GLASS SERVICE INNOVATIVE SOLUTION: WOBBE INDEX STABILIZER

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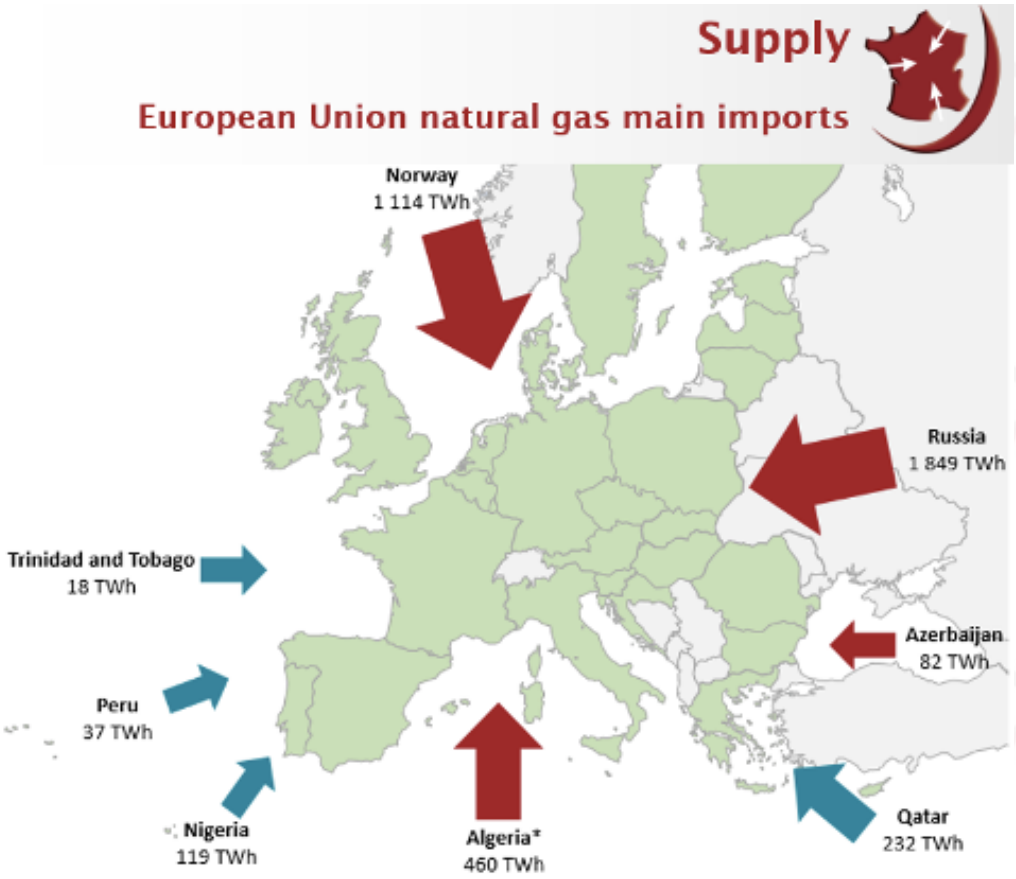
Introduction

In the market for natural gas (NG) there are many different sources with different chemical compositions, calorific power energy (PCI) and consequently, WOBBE index.

The source of NG is nowadays increased by the development of Liquified natural gas LNG development. See Fig. 1



Source: *BP Statistical Review of World Energy (June 2018)*

Figure 1

What is the Wobbe index?

The Wobbe Index (WI) or Wobbe number is an indicator of the interchangeability of fuel gases such as natural gas.

If Vc is the higher heating value, or higher calorific value, and Gs is the specific gravity, the Wobbe Index, Iw, is defined as:

$$I_W = \frac{V_C}{\sqrt{G_S}}.$$

Two different gases with the same Wobbe index can be interchanged without any modification of combustion parameters, e.g combustion ratio, burner pressure and energy power emitted.

Problem

Nowadays NG suppliers do not guarantee the constant quality of NG. Variation in chemical composition is usually weekly and sometimes even daily.

The variability of NG's chemical composition leads to a variety of technological problems in the glass melting furnace and its foreheart.

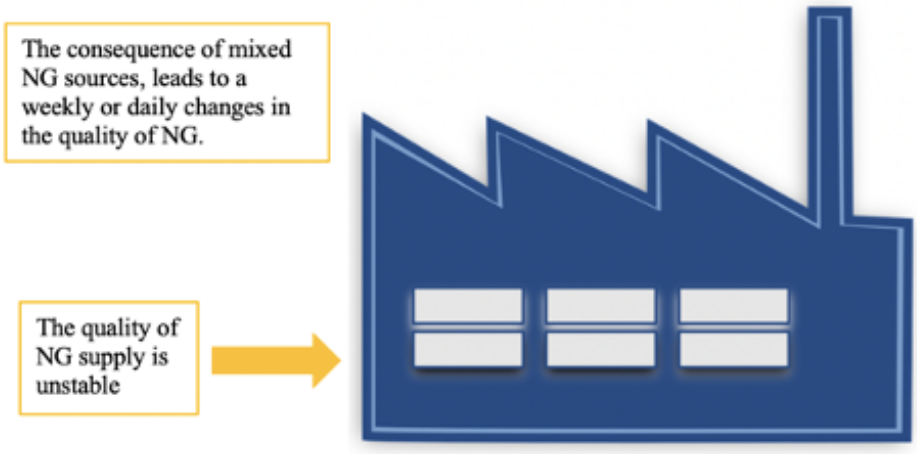


Figure 2

In this article we will introduce a piece of equipment developed by Glass Service, necessary to stabilize the WOBBE index.

Solution

Glass Service Italy developed an innovative solution to stabilize the Wobbe index when mixed air/NG is fed into the forehearth and distributor, as previously said, two different gases with the same Wobbe index can be interchangeable.

problem	solution	area of use
Unstable chemical composition of NG. Unstable value of calorific value Unstable combustion redox index Unstable combustion ratio required	Stabilizer equipment for the Wobbe index	Premixing of air/NG in the combustion area; Foreheart and distributor combustion system

Wobbe index stabilizer (Fig. 3)

This innovative equipment mixes some compressed air to NG and reduces the WOBBE index to the minimum value of NG available from the gas company.

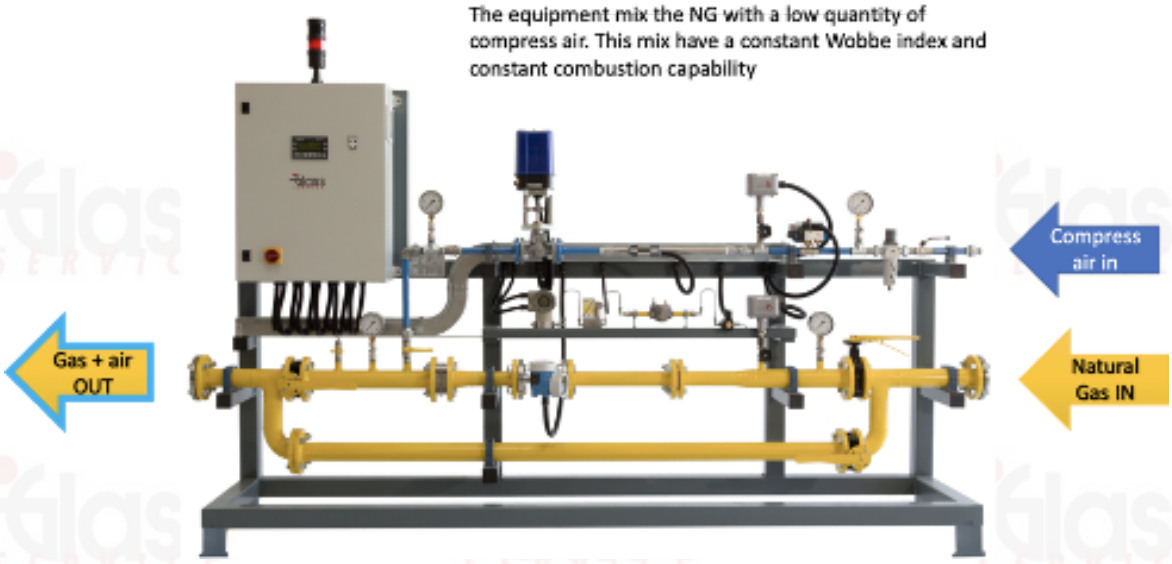


Figure 3

The output is a mixture of NG+air with a stable Wobbe index value. The quantity of air in the mix changes automatically through air and gas flow measurements and compressed air flow automatic regulation, see Fig.4.

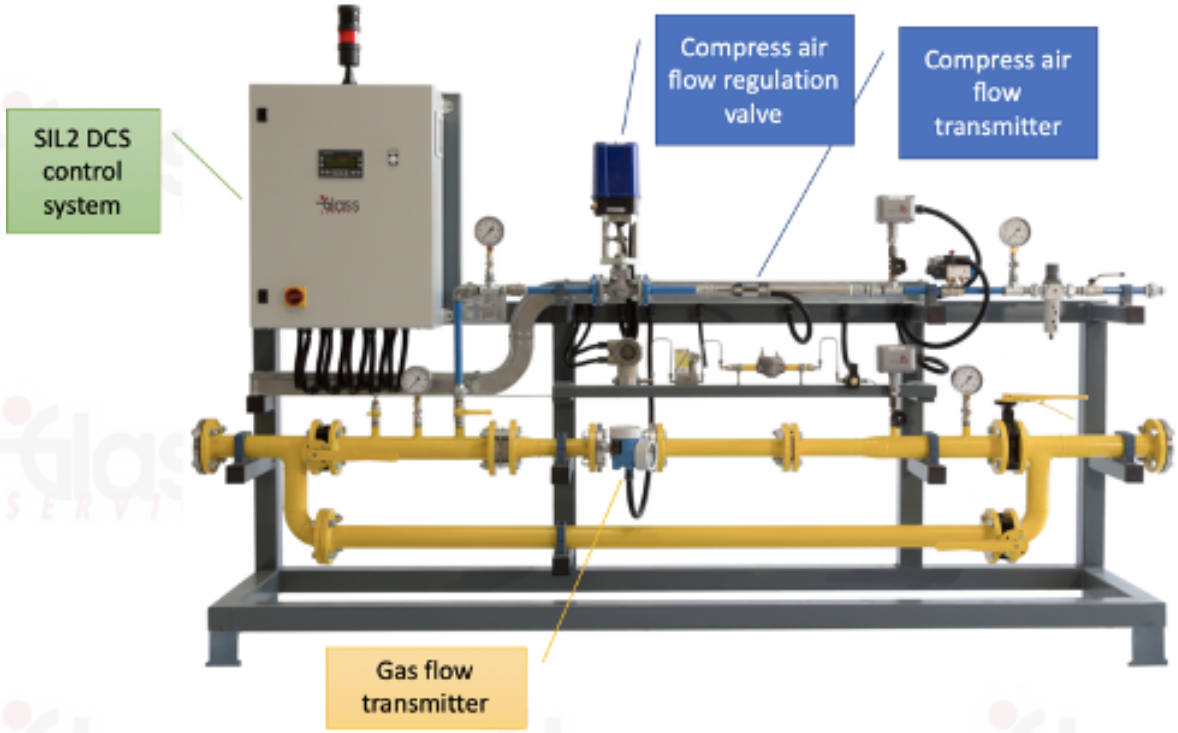


Figure 4

The compressed air is introduced into the gas stream, see Fig.5.

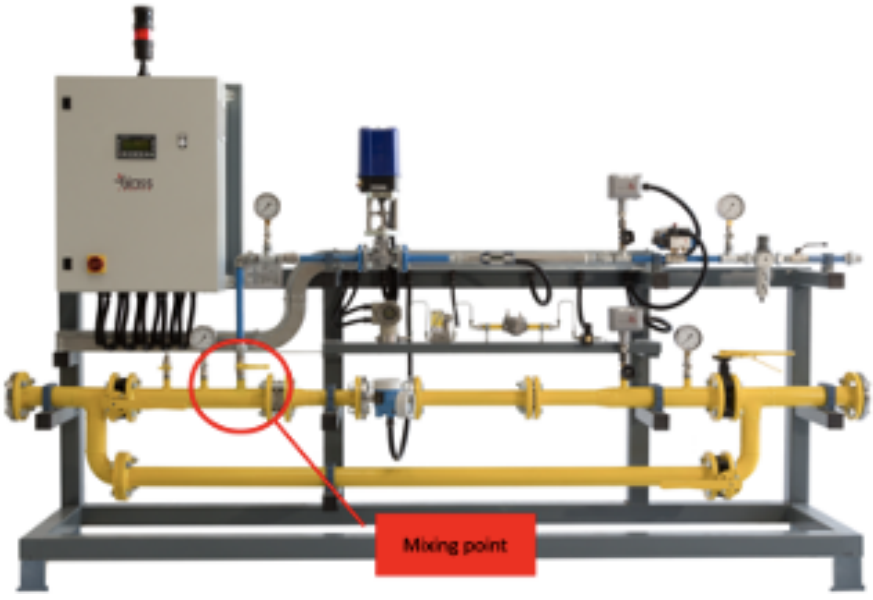


Figure 5

Down flow from the mixing point, a gas chromatographer controls the mix ratio and transmits the Wobbe index to the control device, see Fig.6

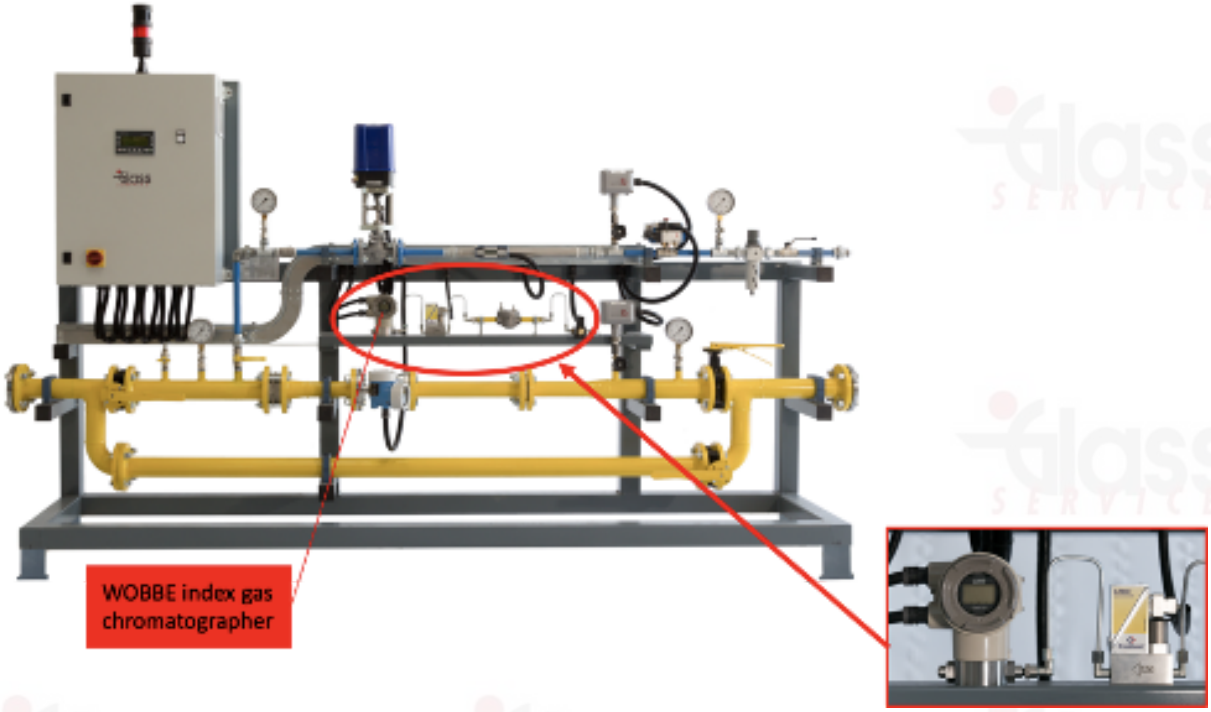


Figure 6

Issues and solution

The risk is that the mix of air and NG can be explosive.

problem	solution
Explosion risk of air/NG mix	Flow control of NG Flow control of compress air
EU standard rules for safety	SIL2 flow control device SIL2 safety parts (pressure switch, flow transmitter, safety shut off valve, etc.) SIL2 control system by Honeywell SIL2 HC900 DCS controller

The air and NG mix can be explosive only in a short range: with a value of NG/air of 5%-15%. The lower explosion limit is called LEL, the Upper explosion limit UEL. Over or under this value range, the mix is not explosive.

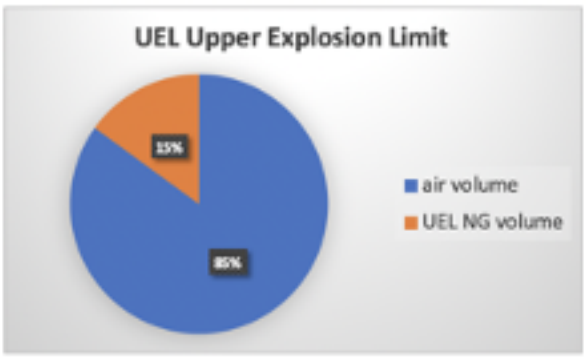


Figure 7

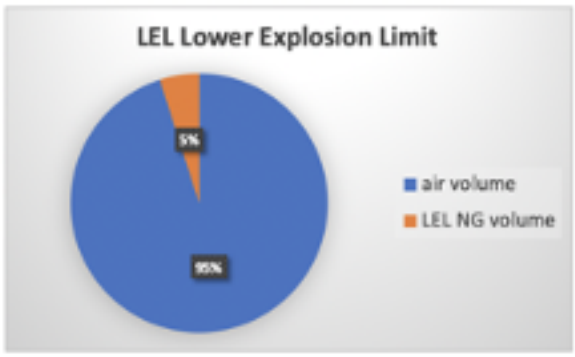


Figure 8

e.g. case 1

NG density	0.717 kg/Nm^3
NG Vc , higher calorific value, max value	38.9 MJ/Nm^3
NG Vc , higher calorific value, min value	33 MJ/Nm^3
WI, Wobbe index, max value	52.22 MJ/Nm^3
WI, Wobbe index, min value	44.39 MJ/Nm^3

In this case, the equipment that we developed will stabilize the Wobbe index to 44 MJ/ Nm3 introducing 13,8% of compressed air (% by volume) in the stream. This value is much lower than the explosion point.

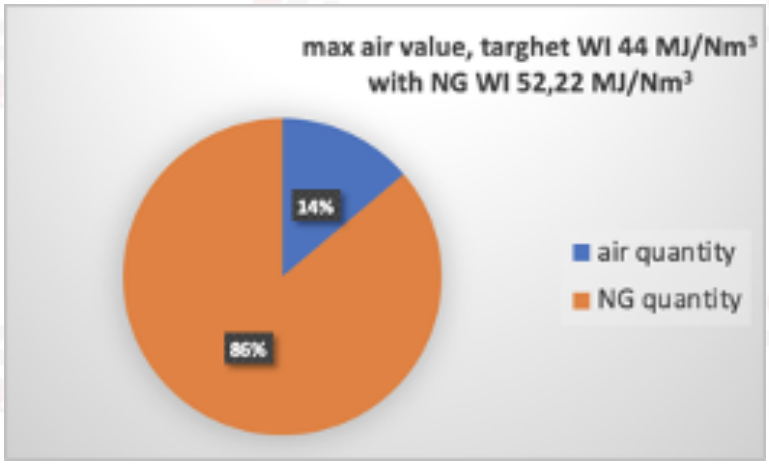


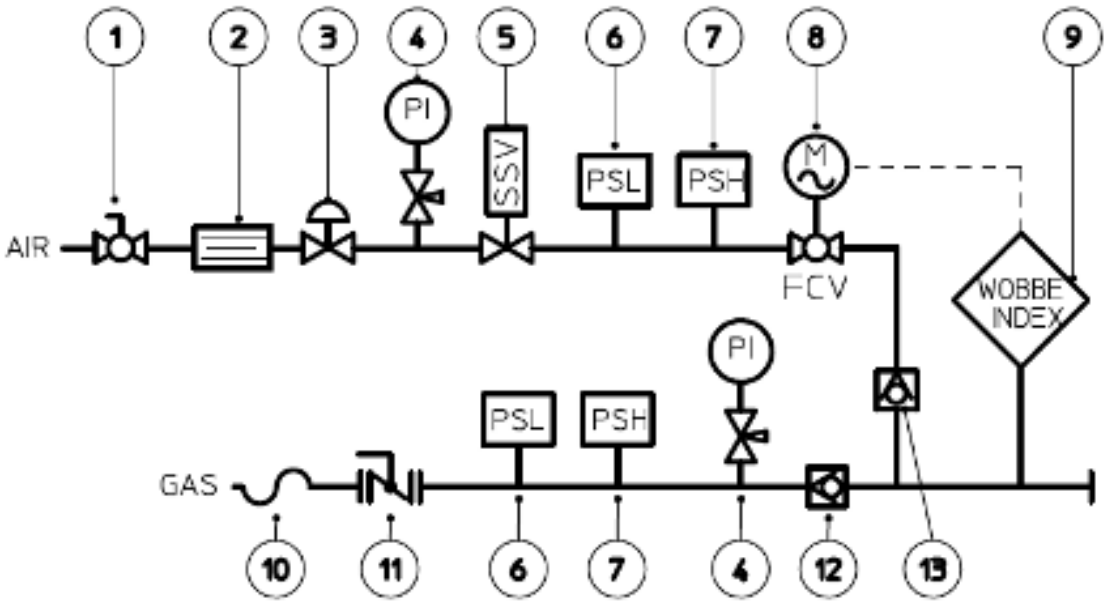
Figure 9

The system is equipped with many of safety devices in order to eliminate the explosion risk. The main concept is to guarantee that the mix air/gas level is lower than the minimum injection point value.

European safety standards require that the safety equipment must be SIL2.

The unit will be designed for:

- NG max flow according to the plant requirement (Nm3/h);
- NG input pressure, max and min, according to the plant requirement;



The equipment is composed of the following devices installed on a skid (see sketch):

Gas section

ITEM	DESCRIPTION
10	N.1 Flex joint
11	N.1 manual valve shut off set
6	N.1 low pressure switch SIL2 safety standard
7	N.1 high electronic pressure switch high accuracy, SIL2 safety standard
4	N.2 NG pressure gauge and relative cock valve
12	N.1 NG gas no return valve
9	WOBBE INDEX, NG calorimeter analyzer, including board computer

Gas section - devices list

Compressed air section

ITEM	DESCRIPTION
1	N.1 manual valve shut off set
2-3	Compressed air pressure reducer including filter and liquids separator
4	pressure gauge and relative cock valve
5	N.1 shut off electrovalve SIL2 safety standard
6-7	N.2 pressure switch SIL2 max and min pressure
8	Flow regulation valve with integrated electrical servomotor
13	No return valve

Compressed air section - devices list

Electrical control board

1. Control board including:
    a. WOBBE index calculation loop
    b. Alarm management
    c. Alarm list and historical
    d. Local touch screen display
    e. Safety SIL 2 device

All equipment will be installed on a metal frame and electrical box ready for installation.