METHODS AND EQUIPMENT FOR MEASURING POLLUTANT
EMISSIONS (STACK EMISSION TESTING)

O U T L I N E

by

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1. **Measurement of Gas Flow, Temperature and Humidity**

    a. The standard pitot tube

        (Total or impact pressure) - (static pressure) =
        velocity pressure

        $V = 2g\ h$

        v = gas velocity, ft./sec.

        h = ft. of head of gas

        h_w = velocity pressure in inches of water gauge

        $h \times$ (density of gas) $= \dfrac{h_w}{12} \times$ (density of water)

        g = gravitational acceleration, 32.2 ft./sec^2

        $V = \sqrt{\dfrac{2 \times 32.2 \times 62.4 \times h_w}{12\ s}}$

        s = density of gas (lbs/C.F.) at stack temperature
            and pressure conditions

        $V = 1096.5 \sqrt{\dfrac{h_w}{s}}$ ft./min.

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b. Location of pitot tube traverse points

   Circular duct;   0.316R,   0.548R,   0.707R,   0.837R,   0.916R

   R = radius

c. Temperature and humidity of stack gas.

2. Collection of Stack Samples

a. Equipment for collection of particulate matter - sampling
   probe, nozzle and filter media.

b. Types of filter media; alundum thimbles; glass thimbles (S and S)
   or (MSA 1106-B); paper thimbles (Whatman); chemical filter
   papers, (cotton, wool, ny on, orlon, asbestos, etc.).

c. Equipment for collection of gas samples.

   Absorption devices: Standard or midget impinger, fritted glass
   bubbler, other types of bubblers.

   Temperature control baths; condensers and freeze-out traps.

   Adsorption devices: Activated carbon, silica gel, alumina, etc.

d. Meters for volume flow or flow rate measurements: calibrated
   orifice; critical orifice, rotameter, wet and dry gas meters.

e. Pumps or ejectors.

3. Isokinetic Sampling for Particulate Matter

a. Errors due to non-isokinetic sampling.

b. Watson relation of validity of sample to duct and nozzle flow
   conditions:

$$\frac{C}{C_o} = \frac{U_o}{U} \left\{ 1 + \frac{}{} (p) \left[(\frac{U}{U_o})^{\frac{1}{2}} - 1 \right] \right\}^2$$

where

C = concentration measured

C_o = true concentration

U_o = stream velocity

U = mean gas velocity at sampling orifice

$$p = \frac{d^2 s \; U_o}{18 \; nD}$$

d = diameter (mean) of particles

D = diameter of orifice

s = density of particles (specific gravity)

n = viscosity of gas

c. Methods of attaining isokinetic conditions.

"Nul l" type nozzle; variation of the flow rate at each sampling point to match velocity in nozzle (of constant diameter); use of series of nozzles of different diameters.

4. Typical Calculations