SOURCE-LEVEL EXTRACTIVE SYSTEMS

Source-level extractive systems remove gas directly from the stack or duct, filter out particulate matter, and transport the gas for analysis. Three types of source-level extractive systems are marketed commercially:

1. hot–wet systems (Figure 3-1)
2. cool–dry systems with conditioning at the probe (Figure 3-2)
3. cool–dry systems with conditioning at the CEM system shelter (Figure 3-3)

Hot–Wet Systems

The simplest type of extractive system uses a heated line to transport the flue gas to an analyzer that incorporates a sample cell heated above the flue-gas temperature. The gas is delivered to the analyzer both hot and wet, but minimally conditions the gas by removing particulate matter with a coarse filter located at the probe. The technique is useful when monitor-

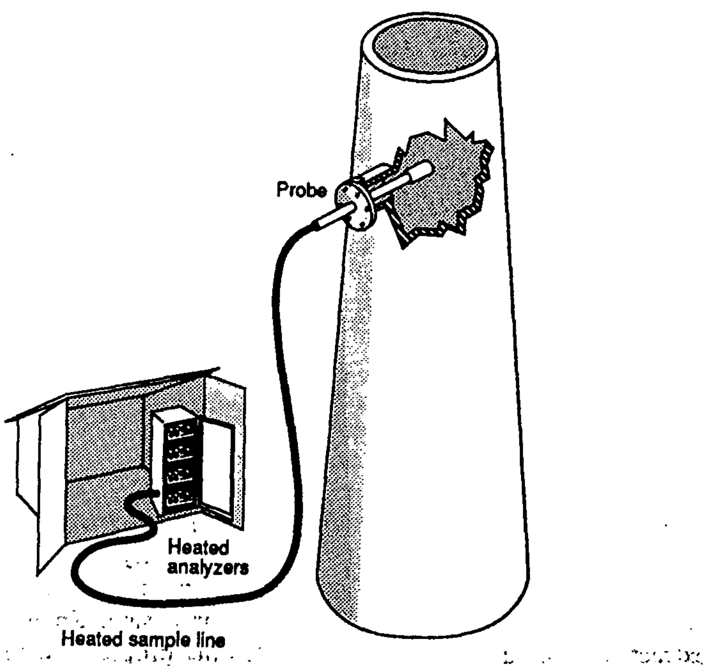

FIGURE 3-1. A hot and wet CEM system.

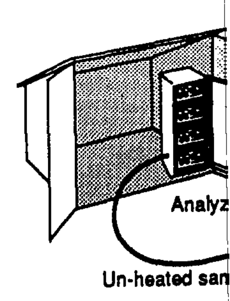

FIGURE 3-2. A cool and dry CEM sy

ing of water-soluble gases, such
emission values are to be repor
removed from the sample gas,
systems are avoided. However, c
temperature of the sample abo
analyzer exhaust. If the heating
condense and foul the system.
damage to the analyzer.

The hot–wet systems were ma
ation with ultraviolet analyzers c
NO. The technique is used to
applications noted previously.

Coo

In a more widely used extracti
before it enters the analyzer. T
temperature and moisture is rer

The first continuous emission monitoring requirements in the United States were promulgated in 1971. However, the CEM industry did not begin to develop until after October 6, 1975, when the U.S. Environmental Protection Agency (U.S. EPA) established performance specifications for CEM systems and required their installation in a limited number of sources. Since that time, CEM systems have been applied to a wider range of sources, and 15 years of experience have led to the evolution of analyzers that can measure stack emissions with a high level of confidence.

The earliest focus of CEM technology was on the analyzer—the instrument that could do the job of measurement. However, it was soon found that the process of transporting the gas to the analyzer was a source of many problems. These problems were addressed in a number of ways by CEM "systems" vendors. Those who understood the effects of corrosive stack gases on materials and the effects of pressure and temperature on gas transport were able to design and successfully market systems that worked under severe sampling conditions.

A CEM system is actually composed of three subsystems: the sampling interface, the gas analyzers, and the data-acquisition–controller system (Figure 1-1). The sampling interface is a subsystem that either transports or separates the flue gas from the analyzer. CEM systems are usually characterized in terms of the design of this interface. In general, the systems can be classified into three basic groups: extractive systems, in-situ

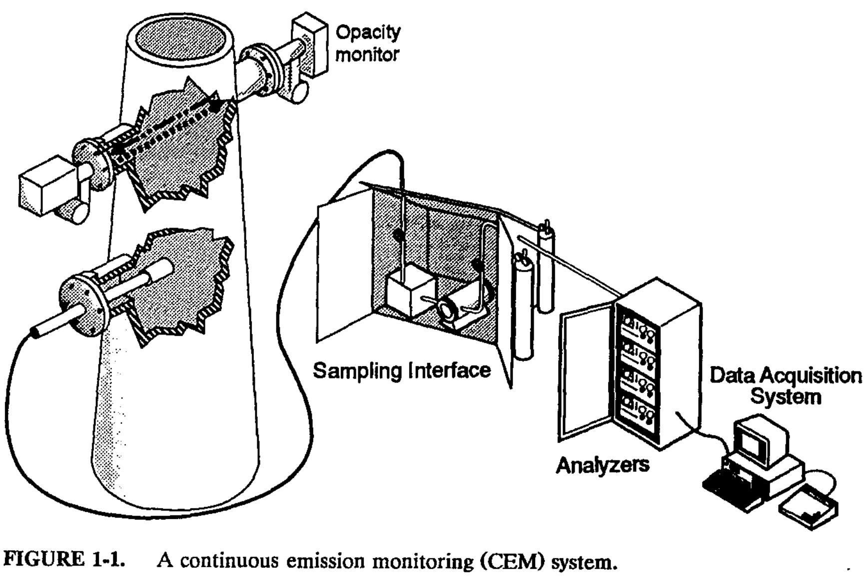

FIGURE 1-1. A continuous emission monitoring (CEM) system.

TABLE 1-1 Classification of Sou

Extractive Systems	I
Source-level	F
Dilution	F

systems, and remote sensors. A
Table 1-1.

In the case of extractive syste
designed to extract and condition
the case of in-situ systems, the i
designed to align or support th
minimize interference from parti
effect have no interface between
ment, other than the ambient atr

EXTRAC

Extractive gas-monitoring syster
source measurements. In these s
stack and is transported to analyz
concentrations. Many of the ear
using rotameters and then applie
ments. However, frequent probl
tion ratios, so analyzers were sub
gas directly at source-level conc
systems have proven to be qui
application in the 1970s and earl

Many of the problems associat
since been eliminated by new t
advent of the "dilution probe" ha
measurements. These systems a
exhibit good performance.

The basic problem associated
indeed, "systems." In order for a
tions, the gas sample must be
usually must be removed and th
temperature. This requires the

can also become contaminated with condensable or reacted materials, which become difficult to remove. On occasion, entire sample lines will need to be replaced because these problems cannot be resolved. It is evident, then, that a good source-level extractive system design will minimize the length of heated sample line.

In properly installed systems, heated sample lines are generally less than 250 ft in length. They slope at a minimum of 5° from the probe all the way to the moisture removal system or analyzer. Because sampling line can distort when heated, care is taken to avoid sags in the line, where condensate might collect. Hot spots are also avoided by preventing the line from touching itself or other sample lines.

Sample line is generally incorporated in a tube bundle, or umbilical. A typical umbilical tube assembly is shown in Figure 3-7. Sample lines can be operated either at a constant power density or can be self-limiting (self-regulating). The self-limiting lines are more appropriate to CEM applications because the line will maintain a specified minimum operating temperature if the ambient temperature should fall (e.g., during subzero conditions in winter) and will not exceed a specified maximum temperature if the ambient temperature rises. The sample line, blowback line, and zero-gas–calibration lines as well as electrical cables can all be incorporated into the umbilical. Also, thermocouples can be placed at intervals

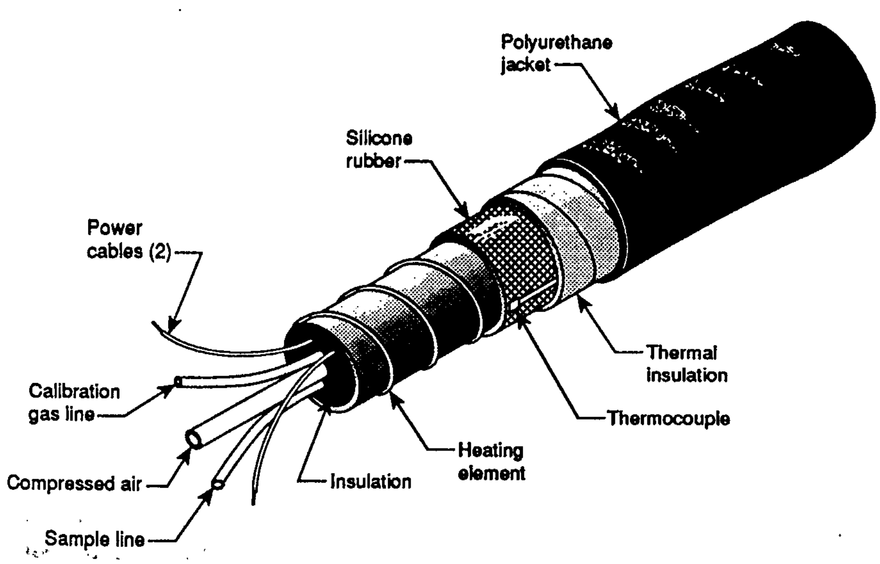

FIGURE 3-7. An umbilical assembly.

along the line to monitor the tem
reduction. Sample lines are gene
significantly to the expense of an e
priced per running foot and a tota
CEM system vendors unless the ex
bid specification.

Although much information has
cal resistance of sample line mate
1974, Podlenski et al. 1984) most s
No. 316 stainless steel to avoid che
Problems do occur with Teflon, be
250°C. Efforts used to increase sa
sation sometimes result in melting

Moisture R

Moisture is usually removed befor
because water vapor and acid gas
pump and corrode the interior.
temperature at which air is saturat
condense, and many of the mois
reduce the sample temperature b
and permeation dryers are most
extractive systems. A successful sy
sample-gas flow rates and stack-
must remove condensed water ra
contact with dried gas.

Condensation Systems

A typical approach to moisture re
ated condenser such as that sh
system consists of a coil of glass of
be water, an antifreeze solution
refrigeration system. To avoid fre
is not allowed to go below 35°F
condensed water vapor, and the
ously removed using a peristalt
removed automatically because, in
operator fails to perform this ma
risk that the trap will fill and wat