Source Test Procedure **ST-32**

ETHANOL, INTEGRATED SAMPLING

(Adopted December 21, 1988)

REF: Regulation 8, Rule 42

1. APPLICABILITY

1.1 This procedure is used to quantify emissions of ethanol. It determines compliance with Regulation 8-42.

2. PRINCIPLE

2.1 Sample gas is drawn through Greenburg-Smith impingers containing distilled water which absorbs the ethanol. The ethanol is then analyzed by gas chromatography as specified in Analytical Procedure Lab-29.

3. RANGE

3.1 The minimum measurable concentration of ethanol is 1 ppm at the sample volume specified in this procedure.

4. INTERFERENCE

None known.

5. APPARATUS

5.1 Probe. The probe is constructed of borosilicate glass tubing fitted with a glass wool filter in the nozzle.

5.2 Condensers. Use four Greenburg-Smith impingers, connected in series, as absorber/condensers. The fourth impinger shall be modified by removing the impaction plate and attaching a thermometer to the inlet stem.

5.3 Cooling system. Use an ice bath to contain the impingers.

5.4 Sample pump. Use a leak-free vacuum pump capable of maintaining a 14.3 liter/min (0.5 CFM) flow rate at 380 mm Hg (l5 inches Hg). The pump must have a flow control valve and vacuum gauge attached to the inlet.

5.5 Silica gel tube. Use approximately 500 cc of silica gel (with a Drierite indicator) to insure that the gas entering the dry test meter is dry.

5.6 Dry test meter. Use a dry gas test meter accurate to within $\pm2\%$ of the true volume and equipped with a thermometer to measure the outlet temperature.

5.7 Connections. Use Teflon tubing for all sample contacting connections. Vinyl tubing is acceptable for all other connections.

5.8 Barometer. Use a barometer that is accurate to within ±0.2 inches of mercury.

5.9   Rotameter. Use a calibrated rotameter to measure the sampling rate through the dry test meter.
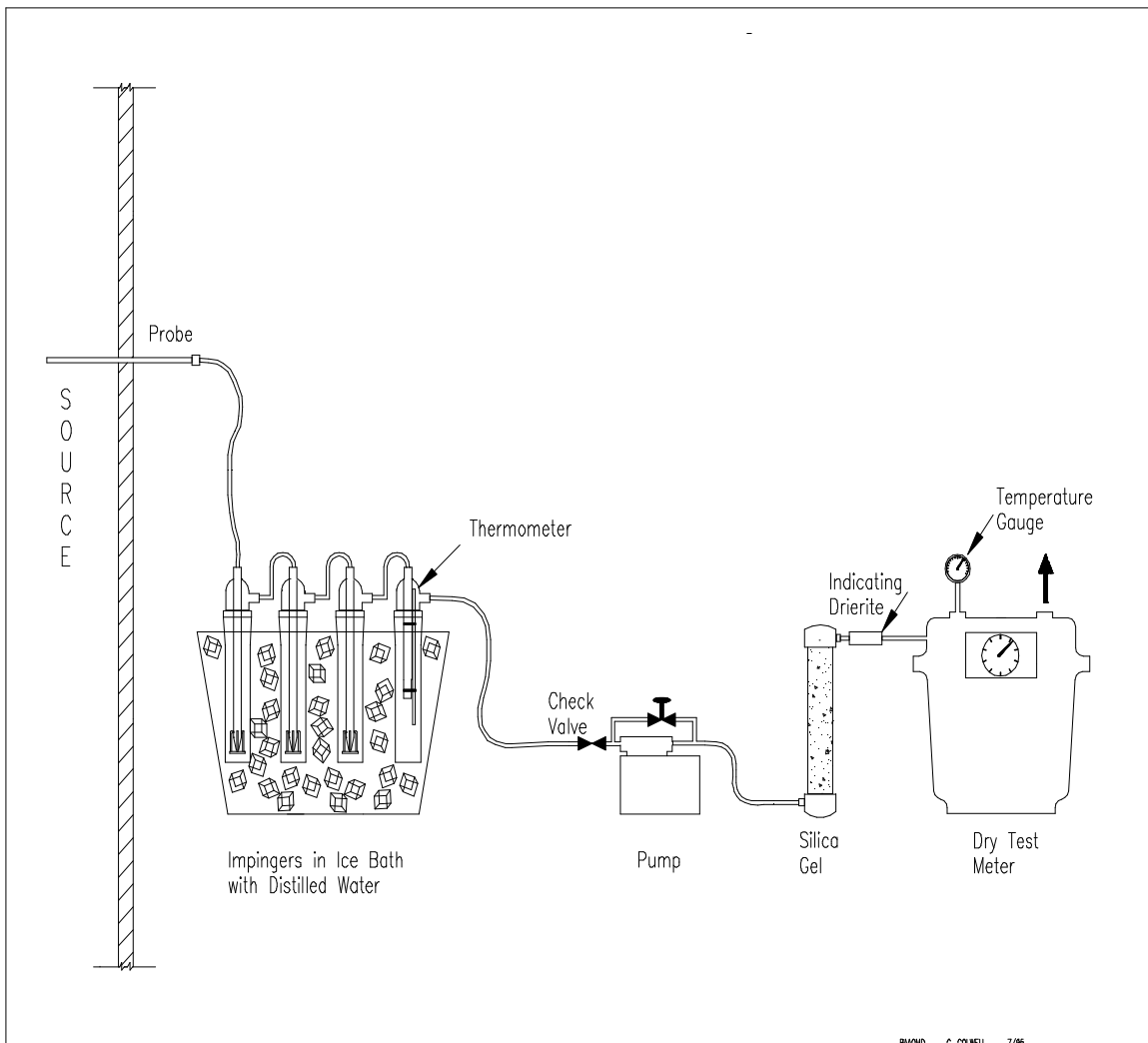
6.   REAGENTS

6.1   Distilled water.

7.   PRE-TEST PROCEDURES

7.1   Add 100 ml of distilled water to each of the three unmodified impingers.

7.2   Stopper the impingers.

7.3   Retain 100 ml of the distilled water to analyze as a blank.

7.4   Assemble the sampling train as shown in Figure 32-1.

Figure 32-1

Ethanol Sampling Train

7.5   Leak-test the sampling train by starting the pump, plugging the probe, and adjusting the pump inlet vacuum to 380 mm Hg(15 inches Hg). The leak rate must not exceed 0.57 liter/min (0.02 CFM) through the dry test meter. Before stopping the pump, carefully release the plug in the sample probe to avoid backflow of the impinger solution.

7.6   Record the initial dry test meter reading and the barometric pressure on the sampling data sheet, Figure 32-2.

7.7   If there is evidence of concentration stratification, select the sampling traverse points according to ST-18. Otherwise, sample at a single point.

8.   SAMPLING

8.1   Each test run shall be of thirty minute duration when testing emissions from continuous operations. Each test run at batch process operations shall be for 90% of the batch time or thirty minutes, whichever is less.

8.2   Position the probe at the sampling point and start the pump.

8.3   Sample at a constant rate of 14.3 liter/min (0.5 CFM) during the test as determined by the rotameter. Use the rotameter only to establish the initial sampling rate, then remove it from the system.

8.4   Record the following information at five-minute intervals:

> Dry test meter temperature
> Impinger outlet temperature
> Dry test meter volume

8.5   Add ice as necessary to maintain impinger temperature at 7 ^{O}C (45°F) or less.

8.6   At the conclusion of each run, stop the pump, remove the probe from the stack, record the final meter reading. Point the probe upward and purge the sample train with ambient air.

8.7   Take three consecutive samples.

9.   POST-TEST PROCEDURES

9.1   Stopper the impingers until they are analyzed.

9.2   Individually analyze the distilled water solutions and blank for total ethanol content according to the Analytical Procedure Lab-29.

10.   CALCULATIONS

10.1   Standard sample volume:

$$V_0 = \frac{(530)(V_m)(P_b)}{(29.92)(T_m)}$$

Where:

    Vo   =   Corrected sample volume, SDCF at 70 ^{o}F and 29.92 inches Hg

    Vm =   Uncorrected Meter Volume, ft^3

    Tm =   Average Run Meter Temperature, ^{o}R

    Pb   =   Barometric Pressure, Inches Hg

    530 =   Standard Temperature, ^{o}R

   29.92 =   Standard Pressure, inches Hg

10.2   Ethanol concentration:

$$C = \frac{(386.9)(10^6)(W)}{(453.6)(46.07)(V_o)}$$

Where:

    C   =   Ethanol concentration, ppm by volume on a dry basis

    W   =   Total weight of ethanol in the impinger catch, for each run, grams

    10^6 =   Conversion to parts per million

   386.9 =   Standard molar constant, ft^3 per lb-mole

   453.6 =   Conversion from grams to pounds

   46.07 =   Molecular weight of ethanol, lb per/lb-mole

10.3   Stack volume flowrate. Determine in accordance with ST-l7.

10.4   Ethanol mass emission rate:

$$M = \frac{C \times 46.07 \times 60 \times T \times Q_o}{386.9}$$

where:

    M   =   Ethanol mass emission rate, lb/day

    T   =   Plant operating hours per day

    Q_o =   Stack volume flowrate, SDCFM

11.   REPORTING

11.1   Report the data indicated on Figure 32-3.

Figure 32-2

Integrated Sampling
Source Test Data Sheet

Source Operation: _____

Plant: _____

Sample Type: _____

Process Cycle: _____

Duct Size: _____

Duct Pressure: _____

Source Test No.: _____

Run No.: _____

Date: _____

Barometric Pressure _____

Leak Rate _____ @ 15 " Hg

Sampling Train: _____

Sampling

Time	Rate, CFH	Meter Temp, °F	Volume, Ft^3	Vacuum, "Hg	Saturated Gas Temp, °F

Source Test Team: _____

Figure 32-3

Report No.: _____ Test Date: _____	**BAY AREA AIR QUALITY MANAGEMENT DISTRICT** **Summary of Source Test Results**	**Test Times:** **Run A:** _____ **Run B:** _____ **Run C:** _____
Source Information		**Test Representatives**
Firm Name and Address	Firm Representative and Title Phone No. (**)**	
Permit Conditions:	Source: Plant No. Permit No. Operates Hr/Day & Day/Yr.	Operating Parameters
Applicable Regulations:		

Source Test Results and Comments:

METHOD TEST	RUN A	RUN B	RUN C	AVERAGE	LIMIT
ST-32 Ethanol. ppm					

Test Team Leader	Date	Reviewed by	Date	Approved By	Date