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ANALYZER SOLUTIONS

Furnace Efficiency and Flare Control

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The case

Higher energy cost and environmental regulations ensure that there is an increased focus on energy efficiency in refineries. Approximately 75% of energy consumption in petrochemical and refining industries is used by furnaces (or heaters) and boilers.

Within a small to mid-size refinery with 80 MW Crude furnace duty and a capacity of 100 thousand barrels per day, estimated fuel gas cost range between $5,000,000 and $15,000,000 per year (depending on local fuel gas cost) for just the Crude unit.

For flares several regulations are driven by reduction in carbon footprint, to save energy, reduce emissions and optimize production processes to limit flaring

Optimizing furnace control

Wobbe Index defines the relation between Specific gravity and Heating value

Heating value (MJ/Nm^3 or BTU/SCF)

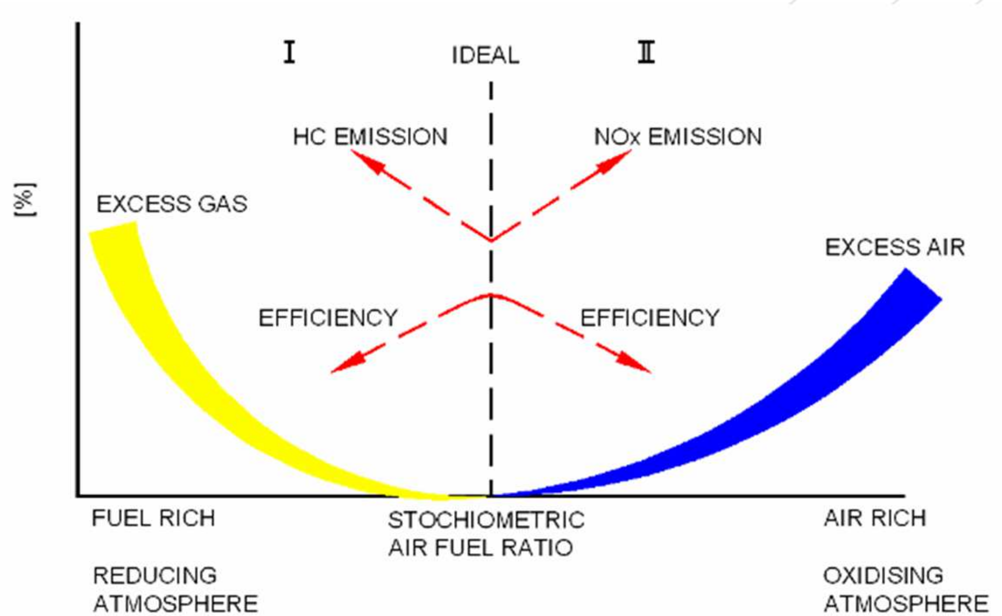
$$Wobbe\ Index = \frac{Heating\ Value}{\sqrt{Specific\ Gravity}}$$

Specific Gravity = Density gas / Density air

Heating value can also be referred to as Calorific value or BTU

Same relation between Combustion Air Requirement and Air Demand.

Optimizing furnace control

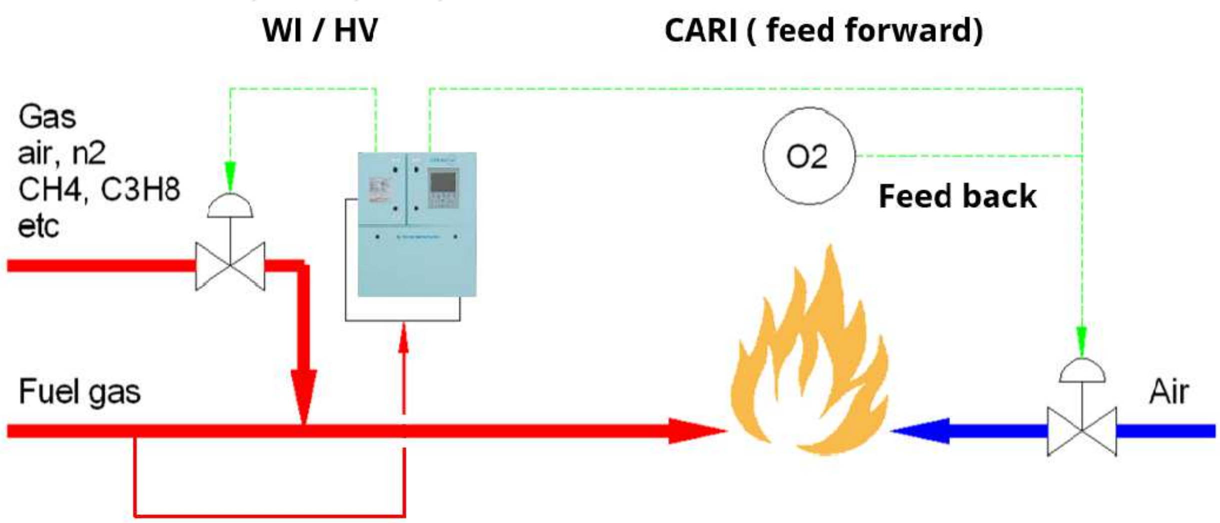


Stabilize the Wobbe index or Heating value) and control the air/fuel ratio in such a way that disturbances are minimised, and that combustion process occurs with maximum efficiency.

Optimizing furnace control

Using the CARI signal for feed forward Air/Fuel ratio control

Use Wobbe Index (or Heating Value / BTU) signal for feed forward control and/or monitoring of the thermal load

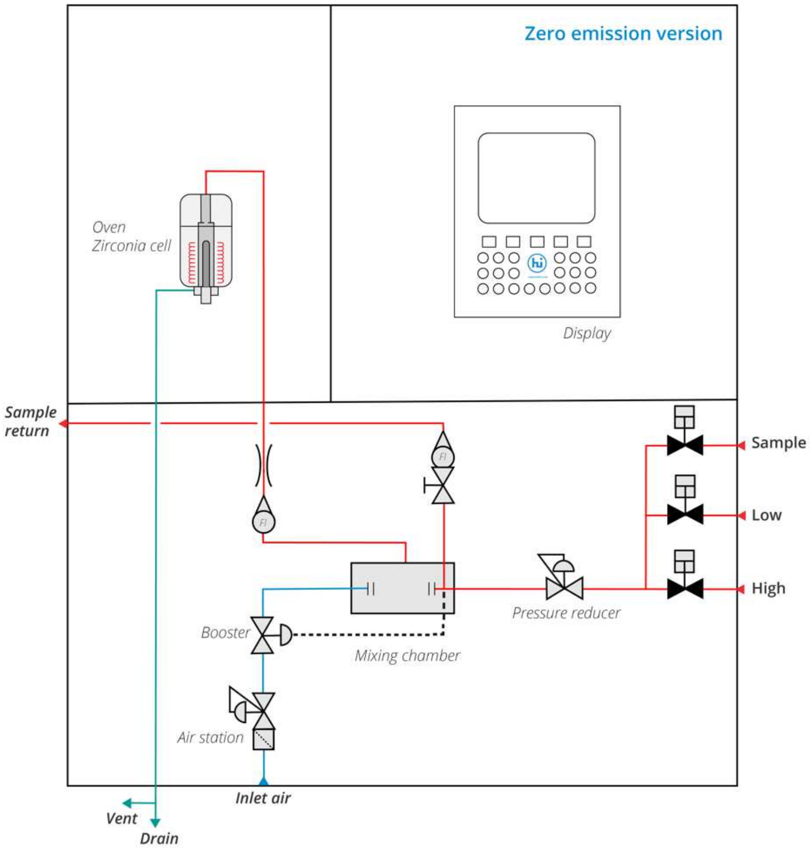


WIM Compas

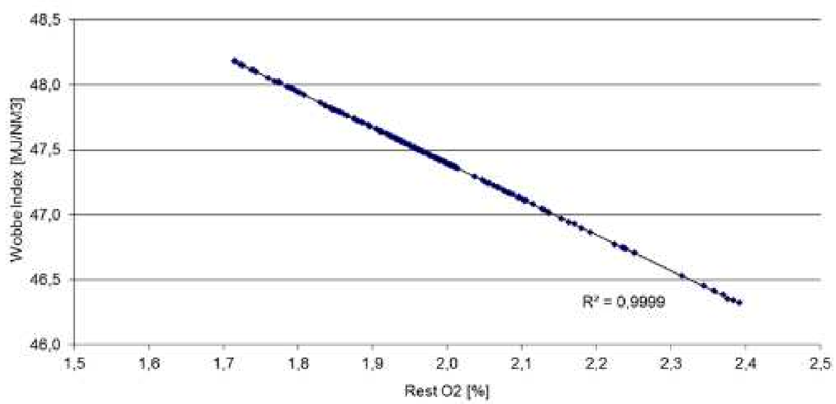
The WIM COMPAS™ is a fast-responding online analyzer based on residual oxygen method (ASTM D4891-13 and ISO 15971) used to optimize and control the energy flow by measuring:

- Wobbe Index
- Heating Value
- CARI (Combustion Air Requirement Index)
- Air Demand or Air/Fuel ratio
- Specific Gravity (SG), or Relative Density
- Mol Weight

WIM Compas for fuel gas measurement - Continuous



- Sample is mixed with Air in a mixing chamber, over orifice
- Gas – Air mixture is catalytically combusted at 812°C (1493°F)
- Rest O_2 is measured with a zirconia cell: direct measurement of the CARI.
- Automatic calibration Low and High
- CARI correlates to Wobbe Index (according ASTM and ISO standards)
- Flue gases (CO2 and H2O) are vented into atmosphere
- Bypass containing 100% gas. Back to sample or to flare
- Specific Gravity cell option for output SG, LHV, HHV, density (STP) and MW



Case study 1: fuel gas control in refinery

The payback period of a residual oxygen analyzer is typically several months depending on a number of factors such as furnace duty, fuel cost and efficiency improvement. Based on a recent case the savings and payback period have been assessed.

Case study: Savings and payback period for an example refinery in South East Asia (2019):

60 MW Crude furnace duty (~75 thousand barrels per day)

Total investment on analyzers (only) : $200.000 USD

Total energy consumption: 1.794.600 MMBTU/year

Fuel cost: $6 USD/MMBTU (based on fuel cost in Asia)

Total fuel cost: $10.767.600 USD/year

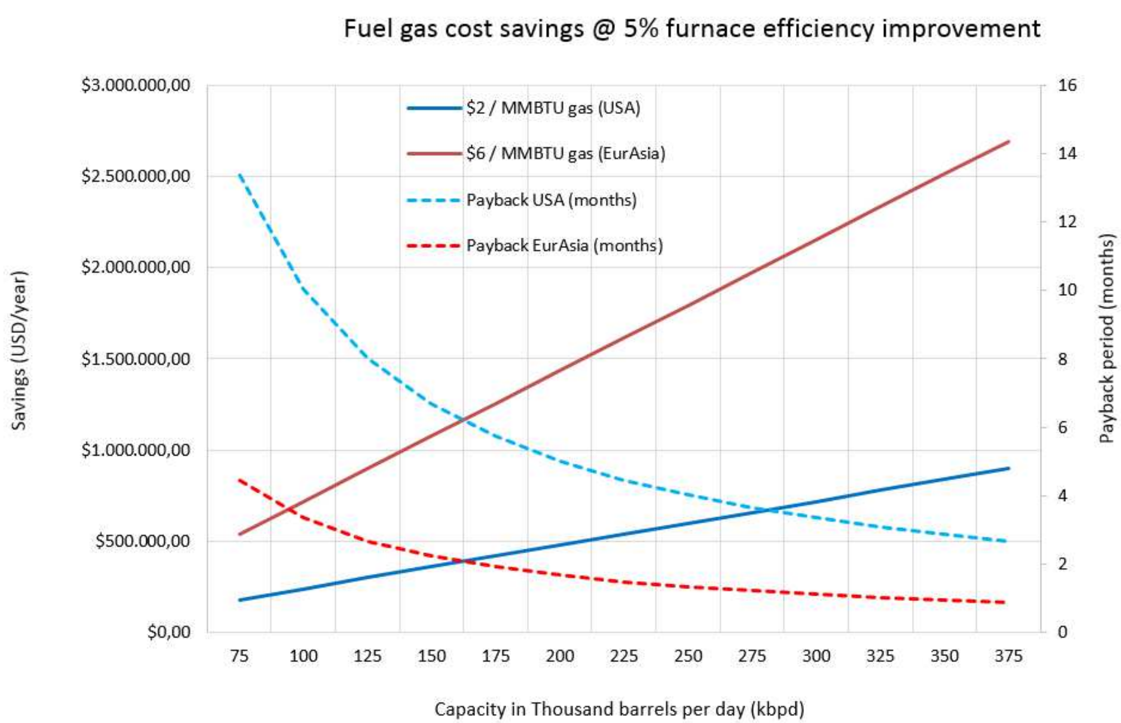
Realized furnace efficiency improvement: 6.8%

Savings on fuel gas: $732.000 USD ($986.000 SGD)

Payback period: 3 months

Case study 1: fuel gas control in refinery

The results have been extrapolated to determine the potential savings for other furnace duty cases. The furnace efficiency improvement have been set at 5%. i.e. more conservative in comparison to case study above.



Case study 1: fuel gas control in refinery

Typical set-up:

- 3-sided shelter or cabinet
- Sample probe / Hobré Flow Impact prove
- Pressure reduction system
- Sample conditioning system
- Gas bottle facilities
- Heat traced tubing
- Stream switching cabinet
- Compact GC (component measuring)
- Other customer specific solutions (Turn-key)

Optimizing flare gas combustion efficiency

Drivers:

- Ensure a minimum BTU value of Flare (EPA regulations)
- Prevent for flame out
- Monitoring flare streams

Monitoring of the heating value of flare gas is done to ensure a minimum heating value of the flare gas. In case the heating value drops below a certain number, natural gas is added to prevent for flame out errors.

In some areas end users are obliged by law to monitor the heating value of their flares to prevent for emissions caused by unburned hydrocarbons.

Optimizing flare gas combustion efficiency - Challenges

Wide variety of possible composition

As many different suppliers connect to flare large fluctuations in composition will occur

Condensation of heavy hydrocarbons and water

Flares operate on low pressure (just above ambient pressure)

Flares are often saturated at ambient pressure. Boosting the pressure will cause condensation

Condensation will disrupt the measurement, plugs analyzers and leads to extra maintenance

Presence of corrosive elements

High levels of corrosive elements (for instance H_2S) can be present. With a combustion type analyser these elements can cause clogging of the hot section of the analyser

Remote locations

Flares are typically installed at remote locations. Analyser shelters are not always available.

Optimizing flare gas combustion efficiency - Challenges

Wide variety of possible composition

Residual oxygen measurement principle takes all combustibles (and others) into account

Condensation of heavy hydrocarbons and water

Analyzer can measure at low and even sub-atmospheric pressure

Analyzer can measure at up to 150 °C, so above sample dew point

This results in low maintenance demand

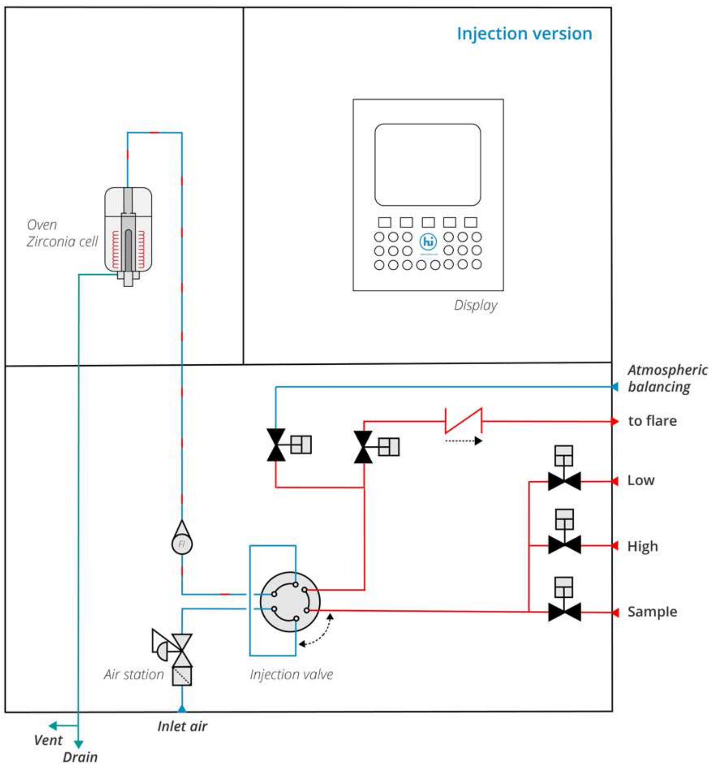
Presence of corrosive elements

Analyzer injects small amount of sample in a continuous air stream, immediately diluting it before the measuring cell

Remote locations

Analyzer can be installed in -20 - + 55 °C, and only requires 3-sided shelter. It has complete hazardous area classification

WIM Compas for flare gas measurement - Injection



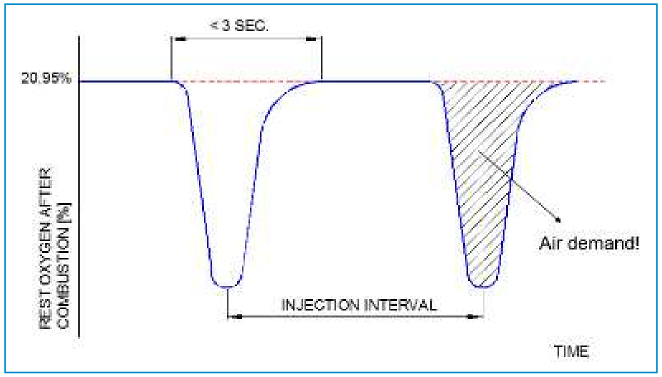
Fixed volume of sample gas is injected in Air flow

Gas is catalytically combusted at 812°C (1493°F) with typical injection interval of 30 sec.

Rest O_2 is measured with a zirconia cell and is a direct measurement of the Air Demand.

Flue gases (CO2 and H2O) are vented into atmosphere (no Hydrocarbons)

Bypass containing 100% gas. Back to sample or to flare



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WIM Compas – High Temperature (HT)

HT Enclosure

HT Heater assembly
(instead of Plate heater)

Features

- Update time 30 sec
- Standard: Heating Value and Air Demand
- Optional: Wobbe Index and CARI output and hydrogen
- Max. temp 150 °C / 300 °F

Case study 2: flare gas monitoring in refinery (USA)

Several Regulations are Driven by Reduction in Carbon Footprint US EPA

- Refinery Sector Rule
- GreenHouse Gas Emission Rule for Chemical Plants
- Upcoming Regulations
  - 40 CFR 60 Subpart OOOOc Emission Guidelines for Greenhouse Gas from Existing Crude Oil and Natural Gas Facilities.

Penalties for injunctive relieve, emissions of pollutants and other violations have been know as high as $ 1 – 3 million or $ 37.500 per violation per day.

Typical cost of analyzer system $ 200.000 excluding plant integration

H2 credit system saves methane addition significantly

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Case study 2: flare gas monitoring in refinery

Typical set-up:

- 3-sided shelter or cabinet
- Pressure reduction system
- Sample conditioning system
- Gas bottle facilities
- Heat traced tubing
- Integrated hydrogen measurement (H2 credit)
- Other customer specific solutions (Turn-key)

Questions?