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ECOPLANT: THE EXPERIENCE OF ECO-MINIMILL AT TUNG HO (TAIWAN) APPLIED IN THE BRAZILIAN SCENARIO[1]

Filippo Verlezza[2]
Paolo Cancian[3]
Mario Fabro[4]

Abstract

Products are awarded of Ecoplant status in the SMS Meer organization, on the basis of their compliance with the following economic and ecological criteria as significant reduction in the use of raw materials, significant reduction in the use of energy and operating media, significant reduction in emissions and significant improvement in the recycling quota. This article will present an overview of the Tung Ho plant, to examine then in detail the core technological concept of the direct link between caster and rolling mill and the related considerable advantages in terms of reduction of energy requirement and emissions. A breakthrough step in Minimill design took place in 2008, the outcome of the combined efforts of SMS Meer Concast, SMS Elotherm and SMS Meer, all members of the SMS Group: Tung Ho Steel Enterprise Corp. is the Taiwanese company where a real uninterrupted route has been established between the operations of an electric steelworks with continuous caster and those of a rolling mill. This concept is easily applicable to all the other countries with fast grow forecast like Brazil. Brazilian grows and energy policy will be linked with the Tung Ho experience. Limitations of energy losses, fuel-oil consumption, and emissions of pollutants in the atmosphere demonstrate SMS concern for economic and ecological issues.

Key words: MiniMill; MicroMill; Long products; Continuous caster; Rolling mill; Meltshop.

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[2] *Sales Area Manager, SMS Meer SpA – Italy*
[3] *SMS Minimill Team, SMS Meer SpA – Italy*
[4] *Sales Manager Long Products, SMS Meer Service Inc. - USA*

ISSN 1983-4764

1 INTRODUCTION

1.1 Plant Overview

The new Minimill is located in the industrial area of Taoyouan, Taiwan. The installation is bringing to the Group an additional capacity of 1,200,000 tpy of cast billet and an additional rolling capacity of 800,000 tpy of rebar with dia. 10 to 43 mm and rebar in coils dia. 10 to 25 mm. The two production areas are linked by an induction heating furnace for temperature equalization, without the traditional billet reheating furnace.

1. Scrap yard
2. Electric Arc Furnace
3. Ladle Furnace
4. Fume Dedusting Plant
5. 5 strands Continuous Caster
6. Induction Equalizing Furnace
7. Continuous Rolling Mill
8. High-Speed Finishing Block
9. Straight Bar Cooling Bed with HSD®
10. Finishing Facilities for Straight Bar
11. VCC® Coiled Bar Production Line

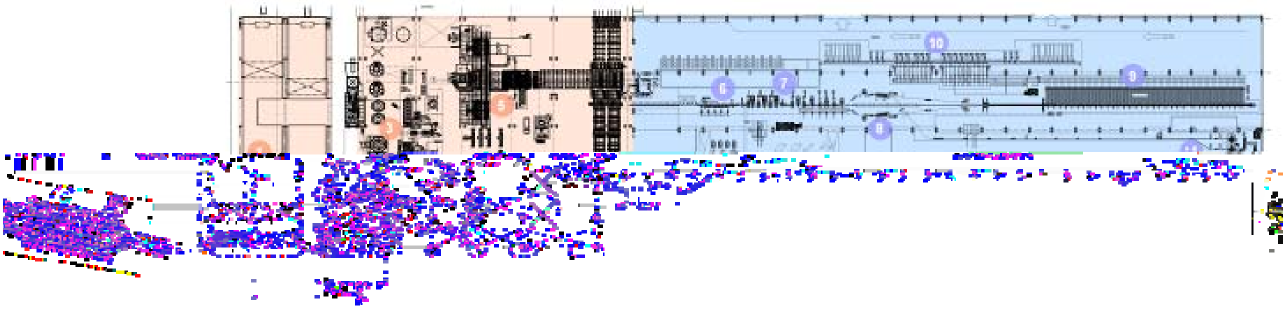

Figure 1: Plant lay-out.

2 METHODS

2.1 Steel Making and Casting

The meltshop is fit for the production of carbon steels however its design already considers future production of special steels , by installing a vacuum degasser and equipment for submerged casting. The technological equipment has been entirely designed and delivered by SMS Meer Concast:
The electric arc furnace is conceived around the concept of the Ultra High Chemical Power EAF developed by SMS Meer Concast. The UHCP operation is based on the utilization of powerful CONSO oxygen injectors.
After tapping, the ladles are then transferred to the Ladle Furnace.
After secondary metallurgy processing, the liquid steel is transferred to the continuous casting machine.
Completing plant installation are scrap handling and delivery equipment to the EAF, automatic alloy addition storage and delivery systems to both EAF tapping and LF. Environmental protection is assured by a dry-type fumes suction and filtering system.

ISSN 1983-4764

Billet caster design is based on the use of INVEX® Mould technology for high-speed casting.
INVEX® technology has been selected because of two main reasons:

- high casting speed is possible and reliable.
- billets, have a more favorable temperature distribution.

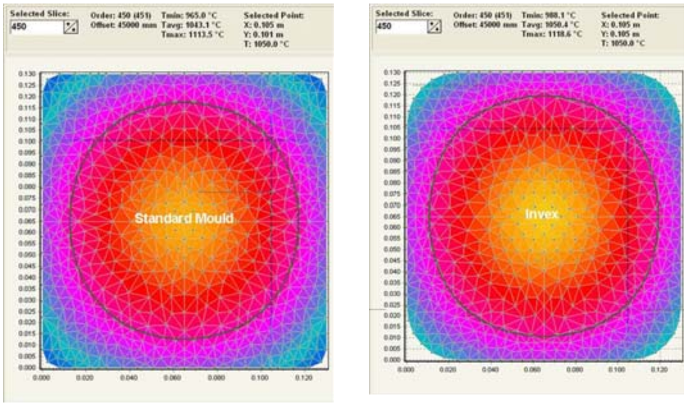

Figure 2: Comparison of standard and INVEX® mounds where corners have a more uniform temperature.

These high casting speeds are necessary to eliminate the traditional reheating furnace, which is the key to minimize the emission “foot-print” of the Minimill.
The surface temperature of the billets delivered to the induction heater is higher and more homogeneous, thus requiring only a minimal energy to reach ideal rolling temperature.

2.2 Rolling Mill

The rolling mill is designed for continuous hot charging of the cast billets. Billets are delivered to the mill in an optimal temperature range but still need equalization since the surface is colder than required, while the core is hotter.
The equalization process in this new Minimill is achieved thanks to an SMS Elotherm induction re-heating system which recovers all the heat losses and perfectly equalizes the billet temperature, both in cross section and lengthwise, thus delivering the billets to the mill at a suitable temperature for rolling operations.
The continuous rolling mill is equipped with fourteen stands followed by a six-pass high speed block arranged in “V” configuration.
The roughing and intermediate mill stands are of the SMS Meer HL housingless design.
The SMS Meer “V” block is specifically designed for highly efficient and productive finishing of rebar up to 45-50 m/s. The capability of maintaining very close tolerances in this single strand rolling results into a considerable yield increase compared to the traditional lower speed slit rolling for the same plant productivity.

ISSN 1983-4764

Figure 3: Induction heating system in operation.

Figure 4: Finishing mill in operation.

The plant can produce rebars in straight bar or coils with VCC® line. The straight bar process line is equipped with the industry leading SMS Meer HSD® High Speed Delivery system for safe and reliable delivery of bars up to 45 m/s on the cooling bed. The SMS Meer VCC® Vertical Compact is designed for 9.5 to 19 mm rebar at a speed of 35 m/s and up to 3 ton coil weight.

2.3 Direct Connection between Caster and Mill

In conventional Minimills it is established practice to cool down and store cast billets for independent subsequent rolling operations. Billets are therefore loaded at a later stage in a fossil fuel fired reheating furnace to heat up to rolling temperature from, in most cases, ambient temperature. At Tung Ho Steel this step was completely eliminated since the direct link between the continuous casting machine (CCM) and the rolling mill allows sparing the residual heat of the casting process. Billets at CCM discharging have an average temperature very near or already in the range required for rolling, but with a noticeable cross sectional difference, as the core is hotter and the surface is colder than required. In order to properly roll the billet, the temperature has to be equalized across the section by reheating the surface and allowing sufficient time for the hot core temperature to migrate towards the external perimeter. At the end of the equalization process, the temperature differential is limited to 25 °C only.
This task is performed by induction technology, the main advantages of which are:

ISSN 1983-4764

- Extreme flexibility: the system can rapidly adjust at the variation of input conditions such are billet temperature and speed
- On-demand system utilization: coils are energized only when needed and no preheating is required.
- Ease of installation and operation, limited footprint
- Maximum **energy efficiency** since power input is only required when rolling and induction heater is idled during inter-billet time as well as during maintenance and emergency shut-downs.
- **Absence of emissions!**

2.4 Environmental Issues when Burning Fossil Fuels

Traditional reheating furnaces burn natural gas or fuel oil. It is well known that the environmental impact of producing, storing transporting and consuming these fuels is considerable.
Burning fossil fuels generates greenhouse gases like CO_2, NO_x and SO_x. Greenhouse gases are emissions in the atmosphere that absorb and emit radiation within the thermal infrared range. This process is considered the base cause of the greenhouse effect.
Greenhouse gases, besides the fact of being toxic to living beings, are addressed as the fundamental cause of the well addressed ‘global warming’.
Even though natural gas is often described as the cleanest fossil fuel, producing less greenhouse gas per energy unit delivered than oil and far fewer pollutants, it substantially contributes to global emissions. Fuel oil ranks as a greater emitter though not as great as coal.
NO_x and SO_x as well as CO_2 are also contributors to the phenomena of the so called acid rains. Acid can have harmful effects on environment.

Table 1.- Fuels specif contents and emissions

Fuel	Specific Carbon Content (kg_C/kg_{fuel})	Specific Energy Content (kWh/kg_{fuel})	Specific CO_2 Emission (kg_{CO2}/kg_{fuel})	Specific CO_2 Emission (kg_{CO2}/kWh)
Coal (bituminous/anthracite)	0.75	7.5	2.3	0.37
Gasoline	0.9	12.5	3.3	0.27
Light Oil	0.7	11.7	2.6	0.26
Diesel	0.86	11.8	3.2	0.24
LPG - Liquid Petroleum Gas	0.82	12.3	3.0	0.24
Natural Gas, Methane	0.75	12	2.8	0.23
Crude Oil				0.26
Kerosene				0.26
Wood 1)				0.39
Peat 1)				0.38
Lignite				0.36
Bio energy	0	-		0 2)

ISSN 1983-4764

APPLICATION OF TUNG HO CONCEPT AT BRAZILIAN ENERGY AND ENVIROMENTAL POLICIES

- Hydrolectric: **73.63 %**
- Gas: **11.27 %**
- Biomass: **5.82 %**
- Oil: **5.36 %**
- Nuclear: **1.88 %**
- Carbon: **1.43 %**
- Wind: **0.62 %**
- Solar: **<0.01 %**

Figura 5: Brazil electrical power generating sources (2010).

Brazilian energy and environmental policy, historically, is one of the greenest worldwide.
In a country like Brazil where 80% of energy is generated by renewable sources, the Tung Ho experience makes much more sense.
The forecast for Brazilian energy increasing demand is around 5.3 % per year from year 2010 to 2020.
By this trend Brazil will increase the available power from 2,959 kWh/person to 4,230 kWh/person per year.
In Brazil GNP is fast growing, dragging the energy demand, nevertheless Brazilian governments do not forget the environmental aspects.
The PDE 2020 (ten years governmental energy programming deal) has assigned 236 billon US$ for the power production increase during the next 10 years (2010-2020).
The new power level production will be reached by increasing the hydroelectric and wind mills units particularly. Mostl of the new Hydroelectric units will be installed in the northern part of the country, not yet exploited. Belo Monte unit, in Parà state, with 11,200 MW will be in 2015 the 4th biggest hydroelectric power unit worldwide.
Brazil in 2016 could become the 6th biggest worldwide energy producer by wind mills. Mostly of them will be installed on the Ocean's cost where wind is constant and strong.
Moreover, the Brazilian government in the past (Lula president), took the commitment to decrease in the greenhouse emissions about 36/39% within 2020.

ISSN 1983-4764

The entire above situation, together with Brazilian historical tendency, using renewable energy source like bio-alcohol also for transportation, makes this country a perfect scenario to install a plant like Tung Ho.
Steel making plants are remaining one of the most polluting sources in the country. Plants for steel production or transformation are directly polluting by emission due to fossil fuel combustion (particularly Natural Gas and Oil) and indirectly being the biggest energy consumer plants in the industry.
Cost for fossil fuels is destined to increase in future meanwhile electrical power generated by alternative source will be cheaper.
The electrical power, consumed by the Induction furnace between Continues Casting Machine and Rolling Mill will be much more ecological than in any other western country.

3 RESULTS

3.1 "ROE - Return on Environment"

The initial design for the Tung Ho project envisaged the use of gas fired reheating furnace to heat billets. However, in line with the Taiwanese Government policies soliciting the use of cleaner means for heating, Tung Ho was keen for a concept in which emissions are substantially cut to zero. Tung-Ho then decided to adopt the "electric fueled" induction furnace concept introduced by SMS and to recover most of the residual heat of the continuous cast billets with the direct link approach between caster and mill. In Taiwan 19% of energy is generated by nuclear power, which are virtually free greenhouses gas emission.
Only billets with more than 870 °C approx measured at the CCM outlet follow the route to the induction furnace where they are heated up to enter the rolling mill at a temperature higher than 950 °C.
Eliminating the reheating furnace results in the following environmental emissions reductions:

- saving of 72,000 t/y CO_2 emissions;
- saving of 410 t/y SO_2 emissions;
- saving of 225 t/y of NO_x emissions.

CO_2 = 47,400 cars
NO_X = 280,000 cars

Figure 6: Corresponding reduction in emissions by eliminating the reheating furnace, based on 10,000 km / year and EURO 4 highly efficient gasoline car type

ISSN 1983-4764

3.2 Investment Cost Savings at Tung Ho

Savings in capital investment are achieved in consideration of the following points:

- Cost of an induction furnace is substantially lower than that of a traditional reheating furnace,
- A traditional reheating furnace is lined with a substantial quantity of refractory materials which an induction furnace does not require,
- A traditional reheating furnace calls for considerable foundation works, while the induction furnace foundations are negligible,
- Induction furnace installation and commissioning hours and cost are much less than for a traditional furnace,
- Learning curve is faster and easier to get for an induction furnace.

3.3 Operational Costs and Energy Savings At Tung Ho

Table below summarizes the economic assessment weighing the different solutions. The comparison concerns the cost of energy to heat billets with a traditional furnace configuration based on cold charging vs. the Tung Ho applied concept. The latter show savings amounting to over nine million.

Table 2. Energy cost comparison

Energy Cost Comparison					
Traditional Mill With fuel-oil Furnace			**Tung-Ho Hot Method With Induction Heating System**		
Cold Charging Consumption	26	kg/t	Induction Heating Consumption	26	kWh/t
Stand-by Consumption	694	kg/hr	Stand-by Consumption	0	kWh
Heavy Oil Cost (2008)	0.43	€/kg	Electrical Energy Cost (2008)	0.039	€/kWh
Total Yearly consumption (heavy oil)	24,096	t	Total Yearly consumption (electric energy)	22,568	MW
Total Yearly Cost	**10.361.142**	€	**Total Yearly Cost**	**880.152**	€

Basis: 140 t/hr production rate and 868,000 tons per year
2,200 stand-by hours/year, 15 days/year shut down for maintenance = 6,200 NET production hours per year

3.4 Euro/Year Production Costs

Additional savings in operations are achieved in consideration of the following points:

- Increased metallic yield, as primary oxidation in induction furnaces is lower (30% less) compared to the traditional configuration,
- Reduced maintenance and spare parts: induction furnace is less exposed to wear and components failure,
- Reduced manpower required: no billet storage and intermediate handling.