$$M_{HC} = M_C + \alpha M_H + \beta M_O$$

Where:

M_C = Molecular weight of carbon=12.01 [g/mole]
M_H = Molecular weight of hydrogen=1.008 [g/mole]
M_O = Molecular weight of oxygen=16.00 [g/mole]
α = Hydrogen to carbon ratio of the test fuel
β = Oxygen to carbon ratio of the test fuel

(3) The value of $Density_{NOX}$ above assumes that NO_X is entirely in the form of NO_2

(d) The dilution factor, DF, is the ratio of the volumetric flow rate of the background air to that of the raw engine exhaust. The following formula is used to determine DF:

$$DF = \frac{13.4}{C_{D_{HC}} + C_{D_{CO}} + C_{D_{CO_2}}}$$

Where:

C_{DHC} = Concentration of HC in the dilute sample [ppm]
C_{DCO} = Concentration of CO in the dilute sample [ppm]
C_{DCO2} = Concentration of CO_2 in the dilute sample [ppm]

(e) The humidity correction factor K_H is an adjustment made to measured NO_X values. This corrects for the sensitivity that a spark-ignition engine has to the humidity of its combustion air. The following formula is used to determine K_H for NO_X calculations:

K_H = (9.953 H + 0.832)

Where:

H = the amount of water in an ideal gas; 40 CFR 1065.645 describes how to determine this value (referred to as x_{H_2O}).

K_H = 1 for two-stroke gasoline engines.

(f)–(g) [Reserved]

(h) The fuel mass flow rate, F_i, can be either measured or calculated using the following formula:

$$F_i = \frac{M_{FUEL}}{T}$$

Where:

M_{FUEL} = Mass of fuel consumed by the engine during the mode [g]
T = Duration of the sampling period [hr]

(i) The mass of fuel consumed during the mode sampling period, M_{FUEL}, can be calculated from the following equation:

$$M_{FUEL} = \frac{G_s}{R_2 \times 273.15}$$

Where:

G_s = Mass of carbon measured during the mode sampling period [g]
R_2 = The fuel carbon weight fraction, which is the mass of carbon in fuel per mass of fuel [g/g]

The grams of carbon measured during the mode, G_s, can be calculated from the following equation:

$$G_s = \frac{12.011 \times HC_{mass}}{12.011 + 1.008\alpha} + 0.429CO_{mass} + 0.273CO_{2mass}$$

Where:

HC_{mass}=mass of hydrocarbon emissions for the mode sampling period [grams]
CO_{2mass}=mass of carbon monoxide emissions for the mode sampling period [grams]
CO_{2mass}=mass of carbon dioxide emissions for the mode sampling period [grams]
α=The atomic hydrogen to carbon ratio of the fuel

[60 FR 34598, July 3, 1995, as amended at 70 FR 40450, July 13, 2005]

§ 90.427 Catalyst thermal stress resistance evaluation.

(a) The purpose of the evaluation procedure specified in this section is to determine the effect of thermal stress on catalyst conversion efficiency for Phase 1 engines. The thermal stress is imposed on the test catalyst by exposing it to quiescent heated air in an oven. The evaluation of the effect of such stress on catalyst performance is based on the resultant degradation of the efficiency with which the conversions of specific pollutants are promoted. The application of this evaluation procedure involves the several steps that are described in the following paragraphs.

(b) *Determination of initial conversion efficiency*. (1) A synthetic exhaust gas mixture having the composition specified in §90.329 is heated to a temperature of 450 °C ±5 °C and passed through the new test catalyst or, optionally, a test catalyst that has been exposed to temperatures less than or equal to 500 °C for less than or equal to two hours, under flow conditions that are representative of anticipated in-use conditions.

(2) The concentration of each pollutant of interest, that is, hydrocarbons, carbon monoxide, or oxides of nitrogen, in the effluent of the catalyst is determined by means of the instrumentation that is specified for exhaust gas analysis in subpart D of this part.

(3) The conversion efficiency for each pollutant is determined by:

(i) Subtracting the effluent concentration from the initial concentration;

(ii) Dividing this result by the initial concentration; and

(iii) Multiplying this result by 100 percent.

(c) *Imposition of thermal stress*. (1) The catalyst is placed in an oven that has been pre-heated to 1000 °C and the temperature of the air in the oven is maintained at 1000 °C ±10 °C for six hours.

(2) The catalyst is removed from the oven and allowed to cool to room temperature.

(d) *Determination of final conversion efficiency*. The steps listed in paragraph (b) of this section are repeated.

(e) *Determination of conversion efficiency degradation*. (1) The final conversion efficiency determined in paragraph (c) of this section is subtracted from the initial conversion efficiency determined in paragraph (b) of this section.

(2) This result is divided by the initial conversion efficiency.

(3) This result is multiplied by 100 percent.

(f) *Determination of compliance with degradation limit*. The percent degradation determined in paragraph (e) of this section must not be greater than 20 percent.

[60 FR 34598, July 3, 1995, as amended at 64 FR 15244, Mar. 30, 1999]

Appendix A to Subpart E of Part 90—Tables

Table 1—Parameters to be Measured or Calculated and Recorded

Parameter	Units
Airflow rate (dry), if applicable	g/h
Fuel flow rate	g/h
Engine Speed	rpm
Engine Torque Output	N m
Power Output	kW
Air inlet temperature	°C
Air humidity	mg/kg
Coolant temperature (liquid cooled)	°C
Exhaust mixing chamber surface temperature, if applicable	°C
Exhaust sample line temperature, if applicable	°C
Total Accumulated hours of Engine Operation	h
Barometric Pressure	kPa

Table 2—Test Cycles for Class I-A, I-B, and Class I-V Engines

Mode Speed	1	2	3	4	5	6	7	8	9	10	11
	Rated Speed					Intermediate Speed					Idle
Mode Points—A Cycle	....	....	....	....	....	1	2	3	4	5	6
Load Percent—A Cycle	....	....	....	....	....	100	75	50	25	10	0
Weighting	....	....	....	....	....	9%	20%	29%	30%	7%	5%
Mode Points—B Cycle	1	2	3	4	5	....	....	....	....	....	6