FUEL SAVING SCENARIOS ANALYSED WITH MATHEMATICAL MODELLING

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Abstract

Fuel savings have been increasingly climbing the priority agenda of a diversity of companies and the recent development of global economy is speeding up the pace. Energy intensive industries are particularly engaged in finding out creative solutions towards efficiency. On addressing the trade-off between shortage of resources and the need for R&D investments, "mathematical modelling" rises as a sure solution. The present study consists of the analysis of several scenarios developed with GS-GFM for the temperature hold of coke ovens, culminating on possible 40,8% savings in fuel consumption, compared to the common practice.

INTRODUCTION

This study consists of a method of utilizing the thermal energy from waste gases produced on holding the temperature of coke ovens. The method enables the collection of the energy usually emitted through the chimney and their reuse for holding the temperature of ovens not equipped with burners. Forced exhaustion allows the gas to flow in the opposite route to that in normal operation of the ovens.

During the normal operation of these ovens, combustion of coal volatiles usually takes place maintaining the temperature of the whole refractory structure adequate for operation, without the need for external burners. Thereafter, once the operational temperature has been achieved, around 1.110°C, the ovens remain permanently heated as a result of the operation itself.

This feature of thermal self-sustaining contributes to the structural integrity of the coke ovens. Usually lined in silica, they endure high temperatures, but are sensitive to cooling down, so that steadily high energy levels are desirable. In extreme events, the constitutive materials may undergo property changes so that they become unusable.

As a result, in times of suspension of operation for inspection or for cleaning the ducts or the boiler, or because of demand reduction, for instance, strategies are necessary for the conservation of temperature of the coke ovens.

The state of the art observed in addressing that issue corresponds to a method for keeping the coke oven chamber (A) hot by installing at least one external burner at the oven, from which combustion fumes (H or R), after heating up the corresponding coke oven chamber are converted into waste gases (J). These gases flow through a collecting line (B) and are emitted directly into the atmosphere through the chimney (C). The gases discharged through the chimney according to this method are usually at high temperatures, corresponding, therefore, their issuance to waste of thermal energy.

A. Coke oven
B. Collecting line that connects the ovens and conducts the gases to the chimney
C. Chimney
D. Collecting line that connects the ovens and conducts the gases to the boiler
E. Heat recovery boiler
F. Pusher side door of oven
G. Element blocking the flow of gases to the boiler
H. Combustion fumes of burner installed at the pusher side
I. Combustion fumes of burner installed at the coke side
J. Waste gases
K. Element blocking the flow of gases to the chimney

Figure 1 presents the common practice illustrating the top view of a set of ovens connected by a collecting line (B) with temperature regulation by external burners positioned at each oven (A), producing combustion fumes at the pusher or coke side (H and I, respectively) or on both sides simultaneously. The waste gases (J) are prevented from leaking into the boiler (E) by the locking element (G) and are exhausted through the chimney (C).

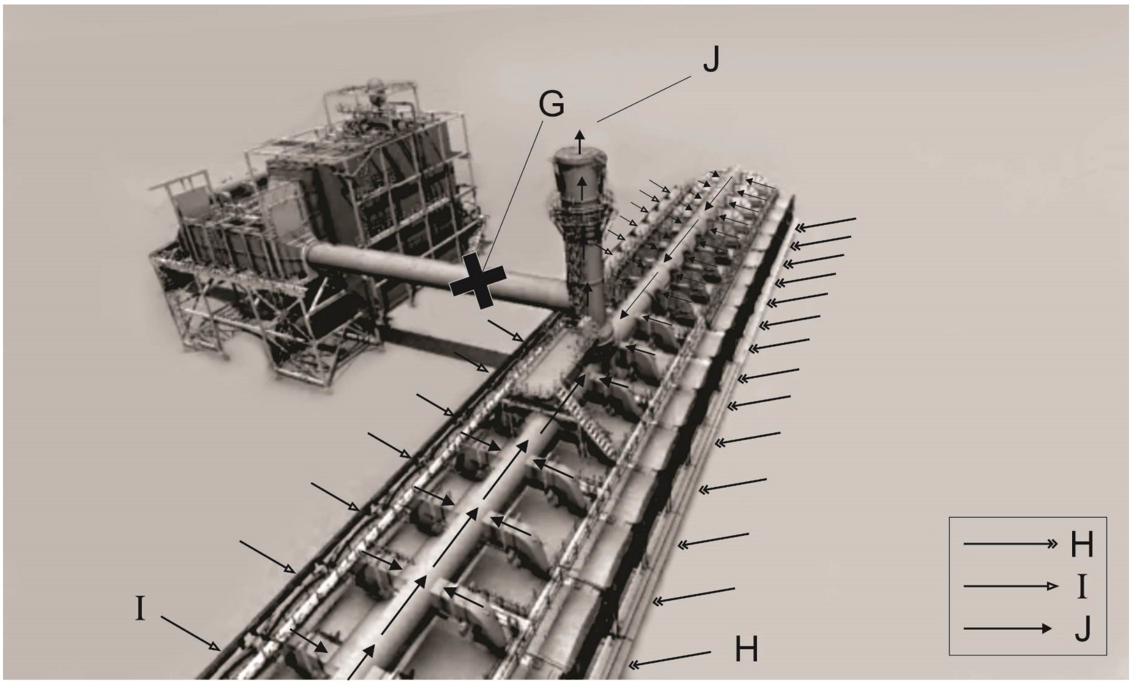

Figure 1: Common practice.

As an alternative for the strategy presented, Thermojet / Æstus tested the possibility of diverting the flow of gases from the chimney into ovens not equipped with burners. Systems were projected to be disposed for supplemental energy, as necessary. The criterion used to limit the amount of energy injected into the oven was the expansion level of silica. Figure 2 presents the result obtained for the common practice scenario. This baseline model was developed and validated on the basis of results from the heating up of 464 ovens, during 5.904 hours, using 1.683 thermocouples (Table 1).

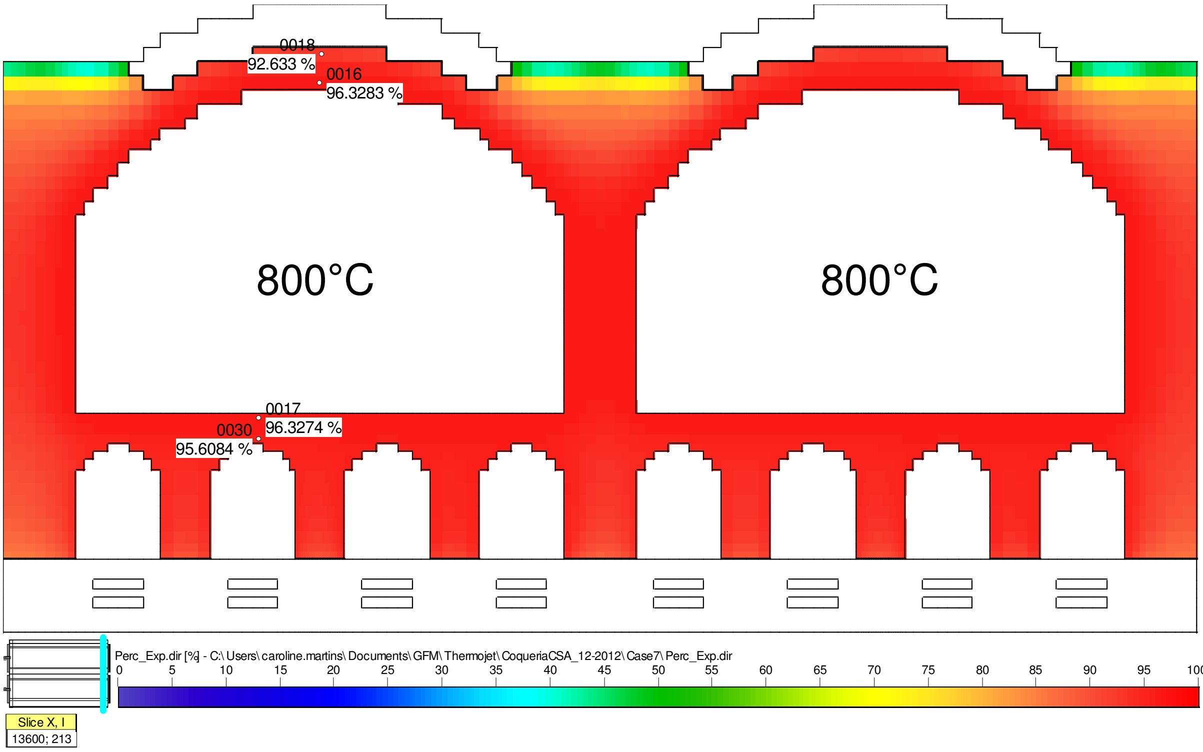

Figure 2: Simulation of expansion levels at common practice.

Table 1: Field data used for validation.

Field Data	Ovens	Hours	Thermocouples
Sol Coqueria	320	3.312	**1.683** (data validation)
TKCSA	144	2.592	

The fuel saving scenario was then modelled and the results were compared to the baseline, with adjustments being made up to achievement of the set-up expansion levels (Figure 3). A 30,5% reduction on gas consumption was firstly achieved. Combined with some changes in the process, it summed up to 40,8% of fuel savings.

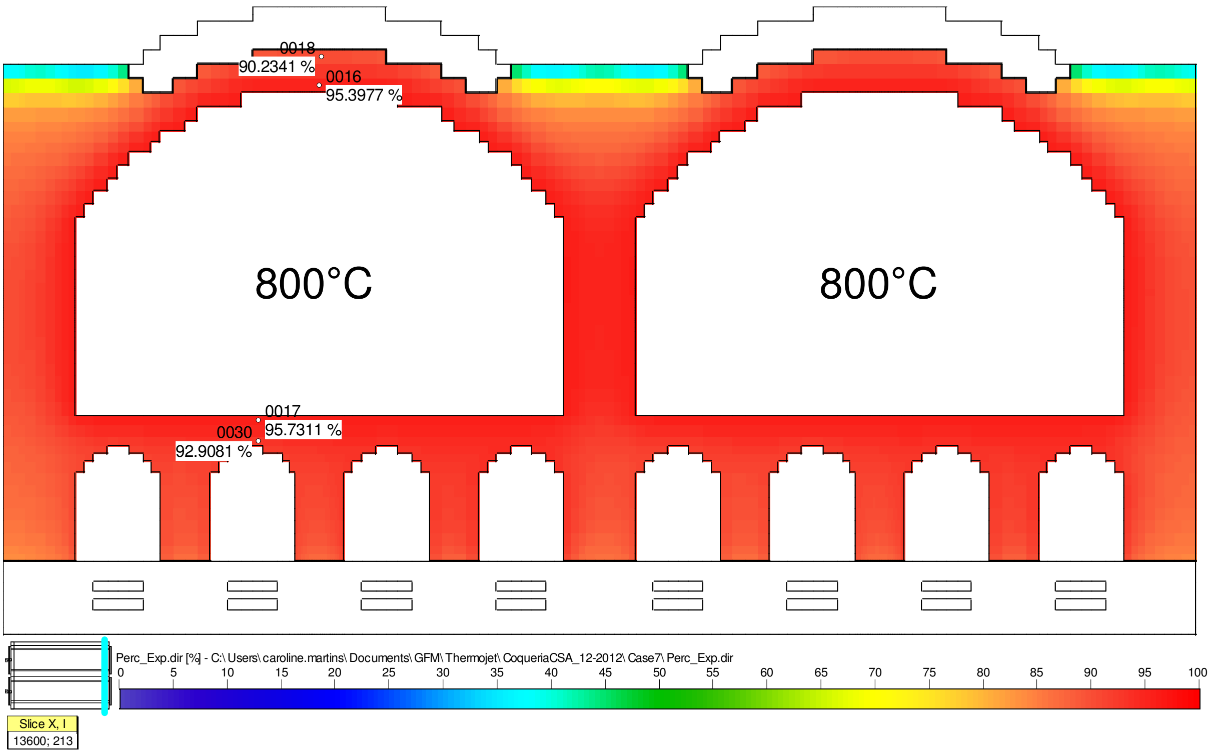

Figure 3: Simulation of of expansion levels at tested scenario.

CONCLUSIONS

The present study illustrates the use of mathematical modelling for cost-effective testing of scenarios allowing the reduction of up to 40,8% of fuel consumption in a project involving the use of around 7.000 ton of LPG/month.

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