FLAMES
Chemical Processes in the Combustion

\[ C + O_2 \rightarrow CO_2 + 94.1 \text{ kcal} \]

\[ C_xH_y + [2x+y/4] O_2 \rightarrow x CO_2 + y/2 H_2O + z \text{ kcal} \]
Flame Ignition
Ignition of Flames: Ignition Energy

- Pilot Burner or Gas/Oil fired Ignitor
- High Energy Spark Ignitor
- High Voltage Ignitor
- Gas
- Light Oil
- Heavy Oil
- Coal Waste
Gas Fired Igniter for Cold Combustion Air
# Definitions

| **Ignitor** | A special high energy or fuel fired unit used to light off an industrial burner or a large utility burner. Fuel fired ignitors are designed for sub-stoichiometric operation to create especially long and tight flames. Their air coefficient can be 0.3 or even lower. This means that only 30% of the required air volume or even less passes through the ignitor tube. Therefore additional combustion air must be available from the burner's windbox or from the combustion chamber. Ignitors have no turn-down ratio. They are generally operated at a fixed setting of air and gas pressure. |
| **Pilot Burner** | A special fuel fired burner used to light off, support and sustain a main burner. Any Hegwein ignitor may be used as a pilot burner. If it is in uninterrupted use for more than 24 hours its flame monitor, be it integrated or external, must be approved for continuous operation. |
| **Burner** | An industrial or utility unit used to create a given amount of heat. A burner offers stoichiometric combustion, i.e. the full amount of combustion air required passes through the burner tube. No additional air is needed. Burners have a certain turn-down ratio. They may be operated in 1-stage, 2-stage or modulating mode. |
Gas Fired Igniter ZA0...

1. Mixing Chamber with Mixing Ring
2. Flame Rod
3. Spark Rod
4. Gas Nozzle
5. Electrode Holder
6. Gas Tube
7. Connecting Rods
8. Support for Connecting Rods
9. Air and Mounting Flange with Ignitor Tube
10. Air Pressure Test Point
11. Inside: Spark Transformer 5 kV
12. Inside: Flame Monitor
13. Multipole Plug and Socket Connector
ZA0 Ignition

- Ø 48 mm
- 500 mm
- Heat release: 120 kW
- Gas supply pressure: 150 mbar
Comparison of Installation Requirements

Other Suppliers
“Eddy-Plate”-Ignitor

Retraction Unit

Air

Gas

Flame Monitor

2 kV

Cabinet at Site

Burner Control

HESI Pack

115 V

115 V

115 V

115 V

115 V

115 V

115 V

24 V

20 mA

Hegwein

Burner Control

Air

Gas

115 / 230 V Supply

90 V Flame Signal
Gas Fired Ignitor PDA2

Flame picture from Babcock Hitachi Kure Test Facility

Fuel: Propane
Flow: 250 m3/h
Heat release: 6 MW
Electrical Igniters and Pneumatic Retraction Units
Example: Dual Fuel Burner for Gas / Oil

High Energy Ignition Device D-HG 400 with Lance

Pneumatic Retraction Unit D-VE 500

Flame Sensor D-LE 603

Oil, Steam

Purge Air, Gas

Control Unit D-UG 660 of the Flame Detector Device

Bar Graph Display D-ZS 129-30

Combustion Air
D-HG 400 – Ignition Spark
Ignition of Flames: Ignition Energy

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- High Voltage Ignitor

- Gas
- Light Oil
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Flame Monitoring
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- High Energy Ignition Device D-HG 400 with Lance
- Pneumatic Retraction Unit D-VE 500
- Flame Sensor D-LE 603
- Oil, Steam
- Purge Air, Gas
- Control Unit D-UG 660 of the Flame Detector Device
- Bar Graph Display D-ZS 129-30
- Combustion Air
Different Methods of Flame Monitoring

- **Ionisation / Rectification**
  - Simple and inexpensive
  - Good Selectivity
  - Fail-Safe/Self-Checking
  - Poor sensitivity
  - Only for smaller gas burners

- **Optical**
  - Simple
  - Good Selectivity
  - Fail-Safe/Self-Checking
  - Bit more expensive

- **Acoustic**
  - Simple
  - Inexpensive
  - Not Fail-Safe
  - Not selective

- **Video / Thermography**
  - Flame Analysis
  - Furnace Camera
  - Combustion Enhancement
  - Not Fail Safe/Self-Checking
  - Different Application
Different Kinds of Operations for Burners

- **Intermittent Operation**
  - One Burner Shut-Down at Least Once in 24 Hours
  - Flame Monitor Test During Burner Start
  - Fail-Safe Circuit Required

- **Continuous Operation**
  - Burner Works for a Long Period Without Shut-Down
  - Flame Monitor Test During Operation
  - Fail-Safe and Self-Check Circuit Required

- **72 h Operation without continuous Supervision**
  - Nobody to be Present at the Plant for Maximum 72 Hours
  - Flame Monitor Test during Operation
  - Fail-Safe and Self-Check Circuit Required
  - Second Shut-Down Path Required

Increasing Requirements
Different Methods of Flame Monitoring

Optical

▲ Simple
▲ Good Selectivity
▲ Fail-Safe/Self-Checking
▼ Bit more expensive
Flame Monitor Overview

A Flame Monitor is always build from a Control Unit and a Flame Sensor

**Single Burner / Single Flame Viewing Furnaces**
- Flame Sensor plus Control Unit
  - or
  - Integrated Compact Flame Monitor

**Multiple Burner Furnaces**
- Flame Sensor plus Control Unit
  - or
  - Integrated Compact Flame Monitor

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Monitoring Flames – Optical

Flame Brightness (DC-Portion)

Flame Flicker Frequency in Hz

Flame Flicker Amplitude (AC-Portion)

Flame Colour

Wavelength

UV 400  VIS 800  IR

λ (nm)

Δλ

i

time t

i_0

i

time t

Δj

i

time t

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Flame Light Emission and Sensor Sensitivity

Intensity of Flame Light Emission

Wavelength of Flame Light Emission in nm

- UV Cell
- GaP Semiconductor
- Silicium Semiconductor
- Germanium Semiconductor
- Coal
- Oil
- Gas

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smart solutions for DURAG GROUP
combustion and environment
Stray Light Effect

High Pass Filter Setup 100Hz

Distance from Burner

Flame Flicker Frequency \( f \) [Hz]

- \( f_1 = 160 \) Hz
- \( f_2 = 50 \) Hz

B1

B2

smart solutions for DURAG Group

combustion and environment
Integrated Flame Monitor Systems
Compact Flame Monitor System

- Power Supply
- Flame Intensity
- Compact Flame Monitor System D-LX 100
- Front Panel
- Adjusting Flange
- Fuel Valve
- Fuel
- Burner

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smart solutions for DURAG GROUP
combustion and environment
D-LX 200

- G1¼"
  (opt. NPT1¼"

- G½"
  (opt. NPT½"

- 6°

- IP65

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Smart Solutions for Combustion and Environment
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Ambient temperature range

-20°C to +60°C

-40°C to +85°C

Image: NASA
Dual channel design throughout

D-LX 200

IR/UV

Channel 1
- Analog 1
- MC 1
- K2
- Ready for Operation
- Flame ON

Channel 2
- Analog 2
- MC 2
- K1
- K3
- Modbus
- 4...20 mA
- LED
- optical Output

K1
K2
K3

Analog 1
Analog 2

MC 3

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Smart Solutions for Combustion and Environment

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Measurement of flame flicker frequency?

92 Hz
Measurement of flame flicker frequency

- Harmonic detection
  - Detection of periodic radiation sources (like fluorescent lamps)
  - Flame off when periodical behaviour is observed for 10 sec
Influence of Dust and Steam
FURNACE CAMERA
with or without
THERMOGRAPHY
DURAG Sensor System -
Online Information from Thermal Processes in:

- Grate fired Plants
- Waste / Coal / Biomass

- Coal / Oil / Gas fired Power Plants

- Cement Plants
- Hazardous Waste Rotary Kilns

- Industrial Firing Systems
DURAG Furnace Cameras

**VISUALIZATION**
*Video Technology*

**TEMPERATURE ANALYSIS**
Thermography
On-site Application for Video and Thermography Sensors

**VIS sensors can be used for:**
- Combustion Processes with light emission
- other thermal processes with temperatures >1,000°C
- however without the influence of external light (sun, daylight, artificial light, ...)

**IR sensors can be used for:**
- Combustion Processes
- other thermal processes with any temperature

**spectral sensitivity of a VIS camera =**
visible range of the spectrum

**spectral sensitivity of an IR camera =**
invisible range of the spectrum, heat radiation
Video System \(\Rightarrow\) Image Processing = Thermography

**Calculations:**

- Temperature (in absolute terms, accuracy app. \(\pm 1.5\%\))
- Temperature Distribution
- Flame Position
- Ignition Point
- Combustion Zone Detection
R&M OF EXISTING BOILERS / ERECTION OF NEW BOILERS

HOW MANY CAMERAS?

Tangential or Boxer (opposite wall) fired:
- depending on the size of the combustion chamber: typically one or two cameras to visualize the entire fireball
- **Position:** above the top-most burner elevation, below the superheaters, pointing 45° downwards
- installation at existing peepholes!

Front Wall fired:
- depending on the size of the combustion chamber: typically one camera to visualize the entire combustion area
- **Position:** in the opposite wall in the center of all burners, or above the top-most and/or below the lowest burner elevation pointing 45° downwards/upwards
- installation at existing peepholes!
THANK YOU FOR YOUR INTEREST

www.durag.de / info@duragindia.com