THE NEW PROGRESS ON ECOARC^{TM} IN THAILAND

BY

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SYNOPSIS:

To reduce energy consumption in the steel industry in the Kingdom of Thailand (hereinafter referred to as “Thailand”), several model projects supported by the governments of Thailand and Japan were implemented. As one of them, an ECOARC^{TM} was installed in UMC Metals Ltd. and started up in November 2012. The ECOARC^{TM} is a high efficiency electric arc furnace with a scrap preheating system developed and designed by JP Steel Plantech Co.
It was a brown-field project which replaces the existing conventional EAF with the ECOARC^{TM}, maximizing reuse of the existing facilities except key components of the ECOARC^{TM}, such as furnace shell, scrap preheating system and direct off-gas treatment system in order to minimize initial investment. After the start-up, commercial operation has been going smoothly. Moreover, all the targets of this project were achieved only within two (2) months after the start-up in spite of the first and brown-field ECOARC^{TM} in Thailand.
This paper describes outline of this model project, remarkable operation results and some tasks to further improve operation.

Keywords: EAF, ECOARC^{TM}, Electric Arc Furnace, High Efficiency, Scrap Preheating

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1 INTRODUCTION

Recently, most industry has been required to be low energy consumer and low-emission not only in industrially advanced nations but in developing nations to prevent global warming.

Since the steel industry is one of the largest energy consumer, it is effective to reduce its energy consumption. In a country which has no blast furnace, electric arc furnaces(EAF) use more energy than any other equipment within the steel industry. Improving the energy efficiency of EAF, therefore, is a priority.

Accordingly, JP Steel Plantech Co(SPCO) has developed "ECOARC™", a revolutionary EAF that represents the most advanced energy recovery and environmentally conscious EAF technology in the steelmaking industry. In Japan and Korea, four (4) ECOARC™ are commercially operated smoothly. Also in Thailand, fifth (5th) ECOARC™ was installed in UMC Metals Ltd.(UMC) and it was started up successfully in November 2012.

In this project, a lot of existing facilities were reused except key components of ECOARC™ technology such as scrap preheating shaft, furnace shell, direct off-gas treatment and scrap handling system to minimize initial cost and construction period.

In this paper, outline of ECOARC™ is explained a little bit first, then outline and operation results of the project are mainly described.

2 OUTLINE of ECOARC™

2.1 CONCEPT

Figure.1 shows the concept diagram of ECOARC™. ECOARC™ consists of a melting chamber and a preheating shaft, which are directly and rigidly connected together.

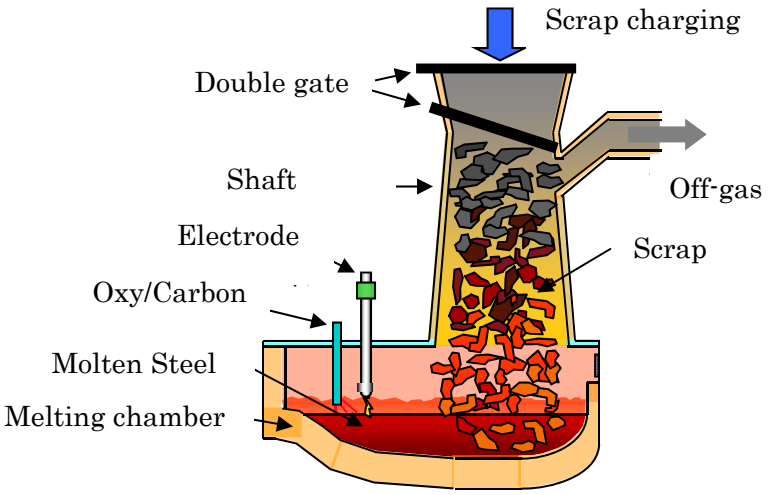


Figure-1: Concept diagram of ECOARC™

As the preheating shaft and the melting chamber are directly and rigidly connected, the whole shaft and chamber tilts altogether. As the connection is tight, there is no air infiltration to the preheating shaft. Also, the opening of the melting chamber is minimized and semi-air tight configuration is realized. Oxygen and carbon lances are attached for slag foaming and molten

steel carbon control. The scrap is fed to the shaft from the top to maintain certain scrap level in the shaft.

Except cold start, the melting process proceeds under flat bath condition. Scrap exists in the shaft throughout a heat and scrap at the bottom of the shaft is always in contact with the molten steel in the melting chamber. Scrap is supplied to the shaft when the shaft scrap level is lowered as a result of melting progress at the bottom of the shaft.

After melting one heat amount of steel, the scrap feeding is stopped. Operation is shifted to super heating period in the state that a scrap is filled up in the shaft, and then molten steel is tapped after getting predetermined steel temperature.

2.3 COMMERCIAL APPLICATION of ECOARC™

Table-1 shows the main specification of the five (5) commercially operating ECOARC™ and ongoing one (1). The former five (5) have achieved large energy saving and improvement of environment inside and outside the meltshop.

Table-1: Main specification of commercial ECOARC™

NO	1	2	3	4	5	6*
Startup year	2001	2005	2008	2010	2012	2014
Country	Japan	Japan	Japan	Korea	Thailand	Japan
Heat size	70 ton	140 ton	130 ton	120 ton	70 ton	200 ton
Furnace Type	AC	AC	AC	AC	AC	AC
Trans Capacity	41 MVA (Reuse)	88 MVA (Reuse)	75 MVA (New)	80 MVA (New)	50MVA (Reuse)	115MVA (New)
Electrode	20 in	24 in	24 in	22 in	22 in	28 in
Product	D-Bar	H-beam, FB, Angle	Rod/Wire For Automobile	D-Bar	D-Bar Billet	Long Product D-Bar

*Under designing at Apr. 2013

3 UMC ECOARC™ PROJECT OUTLINE

3.1 CONCEPT of REVAMPED PLANT

The Thailand ECOARC™ project was planned with an aim to improve the EAF performance and environmental condition of the surrounding area with a minimum shutdown period for installation of ECOARC™ with its auxiliary equipment, direct fume suction system and scrap handling system while reusing the existing meltshop facilities as much as possible. The improvement target figures were cleared just within two (2) months after the

hot-run. Regarding the maximum reuse of the existing meltshop facility, no modification of the overhead crane and meltshop building were necessary though ECOARC^{TM} has a vertical shaft and scrap charging method from the top of the shaft. In addition, the existing main power system including the furnace transformer, the building fume suction system with bag filters, the water treatment system and some other auxiliary facilities were reused. Details will be explained in the later section of this paper.

3.2 INTRODUCTION of UMC METALS LTD.

UMC is a steel mill in Thailand that has a 70-ton EAF, a ladle furnace and a continuous caster. The specifications of main equipment before revamping are shown in the table-2 below.

Table-2: Specification of main equipment before revamping

Process	Equipment	Specification
Electric arc furnace (EAF)	Type, Capacity	AC 70 tons, EBT
	Transformer	50 MVA
	Oxygen Injector	Water cooled lance
Ladle Furnace (LF)	Capacity	70 tons
	Transformer	10 MVA
Fume Suction System	Building Suction	20,000m^3/min

3.3 EQUIPMENT CONFIGURATION

To introduce ECOARC^{TM}, the existing conventional EAF, the direct off-gas treatment system and part of the water cooled duct leading to the combustion chamber were removed and the new EAF, off-gas treatment system and auxiliary equipment were installed. In addition, the existing transformer and electrode lifting system were also reused. The existing scrap bucket was replaced by a smaller one for start heat.

The configuration of the equipment after introduction of the new EAF is shown below.

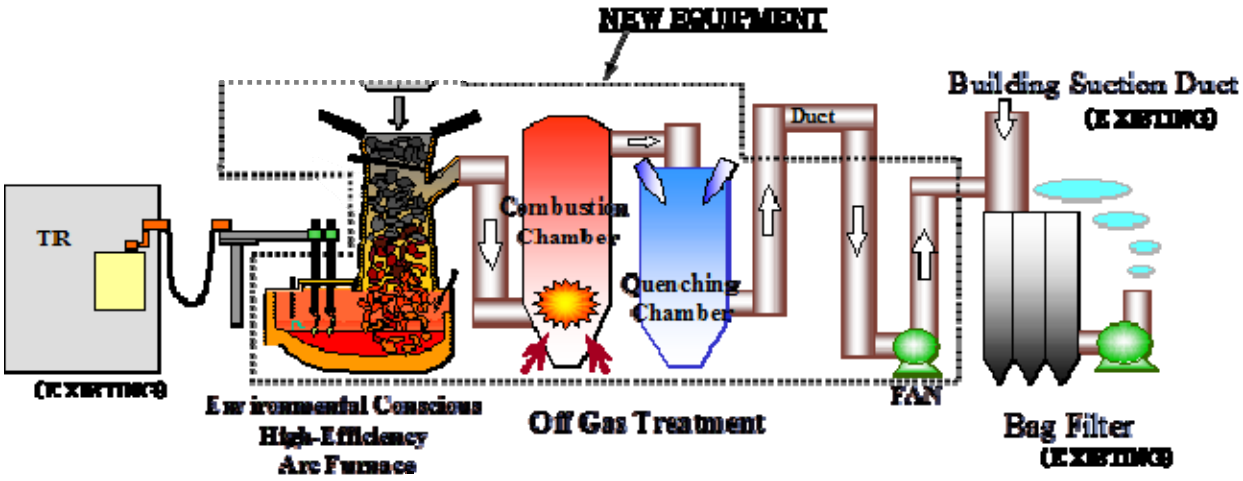


Figure-3: Equipment configuration for ECOARC^{TM}

3.4 LAYOUT

The layout before and after the introduction of the new EAF are shown in Figure-4 and Figure-5. The foundation and building of the scrap yard and melting yard were basically reused with partial modification.

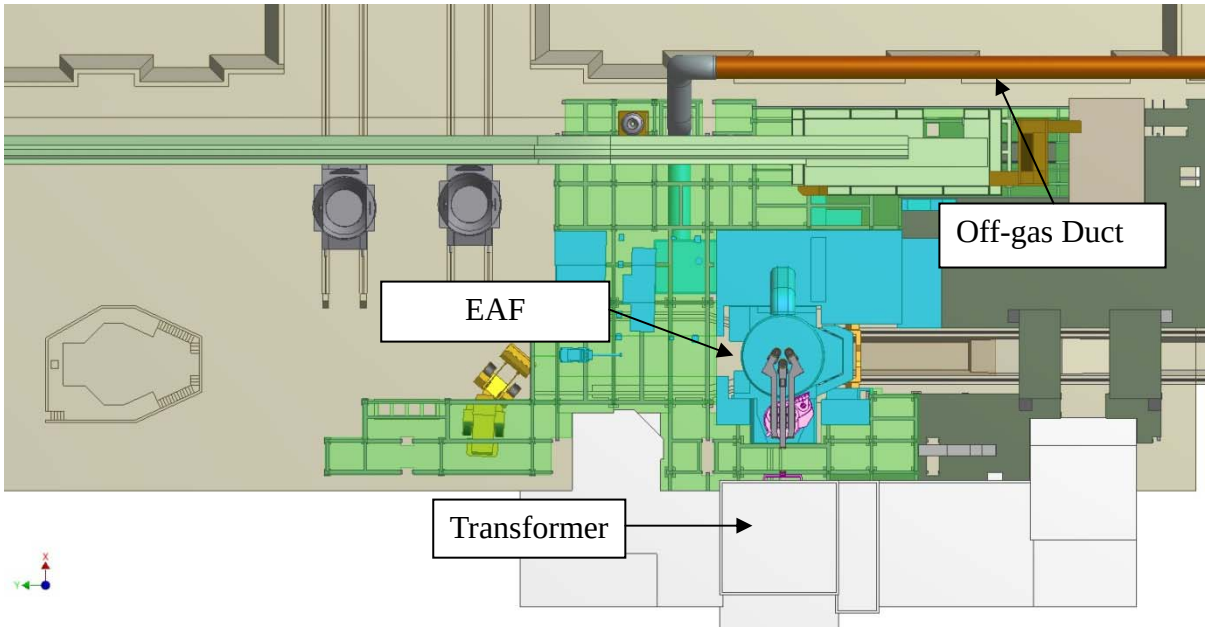


Figure-4: Existing EAF layout

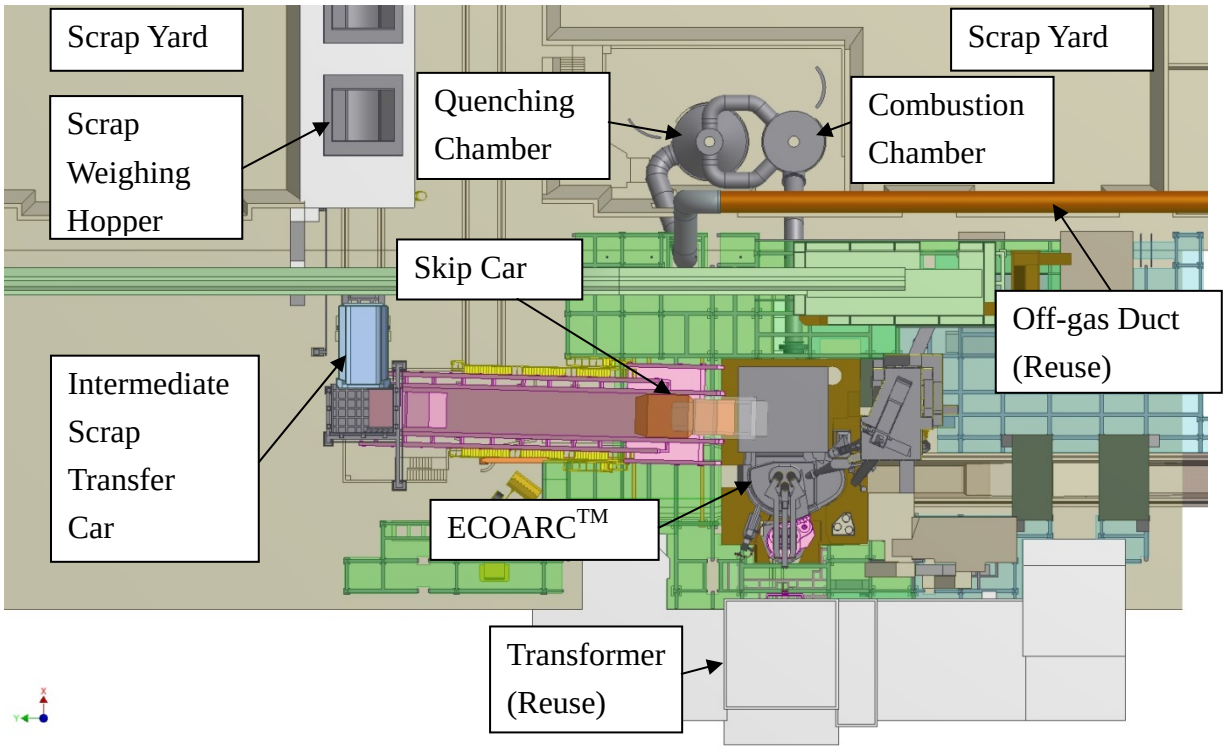


Figure-5: ECOARC™ layout

3.5 EFFECTIVE REUSE of EXISTING FACILITIES

To save cost and shutdown time, many facilities were reused as shown in table-3. The ways to reuse old facilities are as followings:

Table-3: Distinction of new and reuse equipment

Item	Status
Building	Reuse
Foundation	Reuse & Partially New
Scrap Charging Crane	Reuse
Scrap Bucket	New
Transformer	Reuse
Building Suction System	Reuse
Direct Suction Booster Fan	New
Bag Filter	Reuse
Water Treatment System	Reuse
Hydraulic System	Reuse & Partially New
Electrode Positioning & Swing System	Reuse

(1) **Building and Foundation**

As samples of a brown field project, the first and second commercial ECOARC^{TM} projects reused the existing meltshop building and foundation with partial modification. In case of UMC project, the existing building was reused without modification and the foundation was reused with partial modification.

In general, a shaft type furnace requires higher meltshop building depending on required shaft height and scrap charging method. In case of ECOARC^{TM}, however,

1) The shaft and the melting chamber are connected directly and the total height of the furnace is much lower than other type shat furnaces.
2) Due to scrap charging system with a skip car, top of the shaft can be below travelling elevation of a charging crane in typical meltshop building.

Because of the above characteristics of ECOARC^{TM}, meltshop building height can be lower than other type shaft furnaces, which minimizes modification of the existing facilities.

Figure-6 shows comparison between the original furnace and ECOARC^{TM}.

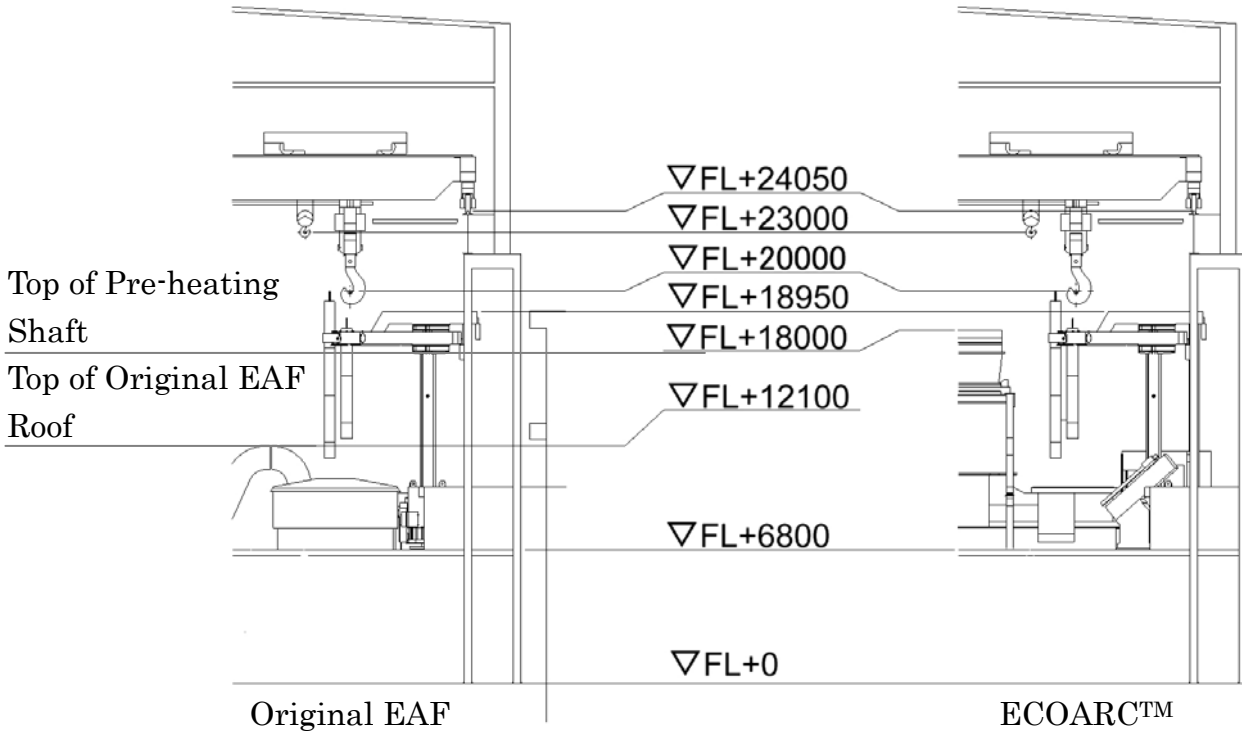


Figure-6: Comparison Between original EAF and ECOARC™

(2) **Scrap Charging Crane**

In a conventional furnace, scrap charging is done a few times a heat with a scrap bucket. It is one of the most risky work in operation of the conventional furnace and it causes deterioration of working environment by flame, dust, metal splash, etc. during scrap charging

In case of ECOARC™, scrap is charged in the shaft with a skip car automatically and no scrap charging crane operation is necessary. As it is not necessary to open the roof for scrap charging, there are no flame nor dust emission by scrap charging and environmental condition around the furnace is good. Therefore, the scrap charging crane is only used for maintenance work and can be reused after revamping to ECOARC™.

(3) **Transformer**

As ECOARC™ can reduce great amount of electrical energy consumption, transformer capacity can be much smaller when replacing a conventional EAF with the same productivity. The first commercial ECOARC™ shown in Table-1 replaced two (2) 70-ton conventional EAFs keeping the same productivity with one (1) 70-ton ECOARC™. The UMC project also reused the original transformer. This shows it is possible to minimize investment cost by reusing the existing transformer while achieving high productivity in a project to replace a conventional EAF with ECOARC™.

(4) **Building suction system**

Due to air tight construction of ECOARC^{TM} which prevent air infiltration, it is possible to minimize direct suction gas volume. In addition, as there is no scrap charging with roof opening, dust scattered around the furnace is small and dust concentration in the secondary suction gas is also small. Therefore, the existing building suction system can be also reused. Moreover, in the UMC project, only two (2) of the original three (3) main fans(totally 20,000m3/min.), which were all running before revamping, are enough for operation with ECOARC^{TM} due to improvement of working environment.

(5) **Water treatment system**

Total required cooling water volume is almost the same before and after the revamping.

3.6 SHORT SHUTDOWN PERIOD

In spite of brown field project, installation and cold run test was finished smoothly. The reasons why it could be achieved are as followings:

(1) **Attentive meeting with UMC**

With cooperation of UMC, sufficient consultation about scope, design, transportation and schedule etc. could be held before SPCO stay in UMC site and no critical oversight was discovered. Also during that stay, we kept contact closely and solved problems before increasing.

(2) **Full 3D CAD design**

All equipment including reuse equipment was modeled in 3D CAD and interference and interface between all facilities was checked. Also ease of transportation and assembly was confirmed in 3D CAD. And no problem was detected during erection and cold commissioning.

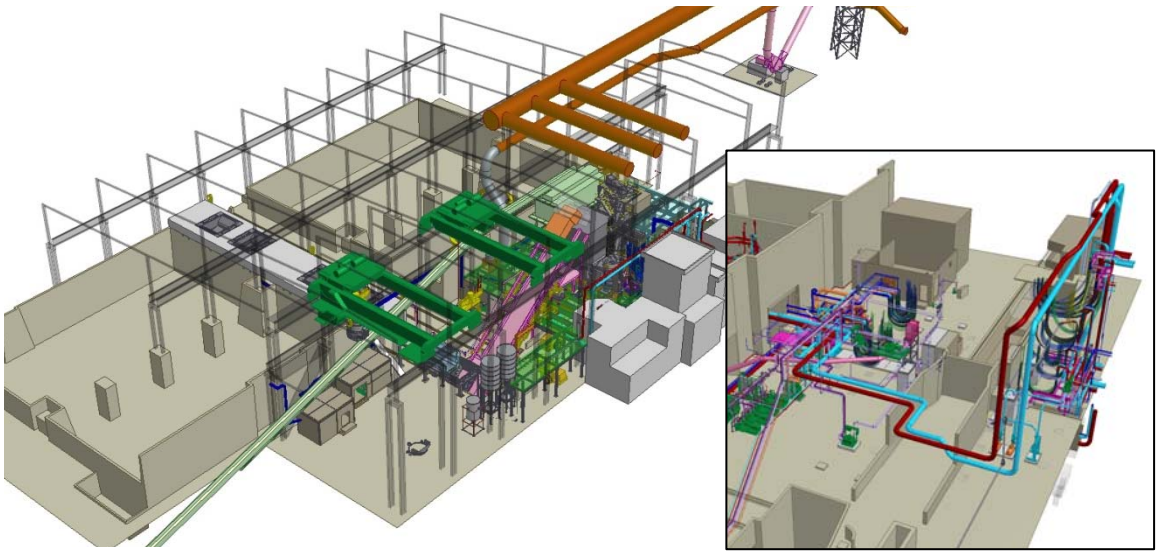


Figure-7: Overall view of meltshop and piping in 3D CAD

4 OPERATION RESULT

After the hot run, operation went smoothly and the performance verification test was successfully conducted in January, 2013. The successful result was brought by high reliability/operability of ECOARC^{TM} and all UMC's efforts to obtain required operation skills in a short time.

The test results are shown in the Table-4 below.

Table-4: ECOARC^{TM} test result in Jan. 2013

ITEM	VALUE
Electric Power Consumption [kWh/tbs*]	285
Fuel(LPG) Consumption [kg/tbs*]	1.4
Scrap to Billet Yield [%]	89.2

*billet weight ton

As shown in the Table-4, the specific electric power consumption has been reduced by more than 100kWh/tbs from the conventional EAF. The scrap-to-billet yield has even increased by about 0.8% t. Recently, in addition, some trials to use large amount of shredded scrap and to mix HBI in the raw material are exercised and it proves that various kinds of scrap can be used for ECOARC^{TM}. The following Table-5 shows improvements in environmental performance obtained at UMC.

Table-5: ECOARC^{TM} environmental performance

No.	ITEM	Old EAF (Oct.3.2013)	ECOARC^{TM} (Dec.16.2013)	REMARKS
1	Dust from Baghouse (Baghouse Inlet) [mg/m^3]	617	437.4	
2	Dust in Respirable Air Around Furnace Area [mg/m^3]	2.7	<0.6	Standard = 5
3	Sound Level Average around Furnace Area [db(A)]	100	87.1	Standard = 90
4	WBGT* Average around Furnace Area [degC]	28.5	28	Standard = 32
5	Dust/Billet [%/ton-Billet]	1.78	0.84	
6	Slag/Billet [%/ton-Billet]	15.52	13.20	

*WBGT: Wet Bulb Globe Temperature

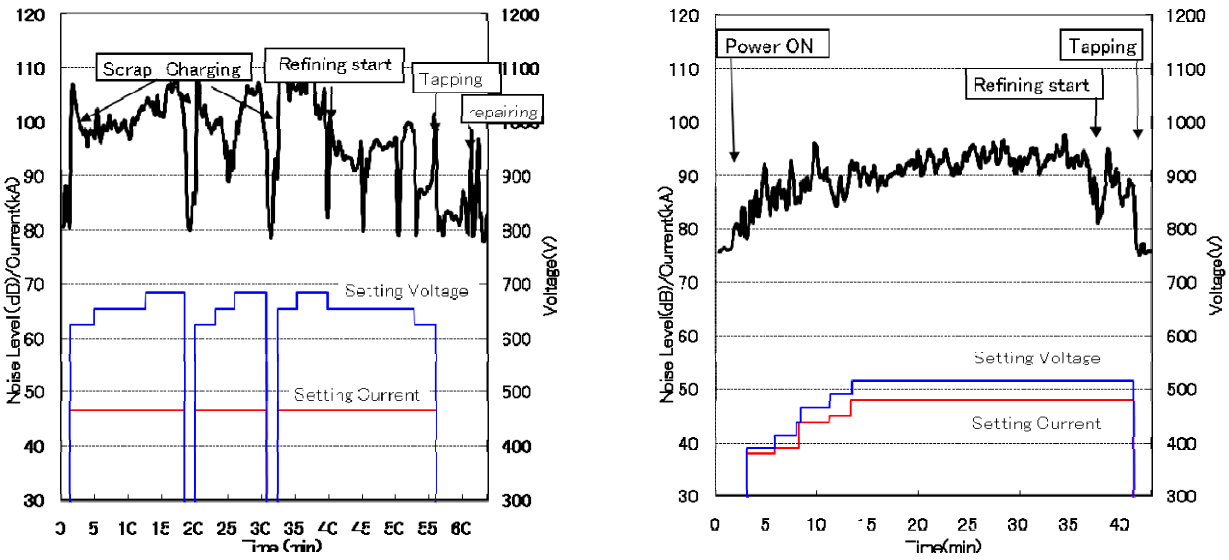
As shown in the table above, ECOARC^{TM} shows lower figures in all the evaluation items.

(1) **Dust Reduction**

In case of ECOARC^{TM}, dust generated in the melting chamber is partially caught by scrap when sucked through the preheating shaft and it comes back to the melting chamber. By repeating this process, dust concentration in the direct off-gas is reduced.

(2) **Environment around furnace**

Environmental condition around the furnace area is improved compared to a conventional EAF. In case of ECOARC^{TM}, scrap is charged through the shaft and it is not necessary to open the roof, which reduces dust around the furnace. Noise around the furnace is significantly reduced too as ECOARC^{TM} is operated under flat bath and sub-merged arc condition by foamy slag. The following figure 8 shows comparison of noise level measurement between a typical conventional furnace and another ECOARC^{TM}.



Conventional EAF ECOARC^{TM}

Figure-8:Comparing noise level of Conventional EAF and ECOARC^{TM}

Like other ECOARC^{TM}s in the past projects, environmental condition around the furnace has been greatly improved compared to the original conventional furnace in UMC. Especially in the UMC project, the performance targets were achieved in a short time and working environment has been improved as well. This is not only improvement of working environment but also reduction of dust treatment/slag disposal work and harmful emissions to surrounding of the steel plant and it leads to reduction of countermeasure cost for environment preservation.

5 CONCLUSION

In spite of minimum investment cost and short-time brown-field revamping project reusing a lot of the existing facilities, UMC and SPCO successfully started up the first ECOARC^{TM} in the Kingdom of Thailand and achieved the performance targets as shown below within two (2) months.

Electric Power Consumption:	285[kWh/tbs]
Fuel(LPG) Consumption:	1.4[kg/tbs]
Billet Yield:	89.2[%]

In addition, improvement of environmental condition such as reduction of dust generation, noise level, etc. by the introduction of ECOARC^{TM} has been confirmed.
It certainly proves that ECOARC^{TM} is a very effective solution to meet the requirements for energy saving and environment protection demanded from all over the world.

6 REFERENCE

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