

## 6% higher hot rolling mill output at ASCOMETAL, Fos-sur-Mer with oxyfuel

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### INTRODUCTION

Since 2005, flameless oxyfuel has been continuously implemented at nine soaking pit furnaces at ASCOMETAL, Fos-sur-Mer (Fig. 1). Today, these furnaces provide more heating capacity and the flexibility that is needed to improve the stream of ingots from the steel plant, especially for cold charged material, to the hot rolling mill, where the utilisation ratio has now risen from 86% to 92%. This paper will present the project objectives, implementation, the technology used, with important results and the conclusions to be drawn from implementing oxyfuel in reheating operations.

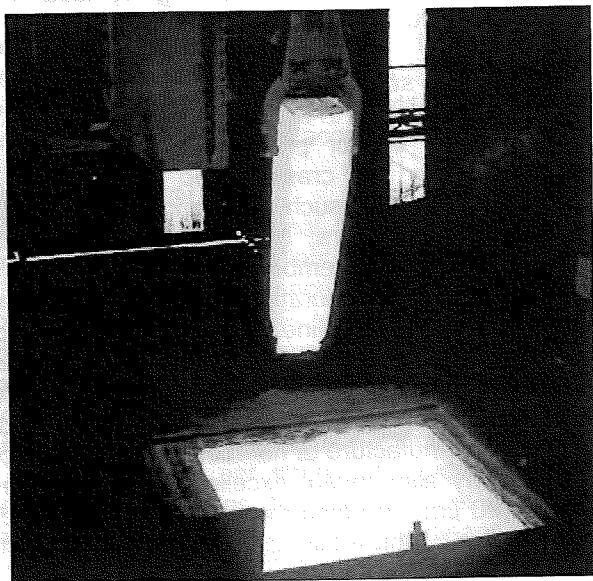


Fig 1 Using oxyfuel, it is possible to reheat the same volume of steel in nine instead of 13 pit furnaces.

### ASCOMETAL, FOS-SUR-MER

ASCOMETAL, a member of the Severstal Group, is an important producer of bearing and engineering steels. At Fos-sur-Mer, 580 employees annually produce 250,000 tonnes of finished products. Soaking pit furnaces are used to reheat hot and cold charged ingots of 5.3, 6.2 or 7.5 tonnes prior to hot rolling. All except one of the pit furnaces have a heating capacity of 80 tonnes. The remaining pit furnace has a capacity of 120 tonnes.

### NEED TO IMPROVE HEATING PERFORMANCE

The performance of the recuperators was, due to their obsolescence, both stagnating and fluctuating when ASCOMETAL began to investigate how to improve reheating operations in 2001. The goals that were set were to achieve better energy utilisation, to reduce the number of furnaces in operation where possible and to comply with the safety requirements for combustion and fuel handling systems (EN 746-2). It was also necessary to minimise emission levels and follow strict legislation, especially for CO<sub>2</sub> and NO<sub>x</sub>. After meetings with Linde, definition of the project requirements and visits to reference installations, a contract was signed in September 2004.

### IMPLEMENTATION

The first installation, in 2005, was to be a stand-alone installation, delivered by Linde, on pit furnace no.14. In this way, the project team could verify the functionality and operation of the control and heating system before integrating it into the on-line control system. ASCOMETAL completed the necessary modifications to wiring, tubing, burner arrangements, pressure regulation, etc. based on instructions and work supervised by Linde. Linde delivered proprietary flameless oxyfuel burners complete with flow-trains for natural gas and oxygen. It was decided to use two flameless oxyfuel burners for a total power input of 4 MW, positioning them at A and B, as shown in Fig. 2, replacing the 4.6 MW airfuel burner previously located at A. The positions of the oxyfuel burners was determined on the basis of Linde simulation calculations and past experience. The new control system and interface that was implemented integrates recipes for the various steel grades.

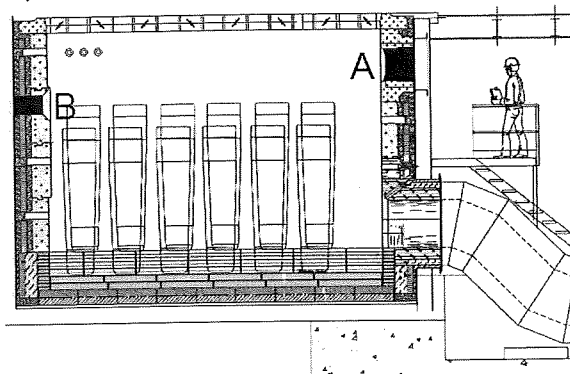


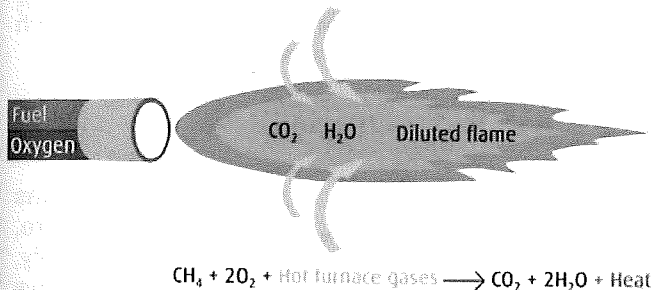
Fig 2 The two flameless oxyfuel burners, positioned at A and B, providing a total of 4 MW power, replaced the 4.6 MW airfuel burner previously located at A.

With oxyfuel combustion, flue gases are reduced by 70-80% due to the lower energy consumption and the absence of nitrogen ballast in the combustion and heat transfer process, hence the requirements for accurate pressure measurement and control rise. An active vertically sliding guillotine damper was installed in the proximity of the furnace flue gas outlet. It was positioned and designed on the basis of directives

from Linde but produced and installed by the ASCOMETAL local project team. Since the successful installation and tests to fulfil the performance guarantee, another eight pit furnaces have been converted. With the conversion and start-up of the final furnace, in January 2007, the number of reheating and annealing furnaces that have been converted to REBOX<sup>®</sup> oxyfuel solutions totals 100. Electrical combustion air-blowers have been removed and recuperators still remain in position but are not operational.

### FLAMELESS OXYFUEL

To achieve the project's challenging goals of uniform heating and drastically reduced heating time, whilst meeting the restrictions on NO<sub>x</sub> emissions, Linde applied flameless oxyfuel. This is sometimes also referred to as 'volume combustion', where the flame is diluted with the hot furnace gases (Fig. 3).



**Fig 3** With flameless oxyfuel, the flame is diluted with the furnace gases, which lowers the flame temperature simultaneously promoting an effective heat distribution.

This takes place at temperatures of over 800°C, when fuel and oxygen will auto-ignite. This results in the flame becoming practically invisible, obtaining both a cooler and a better heat distribution. The diluted flame contains the same amount of energy, but it is more evenly distributed for faster and uniform heating of ingots. With conventional oxyfuel, the high flame temperatures encourage the generation of thermal NO<sub>x</sub>, but with the low flame temperatures of flameless oxyfuel, emissions of NO<sub>x</sub> can be drastically reduced.

### 6% HIGHER MILL AVAILABILITY & LESS FUEL

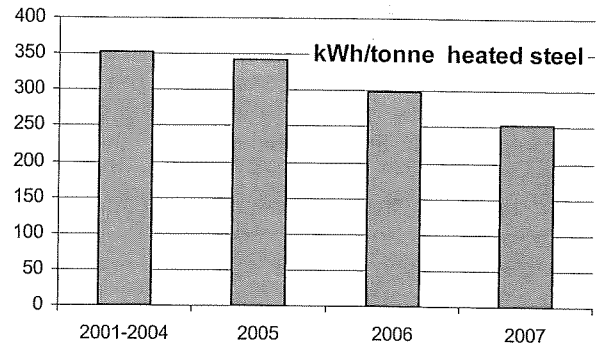
The contract with Linde includes a Performance guarantee stipulating targets for heating time and energy input for full batches of cold and hot charged ingots and various steel grades. The results of these tests (Table I) and today's running production shows that the same production volume can be passed through nine oxyfuel equipped furnaces, leaving the remaining four airfuel furnaces as back-up for extra capacity. Heating cycles have typically been reduced by 33%. This additional heating capacity provides the flexibility necessary to improve the stream of ingots from the steel plant to the hot rolling mill, especially for cold charged material. The effective mill availability has been improved from 86% to 92%.

The oxyfuel installation also reduced fuel consumption by 40%, with the energy input necessary for hot charged ingots being as low as 134-172 kWh/tonne heated steel.

**Table I** Results of performance tests for energy input and heating time for airfuel (AF) and oxyfuel (OF).

Test	AF kWh/t	OF kWh/t	kWh/t saving	AF Hours	OF Hours	Time saving
50KB	340	164	52%	10	5.6	45%
50KB	340	172	49%	10	6	40%
30MR	365	134	63%	12	6,0	50%
58 VT Cold charge	660	365	45%	21	11.3	46%

Prior to 2005, operating with airfuel in all pit furnaces, the average fuel consumption was 350 kWh/tonne heated steel, whereas with the nine oxyfuel-equipped furnaces and four remaining with airfuel currently in use, consumption is now 250 kWh/tonne (Fig. 4).



**Fig 4** Average fuel consumption for all furnaces. In 2007 operating nine oxyfuel and four airfuel pit furnaces.

Emissions of CO<sub>2</sub> and NO<sub>x</sub> in oxyfuel equipped furnaces have both been reduced by 40%. The heating of ingots has shown to be more uniform and reduced scale formation provides a gain of 3 tonnes for every 1,000 tonnes rolled, even without all furnaces in oxyfuel operation.

### CONCLUSION

The ASCOMETAL local project team and Jean-Pierre Riegert, Head of Technologies and Development, can conclude that, with Linde's experience in reheat furnaces and proprietary solutions, it is possible to challenge and upgrade old heating processes. Oxyfuel provides the operations with the additional heating capacity and the flexibility needed to increase the degree of utilisation of existing furnaces and hot rolling mills, whilst also significantly reducing fuel consumption and enabling compliance with increasingly strict environmental legislation. During 2007, the ASCOMETAL Les Dunes site converted three soaking pit furnaces to flameless oxyfuel with one remaining furnace being scheduled for 2008.