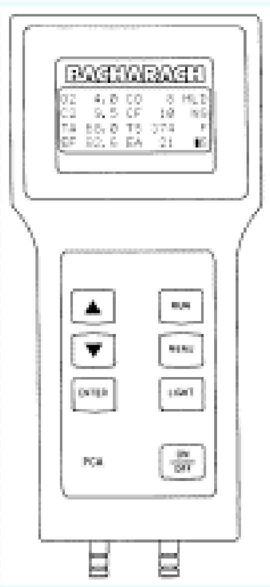
Burner Operation

All process and space heating systems are engineered and designed by the manufacturers to operate with very specific ranges of excess combustion air, carbon monoxide, draft, and stack temperature readings. Unless combustion analysis readings are within these parameters, Steady State Efficiency readings are 'false' and will not reflect actual consumption.

For example, an underfired boiler with a low stack temperature may provide SSE readings that suggest efficient, economical operation. In actuality, all boilers and forced air systems are designed to operate most efficiently at their full firing rate. Underfired burners may cause excessively low stack temperatures which could result in condensation damage and potential flue gas spillage due to loss of stack draft.

Additionally, continual low fire (or underfired) operation of many power burners causes the flame to burn closer to the burner head, exposing it to higher than design temperatures and cause warpage or burn off.

Looking at the flame color, shape and stability have been used as "rules of thumb" for many years but "eyeballing" will not allow you to truly optimize the safety, efficiency, full service life and environmental compliance of your equipment.



Many commercial boilers and high efficiency residential heating systems do not even have an observation port to see the flame. Even when an observation door is available, simply opening the door to view the flame changes all the actual operating conditions and characteristics of the combustion process.[right]

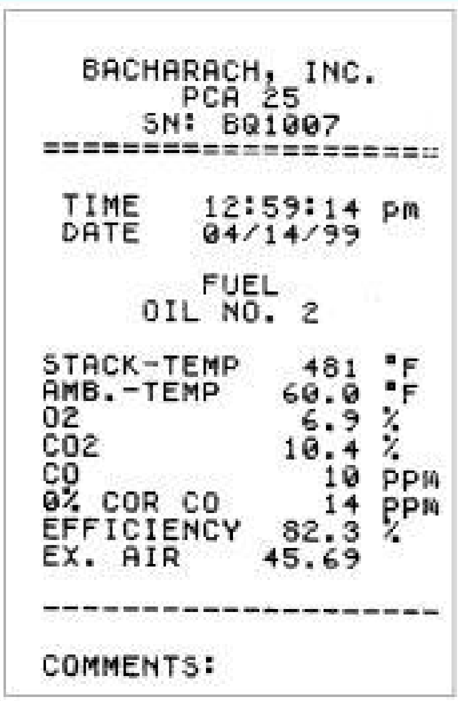
Just as doctors make use of the most sophisticated instrumentation possible when diagnosing their patients, the best way to make sure that equipment you are responsible for is operating safely, and at maximum efficiency, is by using combustion instrumentation.

Traditional, chemical or Orsat type instrumentation will give you information that is comparable in accuracy to electronic instrumentation, but electronic instruments have several very important advantages.

Many electronic instruments measure on a continuous basis, like a movie or video camera. Traditional instruments are more like a still camera, which takes only one picture at time. With traditional instrumentation (the still camera) you might miss the most important picture because your camera is only capable of taking one picture at a time.

Because most electronic instruments draw flue gas samples on a continuous basis, like a video camera, you can see all of the information that will help to evaluate the operating condition of heating equipment throughout the entire cycle of operation from start up to shut down, including transient changes along the way. Electronic instruments will also do sampling and efficiency calculations rapidly and automatically.

Some models will store and/or print out complete reports of test results or transfer the stored data to a computer while adding time and date information to the data collected.



BACHARACH, INC.
PCA 25
SN: BQ1007
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TIME	12:59:14	pm
DATE	04/14/99	

FUEL
OIL NO. 2

STACK-TEMP	481	°F
AMB.-TEMP	60.0	°F
O2	6.9	%
CO2	10.4	%
CO	10	PPM
0% COR CO	14	PPM
EFFICIENCY	82.3	%
EX. AIR	45.69	

COMMENTS:

This provides hard copy documentation that the burner was operating safely and efficiently when you left the job. Undoubtedly, combustion testing will identify additional service work required. The print out can help the customer understand the nature of additional costs.

Over time, it also establishes a history of burner performance and may provide an early indication of a failing component.

A printed readout left with the customer serves as a seasonal reminder to have the burner combustion tested and also lets the customer know they have hired a company which has *invested in the training and test instruments to insure safe, reliable and efficient burner operation.*

To initiate the combustion process, oxygen in the combustion air and the fuel mix and are ignited to produce heat. During the combustion process, carbon dioxide (CO2) is produced in predictable quantities based on oxygen measurements and fuel types.

While the traditional, wet chemical type instrumentation determined the percentage of CO2 in a flue gas sample, electronic instrumentation measures the amount of oxygen (O2) remaining after the combustion process. Again, this is predictable depending on the design of the equipment. For those used to thinking in terms of CO2, many electronic instruments provide a calculated CO2 reading based upon the fuel and the O2 percentage in the flue gases as measured by the instrument.

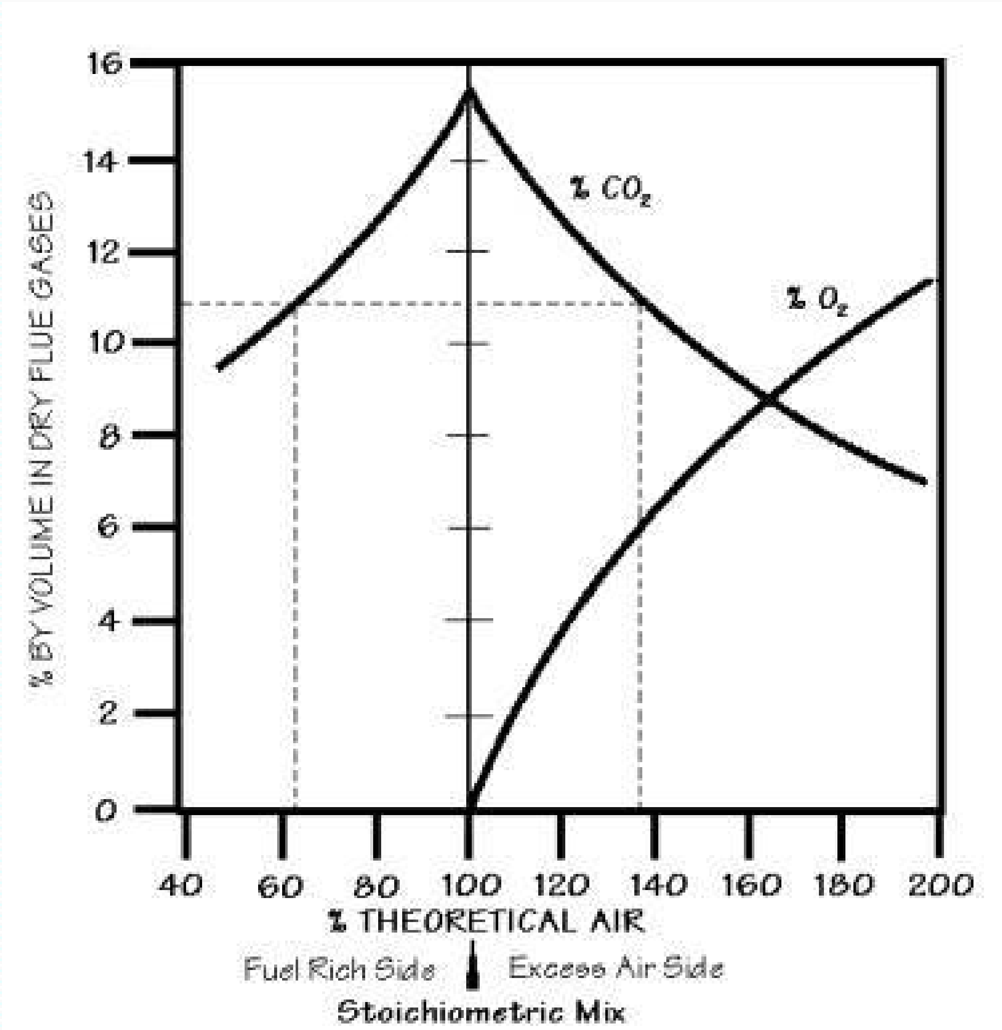
Also, keep in mind that O2, CO2 and excess air are simply different ways of conveying exactly the same information.

The air we breathe is 20.9% oxygen. As more oxygen is used to burn the fuel in the combustion process, more CO2 is produced and diluted by excess air. Flue gas oxygen and carbon dioxide measurements are therefore inversely proportional. That is, as oxygen readings decrease, carbon dioxide readings increase.

Heating equipment is becoming more and more efficient, in part due to increased control over the amount of combustion air. In addition, residential and commercial structures are being built with much tighter envelopes in an effort to reduce fuel consumption. As a consequence, critical factors such as a sufficient combustion air supply, draft, etc. can be very easily affected by such influences as building pressure imbalances or improper fuel pressure.

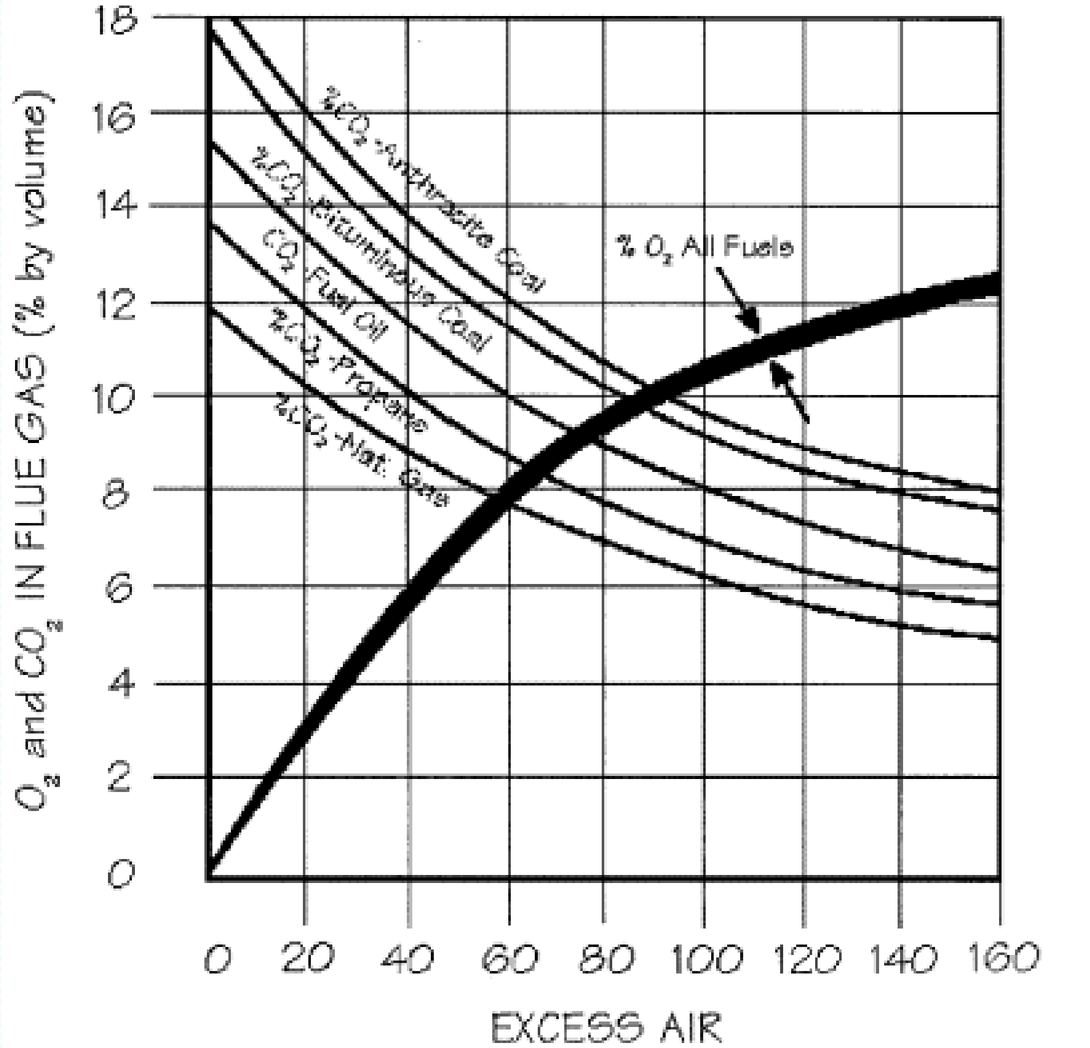
Advantages Of Measuring O2 vs CO2

In addition to more accurately being able to more precisely monitor burner performance, another advantage to measuring O2 in a flue gas sample is that a CO2 measurement does not let us know which side of the stoichiometric curve we are on. The left side of the graph indicates insufficient combustion air resulting in carbon monoxide and/or smoke production as well as inefficient operation. We always want to be on the excess air side of the graph.



Note that CO2 per cent is different for each fuel. O2 per cent however, remains fairly constant with the most common fuels requiring generally a 3% to 9% O2 content in flue gases. This is entirely dependent on the type of unit being tested. Only testing in the field under actual operating conditions can verify whether the system is installed and operating as designed.

Relationship Between O2, CO2 and Excess Air



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