How to Achieve the Best Performance and Longest Life from Your Gas Generator

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Atmosphere generators provide manufacturing flexibility by allowing on-site production of protective atmospheres. Generators have a long track record of low cost operation and minimal maintenance in both commercial and captive heat treat facilities. Three types of protective gas atmosphere generators in common use in the manufacturing environment today will be discussed include: Endogas® (endothermic), Exogas® (exothermic) and Ammogas® (dissociated ammonia). [1] *Also covered will be refrigerant dryers used to reduce the dew point of exothermic atmospheres from 105°F to 40°F. The talk will focus on two keys aspects of obtaining the best performance from a generator, gas ratio and dew point control.*

Atmosphere generation used in heat-treating generally falls into two categories - active and inactive or inert gases.

The active gases are used to either oxidize or reduce metals heat-treated in their presence. Some active gases are exothermic, cracked ammonia (dissociated) and hydrogen. Some inactive gases are purified lean exothermic, nitrogen, and argon.

Occasionally, there is a crossover situation where an active gas is a carrier for an active additive, such as using endothermic atmosphere as the carrier and adding natural gas for carburizing or adding natural gas and ammonia which is 75% H_2 and 25% N_2 for carbonitriding.

The active atmosphere, therefore, must contain some component, which takes an active part in the heat-treating process. Enough hydrogen and carbon monoxide must be present so that various iron oxides are reduced in the furnace to pure iron. In the case of intentional oxidizing, enough free oxygen and/or water must be present to allow the work to become oxidized, such as in the case of steel bluing processes.

This type of atmosphere must be present in sufficient volume and pressure so that air is excluded from the furnace. To have precise control of the active atmosphere, we must reach the level of moisture and oxygen in the furnace where these two constituents will not upset the balance of the atmosphere when it enters the furnace. This is done by raising the temperature to dry out the furnace internals, and purging the furnace chamber with inert gas prior to admitting atmospheres.

The three least expensive and most frequently used active atmospheres are lean and rich exothermic, and endothermic. Lean exothermic atmosphere may be included here since it contains enough oxides to form scale if required. Rich exothermic atmosphere has enough hydrogen and carbon monoxide to reduce iron oxide in the furnace and provide a bright surface on annealed low carbon steel. Endothermic gases are higher both in percentage or carbon monoxide and hydrogen than rich exothermic.

[1] Exogas®, Endogas® and Ammogas® are registered trademarks of SECO/WARWICK Corp.

Inert Gas Atmosphere

An inert gas atmosphere must be present in the furnace at sufficient pressure and volume in order to keep air from entering any part of the furnace. The inert atmosphere must also be free from oxygen and low in moisture so that no oxidation can take place on the parts. Typical applications for an exothermic atmosphere include annealing copper and/or aluminum, or copper brazing.

Nitrogen generators, when the nitrogen used is derived from lean operating exothermic generators, can also be classified as inert gas generators if the water vapor and CO_2 are removed.

Creating an Exothermic Atmosphere with a combustion type generator

The exothermic atmosphere generator is a combustion type generator where, based on the controlled air-gas ratio, the desired protective atmosphere is created. The lean and the rich generator are very much similar in construction and operation, but the difference in heat release requires close attention to the overall cooling system.

In general, natural gas is the most common feed gas used in the generator, so the following equation is based on methane (CH_4). However, virtually the same product gas can be obtained by using propane (C_3H_8) or butane (C_4H_{10}) at their proper air/gas ratios.

Using methane and air for near perfect combustion, the following reaction takes place with 9.5 parts air and one part of methane:

$$CH_4 + 2(O_2 + 3.78N_2) = CO_2 + 7.56\ N_2 + 2H_2O + \text{TRACE}\ (CO + H_2)$$

With the water condensed out, the final product is exothermic atmosphere:

$$11\%\ CO_2 + 1/2\%\ H_2 + 1/2\%\ CO + 88\%\ N_2 \text{ on a volumetric basis}$$

By reducing the air/gas ratio to 6:1, the equation changes:

$$CH_4 + 1.2\ (O_2 + 3.78\ N_2) + \text{Heat} = 0.30\ CO_2 + 0.70\ CO + 0.91\ H_2 + 1.10\ H_2O + 4.54N_2$$

Remove the water and the volumetric analysis becomes:

$$14\%\ H_2 + 11\%\ CO + 5\%\ CO_2 + 70\%\ N_2$$

The CH_4 and O_2 reaction is a very complex one. The ratio of heat release from a lean generator and a rich generator is 7.35:1. The lean generator gives off 81,000 Btu per 1000 cfh produced atmosphere.

The rich generator only gives off 11,000 Btu per 1000 cfh of products. However, the cracking of the unsaturated hydrocarbons requires a minimum temperature of 1800°F, so we have to preserve the heat we release at the lower ratio.

Not only is a minimum temperature of 1800°F required, but also a highly active catalyst is necessary to ensure a complete cracking of the complex hydrocarbons into H_2 and CO. It is very important to notice that the 6:1 ratio represents the low point of operation. Below that ratio, too much free carbon is created and provides too much nuisance maintenance to be practical. The operation at 6:1 ratio does require special attention to the preservation of heat in and around the catalyst section.

The preservation of heat becomes, first of all, a tight control of the thermal conductivity in the selection of the refractory for the combustion chamber wall. When the cooling jacket exit water temperature is maintained at 160°F, enough heat is stored in the catalyst to provide a trouble-free rich atmosphere. Lean atmosphere merely needs cooling, since very little cracking is required.

Exothermic generator construction and operation
This section describes a SECO/WARWICK Exothermic Generator, models manufactured by others may vary in specific details, but the principles of combustion remain the same.

A. General Description

An exothermic generator is, in general, a burner firing into a gas-tight enclosure. The enclosure is used to collect the products of combustion. The products of combustion are cooled to provide a given dewpoint or moisture content based on the final process.

B. Exothermic Generator Construction (indirect chilled)

1. The combustion chamber containing:
    a. Pilot and main burner
    b. Refractory liner (rich or lean) baffles
    c. Active catalyst for the rich types
    d. Untreated catalyst for the lean types
    e. Cooling jacket
    f. Peep sights
2. The air train containing:

a. Air filter
b. Combustion blower
c. By-pass regulator
d. Volume control valve
e. Flow meter

3. The gas train containing:

a. Low gas pressure switch
b. Safety shutoff valve
c. Ratio regulator
d. Limiting orifice valve
e. Gas flow meter

4. The gas cooling arrangement containing:

a. A large water-jacketed exit pipe from the combustion chamber
b. A shell-and-tube heat exchanger
c. A water separator
d. A gas trap

5. The electrical system contains components that perform:

a. Ignition control
b. Flame supervision
c. Combustion blower control
d. Gas pressure control
e. Excess water control (alarm with one minute delay)

The combustion chamber is a double-walled steel cylinder with removable end plates. The space between the walls is used as a water jacket. The water jacket helps to cool the gases.

On a lean generator, about 60% of the total cooling is done by the water jacket. On a rich generator, only 35 to 40% of the total cooling is done by the water jacket. The difference in the amount of water jacket cooling between a lean and rich generator lies in the requirements for heat in a rich generator in the catalyst section for properly cracking the heavier hydrocarbons formed in the incomplete combustion at the burner.

The main burner and the pilot burner are mounted in the one end plate. The two burners fire into the front open space before the combustion products pass over the catalyst (active or inactive).

The catalyst section is packed in such a manner that the gas gets as much contact with the catalyst as possible. Gas (stratification or short circuit) channeling does not take place.

C. Air/Gas Control of the Generator

Any generator will only perform as well as the automatic air/gas ratio control will allow.

Thus, aside for the safety components on the generator, the cross-connected ratio regulator and the adjustment of air and the limiting orifice valve become the heart of the operation. The adjustment is simple, but must be precise to maintain trouble-free operation.

D. Final Cooling

After leaving the catalyst section, the gas enters the cooling section, first through the water-jacketed exit pipe, then into the shell-and-tube cooler.

In the shell-and-tube heat exchanger, the water vapor from the combustion is condensed. The condensate is separated from the gas in the water separator.

It is possible to dry the gas in this manner to a dewpoint of about 10°F above the entering cooling water temperature. In the water separator, the gas goes on to the refrigerant dryer or to the furnace and the water goes to the drain through the gas trap.

The basic protective atmosphere is then either used in the furnace or it can be dried to a low dewpoint, or it can be moved to a purify and dry process.

Perfect combustion of air and gas at a ratio of 10:1 creates 17% by volume of water or a dewpoint of 165°F. For 1000 cfh of product gas, this dewpoint represents 7.54 pounds or 0.94 gallons of water at the high temperature in the chamber. This, of course, is water vapor.

In order to remove all this water and handle the gas, the products of combustion are cooled first by water in the cooling jacket surrounding the combustion chamber. The majority (79%) of all the available water is condensed in the shell-and-tube heat exchanger. The water is removed from the gas stream after condensing in the water separator. 70°F cooling water produces an 80°F dewpoint in the exothermic gas.

When further water removal is required, the product gas has to be refrigerated in a special unit where a final dewpoint of 40°F is obtained. In the refrigerant dryer, 5% of the total water is expelled. A dewpoint of +40°F is often not sufficient, so a desiccant dryer is required to reduce the water to a dewpoint of about -50°F. The moisture content at -50°F is sufficient to many operations.

E. Purification

Another step in the process is removing some undesirable components from the products of combustion. Carbon dioxide (CO_2) - free exothermic, purified exothermic, or nitrogen, all represent that same final product - namely, a very dry gas containing maximum 0.1% CO_2. Carbon dioxide content has been obtained in a well-designed purification system to 800 ppm.

SECO/WARWICK has delivered systems providing a dewpoint of below -80°F and having residual CO_2 level of less than 300 ppm (0.03%).

The current method of removing the carbon dioxide from an exothermic stream is by using a molecular sieve system.

It must have a very exact heat balance, and a large amount of plant space is required. Since the system should be simple, straightforward, insensitive to heat balance, reliable, and have a minimum of maintenance, the molecular sieve purification system works well.

The purification is based on the special property of the molecular sieve material. The water and carbon dioxide molecules are adsorbed by the sieve material. These small pores trap certain sizes of molecules to form a layer around the pellet. The molecular sieve pellets are manufactured with a controlled pore size. This is the purification method.

The type SECO/WARWICK has used in the past adsorbs as much as 20% of its own weight of water and about 5% weight of carbon dioxide. However, the water is most readily adsorbed and since only one layer of molecules will deposit around each pellet, as long as sufficient amounts of molecular sieve material are available to adsorb both the water and the carbon dioxide from the feed stream.

When sufficient virgin material is available, the product gas will emerge with very low dewpoints and very low residual CO_2 as stated before (-85%, or 0.03%). Since the gas stream continues to deposit water and CO_2 in the sieve, sooner or later the bed becomes saturated, and the feed gas will then emerge in the product line untouched with the same moisture and CO_2 content as when it enters the bed.

Before saturation is reached in tower "A", the feed gas is admitted into tower "B" which has had the CO_2 and the water removed, and as soon as tower "B" is on stream, tower "A" is closed off from both the feed gas and the product gas line and tower "C", previously saturated is purified.

The adsorbed moisture and carbon dioxide will now have to be removed before tower "A" again can become available for purification. This reactivation can be accomplished in two ways:

1. By the thermal swing, where the bed is heated above the boiling point of water and a purge gas is used to "carry" out the stream and the CO_2. This method completely removes all traces of gas from the bed.

2. The second method is using the pressure swing. This method utilizes a vacuum pump to break down the adsorptive forces to remove the water and carbon dioxide molecules from the molecular sieve bed. The vacuum pump draws the unwanted gases out of the system and exhausts them to the outside. A vacuum of 28" to 29" of Hg is sufficient to remove the water vapor and CO_2 from the bed. It is not required to reach an extremely low vacuum. The use of a high pump speed to accomplish the reactivation of tower "A" is ample.

The highest degree of purification and reliability of operation is obtained when the control system provides a smooth changeover between the towers. The product gas will then be delivered at a constant pressure and flow rate, and the analysis will be consistently with the specification.

What are the drawbacks to this system? There are no limits to the life of the molecular sieve material in a well-designed system. The molecular sieve is only damaged by attrition or acidic feed gas.

Exothermic Generator (direct chilled)

A different design concept used to produce lean exothermic gas for aluminum annealing utilizes the same air and gas train, but the arrangement of the combustion chamber and the cooling of the gas allow the unit to directly cool the products of the combustion with a water spraying system.

The product gas has been analyzed and found to be of the same quality as that produced with an indirect cooling system. SECO/WARWICK has also used this type of cooling on rich exothermic generators where the gas was used in a process of hardening steel wire.

Endothermic Atmosphere
20/40 Carburizing - Hardening

This type of gas is produced by an endothermic reaction. A mixture of air and gas at such a low ratio, that it will normally not burn, is passed through an externally heated retort. The retort contains an active catalyst, which is needed for cracking the air/gas mixture. Leaving the retort, the product gas is cooled rapidly to avoid carbon reformation before it is sent into the furnace to be heated again and finally the endothermic gas provides the proper environment for the heat-treating process.

Our analysis for endothermic gas made with natural gas and air at a ratio of 2.4:1 looks like this:

$$19.8\%\ CO + 40.5\%\ H_2 + 0.1\%\ CO_2 + 0.5\%\ CH_4 + 39.1\%\ N_2$$

Output = 1.4 x (air + gas) input

Note that there is more output than total input along with the absence of water. This is not included in this formula because the water content corresponds only to about +10°F at this ratio. There is a dewpoint of about +35°F at a ratio of 2.7:1.

At a temperature of 1100°F, there is an ignition of the air/gas mixture and a peak temperature of 2300°F can be easily obtained. Only 25% of the total natural gas burns into CO_2 and H_2O. The remaining methane (CH_4) reacts endothermically (1850°F) with the CO_2 and water vapor to form H_2 + CO + CO_2.

With the mixture of both an endothermic and an exothermic reaction within the same retort, the design of the retort becomes very critical. Both very high and very low temperatures exist within the vessel. This retort design eliminates the low temperature points by using the peak temperature for compensation.

Issues with Soot

When the gas is not cooled fast enough, the endothermic gas goes into a reversal and a lot of carbon is formed by the reformation of the carbon monoxide. This reformation takes place in the temperature range form 1300°F – 600°F.

The gas reversal: $2\ CO = C + CO_2$. It then becomes very important that the gas cooler is kept clean for highest efficiency. A regulated cooler cleanout program will be required. Some generators can run with periods of one year between cleanouts without causing any problems. The reason for such variance in performance can be sought in local conditions:

1. Understanding, care, and interest, for the equipment by the operating personnel.

2. The location of the generator in the plant, where drafts may assist in rapid cooling.

3. Following the instruction manual for the proper operation.

4. Preventive maintenance, frequent and complete.

5. Carbon monoxide, dewpoint analysis of gas and recording of operating flows, pressure and temperature.

6. Good consistent natural gas source.

SECO/WARWICK generators are designed to provide:

1. Excellent ratio control on air-gas system.

2. Excellent uniform heating chamber profile.

3. Excellent heat penetration through the retort and through the catalyst.

4. Low space velocity in retort to provide complete reaction on the process gas.

5. Rapid cooling to prevent reformation on the product gas.

Operating Data For Endothermic Generators		**TABLE I**
NORMAL OPERATION	**GENERATOR (0-2000 CFH)**	**CAPACITY 3000 CFH**
1. Control temperature	1850°F	1950°F
2. Low limit temperature	1750°F	1800°F
3. Excess temperature (high limit)	1925°F	2025°F
4. Recommended dewpoint	35°F	40°F
5. Air/gas ratio (average)		
- natural	2.7:1	2.7:1
- propane	7:1	7:1
- butane	9.5:1	9.5:1
5a. Supply gas pressure	8-28" w.c.	10-28" w.c.
GAS-FIRED UNITS AT RATED FLOW		
6. Burner "On" time (minutes)	10	10
7. Burner "Off" time (seconds)	10-15	10-15

8.	Flue gas (% CO_2)	8-10%	8-10%
8a.	Burner flame color	Blue with slight yellow tips	
BURNOUT PROCEDURE (ALL TYPES) - MUST BE DONE WEEKLY			
9.	Temperature	1800-1850°F	1800-1850°F
10.	Airflow rate (cfh)	50-100	100-200
11.	% CO_2 in air at burnout completion	0.2%	0.2-0.3%
12.	Maximum time between burnout	weekly	weekly
13.	Idling generator, new catalyst	1800°F (no air)	1800°F (no air)
14.	Idling generator, old catalyst	1800°F (50 cfh air)	1500°F (50 cfh air)
15.	Maximum duration of idling with air	12 hours	12 hours

LEAN OPERATION

The ratio should never be lean enough to provide a dewpoint higher than + 90°F.

At this ratio, capacity should be no more than 30%.

Operate "Lean" for 2 hours only.

Lean operation should only be used when normal burnout procedure fails to give normal dewpoint control. If lean operation is required, it indicates that the catalyst needs to be changed.

Startup Of New Retort Or Recharged Retort - All Sizes

1. Maintain temperature at 600°F for 1 hour.

2. Hold for 2 hours at 600°F with 50 to 100 cfh of air only going through the retort.

3. Shut off air.

4. Increase the temperature at 200°F per hour until operating temperature is reached.

5. Hold operating temperature for 1 hour before making endothermic gas.

6. Actual dewpoint at 35°F on the new charge of catalyst should be obtained 5 hours after Step

No. 5 (i.e., after producing endothermic gas for 5 hours).

Problems Caused by Peak Shaving

During a cold spell in the winter months, peak shaving is used to stretch the natural gas supply for the duration of the cold spell. Continuous peak shaving may result in poor performance and soot formation in the retorts of atmosphere generator combustion chambers and coolers.

How is peak shaving affecting the generation of a protective atmosphere?

Most generators in operation operate on a fixed manual adjustment of the regulators and valves in the air and gas trains without any automatic analysis/control system. This fixed adjustment relies on a constant composition of the fuel gas. Normally the pressure and volume changes on the system do not affect the final composition of the product gas. The control of the air/gas ratio is based on a pneumatic balance between the air and gas valves, and the ratio regulator. Thus, under normal circumstances, a normal consistent product gas composition is expected.

The problems from peak shaving come into focus in the main gas orifice. Properly adjusted and based on a given ratio, the orifice is set to pass a given volume of the natural gas. As the peak shaving begins, the new fuel gas becomes heavier in content of hydrocarbons, higher in specific gravity and density; and the orifice now passes an incorrect amount of gas into the system.

The original fixed air/gas ratio is now out of balance.

What happens to the fuel gas during peak shaving?

The only obligation the utility company has is to provide the customer with a consistent heating value, most often, 1000 Btu per cubic foot.

When demands on fuel gas soar or supplies go down, the supply of natural gas is boosted by additives. The additives may include propane, butane, air and many other hydrocarbons among the refinery derivative.

One very popular peak shaving mixture contains 75% natural gas and 25% propane/air mixture.

Generators may experience two types of problems from such a mixture:

- The user's plant may be so close to the supply point of the gas line network that the peak shave gas has not been mixed well enough before the gas enters the plant. Thus, the incoming gas may vary from a high to a low in the amount of natural gas, propane/air mixture.
- The propane/air mixture itself is mixed in a separate mixing unit at a ratio of 54.9% propane to 45.1% air. This ratio provides 1400 Btu per cubic foot. If everything is right

on control, the unit has about 0.1% too much air, which can easily be ignored as long as it is run at 10:1 ratio, however, there is a shortage of 3% air at 6:1 ratio.

Using this same peak shaving gas for an endothermic generator at 2.7:1 ratio, a loss of 8% air will result. This will provide an endothermic product gas with a very low dewpoint and carbon formation in the catalyst.

The major problem is that we are not made aware of peak shaving early enough to make a correction. The second and much more severe problem is the propane/air mixing station. Wide swings on the percentage mixing are far too common. The result is a process gas going rich and lean with the swings on the original propane/air mixture, even if we manage to correct the generator for peak shaving.

Adding to the overall mixing problem is the vapor point of propylene, which may legally be as high as 5% in HD-5 propane. Propylene does not crack in the generator. It only forms soot. It vaporizes more rapidly than propane. Thus, the effect of propylene becomes more severe at peak shaving during very low temperatures.

The best strategy to avoid the peak shaving problem is to install analyzer/controllers onto the generator.

These monitor the dewpoint of the product gas and control the input air/gas ratio to prevent the dewpoint from going too low or high. Our advice to the customer who uses a minimum of analysis or none at all is to burnout the generator more frequently and replace the catalyst just before the season of peak shaving.

When peak shaving of natural gas takes place, more carbon is formed in the retort than usual. In such cases, the burnout should be started at half airflow for 15 minutes and then normal airflow should be used for the completion of the burnout

Note For Endothermic Generators

When peak shaving of natural gas takes place, more carbon is formed in the retort than usual.

In such cases, the burnout should be started at half airflow for 15 minutes; then, airflow, as indicated in Table I, should be used for the completion of the burnout.

Nitrogen (N_2) Based Systems

A commercially accepted practice in the heat-treating industry of producing atmospheres is through the use of N_2 based systems.

The systems, for the most part, are comprised of an N_2 storage tank and compressor, or nitrogen producing generating system, the delivery network and an additive network to bring the constituents necessary to produce the required atmosphere to the furnace equipment.

Endothermic carrier gas has N_2 as one of its main constituents (approximately 40%), and the remaining constituents are added in proper percent by volume, the resulting endothermic atmosphere is a match with a breakdown which is 19% CO, 40% H_2, .4% CO_2, and .3% CH_4 (methane) with N_2 being the remainder.

Once the constituents reach the required temperature of approximately 700°C, or 1292°F, the constituents have combined to match endothermic gas. Both the N_2 based systems and the endothermic generator system will result in a dewpoint of 0°C, or 32°F.

To match the N_2 base carrier gas to endothermic, two basic methods are employed:

- Methanol CH_3O_4 (alcohol) liquid can be added to the furnace along with the N_2 to produce the desired carrier gas.
- In some cases, blending of hydrogen and hydrocarbons with the N_2 from other gas storage supplies is used. Natural gas, butane, or propane, in proper quantities, are also used for constituents, but usually give somewhat undesirable results depending on their particular composition.

These systems can be controlled for proper ratios (and dewpoint) by analyzing and controlling through the use of carbon analyzer/controller, another name for an O_2 probe instrument.

If carburizing is necessary, you simply add the required amount of natural gas, butane, or propane through a separate line to the furnace, the same as with an endothermic generator carburizing application.

Analysis Equipment

With the history of metallurgy going so far back as it does, it is amazing that so much fine heat-treating has been done without analysis in the past. The main reason is that the process of heat-treating has been changed from being a craft to an industrial mass production operation, where the decision-making has been removed from the actual operator level to technical management in the background. The trend is a much tighter control of atmosphere conditions and composition.

Why analyze atmospheres?

- Confirm that the atmosphere is correct for the process and has the desired component in the gas mixture.

- Establish that a purge cycle has brought the oxygen content in our furnace down to a safe level before the heat cycle can proceed.

- Allow the generator equipment to respond to any changes in the fuel gas that may otherwise rapidly develop into a poor process gas with poor quality work or provide a plugged-up generator.

- Predict that the required reaction between the metal and the atmosphere does take place in the future.

Analyzers typically function on a spot or continuous type analysis. The following information describes issues with continuous systems.

Basically all analyzer systems consist of the same main components, the sample system and the analyzer unit

The Sample System

It is of utmost importance that the sample gas is delivered to the analyzer in just the condition the main gas is produced. A good sample system delivers the sample gas to the analyzer in the proper volume and condition. The proper volume or flow rate is required to make the analyzer perform its function reliably and expediently.

The Analyzer Unit

There are six types of analyzers, which readily come to mind during heat-treating with atmospheres:

1. Dewpoint analyzer
2. CO_2 infrared analyzer
3. Combustibles analyzer
4. Thermal conductivity analyzer
5. Carbon/oxygen analyzer
6. Oxygen Analyzer

Dewpoint Analyzer

The dewpoint analyzer is, as are most analyzers, available in both a portable unit and a stationary analyzer package.

Various types of dewpoint analyzers are:

1. Chilled mirror
2. Aluminum Oxide sensor
3. Silicon Based Polymer sensor
4. Fog chamber

The chilled mirror system lowers the temperature of a surface until water condenses on it, and then measures the temperature required to create this condition.

The aluminum oxide and silicon-based polymer are both capacitance type, and the moisture absorbed determines the electrical impendence of the capacitor, which is, in turn, proportional to water vapor pressure. The fog chamber works when a gas sample is pressurized and then suddenly expanded to atmospheric pressure. If this expansion cools the gas below its dewpoint temperature, a distinctive fog will form and be suspended in the chamber. A backlight illuminates the fog. This procedure is repeated until the end point pressure ratio is realized. This pressure, along with the ambient temperature determines the gas dewpoint.

Infrared Analyzer

The non-dispersive infrared (NDIR) analyzer is based on the infrared adsorption characteristics of gases. Using a single infrared beam to measure gas concentrations, this analyzer produces highly stable and reliable results. A single infrared light beam is modulated by a chopper system and passed through a sample cell containing the gas sample to be analyzed. As the beam passes through the cell, the sample gas absorbs some of its energy. The attenuated beam (transmittance) emerges from the cell and is introduced to the front chamber of a two-chamber infrared micro flow detector. The detector is filled with the gas component of interest and, consequently the beam experiences further energy absorption. This absorption process increases the pressure in both chambers. The differential pressure between the front and rear chambers of the detector causes a slight gas flow between the two chambers. This flow is detected by a mass-flow sensor and is processed by a microprocessor into a linear output signal. This linear signal is proportional to the gas concentration. Gases that can be detected by infrared include: methane, ethyl chloride, ethylene chloride, ethyl and methyl alcohol, fluorinated hydrocarbons, carbon monoxide, carbon dioxide, sulphur dioxide, ammonia and others. Elemental diatomic gases such as hydrogen, oxygen, nitrogen, chlorine and the rare gases are not infrared active.

Combustibles Analyzer

The combustibles analyzer employs a different principle of operation since it uses a heated platinum filament on one leg of a balanced bridge circuit. When the test sample passes over this hot filament, the combustibles burn catalytically on its surface thereby raising the filament temperature and increasing its electrical resistance. This unbalances the bridge, which develops an output voltage proportional to the concentration of total combustibles in the sample.

Thermal Conductivity Analyzer

Thermal Conductivity is a basic property of gases that relates their ability to conduct heat. Thermal conductivity analyzers respond to the differences in thermal conductivity between various gases by continuously comparing the sample gas with a reference gas of known thermal conductivity. This unit can:

- Measure the concentration of one gas in a mixture of 2 gases
- Measure the concentration of a gas in a specific mixture of background gases
- Measure the purity of a sample stream containing a single impurity or a mixture of impurities

Carbon Analyzers

Carbon analyzers use a zirconia oxide element sensor to measure the partial vapor pressure of oxygen above 1200°F. Knowing the partial vapor pressure of oxygen and the percentage of hydrogen allows the dewpoint to be determined. This then can be correlated with the carbon potential at any given furnace temperature. These analyzers can be used to control the carbon potential in a furnace or the dewpoint in an endothermic generator. They are very good in minimizing the effects of peak shaving of natural gas since they continuously control the generator at a fixed dewpoint.

Oxygen Analyzers

Oxygen analyzers use an electrochemical galvanic fuel cell that translates the amount of oxygen present in the sample into an electrical current. These analyzers can measure the percent O_2 (%) range, the parts per million (ppm) or the parts per billion (ppb) range. The percent range is generally used as proof of purge. The ppm and ppb ranges are generally used for process determinations.