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THE NEW GENERATION OF FLAME MONITORING SYSTEMS FMS IN COAL FIRED POWER STATIONS

By Michael Thomas, BFI Automation GmbH, Germany

Since the beginning of flame monitoring on industrial firing systems the development of flame sensors demanded constant efforts to optimize the detections system in regards to safety and availability. Semi-conductor sensors and micro controllers set milestones and enabled new principles of measurements and flame signal analyzing.

Today new challenges have to be mastered as combustion processes are being optimized with respect to reducing CO^2 emission and to saving costs. The use of cheaper fuels (e.g. low quality coal) or alternative combustible materials (biomass, waste, etc.) is coming into focus as the fuel is offering a big cost saving potential at zero time.

VARIATION IN FUEL QUALITY AND HUMIDITY

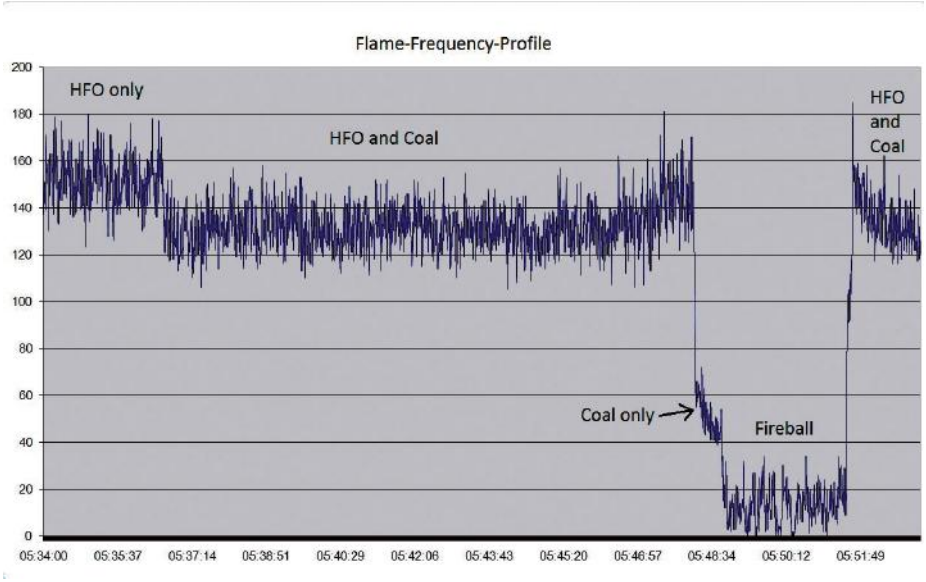
While oil and gas qualities are constant in most cases the coal qualities are varying as much as coal districts. Especially the content of ash and volatile fluctuations is having a strong effect to the combustion. Shifting ignition zones, changing flame shapes and lengths are the results.

The same disturbances can be caused during the raining season. As most of the coal storages are outdoor, the rain will moisten the coal. Wet coal will lead to reduced combustion reactivity. Flame detection might be difficult in case flame radiation is blocked by unburned coal. From the scanner sight port the flame will look darker and contain less flicker content caused by the inhibited combustion process.

MULTIPLE FUEL BURNERS

There are many reasons to use multiple fuels in industrial firing systems but in coal based power plants oil is expediently used for start-up and firing support. Both fuels have to be handled completely differently starting from storage, transport to the burner and the burner design itself.

While the oil is reaching the burner in separate pipes it must be atomized with high pressurized air or steam. The oil-atomizing media mixture leaves the oil gun through small holes with high speed and is mixed with combustion air in front of the burner. The high discharge speed causes strong turbulences which give the flame radiation its characteristic high flicker frequency.



Coal is transported with air in big pipes. At the burner the coal output speed is less compared to oil or even gas flames.

The following diagram shows the frequency profile of oil and coal fired burner flame during cold start. The pure flame radiation has been recorded with a BFI Automation Compact Flame Controller CFC3000IR at Ropar Thermal Power Station, India in 2006.

The measurement illustrates the variation of flicker frequency which corresponds to the mixing speed in different combustion modes.

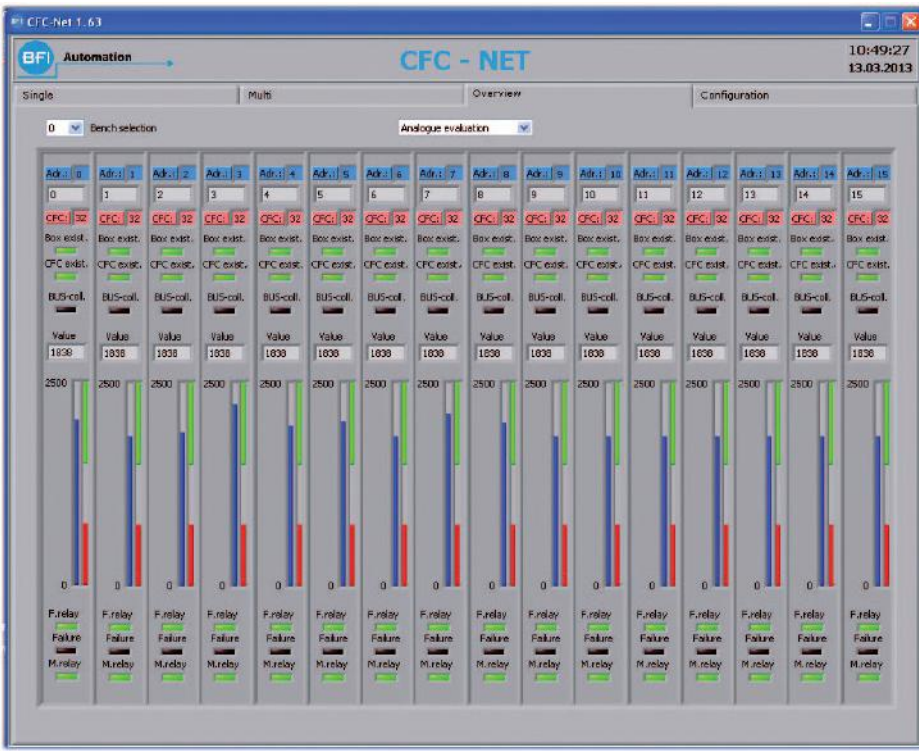
HFO only:	140 – 160 Hz
HFO mixed with Coal:	120 – 140 Hz
Coal only:	40 – 60 Hz
Fireball:	0 – 30 Hz

Different flame conditions can be easily differentiated by analyzing the frequency information. If the frequency evaluation is accurate enough, the flame ON/OFF thresholds can be set at any Hertz and will allow the flame monitoring system to discriminate between different fuels and own burner flames from other sources even with maximum sensitivity setting.

This capability proves itself valuable as it allows the operator to run the boiler with full scanner sensitivity without the risk seeing neighbor flames or the fireball. For 1 Hz thresholds is essential, that flame frequency information is available in the pure form, and is not filtered or converted into an analogue signal.

Conventional systems, which don't have this frequency analysis, may need to reduce the scanner sensitivity. Unfortunately the same lack of sensitivity is not available if needed during poor combustion periods.

BFI Automation and Hitech System & Services installed same systems in India include BALCO, Korba in 2007 and CESC, and Titagarh in 2011. At BALCO, valuable resources could be obtained by switching off the oil auxiliary burners since then. The key to success was that scanner is operating with full sensitivity while the 1 Hz frequency analysis discriminates oil, coal and fireball safely. Both customers connected their SIL3 certified Compact Flame Controllers in a network.



'Different flame conditions can be easily differentiated by analyzing the frequency information. If the frequency evaluation is accurate enough, the flame ON/OFF thresholds can be set at any Hertz and will allow the flame monitoring system to discriminate between different fuels and own burner flames from other sources even with maximum sensitivity setting.'

CONVENTIONAL VS. COMPACT FMS DESIGN

The very first flame monitoring systems were of simple design and consisted of the sensor and the output relay for the binary information Flame ON/OFF.

The first flame scanner with an integrated amplifier on the market was launched by BFI Automation in 1992. Around 20 years later most new FMS designs are compact types.

The Indian market is responding with mixed feelings. Of course new technology is generally welcome but the idea that 100% of the electronics are mounted in the burner area raised concerns. The use of micro-controllers enabled the FMS manufacturer to reduce the total numbers of electronic components, which is indeed the biggest factor for increasing the lifespan. SMD technology with much smaller components helped further to handle higher temperatures.

From the installation point of view the compact design offers more cost saving potential as the additional cabinet in the control room is not needed. R&M can be done in running boiler condition by replacing flame monitoring system burner by burner. This saved enormous production losses e.g. in Aleppo Power Station, Syria in 2011, who replaced all flame scanners by CFC3000UV on 5 boilers without stopping units.

The conventional system with an enhanced frequency analyzing feature is still a good option if space for the amplifier cabinet is available and the replacement job doesn't need to be done in operation. BFI Automation is providing FMS with a frequency based analog signal and an adjustable threshold for the fuel discrimination. Such a system is running at NTPC Talcher since 2011.

FMS WITH NETWORK FEATURE

By connecting all boiler flame scanners to a network single devices will become a combustion analyzing system at minor costs. All individual flame information and scanner parameters will be transparent for the operator. The boiler overview will assist him to identify an abnormal flame on single burners, burner elevation or boiler corners. These systems are even able to indicate dirty lenses and help reducing the maintenance efforts especially on coal fired boilers. Within short time there is a better understanding about the relationship between burner parameters and flame behavior.

For reporting, trouble shooting and comparison a software data logger can be started by the operator at any time. For permanent signal recording BFI provides an inbuilt SD-Card solution. A safety key enables remote access to each of the Compact Flame Controller from the control room for immediate intervention if required. Parameter files can be downloaded and saved centralized and uploaded to any flame scanner connected to the network.

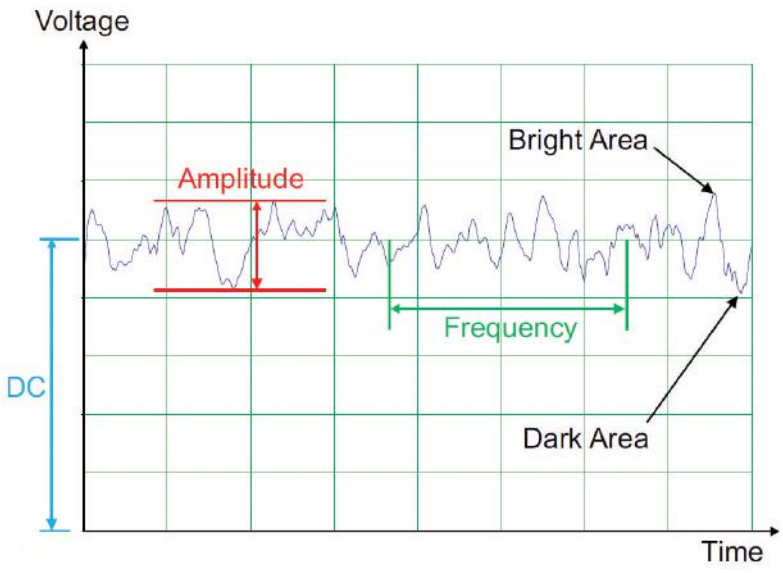
PERFORMANCE TEST

Free Demo-Installation including flame signal recording, analyzing and reporting can be arranged with BFI Automation and its partners. The equipment can be installed within short time. BFI Automation is providing plug-in adapters replacing the existing flame amplifier for temporary installations.

BFI measurements are based on the pure flame sensor output like Amplitude (variation in flame radiation caused by bright and less bright areas of the flame), Frequency (mixing speed of fuel and air) the DC content (flame intensity or brightness of the flame).

First analysis can be done within minutes at the burner. By using SD-Card recorders also long term effects can be captured. Flame signals can be compared under varying ambient conditions, different types of coal or even weather dependent effects like wet coal during raining season.

Difficulties with combustions are highly diverse and only a genuine case study will help us to understand.



BFI Automation

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FLAME MONITORING & EVALUATION SYSTEMS

SIL 3

POWER STATIONS

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REFINERIES, CHEMICAL & SULPHUR RECOVERY PLANTS

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MULTI FUEL BURNERS

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WASTE GASSES & LIQUIDS

LOW-NOX CONDITIONS
AIR & STEAM ATOMIZING
EXHAUST GAS RECIRCULATION

HIGH TEMPERATURE APPLICATION
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GAS TURBINES

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