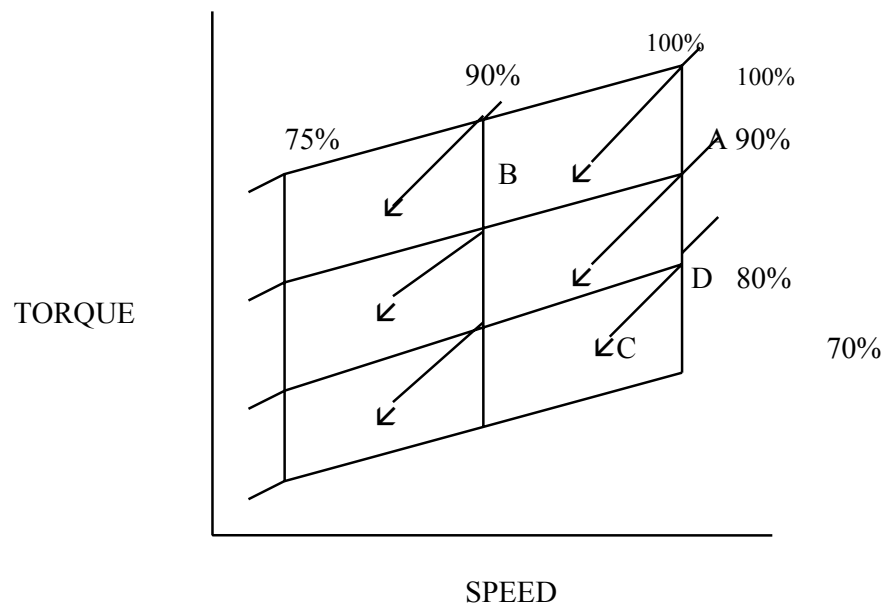
X_L - corrected value of the absorption coefficient under free acceleration;

S_M - value of the absorption coeff. measured at steady speed as prescribed in Para 2.2 of Chapter 3 of this Part which is closest to the prescribed limit value corresponding to the same nominal flow;

S_L - value of the absorption coefficient as prescribed in Paragraph 4.1 of Chapter 3 of this Part, for the nominal flow corresp. to the point of measurement which gave the value S_M ;

- 4.2 The absorption coefficients being expressed in m^{-1} . The corrected value X is given by the smaller of the following two expressions :

$$X_L = S_L * X_M / S_M \quad \text{or} \quad X_L = X_M + 0.5$$



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