THE FIRST ECOARC™ IN KINGDOM OF THAILAND
-INTRODUCTION OF THE HIGH EFFICIENCY ARC FURNACE-

BY

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SYNOPSIS:

The steel industry is the largest energy consumer in the Kingdom of Thailand (hereinafter referred to as “Thailand”). Electric arc furnaces (hereinafter referred to as “EAF”) use more energy than any other equipment within the steel industry. Improving the energy efficiency of EAF, therefore, is a priority of the Thai steel industry.

This paper describes the method of improving energy efficiency by the capture of waste heat in the off gas of the EAF and gives an introduction of the high efficiency EAF that has been installed at UMC Metals Ltd., Thailand under the model project program of NEDO (New Energy and Industrial Technology Development Organization, Japan).

JP Steel Plantech Co. (hereinafter referred to as “SPCO”) has developed “ECOARC™”, a high efficiency EAF that represents the most advanced and proven energy recovery and environmentally conscious technology in the industry. ECOARC™ uses high temperature exhaust gas in a chamber attached directly to the furnace to preheat scrap and treatment technology to remove unwanted chemicals from the waste gas. Already four (4) ECOARC™s are in operation as a commercial EAF in Japan and Republic of Korea and achieved approx. 30 % reduction of energy. The 5th ECOARC™ is in Thailand and targets approx. 30% reduction of energy.

Keywords: EAF, ECOARC™, Electric Arc Furnace, Environment, NEDO, Scrap Preheating

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1 INTRODUCTION

In Thailand, steel demand has been increasing year by year. This demand is met by imports and local production which is largely by EAF route. At the same time, the steel industry is the largest energy consumer in Thailand with the EAF consuming most of that energy. Reduction of energy usage at the EAF is important for Thailand.

In conventional EAF over 30% of all input energy is lost with the exhaust gas [1]. Recovering that energy is a very effective way to reduce energy consumption. At this time, we introduce the high efficiency arc furnace called "ECOARC^{TM}" to Thailand, which has a scrap preheating shaft and that has been developed by SPCO entrusted by NEDO. The preheating shaft is directly connected to melting chamber where steel scrap is preheated by the high temperature gas generated during melting, refining and superheating.

Further, the off-gas is combusted in a combustion chamber, which is located downstream from the preheating shaft, at a sufficiently high temperature and for a long enough time for dioxins to be decomposed. After combustion, the gas is rapidly cooled in quenching chamber, which prevents the re-composition of dioxins. Environmental impact improvements are realized as well as operational merits such as electrode consumption improvement, oxygen and fuel gas consumption reduction.

In Japan three (3) ECOARC^{TM} have been commercially operated and one (1) is under the planning. In the Republic of Korea, one (1) ECOARC^{TM} has been commercially operated. All of them have succeeded in reducing electricity consumption and improving environment pollution. We, SPCO would like to introduce 5th ECOARC on this paper. Herein, ECOARC means Ecologically Friendly and Economical Arc Furnace.

2 ENERGY SAVING TECHNOLOGY

2.1 CONCEPT of ECOARC^{TM}

As shown below Fig-1, ECOARC^{TM} has a preheating chamber that is directly connected to the melting chamber. During ongoing operation, molten steel is present in the melting chamber at the same time scrap is present in the preheating chamber. Scrap at the bottom of the preheating chamber is always immersed in the molten steel. The molten pool’s “flat bath” is always maintained in the melting chamber during ongoing operation. The arc continuously strikes against the flat bath and scrap is melted when it comes into contact with the super-heated flat bath. The gas generated from oxygen lancing and the injection of carbon into the molten pool will come into contact with the scrap right after it is generated and prior to cooling. The gas, which is routed to the preheating chamber so that heat can be recovered, flows out the fume duct. This configuration allows all scrap to pass through the hottest zone, where it will be thoroughly and evenly preheated to a high temperature. Because of this, ECOARC^{TM} has the most efficient scrap preheating system.

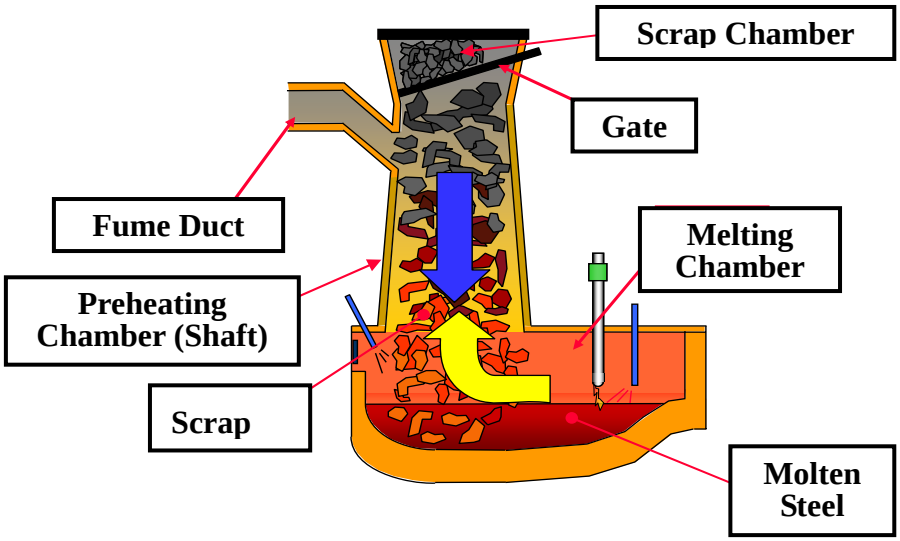

Fig-1: Schematic configuration of ECOARC™

Fig-2 shows the flow of off-gas after the preheating shaft. The generation of harmful chemicals can be avoided by marginally increasing the amount of fuel used. ECOARC™ technology is currently being used commercially at three steelworks. In an ECOARC™ furnace, the oxidation level (OD=CO2/{CO+CO2}) of the off-gas from the preheating chamber is controlled from 60 to 70%, which enables the off-gas to be combusted with a sufficient amount of CO included in the off-gas itself. The off-gas is combusted in the combustion chamber, which is located downstream from the preheating shaft, at a sufficiently high temperature and for a long enough time for dioxins to be decomposed. After combustion, the gas is rapidly cooled by a direct water spray cooling system in the spray cooling chamber, which prevents the re-composition of dioxins. Through this process, ECOARC™ has produced actual dioxin content levels of less than 0.5 ng-TEQ/m3N, which meets Japanese regulations for new electric arc furnaces. Although there are no regulations related to dioxin for the Thai steel sector at this time, if regulations similar to those in Japan are established in Thailand in the future, ECOARC™ technology would comply with such regulations.

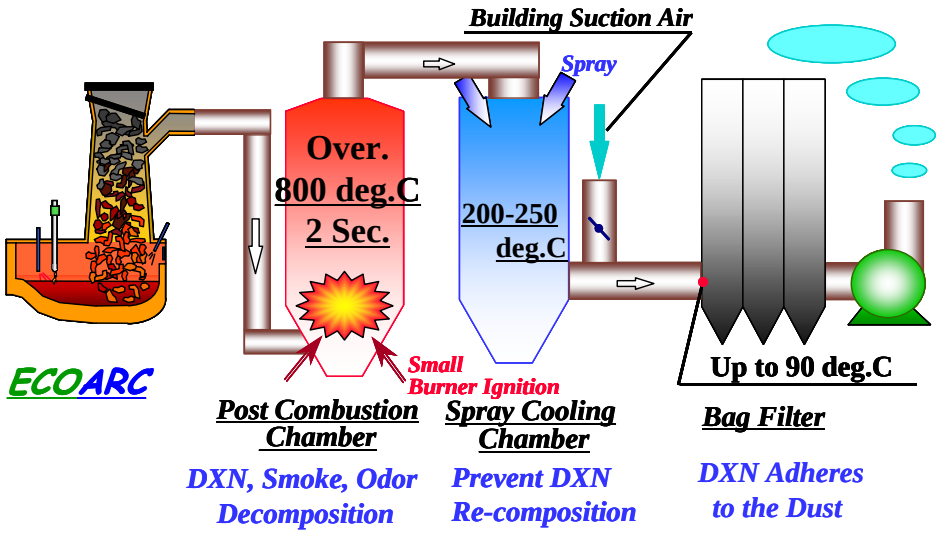

Fig-2: ECOARC™ pollutant treatment

2.2 COMMERCIAL APPLICATION of ECOARC™

Table-1 shows the main specification of the four (4) commercially operating ECOARC™ and preparing two (2). The former four (4) have been achieved large energy saving and improvement of environment pollution inside and outside the meltshop.

Table-1: Main specification of commercial ECOARC™

NO	1	2	3	4	5[4]*	6[5]*
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	88 MVA	75 MVA	80 MVA	50MVA	150MVA
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	Special Steel

[4]*Under construction as at Sep. 2012 [5]*On the drawing board as at Sep. 2012

2.3 OTHER FEATURES

2.3.1 LOW NOISE LEVEL

The noise is largely reduced by the operation of ECOARC™, because of flat bath operation with sufficient foamy slag and no scrap charging from top of the furnace.

Fig-3 and Fig-4 are the results of noise level measurement at the time of operation of a conventional furnace and an ECOARC™ with the same productivity. In the conventional furnace, the noise level approximately 100 dB was recorded in the melting period. On the other hand, the noise level in ECOARC™ was always less than 100 dB and around 90 dB in average.

In addition, as there is no scrap charging with opening a roof like a conventional furnace, there is no large fly dust by scrap charging. Then, the inside of the meltshop building is kept clean in comparison with the conventional furnace.

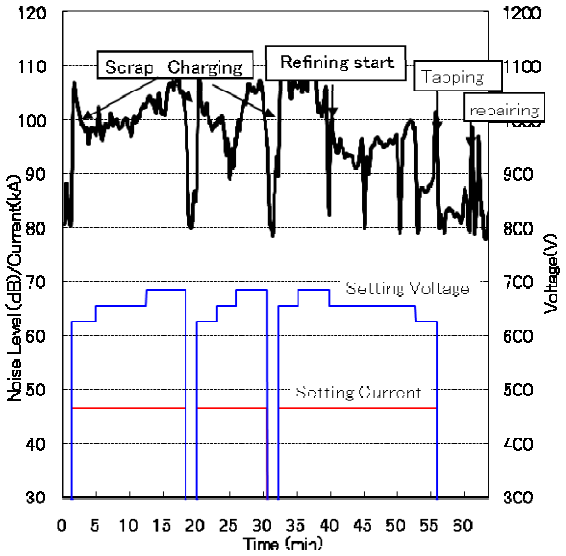

Fig-3: Noise level measurement in conventional EAF

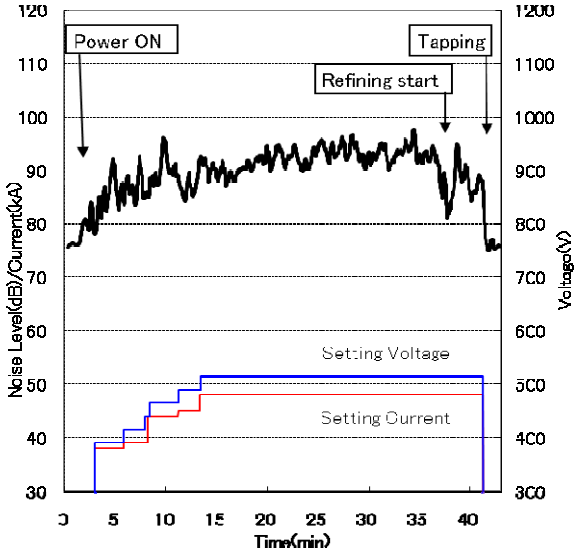

Fig-4: Noise level measurement in ECOARC™

2.3.2 LOW FLICKER and HARMONICS

As ECOARC™ is always flat bath operation, there is no big fluctuation of input power as seen in a conventional scrap melting furnace. Then, it is possible to keep high power factor, low flicker and low harmonics distortion rate throughout a heat. Therefore, the electric facilities necessary to meet power quality regulation (SVC, higher harmonics filter, etc.) can be drastically reduced or it may not even unnecessary depending on required regulation.

Fig-5 shows flicker measurement value in ECOARC™. In addition, Fig-6 and Fig-7 are comparison of higher harmonics distortion for one heat between a conventional furnace and an ECOARC™. From these measurements, it is easy to understand that the ECOARC™ has a great advantage in impact to the power quality requirements mentioned above.

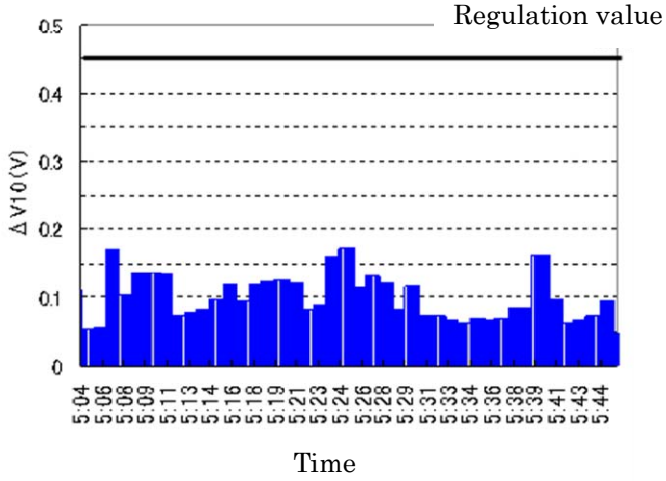

Fig-5: Flicker measurement in ECOARC™

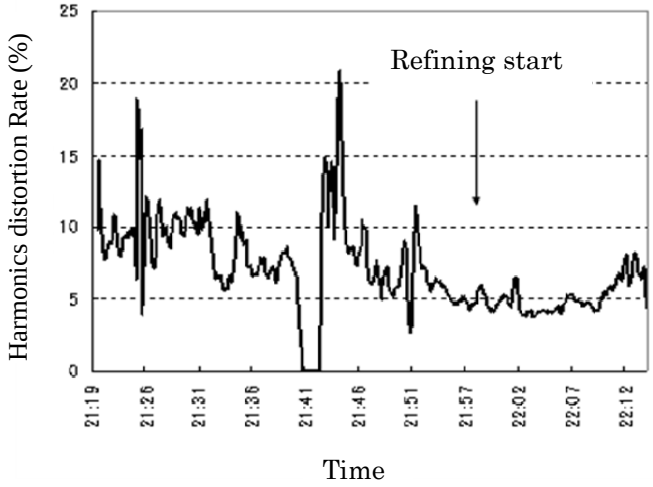

Fig-6: Harmonics distortion rate measurement in conventional EAF

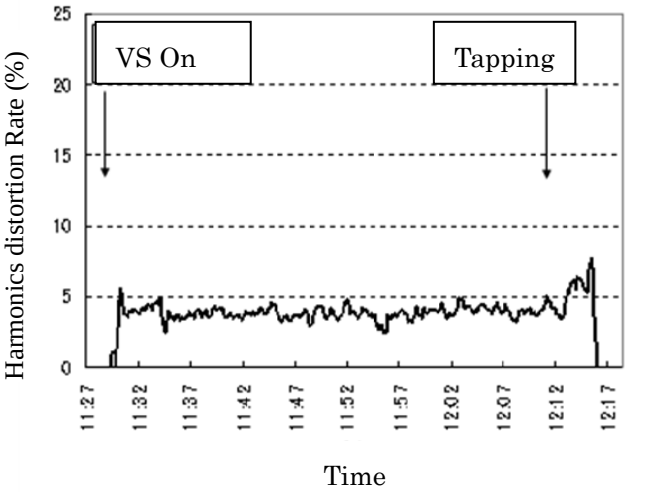

Fig-7: Harmonics distortion rate measurement in ECOARC™

3 ABOUT THE MODEL PROJECT

3.1 NEDO and ADOPTION SCHEME

The New Energy and Industrial Technology Development Organization (NEDO) is Japan's largest public R&D management organization. NEDO coordinated this model project in order to contribute to the development of new energy efficiency and environmental technologies in Thailand and to enhance Japan's industrial competitiveness.

UMC Metals Ltd. (UMC) has been selected for this model project from three (3) candidate companies through a selection process by NEDO and SPCO. The facilities for the three (3) companies were evaluated to see the potential for energy savings and the expected reduction of greenhouse gas generation (GHG). Investment costs were evaluated and the return-ability was established. Further investigation, including policy issues regarding energy and environment of the Thai steel industry and the selected company were carried out, the possibility to utilize the project for promotion of the technology, the business situation and the ability of the nominated company to raise funding were evaluated. Finally the fund bearing ratio between Thailand and Japan was established.

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. Existing facilities were evaluated and at the same time an outline of the target energy saving equipment was studied.

Outline of UMC Metals

- Main products: Billet, D-Bar
- Outline of existing main equipment:

Table-2: Specification of main equipment

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

3.3 BASIC SPECIFICATION of NEW EQUIPMENT

Basic specifications are maintained at the existing facility to concentrate on energy savings efficiency; i.e. reducing power consumption. The productivity of the downstream equipment, i.e. the ladle furnace and the continuous caster, also are maintained to keep the same heating capacity of the arc furnace. Based on the above preconditions, the specifications for the equipment that are introduced in this model project have been determined as below.

- Furnace: environmentally conscious high-efficiency arc furnace (ECOARC^{TM})
- Heat size (tapping weight per heat): 70 tons/heat

Table-3: Distinguish of new and reuse equipment

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

3.4 EQUIPMENT CONFIGURATION

To introduce the environmentally conscious high-efficiency arc furnace, the existing conventional EAF and off-gas treatment system and part of the water cooled duct leading to the combustion chamber would be removed and the new off-gas treatment system and auxiliary equipment would be installed. The existing transformer and electrode arms would be reused. The existing scrap bucket, which is too large, would be replaced by a smaller one.

The configuration of the equipment after the new EAF is introduced would be as below Fig-8.

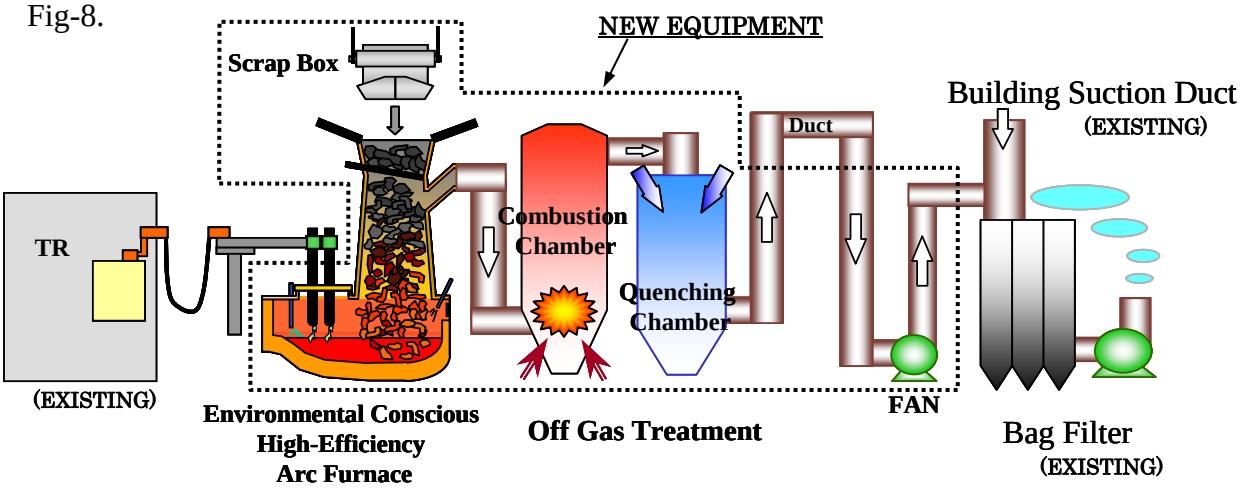

Fig-8: Equipment configuration for ECOARC

3.5 LAYOUT

The layout before and after the introduction of the new EAF are shown in Fig-9 and Fig-10. The foundation and building of the scrap yard and melting yard would basically be reused but partially modified.

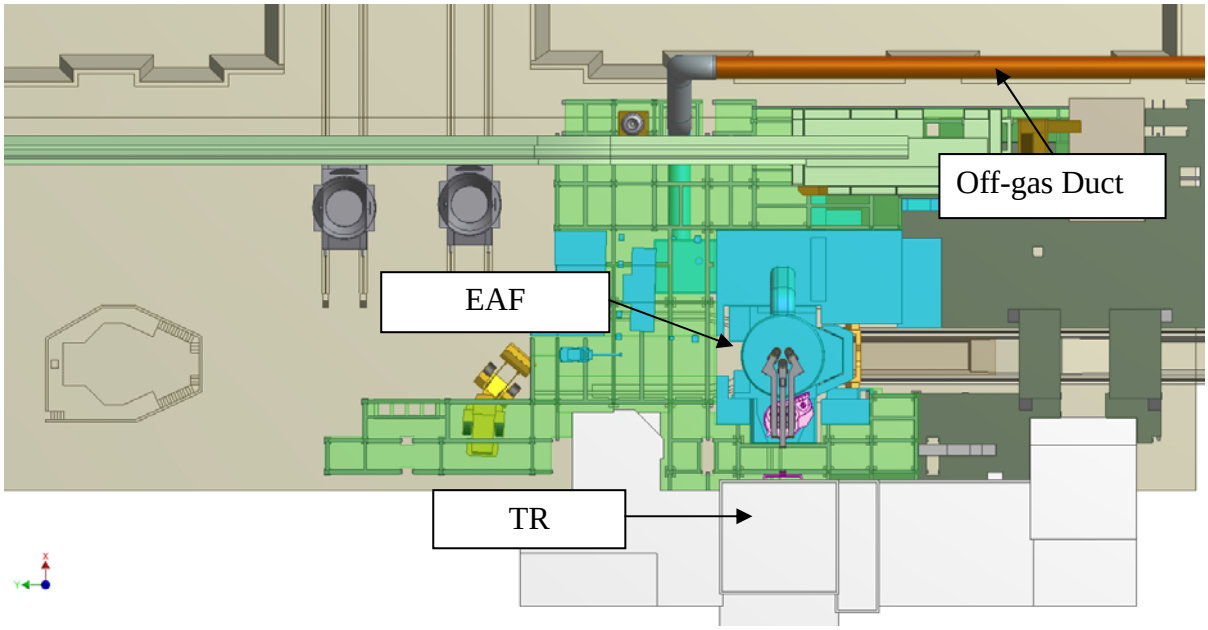

Fig-9: Before model project

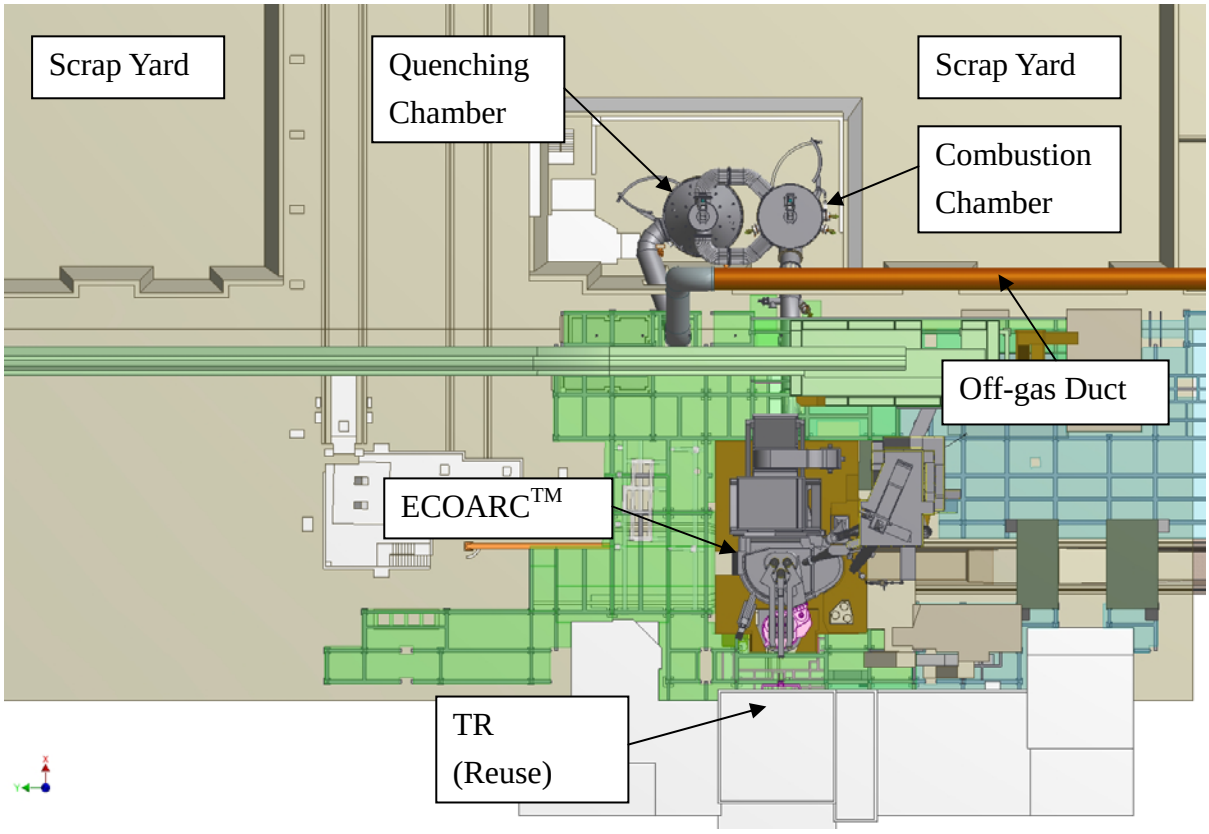

Fig-10: After model project

4 PRESENT STATE

Now as at Sep. 2012, we, UMC and SPCO struggle to start the first ECOARC^{TM} in Thailand until last quarter of 2012. And we shall be able to show you many advantages of ECOARC^{TM} after the hot run. In addition, SPCO is designing 200ton 6th ECOARC^{TM} now, so we shall be also able to show widely answer from 70ton to 200ton. Please be looking forward to it.

Fig-11: State under construction (view from tapping side)

5 Reference

[1]Masanari Yamazaki, Yasuhiro Sato, Ryutaro Seki “OPTIMUM ENERGY MANAGEMENT OF ELECTRIC ARC FURNACE” SEAISI 2010