Using a Coriolis Meter to Improve Combustion Control

Problem

Due to wide variations in fuel gas composition, it is often difficult to control the temperature of furnaces burning fuel gas.

Solution

By using a Micro Motion® Coriolis meter and measuring the fuel gas flow in mass (lbs.) instead of volume (scf), you are able to much better approximate the energy content going into the furnace. The Coriolis meter actually becomes a simple energy meter.

Why It Works

The following information will show that the number of BTU/lb of fuel gas is much more predictable than BTU/scf. This allows you to make a more stable assumption of BTU content for gas entering the furnace when measured in pounds.

- ***Coriolis meters measure mass directly, with no need to correct for line conditions.***
- ***The direct mass measurement greatly improves furnace temperature control, and allows for a higher operating temperature without fear of temperature spikes that could damage the furnace.***

Energy Content of Refinery Fuel Gases

The table below illustrates that the energy content of all hydrocarbons normally present in fuel gas is quite consistent on a mass basis. By comparison, there is a great deal of variability amongst the hydrocarbons on a volumetric basis. Hydrogen is the only component in fuel gas that does not have a similar heating value on either a mass or volume basis. The hydrogen is so light, however, it has little impact on the overall mass-based energy content of the gas.

Energy Content of Refinery Fuel Gases

Gas	Heat of combustion		Energy required for combustion	
	BTU/scf	*BTU/lb*	*lb. of air/lb*	*Cu.ft. of air per cu ft of gas*
Methane	1012	23887	17.2	9.6
Ethane	1772	22323	16.1	16.8
Propane	2522	21669	15.7	24.3
n-Butane	3270	21313	15.5	32.1
Hydrogen	273	51900	34.3	2.4

Fuel Gas BTU Variation

The example below illustrates two extreme cases for H2 content in fuel gas from one refinery.

Even with the hydrogen content varying from 25 to 50%, the mass-based variation in the BTU content was only 3.5%. On a volumetric basis, it was 57.7%.

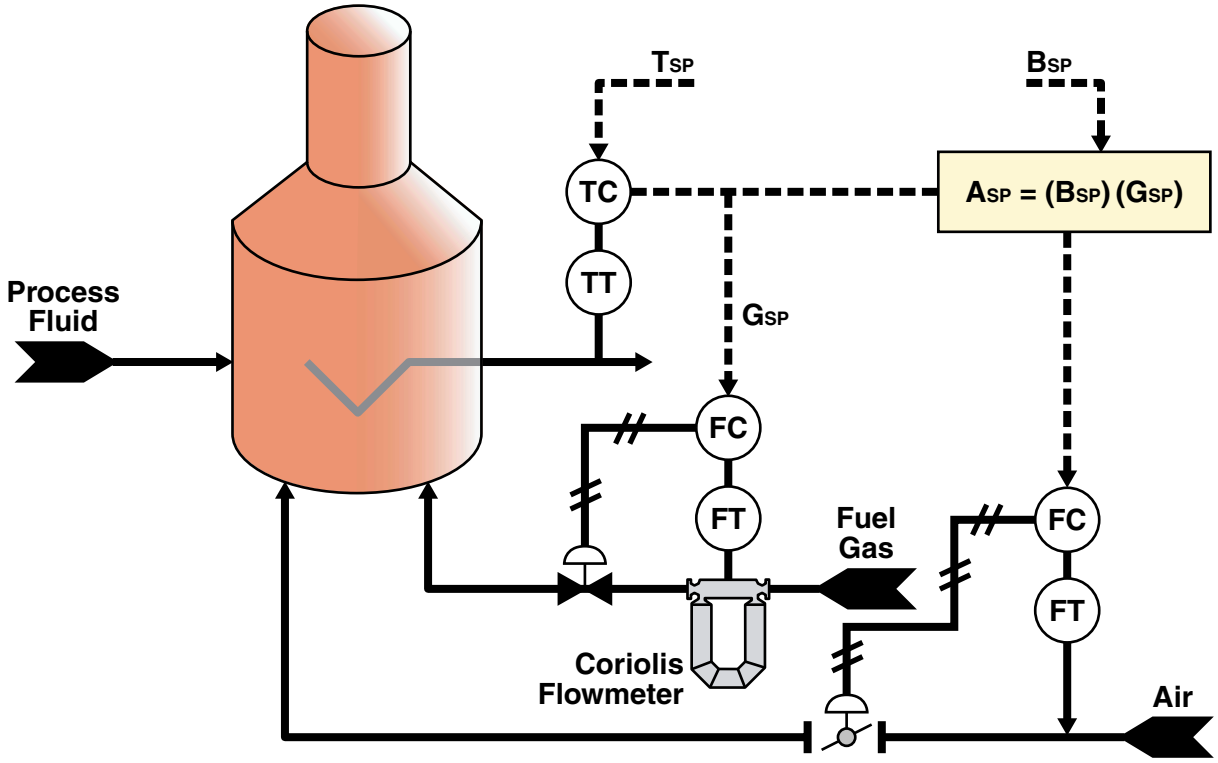
Even though the hydrogen composition changes drastically, this change has only a minimal effect on the overall BTU/lb of the gas. This is due to the extremely low weight of hydrogen when compared to the other gas constituents.

Hydrogen does not add many BTUs total to the system.

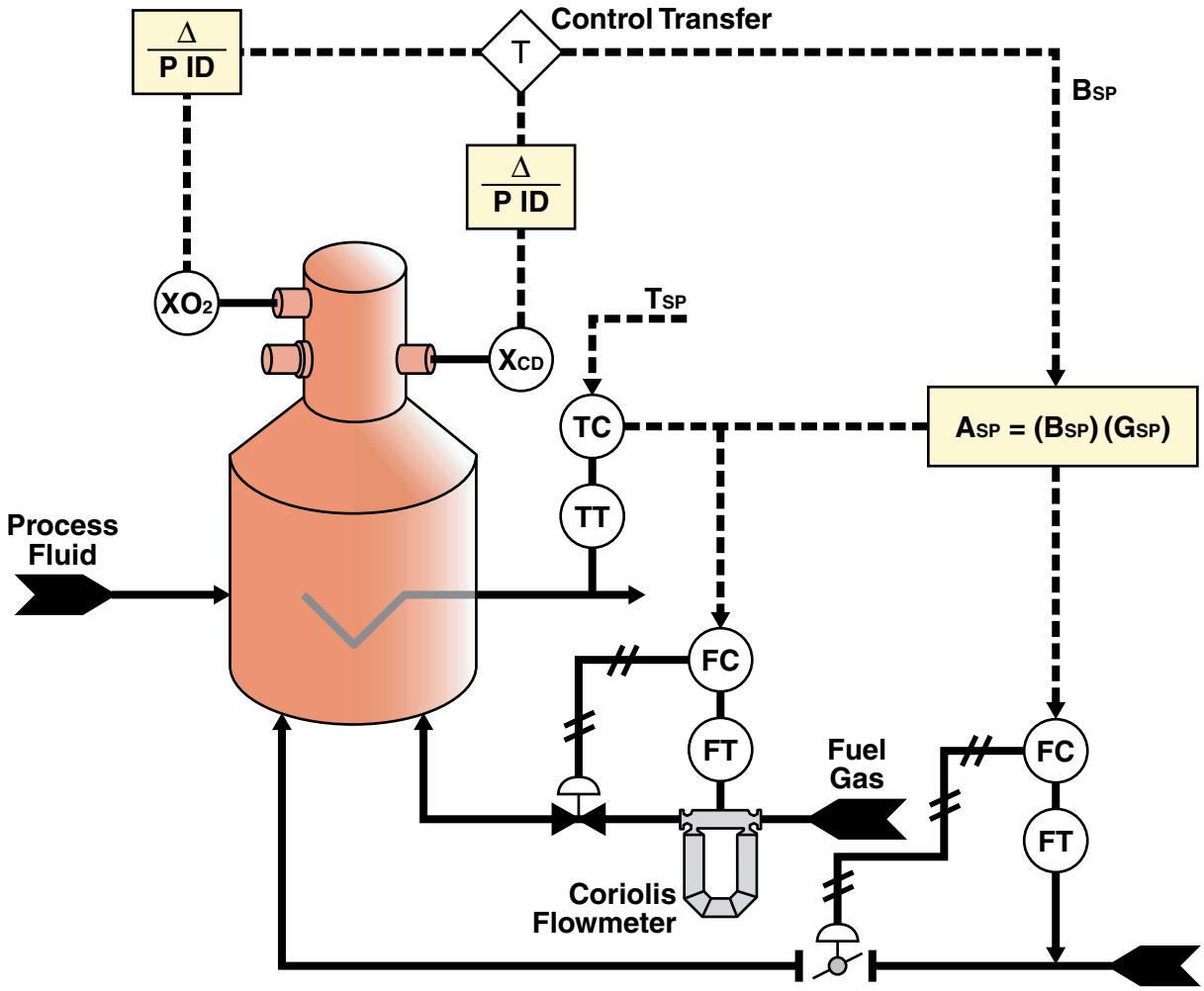
Example of Fuel Gas BTU Variation

Gas	Fuel Gas Composition, mol%		Notes
	Sample 1	*Sample 2*	
Methane	30	47	• *Mass-based variation in BTU content, 3.5% (BTU/lb).*
Ethane	12	15	• *Volumetric-based variation in BTU content, 57.7% (BTU/scf).*
Propane	6	7	• *Variations in hydrogen content do not significantly affect the overall BTU content of the gas, because of hydrogen's low molecular weight.*
n-Butane	2	6	
Hydrogen	50	25	

Process Furnace with Ratio Control



Process Furnace with CO/O2 Trim Control



Micro Motion Meters Allow Increased Boiler Capacity

The example below demonstrates how the operating capacity of a boiler running on fuel gas is improved with a Micro Motion flowmeter.

Some of the other benefits of measuring the fuel gas in pounds (mass flow) are:

- More stable furnace temperature
- Improved combustion leading to lower emissions
- Better stability in emissions helps emissions monitoring equipment operate better
- Reduction of hot spots in furnace tubes

Situation

- ***Boiler fuel gas on cascade control — volumetric flow and temperature***
- ***Rapid changes in the fuel gas composition caused boiler to trip from high temperature***
- ***Plant forced to run boiler at 80% of name plate capacity***

Solution

- ***Installed a CMF200 Coriolis flowmeter on fuel gas to control mass rate of fuel to the boiler, which cascaded to temperature***
- ***Now able to run boiler at 100% of name plate capacity***

Summary: Coriolis Flowmeters on Refinery Fuel Gas Applications

- Hydrocarbon BTU content of fuel gas is much more stable between various constituents on a mass basis
- Coriolis mass flowmeter measures mass flow directly, reduces temperature fluctuations in furnace that are due to changes in fuel gas composition and BTU/scf content
  - Reduces furnace hot spots
  - Run furnace temperature closer to desired setpoint
  - Reduces swings in emissions
- Adding Coriolis meter to existing System
  - Fits into existing control schemes
  - Easy to install and integrate into existing piping system
- Micro Motion ELITE® flowmeter with MVD™ Technology provides highest flow accuracy
- Micro Motion R-Series low-cost, general-purpose flowmeter also a good solution

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