Abstract- Fuel-savings technologies can provide significant economic benefits to steel rolling mills. Billet reheating furnaces in Hospet steel rolling mill consume approximately half of the furnace oil used to produce hot-rolled products. In this paper, Dilute Oxygen Combustion technology was extended to a billet reheating furnace. This flexible dilute oxygen combustion system provide significant fuel savings of 25% with no impact on other critical process parameters like steel surface quality, emissions, refractory, oxide scale, etc. The work reviews installation, startup, operating results and plans for installation on billet reheating furnace in rolling mill section of Hospet Steels Limited.

Keywords- Steel rolling mill, Reheating furnace, DOC Technology, furnace oil consumption, fuel savings, billet, reduced emission.

I. INTRODUCTION

The recent years showed a significant increase both in energy costs and social awareness for environmental concerns. In the industrial sector, these aspects affected revenues and sustainability of the most intensive energy plants, such as steel rolling mills.

In the most recent years, the need for a more rational and efficient use of energy has emerged as a strategic and urgent issue. Such a necessity is particularly perceived in the industrial sector, not only because of the increasing costs of energy, but also as a consequence of the global competition, which stresses some features of the process and its final products (e.g., cost and quality). Furthermore, the rational use of the energy resource may be regarded as a twofold issue, a first aspect being related to the achieved consciousness of the limited availability of energy, regarded as a source, and the second being represented by a mature appreciation of the costs born to procure energy. In fact, according to a wider and wiser view of the problem, the term “cost” is to be appreciated not only in economic terms, but also in its social and environmental features. Therefore, with the aim to promote energy conservation in the iron and steel industry, this paper summarizes measures which can be taken for an effective energy conservation in reheating furnace of HSL. Steel rolling is one of the most important segments of the steel industry. The primary energy sources used in the rolling mills are electricity and fuel oil. Out of the total units surveyed in Hospet steels limited, about 60% of the units are using electricity and 40% of the units are using furnace oil as the main thermal energy input. The specific thermal energy consumption in oil-fired furnaces is in the range of 45 to 65 litres per tonne of finished product. In this paper, the energy conservation in Hospet steels limited’s rolling mills can be achieved mainly by focusing on reheating furnaces, which consume a particularly large amount of energy and for which further energy conservation measures have to be applied.

II. DOC FOR REHEATING FURNACE

Reheating metal is energy intensive process. Though industrial rolling mill reheating furnaces have become much more energy efficient in recent years, oxygen-enriched combustion technologies can improve their efficiency still more. Oxygen enrichment reduces or eliminates the need for combustion air, resulting in less nitrogen oxide production. Dilute Oxygen combustion also increases the flame temperature without increasing fuel cost. Consequently, productivity can be increased while cutting energy use by as much as 50 percent. Dilute Oxygen combustion can be implemented as a retrofit or to replace older technologies.

Need for fuel (furnace oil) conservation.

Oil conservation is an action taken to protect the oil resources of the Earth, as well as the wise management and use of these resources. Oil is an energy-giving substance. Oil conservation is important because oil is also one of the non-renewable resources of the Earth, which means that once it is depleted, nothing can be done to replenish it. When oil supplies are exhausted, people will be forced to make drastic changes in their lifestyle; nevertheless, there is an increasing demand for oil and other fossil fuels.

Fossil fuels include coal, oil, and natural gas; these are the most widely used sources of energy. The demand for oil-powered generating plants also increased due to the extensive use of electricity worldwide. As a result, oil conservation is considered by many researchers to be the best way to help reduce pollution and other environmental problems.
This paper assesses the potential market for dilute oxygen combustion (DOC) in steel reheating. Steel reheating was selected for this evaluation for two reasons. First, the steel industry is one of the largest energy consumers, and reheating is one of its largest energy consuming unit. Second, steel refining processes are the largest consumers of industrial oxygen.

III. DESCRIPTION ABOUT DOC

New dilute oxygen combustion (DOC), combustion technology improves reheat furnace Productivity, reduces furnace oil consumption also reducing NOx Emissions. Hot rolling mills are used during steel production to finish cast steel. In hot rolling, continuous billets of steel are reheated and pulled through a series of rolls that shape them into coils or sheets. The shapes, coils and sheets may then undergo further forming and finishing. During the rolling process, reheat furnaces are used to heat the steel to approximately 1250°C. Figure 1 shows Schematic representation of Dilute Oxygen Combustion. The combustion that takes place in reheating furnaces consumes more furnace oil, by existing air-fuel combustion and also generate NOx emissions, which need to be reduced due to increasingly strict environmental regulations.

**Dilute Oxygen Combustion (DOC) Concept**

- Separate fuel and oxygen injection at high velocity.
- Rapid dilution of fuel and oxygen with furnace gases.
- Diffuse, uniform flame results in very uniform heating.
- Low peak flame temperature minimizes NOX Production.

**Solution**

The Dilute Oxygen Combustion (DOC) system is emerging as a promising technology because it deals with both Potential fuel (furnace oil) savings and increases productivity. Reduces NOx emissions are an additional benefit of this new combustion technology.

The DOC system injects fuel and oxygen into the furnace through two distinct, high velocity jets. Traditional furnaces use only one burner, through which both gases enter the furnace. By using two separate jets, the fuel and oxygen are heated by the furnace gases before reacting with each other. The dilution effect of the gases mixing in the furnace prevents high peak flame temperatures and significantly reduces NOx generation, even with a high nitrogen content in the furnace. The DOC system also differs from the traditional furnace by injecting oxygen instead of only air. This results in a reduction of fuel use and yields lower flue gas temperatures. Furthermore, the diffuse flame in the DOC system heats the steel billets more uniformly, leading to improved quality and mill performance. The overall benefits provided by the system design allow the DOC furnace to run economically at higher production rates.

Because the flue gas is recirculated aerodynamically within the furnace, DOC technology is simple and inexpensive to install compare to conventional system (air-fuel combustion). In addition, the high dilution effect of the gases mixing in the furnace produces exceptionally uniform heating of the steel billets in reheating furnace, resulting in improved rolling mill performance.

Fuel is expensive. So why waste it? This Dilute Oxygen Combustion (DOC) technology is an award-winning technology that represents the next generation of flameless oxygen enhanced combustion for steel reheating. This application provides you with a flexible, low-cost way to convert burners from air-fuel to dilute-oxygen systems. It can increase productivity, decrease fuel consumption, lower operating costs and reduce emissions.

**IV. BENEFITS OF DILUTE OXYGEN COMBUSTION**

The justification for using DOC is to produce a CO2 rich flue gas ready for sequestration. DOC combustion has significant advantages over traditional air-fired plants. Among these are:

- The mass and volume of the flue gas are reduced by approximately 75%.
- Because the flue gas volume is reduced, less heat is lost in the flue gas.
- The size of the flue gas treatment equipment can be reduced by 75%.
- The flue gas is primarily CO2, suitable for sequestration.
- The concentration of pollutants in the flue gas is higher, making separation easier.
- Most of the flue gases are condensable; this makes compression separation possible.
- Heat of condensation can be captured and reused rather than lost in the flue gas.
- Because nitrogen from air is not allowed in, nitrogen oxide production is greatly reduced.
V. DESCRIPTION ABOUT REHEATING FURNACE AND OIL BURNERS IN HSL.

The furnace Description Hospet Steels Limited has delivered the pusher type furnace in 2011. Originally it was built for reheating of billets. Length of the furnace is 24 m and width 7.5 m. schematic block diagram is shown in figure 4. The furnace is divided into three zones, two reheating zones and a soaking zone, which is again divided into three control zones in order to create temperature difference along the billet. Furnace oil is used as a burning fuel. The oil burners are distributed in three different zones such as pre-heating zone, heating and soaking zone as shown in figure 5. The flue gases passes through a recuperator. The main function of recuperator is to transfer heat from flue gas to combustion air flowing through it.

Integration of DOC lances into burners.

The specific burner utilized, called J/L burner, incorporates DOC technology in a “packaged” assembly. In a typical arrangement, several burners will be mounted on the sides of wall of the furnace. The burners/lances are compactly unitized within a refractory block requiring a single furnace penetration per burner as shown in fig 6.

The J/L burner has two main components: the J-Burner portion and the lance portion. The J-Burner consist of fuel injection assembly retained within a concentric oxygen tube. Its design makes use of a patented technology that permits the J-Burner to be recessed within the burner refractory block for a protection from heat and without risk of damage from combustion within the recess cavity.

The lance portion of the burner injects oxygen whenever the furnace is above the fuel auto-ignition temperature. It is separated from the J-Burner by several inches in order to entrain furnace gases and prevent the mixing of oxygen and fuel close to the burner, there by delaying combustion.

This allows the oxygen to become “diluted” with the furnace gases, yielding a much lower flame temperature. Since combustion takes place throughout the furnace chamber instead of directly at the burner, a more diffuse flame is produced, resulting in more even energy distribution throughout the furnace. Modification of burners is shown in figure 7 and figure 8 without DOC lances and with DOC lances respectively.
VI. DOC FOR FUEL SAVING IN HSL

Typical billet reheating furnaces operate with specific fuel (FO) consumption in the range of 65Lits/ton. Furnace on the lower end of this range typically have long, unfired tunnels as well as recuperators that deliver combustion air at temperatures between 250-300°C. Furnace with higher specific fuel consumption typically have shorter unfired sections and may even operate without preheated combustion air. Fig 9 shows the energy distribution for a billet reheating furnace with a specific fuel consumption of 65Lits/ton. As the fig indicates, more energy is lost to the flue then is delivered to steel.

Combustion system utilizing air as the oxidant have nitrogen concentration in the products of combustion on the order of 70% clearly the nitrogen in the flue gases represents the largest loss of energy from the furnace as products of combustion typically exit the furnace at temperatures in excess of 700°C. Reduction of this nitrogen results in less energy loss from the system. Maintaining the same energy transfer to the steel as shown in fig 10, a smaller firing rate is required to close the energy balance, hence fuel savings. In practice, conversion of a portion of a furnace from air/fuel to DOC typically results in a drop in flue gas temperature.

In order to minimize furnace refractory wall work, a method of integrating the fuel and oxygen lances into the air burner was developed. This design eliminated the need for any work on the furnace shell or refractory. Additionally, since the system was designed to operate on either air/fuel or DOC, but not both, the fuel flow control equipment was modified to allow the same control valve to be utilized for both modes of operation. This eliminated the cost associated with a second fuel control skid as well as additional integration work.

VII. RESULTS AND DISCUSSION

By comparing oil consumption from the above table 1 before and after DOC furnace oil consumption is reduced up to 25.80%.

DOC Benefits in Steel Reheating
- Higher furnace productivity
- Fuel savings.
- Uniform heating of billets.
- Low NOx emissions.
- Low carbon emissions.
Fuel Savings for Billet Reheating Furnace through DOC Technology in HSL

- Very low peak temperature.
- Low maintenance.
- Power savings- extra power for air blower is saved.

CONCLUSION

A Rolling Mill Section in a Hospet Steel Plant presents energy Saving opportunities, especially in the reheating furnace that service the mills. HSL installed DOC to the pusher type reheating furnace in order to reduce the furnace oil consumption.

This technique was chosen because replacing new furnace by existing furnace would have been unfeasible. The aimed FO consumption is obtained. DOC technology has been proved that, it consume less fuel than conventional combustion (air-fuel combustion) technologies, uniform temperature distribution in furnace and lower NOx emission. This technology is reliable to operate and easy to install and maintain.

As control of emissions becomes more essential, DOC technology will play a greater role in industrial combustion.

The energy conservation of RMS in HSL is implemented successfully and results are obtained, actual results are provided in this paper.

REFERENCES


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