STG Combustion Control GmbH & Co KG

Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Control Systems

Oxygen Sensors

Lambda-Control

FlammaTec Burner Technology

Mumbai

13-03-2015

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Control Systems

Oxygen Sensors

Lambda-Control

FlammaTec Burner Technology

Mumbai

13-03-2015

The All India Glass Manufacturers' Federation

Conference on Cost Effective Technology In Container Glass - For Tomorrow

Air Staging and understoichiometric Lambda Control

Dr. Peter Hemmann
STG Combustion Control GmbH & Co KG

Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Air-staging

Purpose

Method

Control

Lambda Control

Mumbai

13-03-2015

air-staging: **Create area of reducing fire to reduce NOx**
add any missing oxygen downstreams later

Problem:
Without precise control DeNOx effect is unstable
Without precise control You get skyrocking energy consumption
Without precise control CO may damage furnace and regenerator

Solution for precise control:
- Oxygen measurement & CO monitoring
- Instead of controlling O2% or CO: Control Lambda value
- **Understoichiometric Lambda Control is a proven technology !**

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Control

Control Lambda

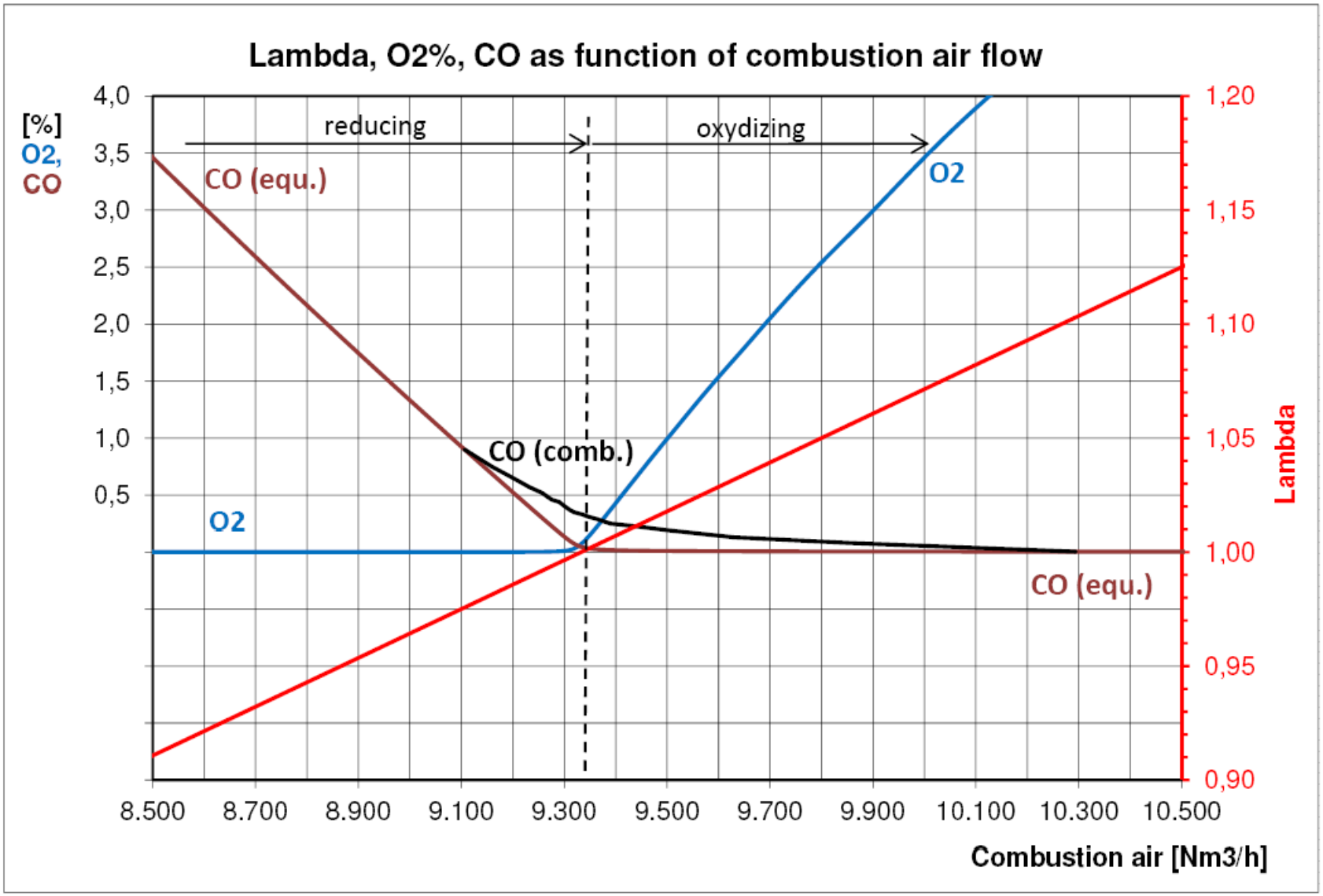
Control
air ingress XF

Indicate
insufficient
burner setting &
insufficient
purging

Mumbai

13-03-2015

Lambda value is linear with combustion air flow – O2% and CO[ppm] are not linear



STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

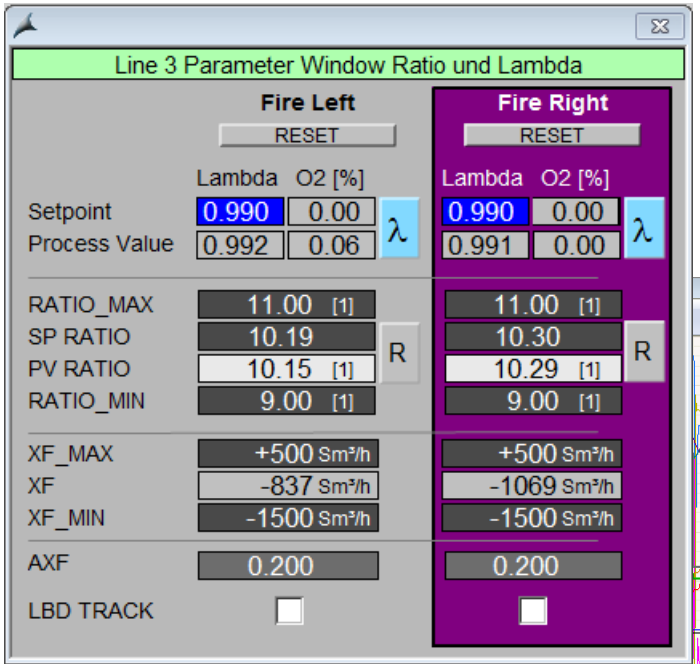
Lambda Control

Control Lambda

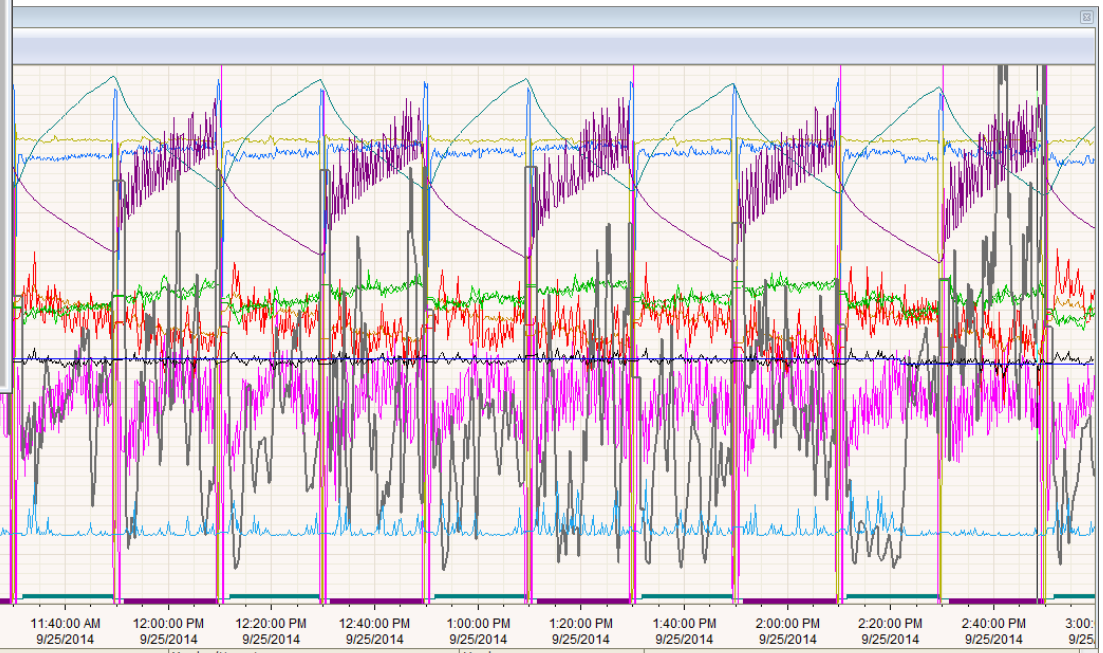
Under-stoichiometric operation

Mumbai

13-03-2015



Understoichiometric operation
Setpoint_Lambda = 0,990



	Name	Tag name Y	X value/time stamp	Y value
1	Lambda Setpoint	ProcessValueArchive\STG_LR_LBD_SP	25.09.14 14:48:21	0.990
2	Lambda actual process value	ProcessValueArchive\STG_LR_LBD_PV	25.09.14 14:48:22	0.990
3	Oxygen measurement %	ProcessValueArchive\STG_LR_O2	25.09.14 14:48:22	0.004
4	CO including peak analysis	ProcessValueArchive\STG_LR_X3	25.09.14 14:48:27	13068.131
5	Setpoint Air/Gas Ratio	ProcessValueArchive\STG_LR_RG_SP	25.09.14 14:48:21	10.316
6	Process Value Air/Gas Ratio	ProcessValueArchive\STG_LR_RG_PV	25.09.14 14:48:21	10.343
7	Ingressed air process value	ProcessValueArchive\STG_LR_VXF	25.09.14 14:48:21	-1140.282
8	Ingressed air used for control	ProcessValueArchive\STG_LR_XFA	25.09.14 14:48:21	-1095.005
9	Sensor Temp Left (Fire Right)	ProcessValueArchive\FN_AnalogInputs_EX-LOX-TI	25.09.14 14:48:20	1461.000
10	Sensor Temp Right (Fire Left)	ProcessValueArchive\FN_AnalogInputs_EX-ROX-TI	25.09.14 14:48:20	1425.900
11	Process Value of Gas Flow	ProcessValueArchive\FN_MGS-FL.PV	25.09.14 14:48:23	1548.322
12	Process Value of Air Flow	ProcessValueArchive\FN_CA-FL.PV	25.09.14 14:48:24 i.	15975.068 i.
13	Furnace pressure process value	ProcessValueArchive\FN_FN-PR.PV	25.09.14 14:48:25	0.207

Source: Trend 9/25/2014 2:59:45 PM

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Control

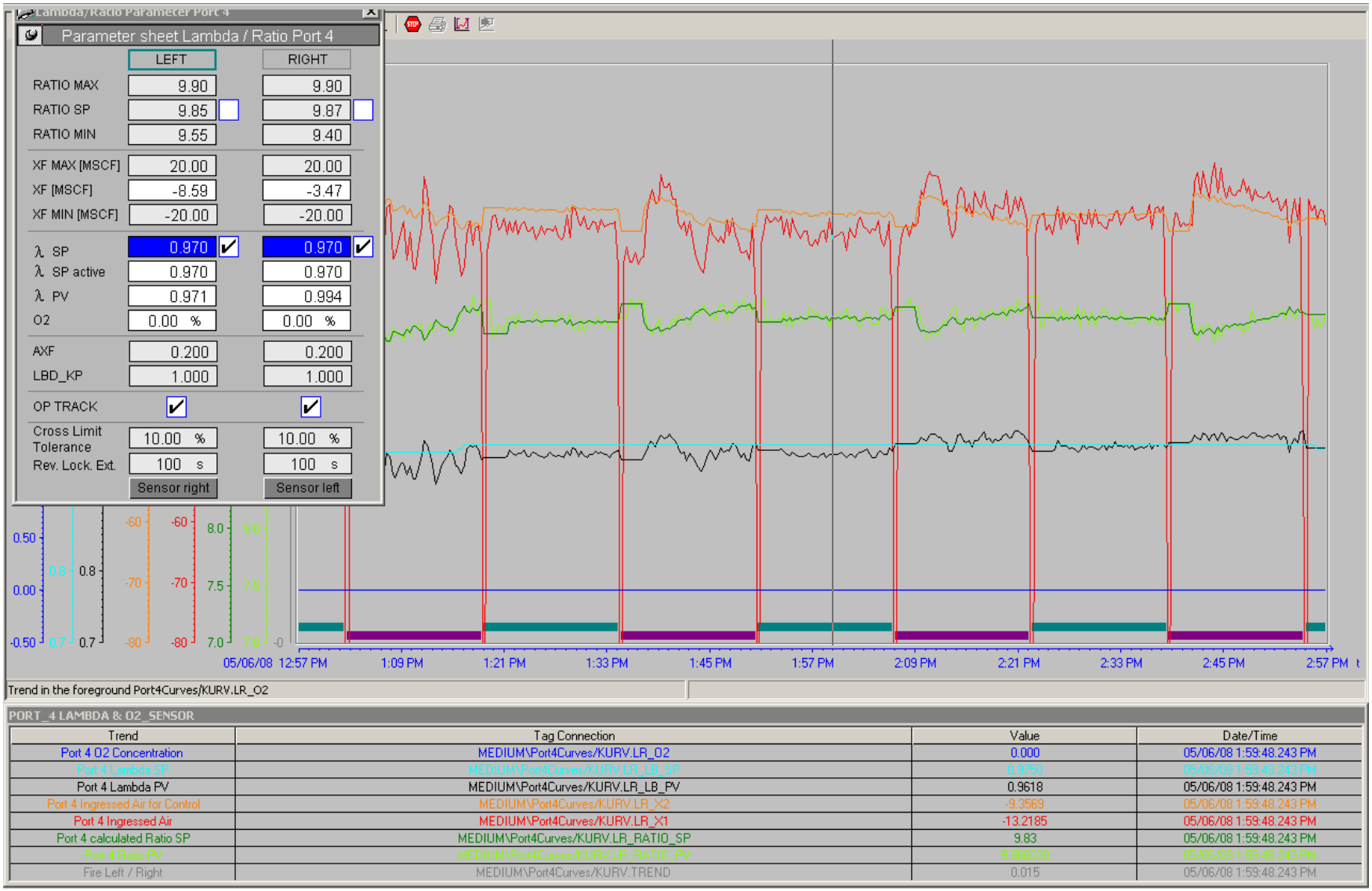
Control Lambda

Under-stoichiometric operation

Mumbai

13-03-2015

Lambda Control of understoichiometric operation: Lambda setpoint 0,97



PORT_4 LAMBDA & O2_SENSOR

Trend	Tag Connection	Value	Date/Time
Port 4 O2 Concentration	MEDIUM\Port4Curves/KURV.LR_O2	0.000	05/06/08 1:59:48.243 PM
Port 4 Lambda SP	MEDIUM\Port4Curves/KURV.LR_LB_SP	0.9750	05/06/08 1:59:48.243 PM
Port 4 Lambda PV	MEDIUM\Port4Curves/KURV.LR_LB_PV	0.9618	05/06/08 1:59:48.243 PM
Port 4 Ingressed Air for Control	MEDIUM\Port4Curves/KURV.LR_X2	-9.3569	05/06/08 1:59:48.243 PM
Port 4 Ingressed Air	MEDIUM\Port4Curves/KURV.LR_X1	-13.2185	05/06/08 1:59:48.243 PM
Port 4 calculated Ratio SP	MEDIUM\Port4Curves/KURV.LR_RATIO_SP	9.83	05/06/08 1:59:48.243 PM
Port 4 Ratio PV	MEDIUM\Port4Curves/KURV.LR_RATIO_PV	9.866020	05/06/08 1:59:48.243 PM
Fire Left / Right	MEDIUM\Port4Curves/KURV.TREND	0.015	05/06/08 1:59:48.243 PM

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Sensor

Advanced signal processing

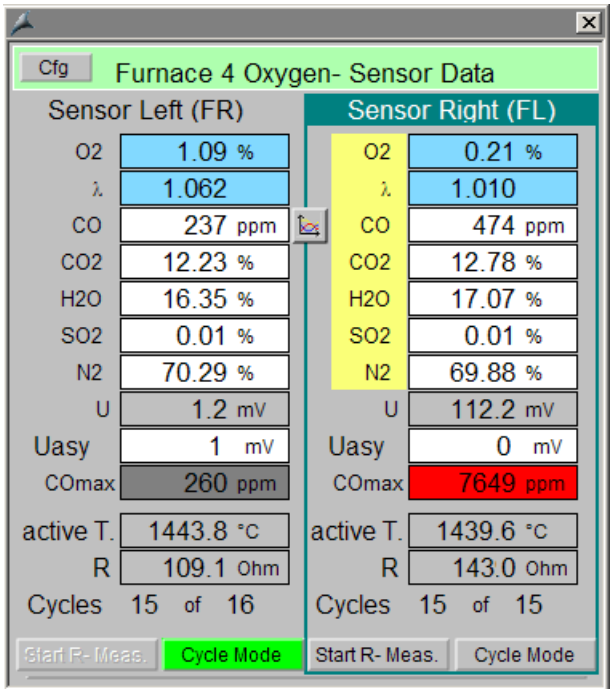
Provides:

O2%
CO[ppm]
PV Lambda
XF air ingress

Mumbai

13-03-2015

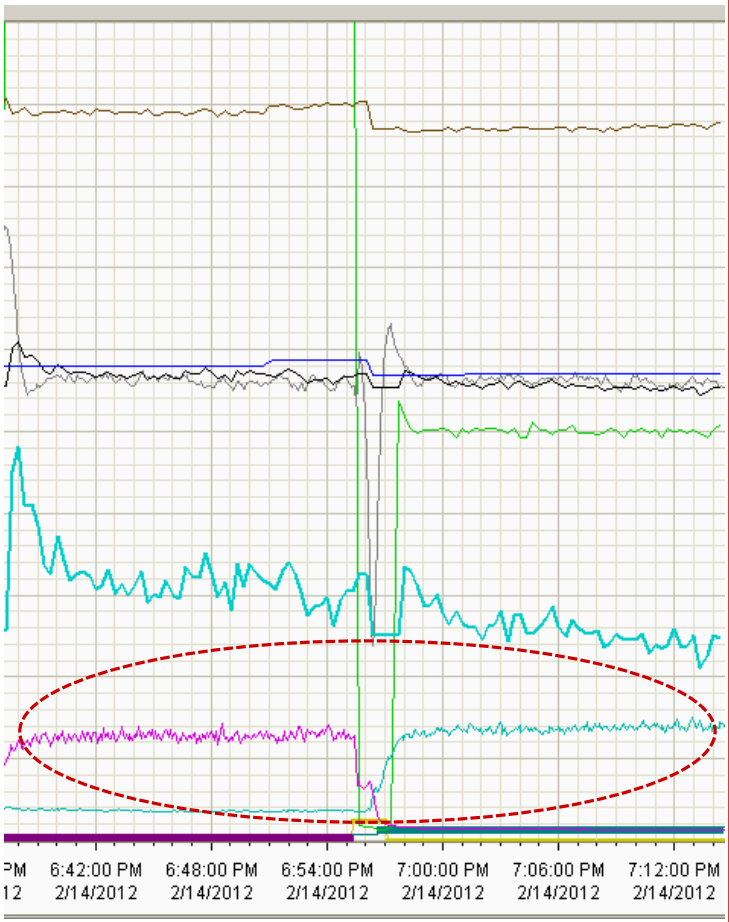
Advanced signal processing provides:



O2%	← Sensor voltage & temperature
CO[ppm]	← Sensor voltage dynamics & temperature
Lambda [1]	← Sensor voltage & temperature & fuel composition
Flue gas composition	← Sensor voltage & temperature & fuel composition
XF[Nm3/h] air ingress	← Sensor voltage & temperature & fuel composition & actual air and fuel flow

STG Combustion Control GmbH & Co KG
Solutions for Technology in Glass
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Different „sensor signal patterns“ indicating different O2%/CO combustion situation:



Normal combustion:
- 1..1,5% O2%
- very low CO[ppm]

Insufficient air – reducing fire:
- O2% nearly zero
- very high CO[ppm]

Insuff. burner setting & port design:
- 1…1,5% O2% *but*
- 2000 … 5000 ppm CO

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

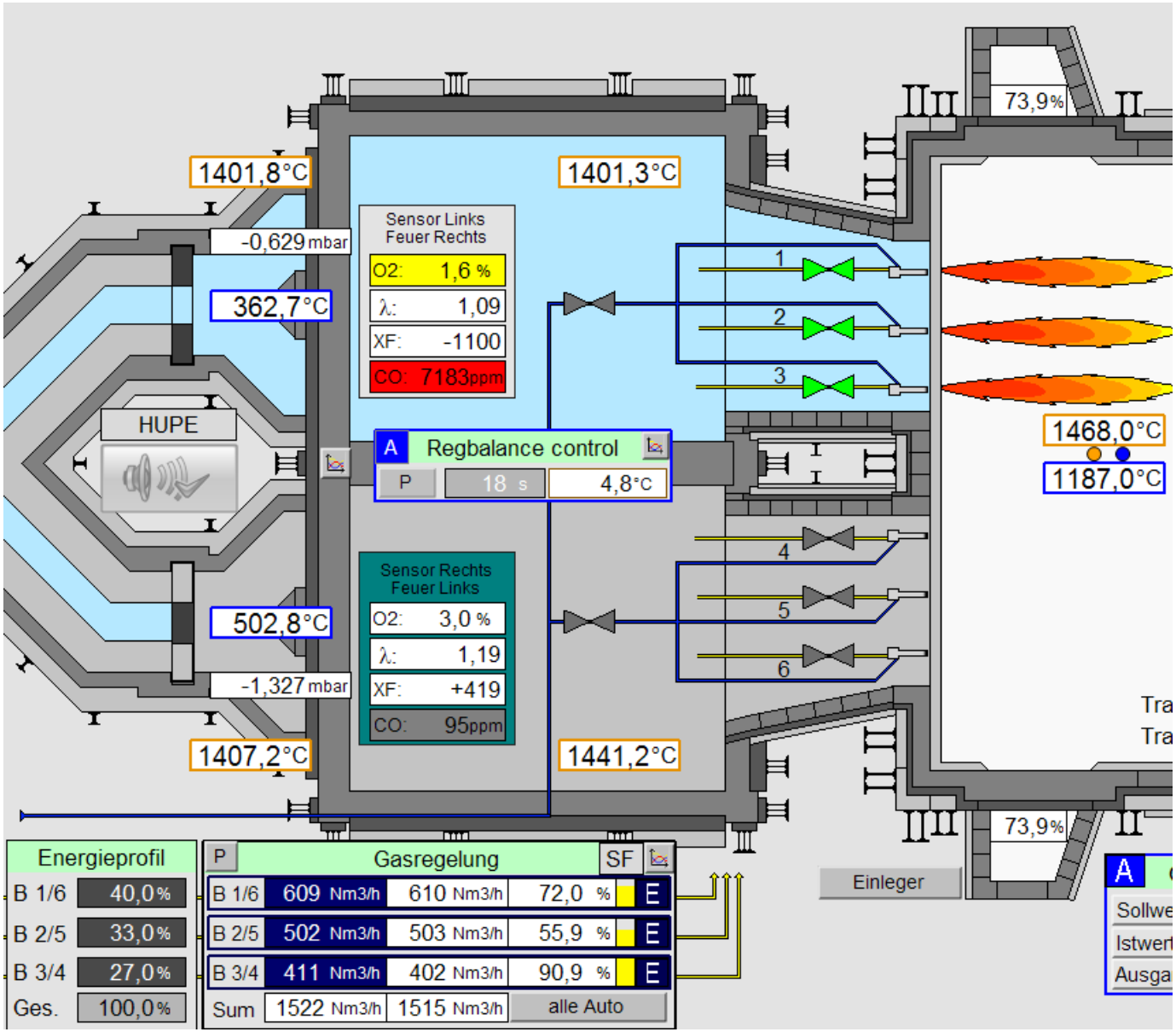
Lambda Sensor

Advanced signal processing

Peaks of CO[ppm] due to insufficient burner settings

Mumbai

13-03-2015



Example:

peaks of CO while sufficient air is available:

Indication of insufficient burner setting

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Control

Control Lambda

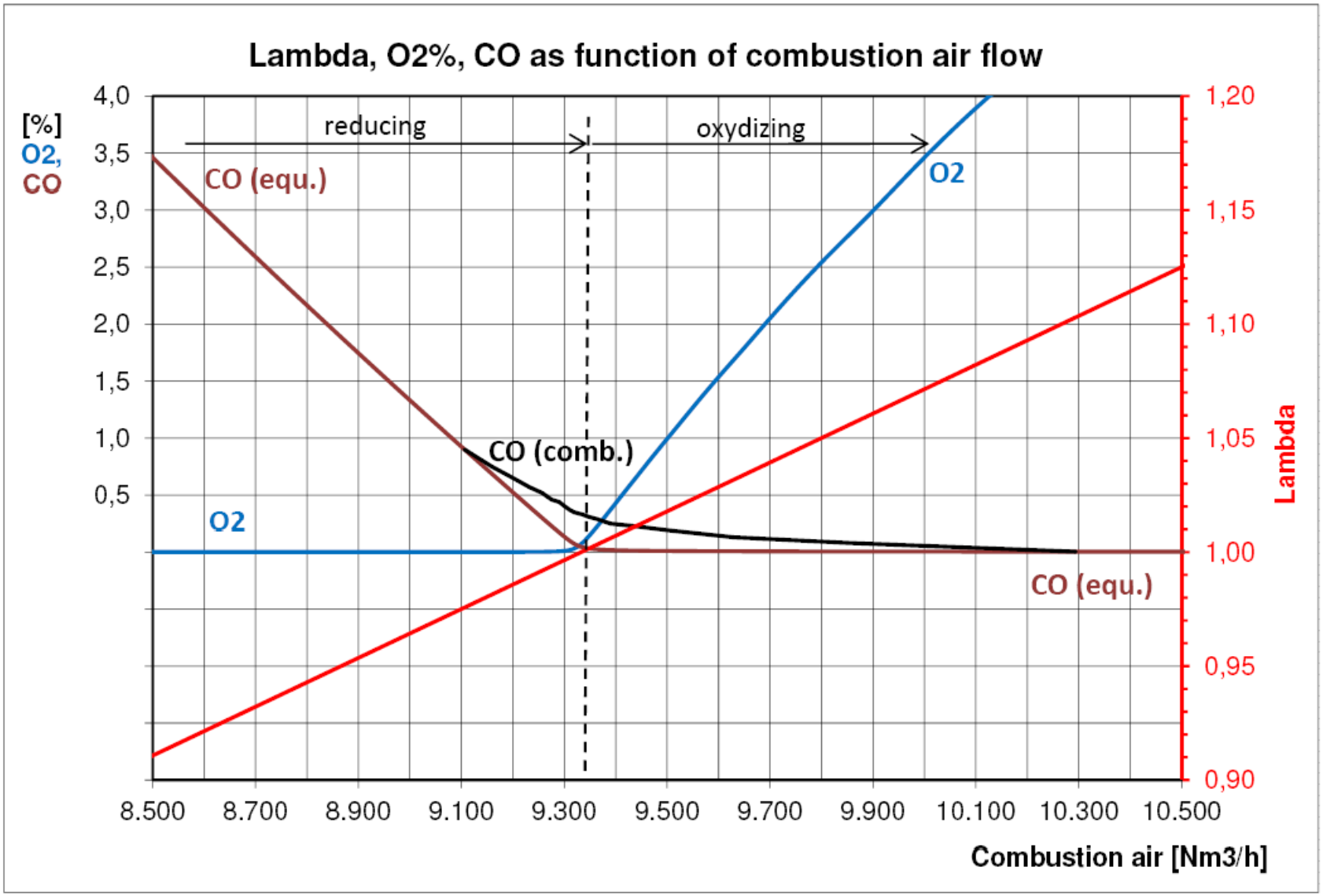
Control
air ingress XF

Indicate
insufficient
burner setting &
insufficient
purging

Mumbai

13-03-2015

Lambda value is linear with combustion air flow – O2% and CO[ppm] are not linear



Lambda Control

Control Lambda

Control
air ingress XF

For Lambda Control:

Convert measurements O2% and CO into linear variable Lambda:

(D_51)

$$\lambda = 1 + \frac{0{,}2094 * (\kappa + \omega + Ge) - 0{,}7906 * \psi}{\sigma} * \frac{[O_2\,\%]}{20{,}94\% - [O_2\,\%]} - \frac{\psi}{\sigma}$$

notice:	20,94% is oxygen percentage in oxydant (air)	O2% in Vol.%
	79,06% is nitrogen percentage in oxydant (air)	N2% in Vol.%

Mumbai

13-03-2015

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

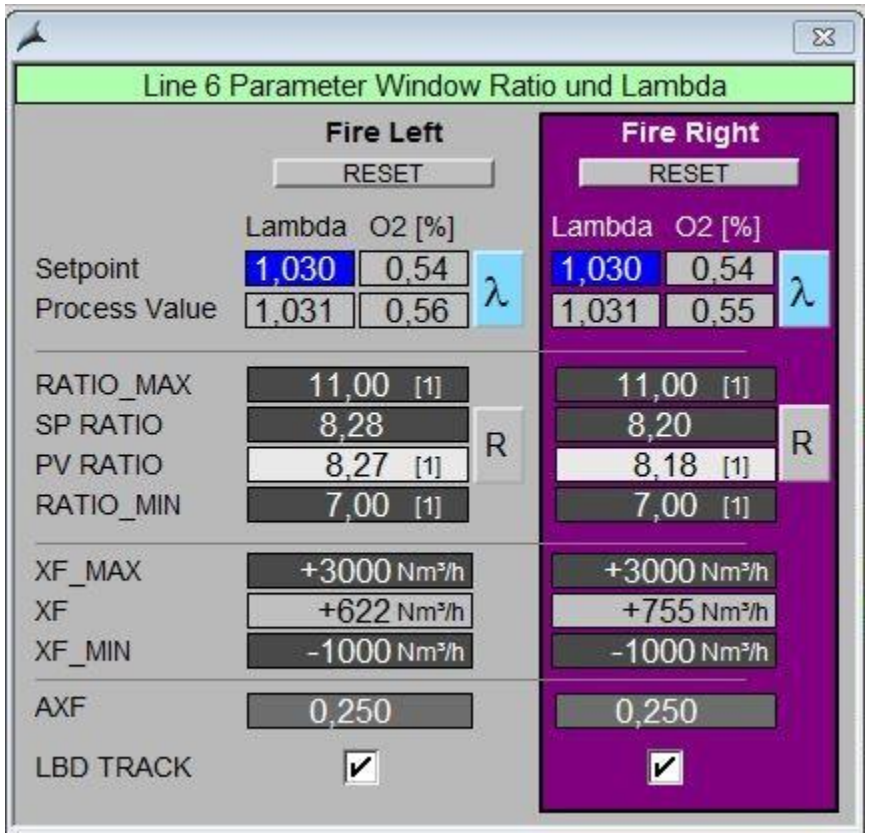
Lambda Control

Control Lambda

Safety limitations

Mumbai

13-03-2015



Ratio: upper & lower limit

Uncontrolled air XF: upper and lower limit

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Control

Control Lambda

Example endport furnace stable Lambda = 1.03

Mumbai

13-03-2015

Stable control of combustion condition **based on a model of XF air ingress** (yellow trend)

	Name	Tag name Y	X value/time stamp	Y value
1	Lambda Setpoint	ProcessValueArchive\STG_LR_LBD_SP	14.10.13 13:30:00 i.	1.030 i.
2	Lambda actual process value	ProcessValueArchive\STG_LR_LBD_PV	14.10.13 13:30:00 i.	1.031 i.
3	Oxygen measurement %	ProcessValueArchive\STG_LR_O2	14.10.13 13:30:00 i.	0.549 i.
4	Setpoint Air/Gas Ratio	ProcessValueArchive\STG_LR_RG_SP	14.10.13 13:30:00 i.	8.316 i.
5	Process Value Air/Gas Ratio	ProcessValueArchive\STG_LR_RG_PV	14.10.13 13:30:00 i.	8.279 i.
6	Ingressed air process value	ProcessValueArchive\STG_LR_VXF	14.10.13 13:30:00 i.	599.640 i.
7	Ingressed air used for control	ProcessValueArchive\STG_LR_XFA	14.10.13 13:30:00 i.	663.629 i.
8	Sensor Temp Left (Fire Right)	ProcessValueArchive\FN_AnalogInputs_LOXYT1.P	14.10.13 13:30:00 i.	1326.379 i.
9	Sensor Temp Right (Fire Left)	ProcessValueArchive\FN_AnalogInputs_ROXYT1.P	14.10.13 13:30:00 i.	1336.936 i.
10	Process Value of Gas Flow	ProcessValueArchive\FN_GSFLO.PV	14.10.13 13:30:00 i.	1293.873 i.
11	Process Value of Air Flow	ProcessValueArchive\FN_ARFLO.PV	14.10.13 13:30:00 i.	10865.723 i.
12	FL/FR	ProcessValueArchive\STG_LR_TREND	14.10.13 13:30:00 i.	0.000 i.

Source: Trend 10/14/2013 3:29:10 PM

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Control

Control Lambda

Example endport furnace stable Lambda = 1.03

Same furnace with CO peaks

Mumbai

13-03-2015

Same furnace 1 year later and CO-indication from oxygen sensor installed

	Name	Tag name Y	X value/time stamp	Y value
1	COMax Fire Left	ProcessValueArchive\STG_OXYFL_COMAX	26.02.14 12:19:09	84.740
2	COMax Fire Right	ProcessValueArchive\STG_OXYFR_COMAX	26.02.14 12:19:08	76.504
3	FL/FR	ProcessValueArchive\STG_LR_TREND	26.02.14 12:19:08 i.	-1.000 i.
4	Furnace pressure process value	ProcessValueArchive\FN_FURNPR.PV	26.02.14 12:18:57	0.503
5	Ingressed air process value	ProcessValueArchive\STG_LR_VXF	26.02.14 12:19:09	870.372
6	Ingressed air used for control	ProcessValueArchive\STG_LR_XFA	26.02.14 12:19:08 i.	805.894 i.
7	Lambda actual process value	ProcessValueArchive\STG_LR_LBD_PV	26.02.14 12:19:08	1.035
8	Lambda Setpoint	ProcessValueArchive\STG_LR_LBD_SP	26.02.14 12:19:09	1.030
9	Oxygen measurement %	ProcessValueArchive\STG_LR_O2	26.02.14 12:19:08	0.630
10	Process Value Air/Gas Ratio	ProcessValueArchive\STG_LR_RG_PV	26.02.14 12:19:08	8.121
11	Process Value of Air Flow	ProcessValueArchive\FN_ARFLO.PV	26.02.14 12:19:14	10934.462
12	Process Value of Gas Flow	ProcessValueArchive\FN_GSFLO.PV	26.02.14 12:19:05	1341.291
13	Sensor Temp Left (Fire Right)	ProcessValueArchive\FN_AnalogInputs_LOXYT1.P	26.02.14 12:19:08	1325.781
14	Sensor Temp Right (Fire Left)	ProcessValueArchive\FN_AnalogInputs_ROXYT1.P	26.02.14 12:19:03	1338.918
15	Setpoint Air/Gas Ratio	ProcessValueArchive\STG_LR_RG_SP	26.02.14 12:19:09	8.158

Source: Trend 2/27/2014 8:16:39 AM

Symmetrical regenerator crown temperatures proof: different Ratio left/right is correct

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Sensor

quality and design of probe

+

installation & maintenance

+

advanced signal processing

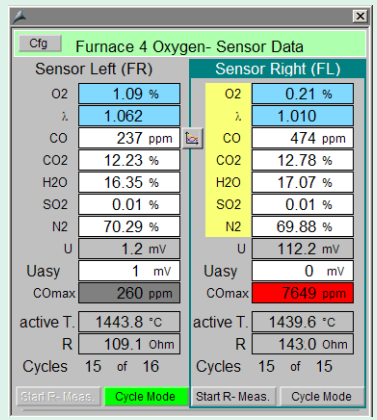
Mumbai

13-03-2015

What decides about result and benefit:

quality and probe design

installation& maintenance



advanced signal processing

Any chain is as strong as it‘s weakest link.

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Sensor

2..8 years of service life

700...1550°C

0...30% O2

0...40000ppm CO

automatic reliability check

Mumbai

13-03-2015

Worldwide:

300 furnaces equipped
= 1200 STG Lambda sensors

- thereof 50 float furnaces
- thereof over 200 container glass furnaces
- thereof about 10 oxyfuel furnaces

50% of installations in regular service

20% of installations used for automatic control
3-4% in understoichiometric operation

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Sensor

Installed in regenerator crown

each port
each firing side

Mumbai

13-03-2015

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Sensor

quality and design of probe

+

installation & maintenance

+

advanced signal processing

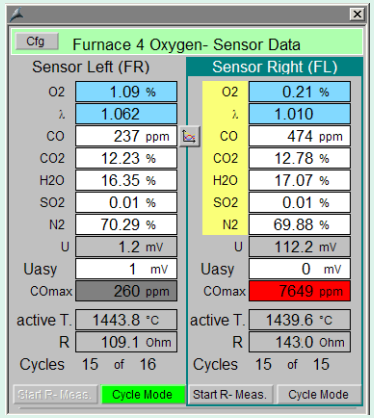
Mumbai

13-03-2015

What decides about result and benefit:

installation& maintenance

quality and probe design



advanced signal processing

Any chain is as strong as it‘s weakest link.

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Sensor

regular on-site maintenance indispensable

service contract

or

signal renting

Mumbai

13-03-2015

Regular maintenance decides:

- service life
- reliability of measurement
- customer benefit

50% of installations under regular maintenance:

- 1…3 service visits per year
- remote data access
- record sensor lifetime data

- service contracts
- **signal renting**

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Sensor

quality and design of probe

+

installation & maintenance

+

advanced signal processing

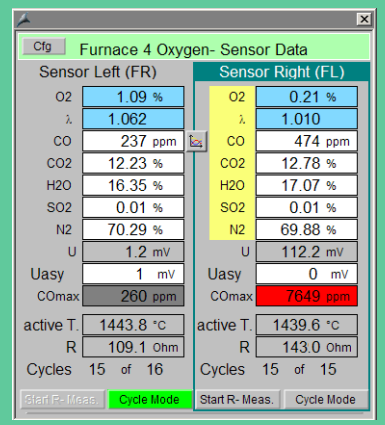
Mumbai

13-03-2015

What decides about result and benefit:

quality and probe design

installation& maintenance



advanced signal processing

Any chain is as strong as it‘s weakest link.

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Sensor

Advanced signal processing

PLC based signal processing unit

Mumbai

13-03-2015

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Sensor

Advanced signal processing

PLC based signal processing unit

Mumbai

13-03-2015

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

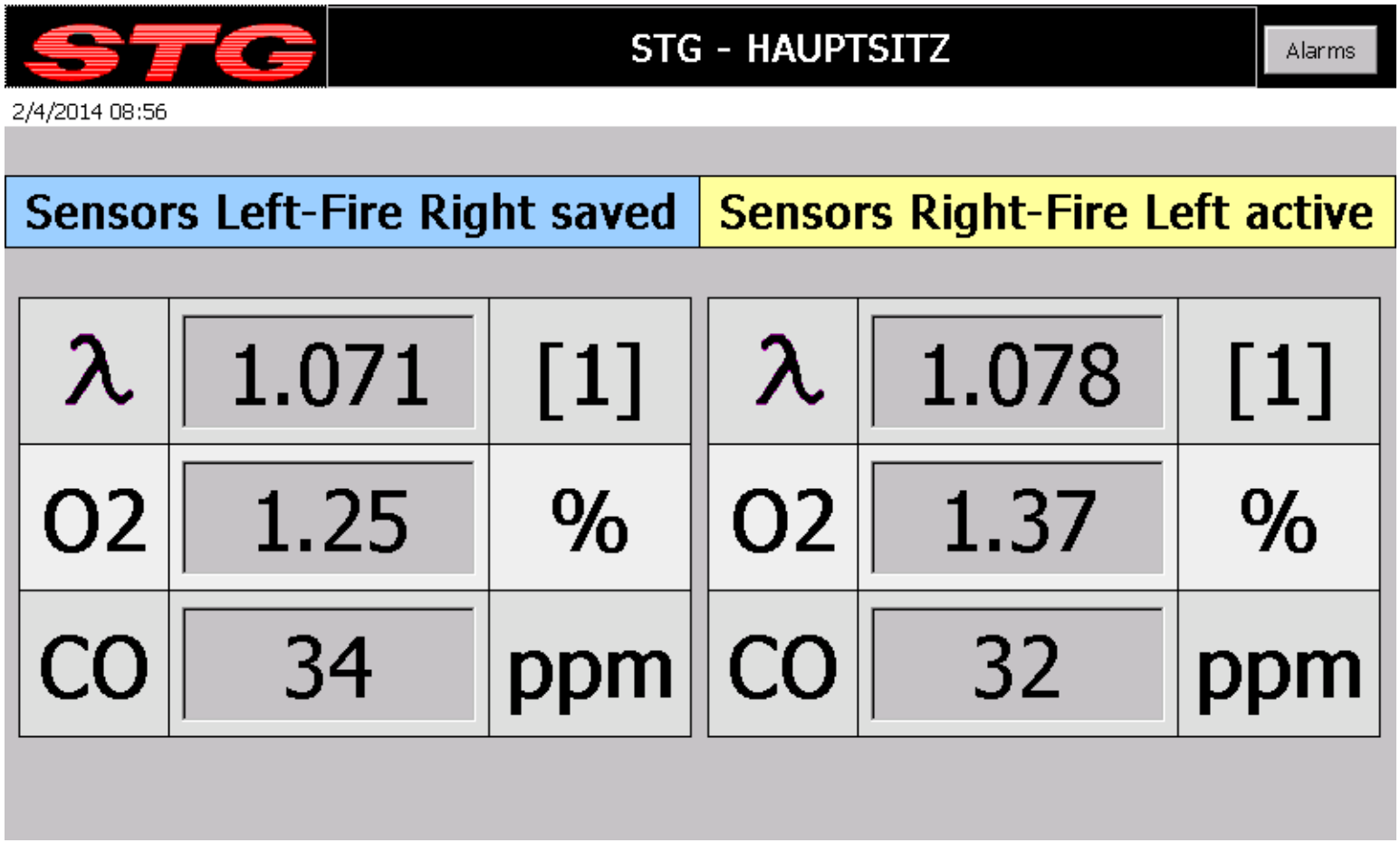
Lambda Sensor

Advanced signal processing

PLC based signal processing unit

Mumbai

13-03-2015



STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

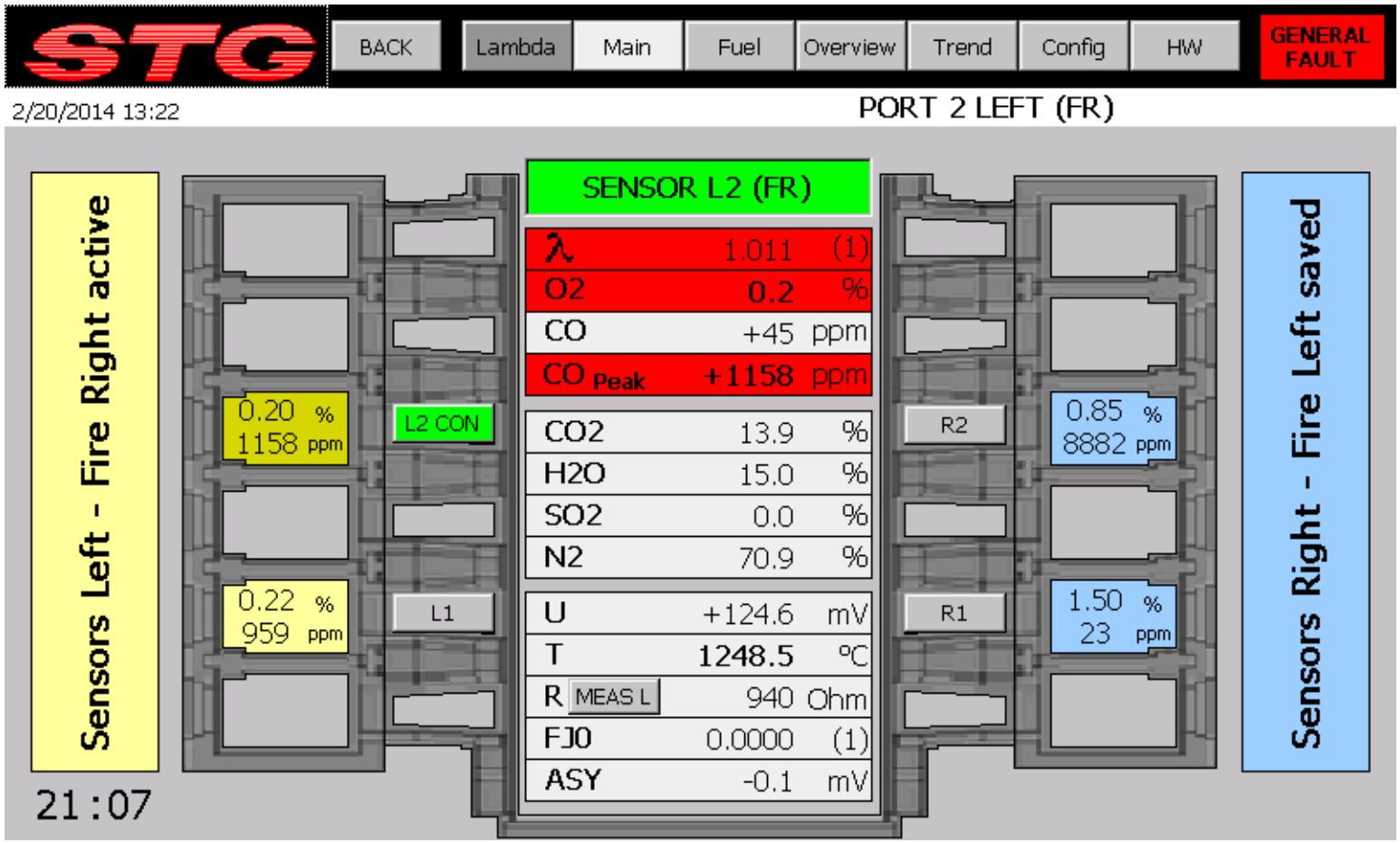
Lambda Sensor

Advanced signal processing

PLC based signal processing unit

Mumbai

13-03-2015



STG
Solutions for Technology in Glass

STG Combustion Control GmbH & Co KG

Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Control

Control Lambda

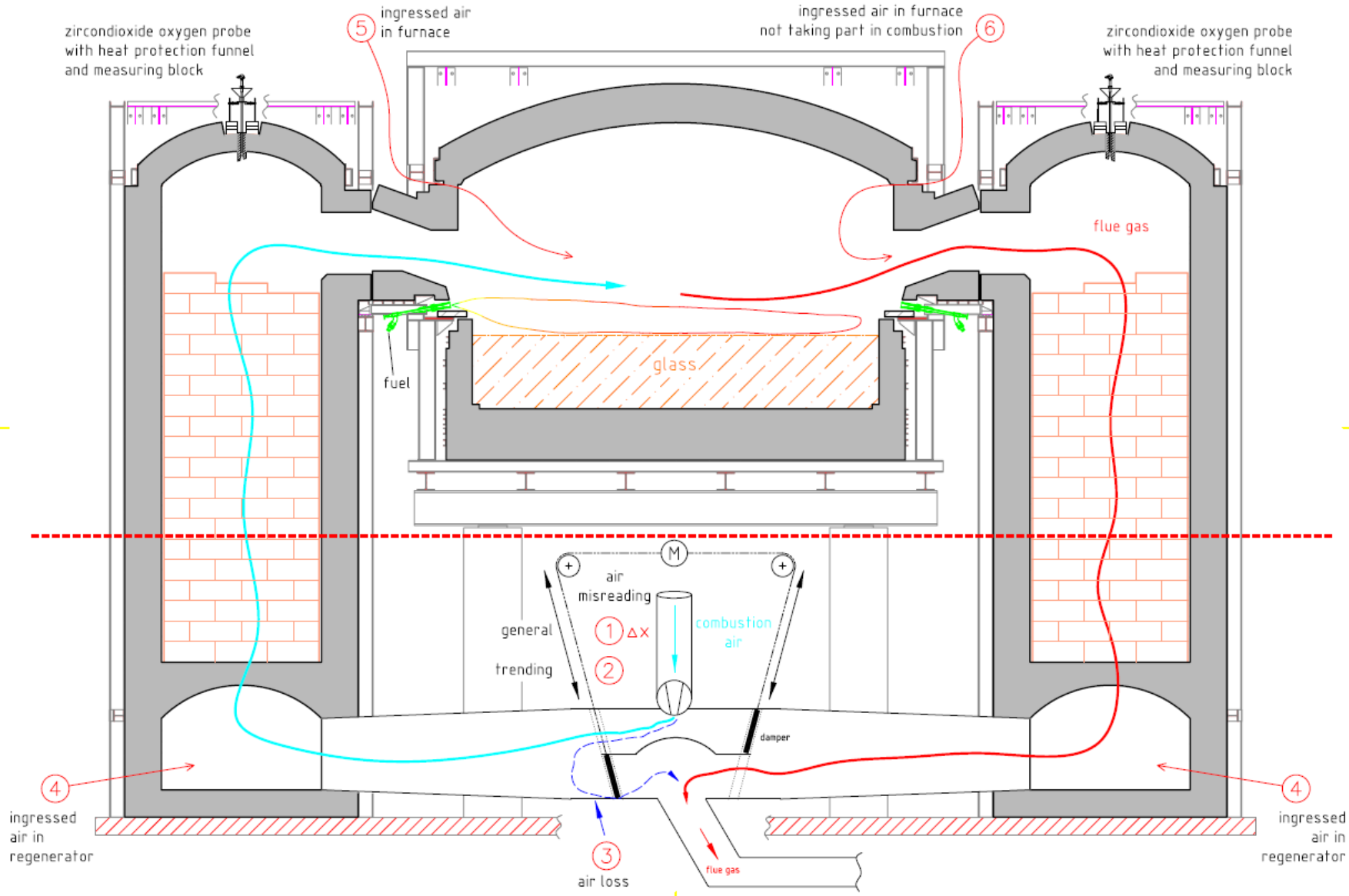
Sources of air ingress XF

decides about control strategy

Mumbai

13-03-2015

Source of air ingress decides about control strategy:



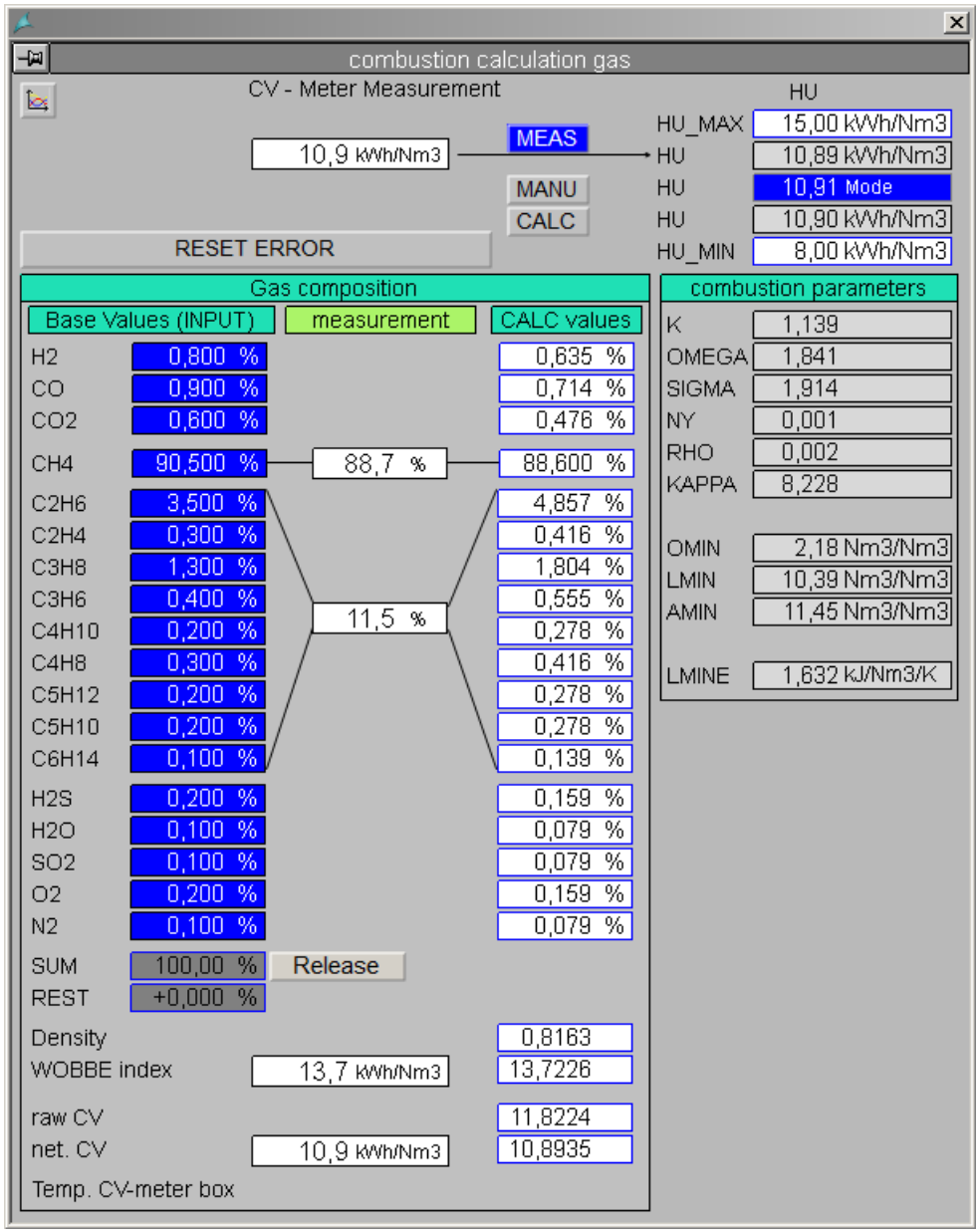
STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Control

Control Lambda

and

online CV meter



consider

stoichiometric gas data

as result of

CV meter measurement

Mumbai

13-03-2015

STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

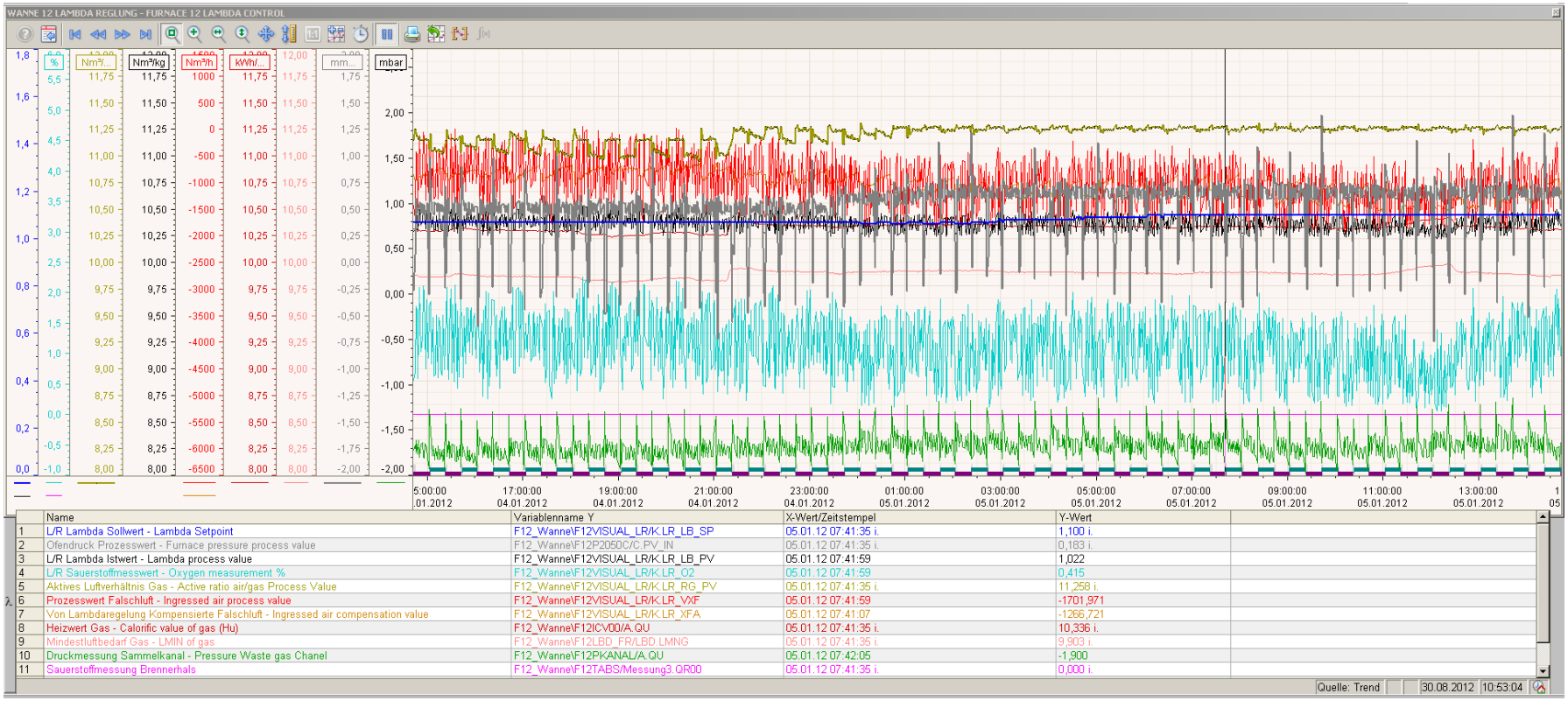
Lambda Control

Control Lambda

and

Furnace Pressure

Lambda Control as indicator for optimal furnace pressure



	Name	Variablenname Y	X-Wert/Zeitstempel	Y-Wert
1	L/R Lambda Sollwert - Lambda Setpoint	F12_Wanne\F12VISUAL_LR/K.LR_LB_SP	05.01.12 07:41:35 i.	1,100 i.
2	Ofendruck Prozesswert - Furnace pressure process value	F12_Wanne\F12P2050C/C.PV_IN	05.01.12 07:41:35 i.	0,183 i.
3	L/R Lambda Istwert - Lambda process value	F12_Wanne\F12VISUAL_LR/K.LR_LB_PV	05.01.12 07:41:59	1,022
4	L/R Sauerstoffmesswert - Oxygen measurement %	F12_Wanne\F12VISUAL_LR/K.LR_O2	05.01.12 07:41:59	0,415
5	Aktives Luftverhältnis Gas - Active ratio air/gas Process Value	F12_Wanne\F12VISUAL_LR/K.LR_RG_PV	05.01.12 07:41:35 i.	11,258 i.
6	Prozesswert Falschluft - Ingressed air process value	F12_Wanne\F12VISUAL_LR/K.LR_VXF	05.01.12 07:41:59	-1701,971
7	Von Lambdaregelung Kompensierte Falschluft - Ingressed air compensation value	F12_Wanne\F12VISUAL_LR/K.LR_XFA	05.01.12 07:41:07	-1266,721
8	Heizwert Gas - Calorific value of gas (Hu)	F12_Wanne\F12ICV00/A.QU	05.01.12 07:41:35 i.	10,336 i.
9	Mindestluftbedarf Gas - LMIN of gas	F12_Wanne\F12LBD_FR/LBD.LMNG	05.01.12 07:41:35 i.	9,903 i.
10	Druckmessung Sammelkanal - Pressure Waste gas Chanel	F12_Wanne\F12PKANAL/A.QU	05.01.12 07:42:05	-1,900
11	Sauerstoffmessung Brennerhals	F12_Wanne\F12TABS/Messung3.QR00	05.01.12 07:41:35 i.	0,000 i.

Increase of furnace pressure from 5 to 7 Pa (dark grey trend)

→

XF air ingress reduced (red) brings in line left and right RATIO (green)

Mumbai

13-03-2015

STG
Solutions for Technology in Glass

STG Combustion Control GmbH & Co KG

Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Control

Control Lambda

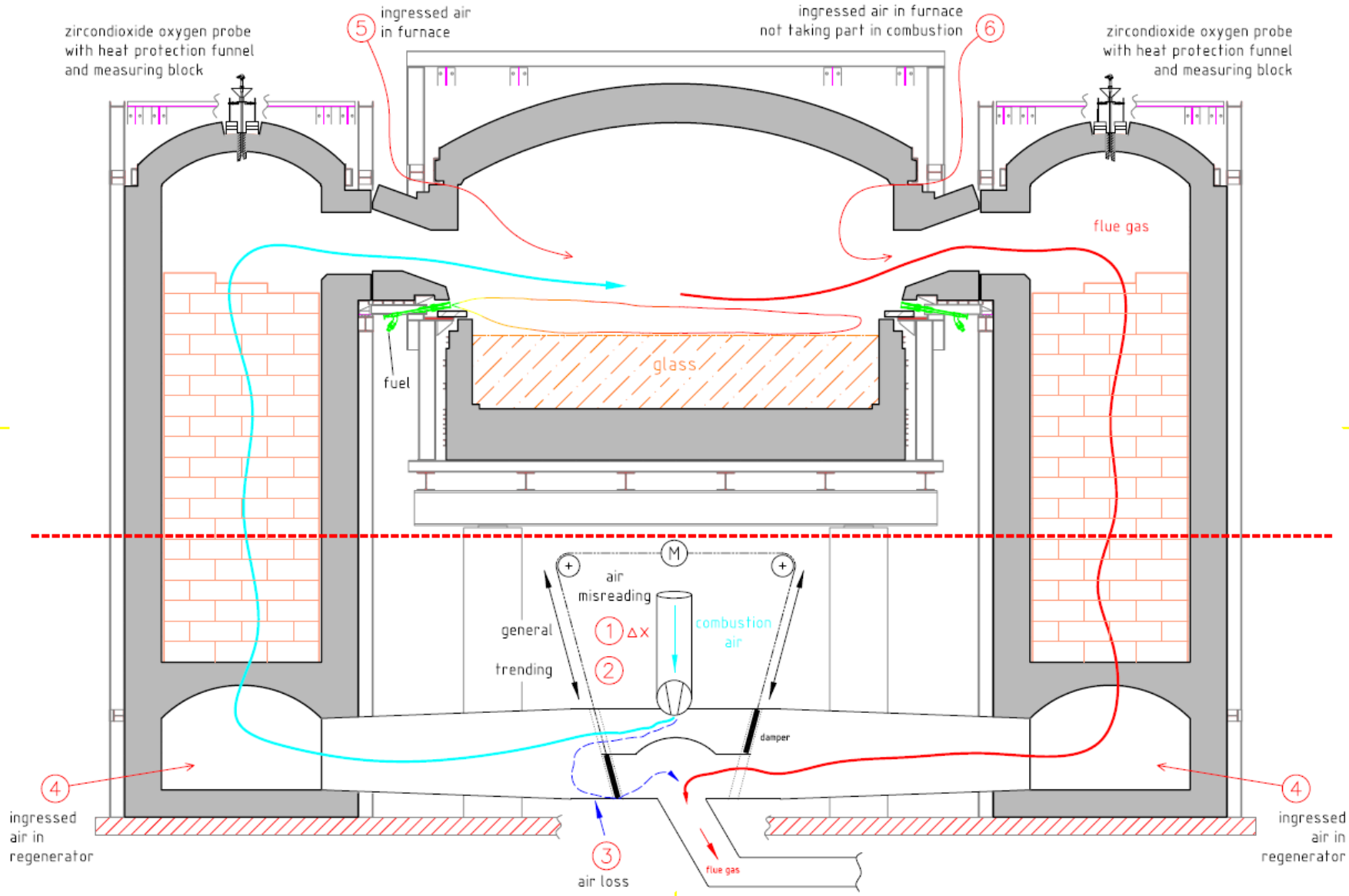
Sources of air ingress XF

decides about control strategy

Mumbai

13-03-2015

Source of air ingress decides about control strategy:



STG Combustion Control GmbH & Co KG
Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Control

Summary

Principles

Mumbai

13-03-2015

LAMBDA Control : Summary & Principles

- Advanced signal processing provides O2% and CO[ppm]
- Convert to linear process value Lambda and XF air ingress
- Use XF to identify optimal furnace pressure to avoid air ingress into furnace chamber at all
- Continuously forming model of XF air ingress
- Compensating XF air ingress in limits
- Choose Lambda setpoint lowest to avoid CO peaks
- Improve burner settings to reduce Lambda setpoint
- or let Lambda setpoint be determined by glass quality requirements (as for crystal glass)

Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

Lambda Control

Customers Benefit

Mumbai

13-03-2015

LAMBDA Control : Customers benefit

- 1…5% energy savings due to stable operation at low excess air (identification of CO peaks as limit conditions)
- energy savings while avoiding air ingress into furnace chamber (identification of optimal furnace pressure)
- energy savings due to identification and improvement of insufficient burner settings
- 5...10% increase of melting rate as result of stable continuous combustion
- improve quality conditions for white crystal glass (keeping 3% O2 reliably constant)
- 1/2...1 year longer service life while avoiding CO peaks from insufficient purging of regenerators

STG Combustion Control GmbH & Co KG

Kiekebuscher Weg 14 ▪ 03050 Cottbus ▪ Germany ▪ Phone +49 (0)355 59 02 00 ▪ Fax +49 (0)355 54 11 24 ▪ www.stg-cottbus.com

STG Cottbus

Let us make the world as green as possible

Mumbai

13-03-2015