HyTecHeat

HYbrid TEChnologies for sustainable steel reheating – HyTecHeat

HORIZON-CL4-2022-TWIN-TRANSITION-01-16, Modular and hybrid heating technologies in steel production (Clean Steel Partnership)
GA number:101092087

Deliverable 1.2: Definition of technical specs of the multi-fuel burner

WP1: Individuation of reference industrial scenarios, data collection and definition of hybrid oxidation conditions.

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EXECUTIVE SUMMARY

The deliverable 1.2 was prepared as part of the European Commission Horizon 2022 funded project Hytecheat, “HYbrid TEChnologies for sustainable steel” (Grant Agreement-101092087-HyTecHeat). The aim of this report is to describe the technical specifications of the burner provided by Tenova. The burner will be used in the experimental rig of Swerim. In particular, the thermal power, the combustion mode (i.e., flame or flameless), the air preheating temperature, the reference NOx emissions, the required temperature uniformity, the necessary turndown ratio, are all dependent upon the process conditions that are realized in the reference furnace.

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OVERVIEW OF THE DELIVERABLE

WP:1

Task 1.2

Title : Definition of technical specs of the multi-fuel burner

1. LIST OF ABBREVIATIONS AND ACRONYMS

AEM - Anion exchange membrane
ASME - American Society of Mechanical Engineers
ASTM - American Society for Testing and Materials
API - American Petroleum Institute
CEI - Italian Electrotechnical Committee
CEN - European Committee for Standardization
CGA - Compressed Gas Association
D – Deliverable
DM – Ministerial decree
EC – European Commission
EMC - Electromagnetic Compatibility
EN – European standard
ESS - Emergency System
GA – Grant agreement
GARCS – gas/air ratio control systems
IEC - International Electrotechnical Commission
ISO - International Organization for Standardization
H2020 – Horizon 2020 The EU Framework Programme for Research and Innovation
HIC – Hydrogen Induced Cracking
LVD - Low voltage Directive
MAWP - Maximum allowable working pressure
MD - Machinery Directive
PC – Project Coordinator
PED – Pressure equipment directive
PEM - proton exchange membrane
RES - Renewable energy source
STD - Standard
WP – Work package
UNI - Ente Nazionale Italiano di Unificazione
TR – Technical report

2. INTRODUCTION

From the reference operating conditions defined in Task 1.1, the technical specifications of the multi-fuel H2/CH4 combustion system is defined. In particular, the thermal power, the combustion mode (i.e., flame or flameless), the air preheating temperature, the reference NOx emissions, the required temperature uniformity, the necessary turndown ratio, are all dependent upon the process conditions that are realized in the reference furnace.

3. BURNER OVERVIEW

The choice of the burner type depends by different factors, first of all the thermal power and the furnace temperature.

In the Tenova burner portfolio is possible to find the solution for different applications both for cold temperature (<800 °C) and for high temperatures.

TLX : FLAMELESS TECHNOLOGY FOR HEAT TREATMENT

TLX burners are mainly installed on Heat Treatment and Roller Hearth Furnaces for direct rolling of thin slabs and on Rotary Hearth Furnaces. These ultra-compact burners allow achieving extremely low NOx emissions by means of the flameless technology. Furthermore TLX burners are the ideal solution whenever high temperature uniformity is required.

Fuels:	Natural Gas, COG, Mixed gas, LPG
Turn-down:	10% - 100%
NOx emissions:	100 mg/Nm^3 @ 3% O_2 for Natural Gas The emissions are referred to these operating conditions: • Air excess 5% • Air temperature ≤ 450°C • Furnace temperature ≤ 1250°C • Burner load ≥ 80% The reported value is the expected one. The guaranteed value will be fixed case by case according to furnace type and working conditions.
Main Features:	• NOx emissions not dependent on air temperature and on burner load • Very low CO emissions (below 5 ppm) • Work with cold and hot air (up to 520 °C) • Turn-down in flameless mode • Equipped with pilot burner and UV sensor, if required

Figure 1: standard TLX in TENOVA burner catalogue 1 of 2

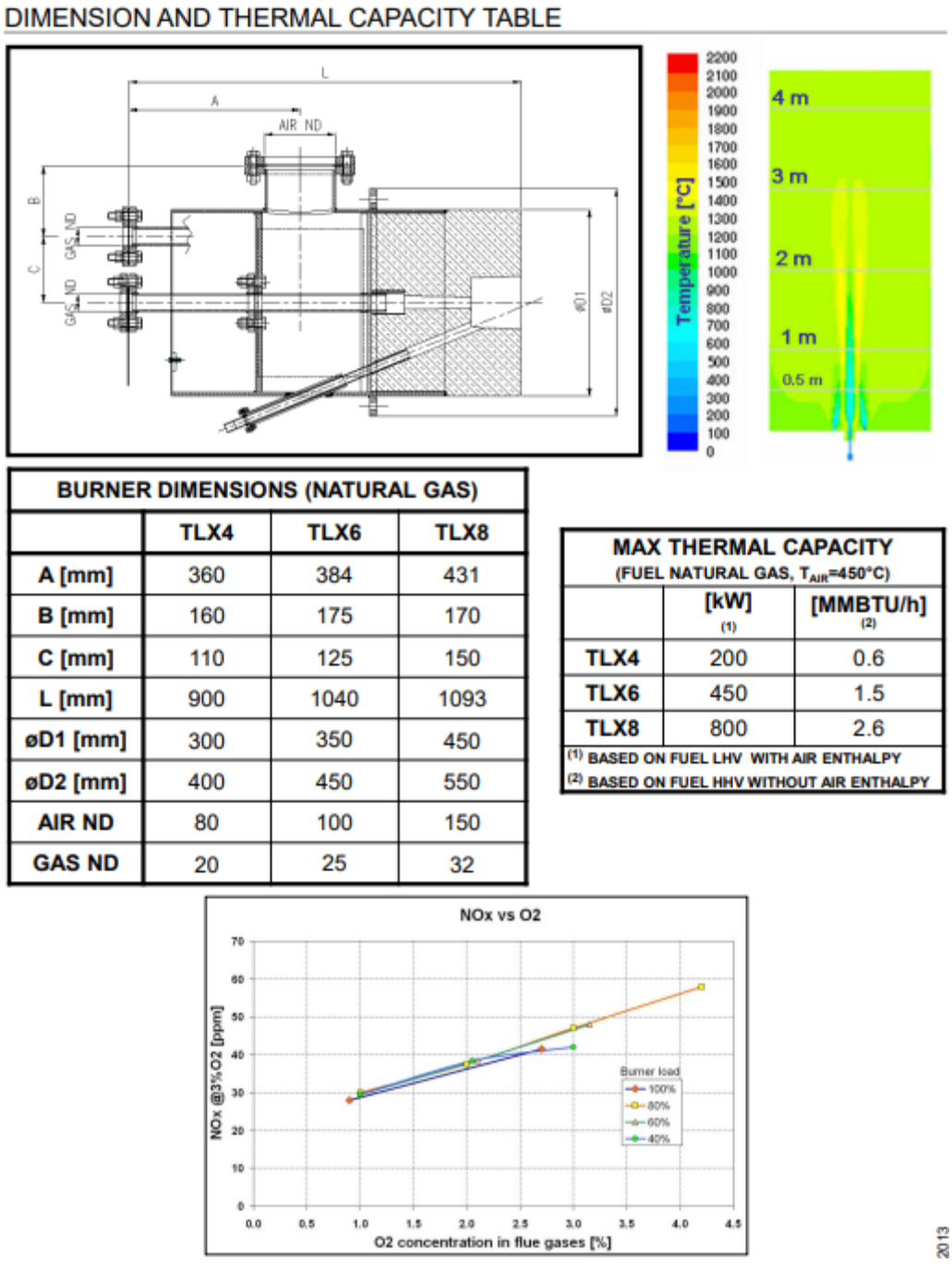

Figure 2: standard TLX in TENOVA burner catalogue 2/2

Considering the target of the tests in SWERIM AB where the maximum furnace temperature is 1250 - 1280°C, the selected burner configuration has the characteristic to cover all the process parameters of the experimental tests. The burner, however need in a special design that is in the scope of Hytecheat project, will work with mixtures of LPG and hydrogen and with mixtures of combustion air and oxygen (from 0-100% to 100-0%).

The name of the burner is TLX6 Flex.

For simulating the characteristics of common Natural Gas, the LPG will be mixed with hydrogen with the following compositions; the following gas will be defined as Base Gas:

1/3 LPG and 2/3 H2 (in volume)

- LCV: 9143 kcal/Nm3
- Density: 0,6813 kg/Nm3
- Air and gas ratio: 9,527 Nm3/Nm3

4. BURNER POWER AND FLOWRATES

The nominal power of the burner is 320 kW. The corresponding flow rates are:

- Nominal base gas flow (100% base gas): 31 Nm3/h considering LCV of 9143 kcal/Nm3
- Nominal hydrogen flow (100% H2): 107 Nm3/h considering LCV of 2590 kcal/Nm3
- Nominal combustion air flow with 100% base gas: 311 Nm3/h with 5% air excess and At of 9,527 Nm3/Nm3
- Nominal combustion air flow with 100% H2: 262 Nm3/h with 5% air excess and At of 2,38 Nm3/Nm3
- Nominal oxygen flow with 100% base gas: 65 Nm3/h with 1% O2 excess
- Nominal oxygen flow with 100% H2: 56 Nm3/h with 1% O2 excess

5. COMBUSTION MODE

The TLX6 Flex is able to work both in flame and in flameless mode. In the first case, the fuel is injected by using the central gas lance while the combustion air is injected by using the single air inlet. When the furnace temperature is above the self-ignition temperature of the fuel, the flameless combustion can be used by closing the central gas inlet and opening the lateral gas lances. The flameless combustion is used for reducing NOx emissions. The expected NOx emissions of the conditions working in flameless combustion is < 150 mg/Nm3 @ 3% O2.

Condition	Furnace temperature	Combustion mode	
		Comburent	Fuel
1	< 850°C	Enriched air up to 25% O2 max.	100% base gas in flame mode – central gas lance
2	< 850°C	Enriched air up to 25% O2 max.	100% H2 in flame mode – central gas lance
3	< 850°C	Enriched air up to 25% O2 max.	variable mixtures base gas-H2 in flame mode – central gas lance
4	> 850°C	Enriched air up to 25% O2 max.	100% base gas in flame or flameless mode – central or lateral lances

5	> 850°C	Enriched air up to 25% O2 max.	100% H2 in flame or flameless mode – central or lateral lances
6	> 850°C	Enriched air up to 25% O2 max.	variable mixtures base gas-H2 in flame or flameless mode – central or lateral lances
7	> 850°C	Combustion air with oxygen lancing – up to 100%	100% base gas in flameless mode – lateral lances
8	> 850°C	Combustion air with oxygen lancing – up to 100%	100% H2 in flameless mode – lateral lances
9	> 850°C	Combustion air with oxygen lancing – up to 100%	variable mixtures base gas-H2 in flameless mode – lateral lances

Table 1: combustion mode

6. TURN DOWN

The power of the burner can be reduced from 320 kW to 150 kW – turn down 2,15:1.

7. COMBUSTION AIR TEMPERATURE

The burner is designed for working both with preheated air up to 450°C and, as in the case of the experimental tests in Swerim AB, with cold air.

8. PRESSURES AT THE BURNER

The burner is designed for working with the following pressures:

- Combustion air pressure: <450 daPa
- Natural gas pressure: <2000 daPa
- Hydrogen pressure: <2000 daPa
- Oxygen pressure: <3000 daPa

9. MECHANICAL CONNECTIONS

The burner will be installed on the test furnace by using a flange connection. The flange dimensions is represented in the “Assembly drawing”.

The combustion air connection is a flange ND100, NP6

The 2 fuel connections (flame and flameless) are flanges ND20, NP10

The oxygen connection is a flange ND25, NP10.

10. BURNER CONTROL

The light up of the burner is carried out by a dedicated ignition electrode.

The flame control system is carried out by a dedicated U.V. sensor connected to a burner control unit, which is able to control the gas shut-off valves in function of the signal of the U.V. cell.

The burner can work in proportional or in on-off mode.

11. ASSEMBLY DRAWING

The following figures represent the TLX general assembly where it is possible to check the overall dimensions of the burner.

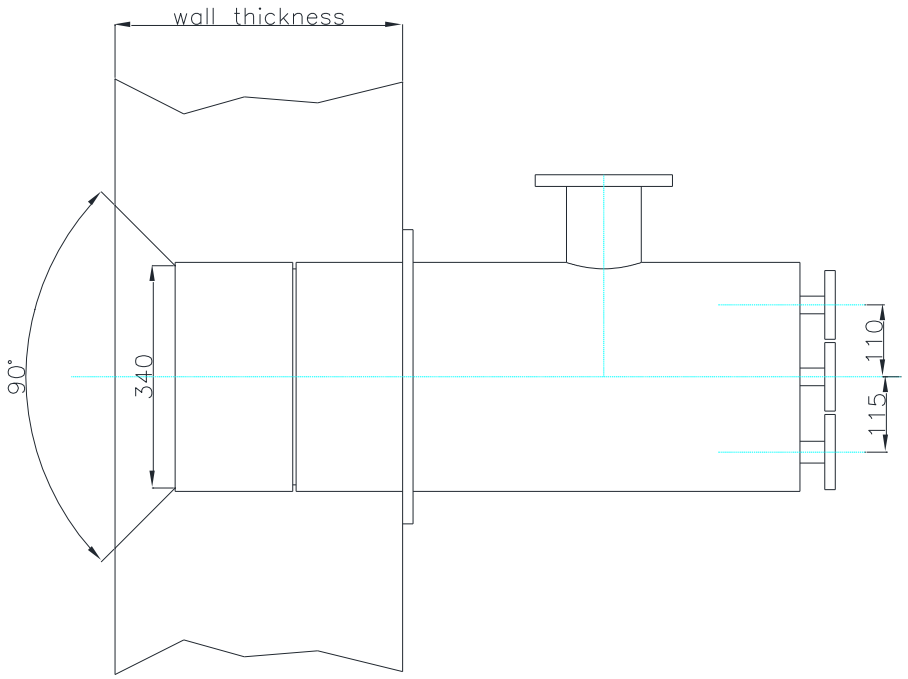

Figure 3: Longitudinal view of TLX

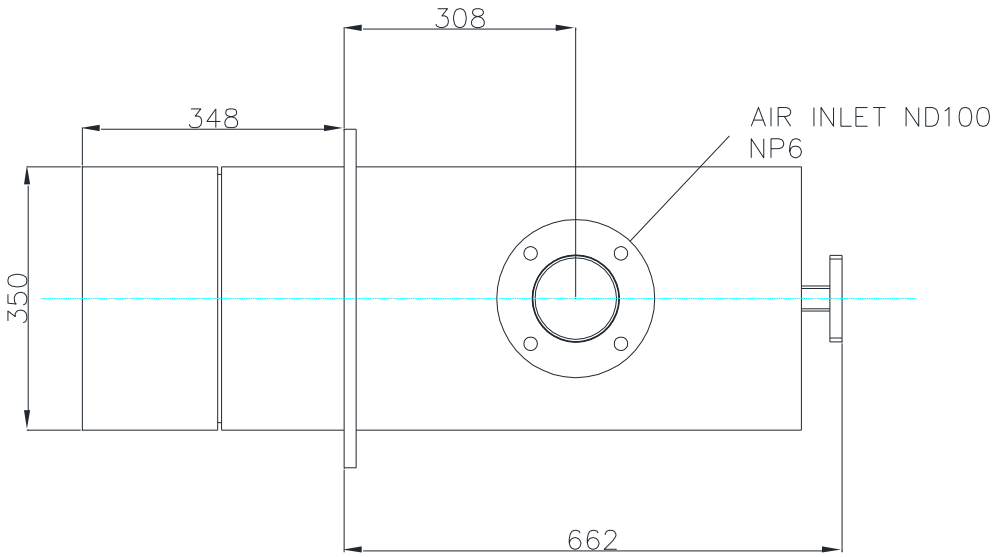

Figure 4: Longitudinal view of TLX

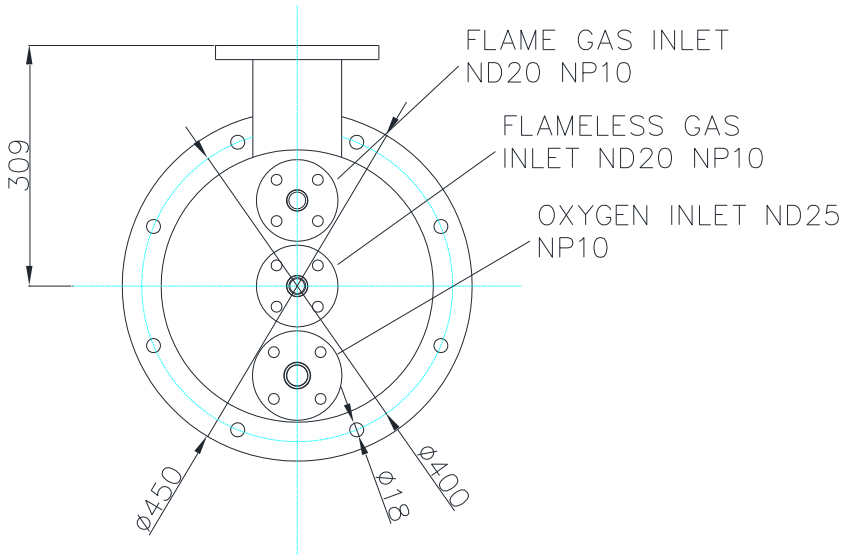

Figure 5: bottom view of TLX