INOGATE

PROGRAMME FUNDED BY THE EU

Industrial Energy Efficiency

Tools, Metering and Data Gathering Techniques, Lecture 3A

Ian Boylan, BE, M.EngSc, CEM CEA CMVP

Improving university curricula in the areas of
a) energy efficiency in the sectors of energy, industry and buildings, and
b) renewable energy sources (AHEFs AM-54, AM-55, AM-56)

BUILDING PARTNERSHIPS FOR ENERGY SECURITY

Lecture Learning Objectives

- To introduce the student to useful tools for gathering energy data to allow energy savings calculations to be made
- To identify the principles of operation of measurement equipment to ensure that it is not incorrectly used leading to incorrect results
- To show the student the key aspects of an energy project undertaken
- To develop among the students understanding of risk and to encourage discussion of merits and demerits of approaches

Register of Opportunities

- We now have a register of opportunities of potential ways to save energy within the organisation
- Some opportunities will not be viable for implementation
- We need to prioritise the opportunities for implementation
- To prioritise these we need to know the potential size of the energy savings, the value of these savings and the cost of implementation

Metering and data gathering Techniques

- This section will look at the tools necessary to gather the data to allow the energy saving potential to be calculated
- It will also look at some potential issues related to this data gathering and some approached that may assist
- Data analysis will take place in the next section on a sample of the metered data gathered

Instrumentation

- Calibration
  - Knowing that what the instrument is saying is correct
  - Typically checked against a traceable national source
  - For typical energy auditing work it can be done by checking against a known good instrument
- **Most errors in temporary instrumentation use come from errors in use and errors in analysis and not from the instrument calibration or lack of it.**

Fixed flow meters

- Many shapes and sizes, typically within 1-3% accuracy
- Need to monitor on a regular basis to allow trends to be established or to set up recording log
- Used in place, not typically installed for audit unless needed for other purposes such as on-going monitoring

Ultra-sonic flow measurement

- Operates on the basis that sound signal in moving fluid has its velocity affected and measurement of this response can give flow reading
- Set up is vital for correct reading
- Pipe quality important as well as pipe cleanliness.

- Galvanised pipe impossible to use
- Typically incorporates a data logger also
- Can be used for Gas also

Combustion Analyser

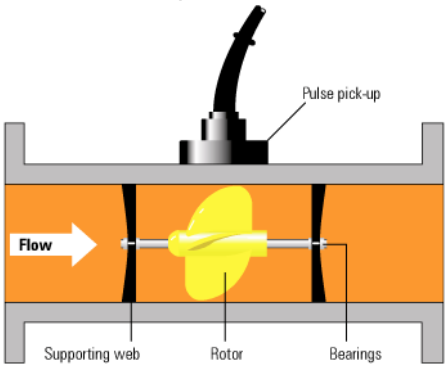
- Used to assess combustion efficiency of boiler
- Excess oxygen and stack temperature determines efficiency of combustion
- Allows determination of combustion efficiency for various stack temperature rise

Mini-Data loggers

- Many different makes and models
- Temperature, relative humidity
- External temperature probes
- Motor run time
- Light on/ off
- Occupancy
- State
- Some models can be remotely read

Steam Flow meters

- Many various types
- Orifice Plate (4:1-5:1 Turndown)
- Turbine (10:1 Turndown)
- Inline Variable area (Turndown up to 50:1)
- Vortex Shedding (“Reasonable turndown)
- Pressure compensation important
- Oversizing often an issue

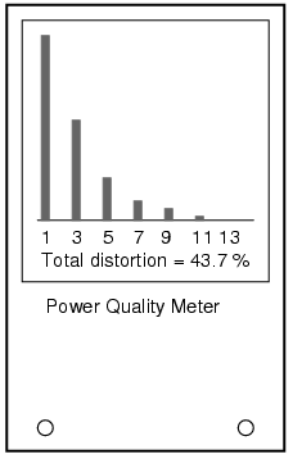


Water conductivity

- Normally tested by fixed installed instruments
- Testing needs to be done on cooled sampled, not hot water
- Conductivity gives TDS levels

Electricity

- True RMS Wattmeter required
- Measures Real Power; Apparent Power; Power Factor; Reactive Power;
- Power quality meter better – allows assessment of harmonic quantities



Lux Level Meter

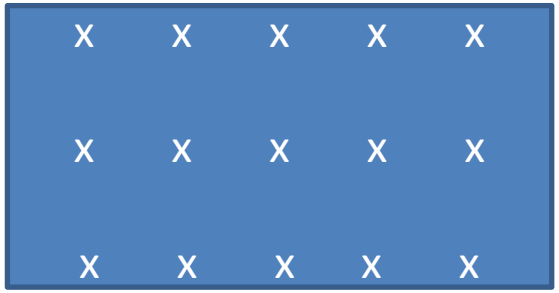
- Measurement of Lux level

Non contact temperature measurement

- Measurement of temperature from radiated energy
- Emissivity of material vital to be taken into account
- Can give false reading especially from glass or reflective material
- Better instruments can adjust emissivity
- A roll of black insulating tape can be useful

Air temperature and flow measurement

- Hot wire thermo-anemometer
- Dry bulb temperature
- Wet Bulb Temperature
- Humidity (absolute and relative)
- Air flow
- Air Pressure
- Density and specific volume
- Enthalpy
- Be sure to measure over a grid



Air leaks

- Ultrasonic leak detection
- Tuned microphone leads you to the leak location
- Sound (amplitude), pressure and CSA tells you leak volume (Bernoulli principle)
- Similar used for steam trap leak testing (more specialised)

Questions/ comments?

IAN BOYLAN
BE, M.ENGSC, CEM CEA CMVP

INDUSTRIAL ENERGY EFFICIENCY

Lecture 3B

Implementation of energy project

Project Management

- Planning required when the decision to implement has been taken
- Needs to be carefully assessed
- Often needs project to be broken into individual mini-projects (individual components), each with their own individual timelines and responsibilities

Project for Analysis

Anaerobic Digester

- Waste water from process
- 4000-5000 m^3 of Effluent/Day
- Biogas formed in the treatment of the effluent
- 70-80% Methane (CH_4), currently flared to minimise environmental impact ($CH_4 \rightarrow CO_2$)

Proposal – 2 Competing proposals

Install Bio-gas engine

- Combust bio-gas in a bio-gas engine to produce electricity
- Utilise the heat from the bio-gas engine to pre-heat the boiler make-up water
- Offset electrical use
- Offset boiler fuel use

Feed the bio-gas into existing oil boilers

- Offset the fuel use of existing boilers and generate steam

Gas Testing

Gas Test Results : 06 May 2013 to 10 May 2013	Analysis of Gas – Bulk Gases (Standard) GC (Method 72)
Material Type Bio-gas	CERAM Sample Reference 12345
Results	
Methane	82.7 %
Carbon Dioxide	14.1 %
Nitrogen	2.5 %
Oxygen	0.6 %
Hydrogen	122 ppm
Ethylene	<5 ppm
Ethane	<5 ppm
Acetylene	<5 ppm

Bio-gas Engine selected

- To introduce gas into boilers will require stabilisation of pressures and gas quality
- Company fearful of undertaking a project that will introduce additional risk on existing utility assets
- Bio-gas engine stand-alone

Engine Sizing

- Biogas CHP Engine Generator combination
  - 600 kW Electrical
  - 612 kW Thermal
  - Overall efficiency 86%
  - Elec. Efficiency 43%
- Gas Holder 500 m³ capacity
- Mechanical
  - Bring Biogas to Engine

Project Scope

- MECHANICAL
  - Install Gas Pipe Work to Gas Holder
  - Moisture Traps & Valves
- Electrical
  - 800 kVA step up Transformer 400/10,500 Volts
  - MV Cable to 10kV internal grid system
  - Install Earth Grid & Lightning Protection
- Civil
  - Engine & Gas Holder Compound foundation base

Identified Risks

- **Maintenance:**
- Oil Changes Critical every 2-3 Weeks

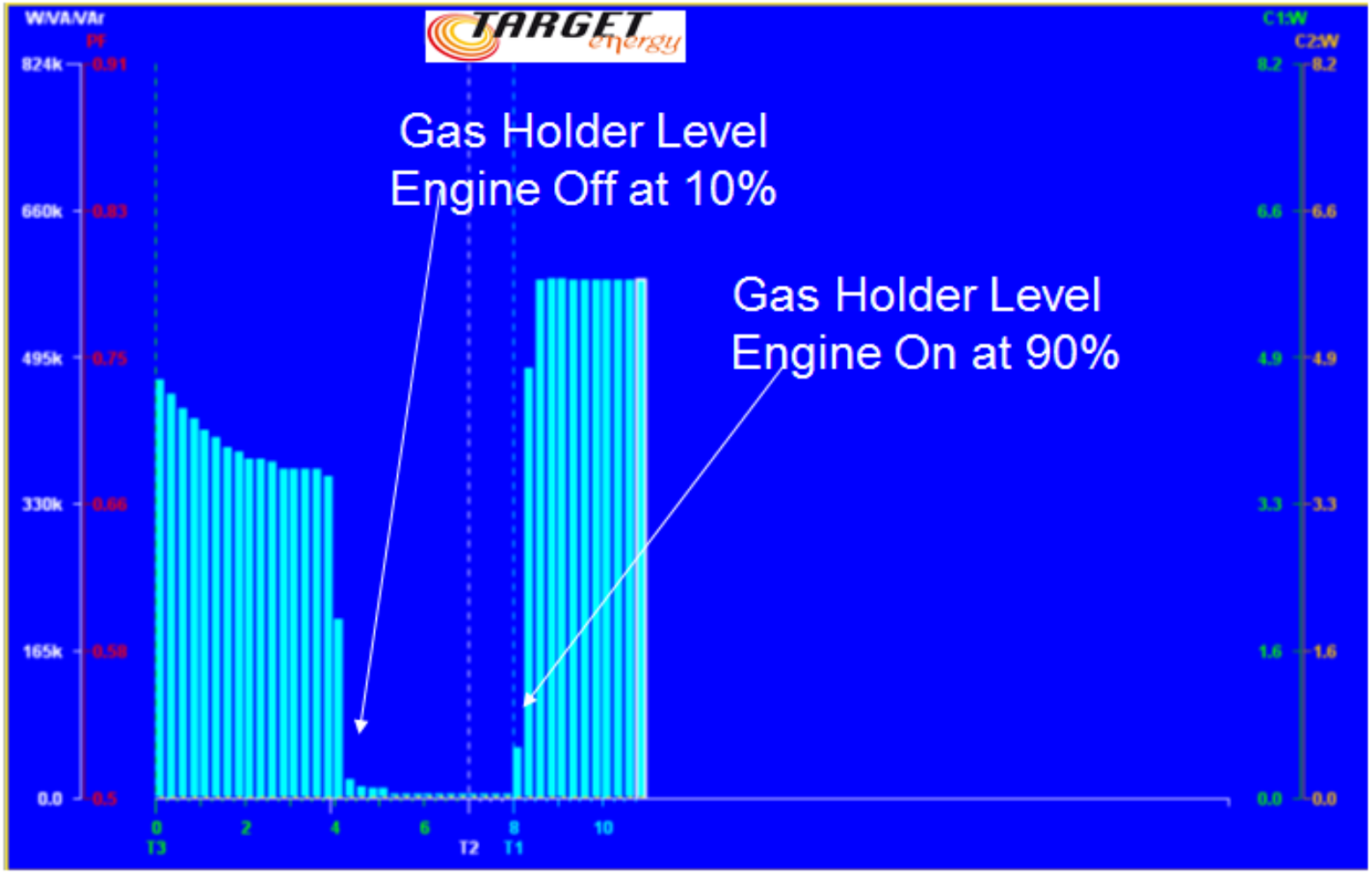
- High Levels H_2S in Biogas can cause corrosion – This will occur from time to time even though not identified on gas tests

Gas Holder

Gas Bag inside White Dome

Gas Level Control
Engine off at 10%
Engine on at 90%
Flare at 95%
Throttle Control

On/Off Power arrangement for engine when gas dome not full



Inside Proposed unit

Engine

Generator 600 kW

Gas Train

Different Approaches

Approach 1

- Supplier Own and operate –pay as you use 15% reduction in cost of energy supplied
- Remote Monitoring through Broadband
- Full responsibility for asset maintenance on supplier
- Full maintenance on asset for 10 yr. period

Different Approaches

Approach 2

- Contractor supply and install. Remote operate (on contract)
- Remote Monitoring through Broadband
- Full responsibility for asset maintenance on supplier through maintenance contract
- Full maintenance on asset for 10 yr. period

Different Approaches

Approach 3

- Supplier install
- End user own and operate
- Maintenance carried out in-house or contracted out as required

Discussion

- Consider the pro's and cons of each of the alternative approaches.
- Recommend an approach
- Outline why?

Projected Savings

- Generated Electricity 3.2 GWh/ yr
- Generated heat 2.7 GWh/ yr
- Electricity displaces electricity currently purchased from external supplier
- Heat replaces that generated from a boiler currently operating at about 68% efficiency.

Questions/ comments?

IAN BOYLAN
BE, M.ENGSC, CEM CEA CMVP