Design and Construction of Coke Ovens by TKEC on the Non-Recovery Plant of Illawarra Coke Company in Coalcliff, New South Wales, Australia.

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Summary

Now that the first two Non-Recovery Technology ovens have been builtand commissioned, TKEC can demonstrate the advantages of this technology as compared with the existing ICC ovens or the technology of competitors in day-to-day operation. On the part of ICC, the ovens shall be run in a separate pushing cycle utilizing 48 hours coking time, meaning that productivity will be significantly increased. In normal operation, these ovens will also be utilized for carbonization tests which will prove achievable coke qualities – already very good with the existing ICC plant - and provide interested clients with the opportunity to test their own coal blends in these new technology ovens.

Keywords: Non-Recovery Coke Plants, Coke Oven Design.

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[1] 1st International Meeting on Ironmaking, September 24th tp 26th, Belo Horizonte, MG - Brasil

1. The Market for Heat-Recovery Technology

Thyssen Krupp EnCoke –formerly TSOA- holds a license for the Non-Recovery Technology since 1995, offering it on the world market since that time. On account of the growth in projects for so-called

merchant coke plants planned in the green field, not linked through a gas network to a blast furnace,
and because of the U.S. EPA which expressly gives preference to Non-Recovery Technology for new coke plants
and due to the decline in net profits for products from coal by-product recovery

the Non-Recovery Technology, or better to say the Heat Recovery Technology, has attained a strong position on the world market for new coke plants in competition with the conventional cokemaking technology. Projects for new coke plants are currently planned or pre-planned in:

Australia:	1.0 million tpy coke, dry
Brazil:	1.5 million tpy coke, dry
India:	0.72 and 1.75 tpy coke, dry
USA:	1.25 tpy coke, dry

Besides, numerous other projects have currently entered the preliminary planning stage for application of the Heat-Recovery Technology in Columbia, India, and in other countries.

At present, there are three companies offering the Non-Recovery Technology:

Sun Coke, USA
Mitsui/Enron, Japan/USA
ThyssenKrupp EnCoke, Germany

Besides, there are other companies in India and China offering this technology, but appearing on local markets only.

With its plants in Vansant, Virginia, USA and Indiana Harbour, Illinois, USA, the company SUN COKE has got two reference plants, though actually it is no plant engineering company but rather a plant operator. Therefore, it is dependent upon the support from a partner, which has been Raytheon Engineers up to now while seeking a new partner at present, to build such a plant. Beyond the field of Non-Recovery Technology it does no business in the field of coke plant engineering.

Mitsui has got a reference plant as it owns the plant Sesa Goa in India. A license for the territory of India, North and South America as well as Europe has been granted to Enron. Mitsui is no plant engineering company either, but a trading company, taking recourse to its subsidiary Toyo Engineering for engineering tasks. Neither Toyo Engineering nor Enron do business in the field of coke plant engineering beyond the Non-Recovery Technology sector.

Through its license granted by Pennsylvania Coke Ltd. (PACTI), the company TKEC, being a well-established coke plant engineering company, has got access to the know-how and findings of the research and development work done on PACTI's experimental plant in Nova Rosita, Mexico. After its successful operation, however, this experimental plant was dismantled. PACTI's technology had been developed on the basis of SUN COKE's technology. On the basis of its experience and know-how in coke plant engineeringalong with the valuable knowledge gained from our cooperation with Illawarra Coke Company (ICC) over the last four years, TKEC has modified PACTI's technology substantially. Moreover, TKEC has entered into a collaboration agreement with ICC It is not by mere accident that the Heat-Recovery Technology offered by TKEC has many features in common with the Non-Recovery Technology available from ICC, for example, the approach of charging the ovens by means of charging cars - what is called top charging - comes close to conventional cokemaking technology and bears substantial advantages as compared with other charging methods, e.g. side charging.

To have some reference and access to operator's know-how in competition with others in Non-Recovery Technology, the collaboration agreement stipulates that:-

"TKEC jointly with ICC will build two ovens which will be integrated into the existing plant in Coalcliff,. with the intention being to reconstruct all the other ovens on demand;
TKEC will carry-out carbonization tests on the plants of ICC;
training on the job of plant crews of TKEC's clients in future will be performed by ICC;
a know-how transfer between ICC and TKEC will be established".

As stipulated under this collaboration agreement, two ovens were integrated into the existing plant of ICC in Coalcliff, Australia, applying the current status of the TKEC design. These ovens substitute for two Non-Recovery ovens which had originally been built in 1914and modified over the years.

The coke plants of Illawarra Coke Company Pty Ltd., Coalcliff, Australia

The first ovens of ICC's coke plants were built in 1912. Sinceconstruction a lot of these ovens are still producing without ever having been rebuilt and only requiring basic repairs.

ICC's two coke plants are situated near Wollongong in New South Wales approx. 100km south of Sydney. The Corrimal plant is 5km north of Wollongong with the Coalcliff plant being a further 25km north.

	Corrimal		Coalcliff
Batteries	C1	C2	1
Year built	1912 (40 ovens)	1962	1914 (50 ovens)
	1930 (10 ovens)		1960 (8 ovens)
Number of ovens	50	32	58
Oven width, in mm	1940	2750	2740
Oven length, in mm	9500	9600	11380
Clear oven height	1830	2000	2500
Annual coke production capacity, in t	120,000		130,000
Oven coal charges, in t, wet			
Coking time 72h	15	24	28
Coking time 96h	19	28	34

Source: Coke Outlook 2000, Chicago.

The longer coking times are mainly attributable to the fact that the New South Wales EPA will only allow the plants to operate on day shift, five days per week.. No production occurs on weekends or public holidays

All the other data and information given below relates to the plant at Coalcliff where the two ovens were integrated by TKEC.

This photo gives a general view of the coke plant.

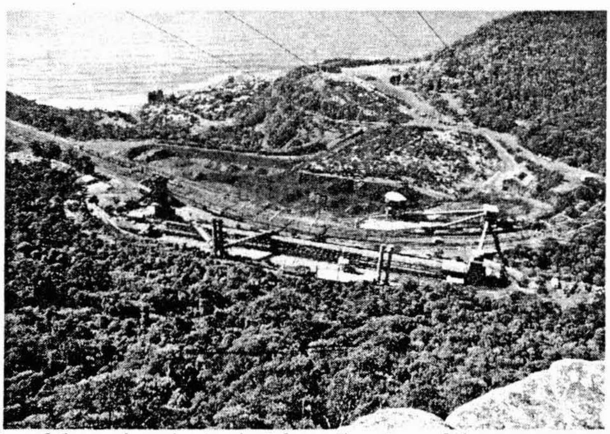

Fig. 2.1, Photo of the coke plant, shot from the .top of the escarpment behind the cokeworks.

It shows the heavily vegetated landscape stretching to the Pacific Ocean near the village of Coalcliff. The environment around the cokeworks is home to many species of plants, animals and birds which duplicate those in the nearby Royal National Park.

The 58 ovens of the battery are served with one set of machines, comprising of:

Two charge cars, travelling side by side on the oven top. Two charging holes are served by each charge car. The charge cars are equipped with a cabin, a magnetic lifting device for the charging hole lids, telescopes and air canons.
One coke pusher machine, including leveler bar, pusher ram head and suction including dust filter.
One remote controlled coke quenching car.

The doors are pulled-up and re-installed again, by the use of a central rope winch on the oven.

The plant is equipped with one coal tower and a combined quenching tower accommodating the coke pusher and wharf. Hence, quenched coke is directly withdrawn from the quenching tower.

2. Design of existing ovens on the Coalcliff plant

The design of the existing ovens on the coke plant in Coalcliff is characterized by the following features:

The ovens are made of fireclay refractories.
An anchoring system in its actual sense does not exist. Expansion is absorbed through a joint between the oven main vault (180°arch) and oven front with door arch (60°arch). The buckstays and wall protection plates are fixed (welded and embedded in concrete.)
The sole heating system is encompassed within the oven and therefore does not take advantage of secondary air. The waste gas exits the ovens via two downcomers and then passes into the common underground flue system.
The ovens stand on strip foundations directly in the subsoil. Whilst there is no heat discharge there have never been subsoil problems or sinking ovens etc due to this factor.

3. TKEC ovens on the Coalcliff plant

3.1 Oven design

While the ovens designed and built by TKEC were to come up to the latest state of the art technology and represent a marked improvement over those ovens installed thus far, they had to be integrated into the existing plant and be operable by existing machines. . On the basis of recorded repairs performed on the existing ovens in the 80s, TKEC chose the following oven dimensions:

Oven dimensions of TKEC ovens, inside, hot:

Length:	≈10,900mm
Width:	≈ 2,670 mm
Height:	≈ 2,500 mm

The summary given below on the refractory structure already outlines substantial differences in TKEC's oven as compared with those ovens used thus far:

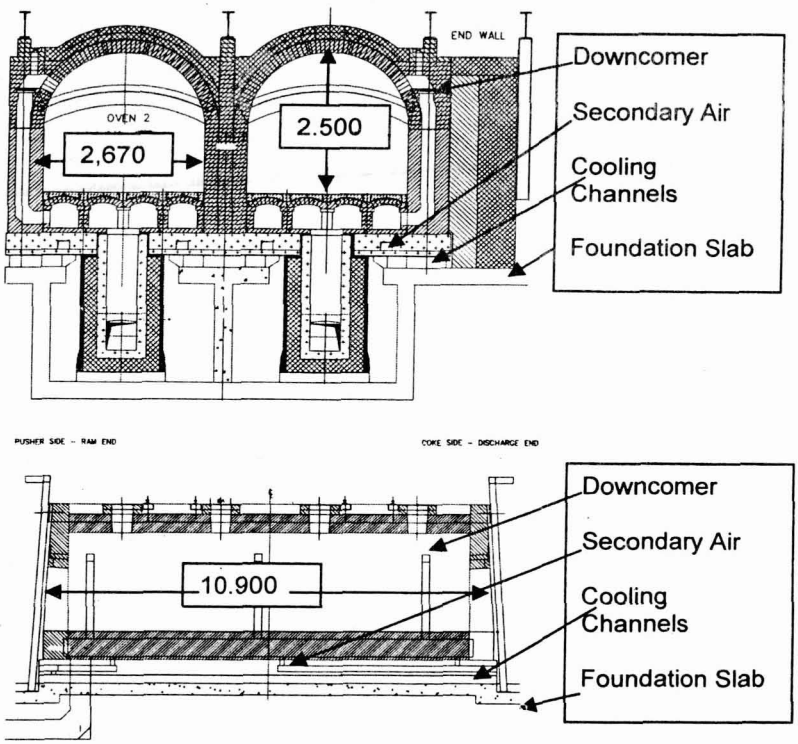

Fig. 3.1.1/2 - Refractory Cross Section

The main features and differences are summarized below:

- Now the ovens are made of silica.
- There is an anchoring system with mobile buckstays and adjustable springs.
- Only three downcomers per oven wall are provided, which can be adjusted individually via a slide brick.
- The sole heating has got eight air intake ports for secondary air which are adjustable.
- The oven stands on continuous reinforced concrete slabs; cooling air can discharge the heat through the steel girder layer.

The ovens were connected to the existing waste gas flue of the battery. The following figure shows the waste gas route and the structural setup of the waste gas channel.

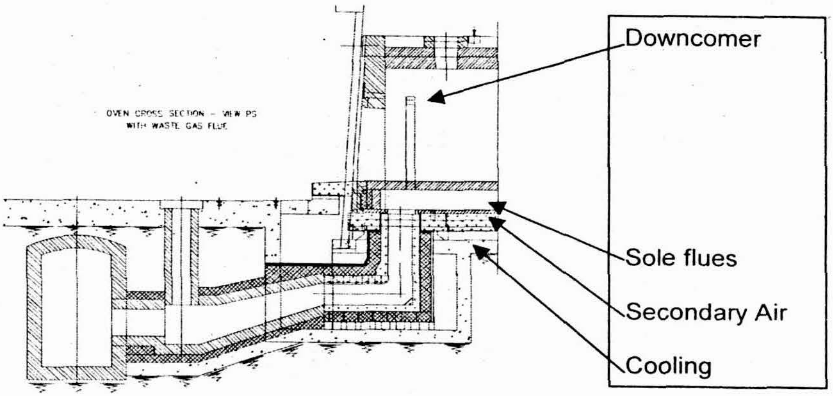

Fig. 3.1.3 – Waste Gas Channel

The anchoring with a Non-Recovery oven must fulfil tasks which differ from those to be satisfied by a conventional coke oven. Hence there is no need for a pre-tension of the wall. The main aim is merely to promote a uniform expansion of the brick structure during heating-up. Thus it is possible to take substantially smaller dimensions for the anchoring than those to be taken for a conventional coke plant. The upper oven anchoring is taken-up via stub anchors and introduced into the support bearing for the charging car track beams rather than through conventional tie rods.

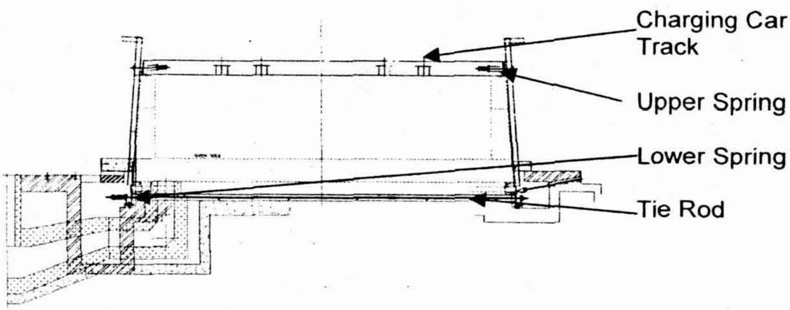

Fig. 3.1.4 – Bracing

The lower anchoring has got a continuous tie rod, it is equipped with springs on machine side only because access to them is easier there.

The accessibility of springs and air flaps certainly is a compromise, because the new ovens attain a major construction height due to air cooling, insulation layers, and secondary air feeders. As the coal charging car track and oven sole represent the fixed points here, it was necessary to build deeper into the subsoil, implying a worse situation in terms of expenditure and handling as compared with a new plant.

The buckstay is pulled by two tie rods from the springs against the oven front. It exerts pressure via a total of eight pressure bolts onto the wall protection plate and via four pressure bolts onto the separate wall protection plate for the oven sole area.

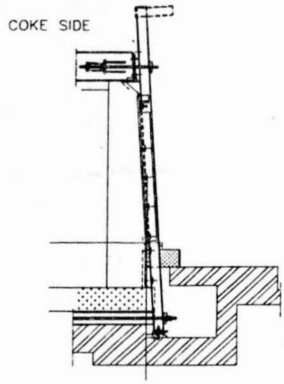

Fig. 3.1.5 – Buckstay

The actual oven front and the buckstay are inclined by 3,5°, while the oven sole area is vertical.

The buckstay rests on a glide bearing at its foot point. At its upper end, a gallows is mounted to accommodate the deflection pulley for the door opening winch.

The pressure bolts of the buckstays exert their force onto the stiffened wall protection plates. By way of the steel plate mounted in the area of the door arch, the refractory material is protected against wear and tear when the door is pulled up. This combination of wall protection plates - on which the door rests and glides, too - and the steel plate mounted in the door arch in mobile arrangement towards the wall protection plate, forms the chamber frame. Hence, it only consists of flat steel with stiffeners rather than of cast iron.

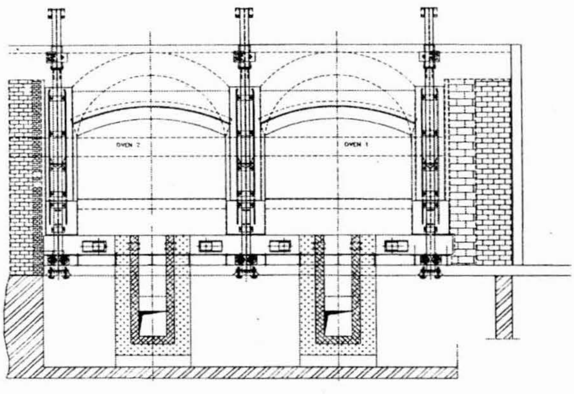

Fig. 3.1.6 – Chamber Frame

The doors are identical in design to the existing ones and will be modified later-on, if required. But the winch to open the door just allows for installation of very light-weight doors, thus restricting potential improvements.

The ovens are heated-up by means of two heat-up burners each. The burners are installed into door apertures, heating-up the ovens for three weeks until a temperature over 1,000 °C is reached. The heating-up for the next ovens shall be performed approx. within two weeks.

3.2 Construction of TKEC ovens

Work on the ovens started in October 2000. At first it was necessary to build a bridge over the still existing ovens no. 1,2, and 3 in order to ensure proper operation of the charge cars and the remaining battery. Upon completion of the bridge, the "old" ovens 1 and 2 as well as the buttress wall towards the coal tower were demolished ,and the construction pit was excavated. Oven no. 3 which was still standing but shutdown had to be braced horizontally, due to the battery slope of approximately 1 %. Previously the ovens were supported by the buttress wall.

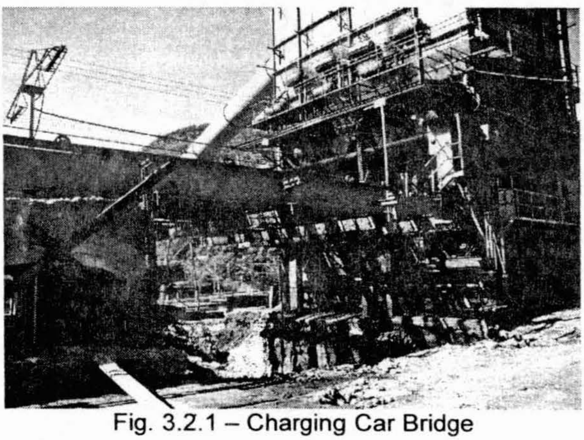

Fig. 3.2.1 – Charging Car Bridge

Shortly after the auxiliary structures were installed, very heavy unseasonal rains were experienced readily converting the construction pit into a pool. The unseasonal weather has accompanied construction work till now, entailing frequent delays. The site location at the foot of the steep escarpment represents a problem as rainwater collected on the plateau soaks into the lower soil stratum, thus directly entering the construction pit and other structures at a point some 2 m below the soil surface. In the worst case it meant that water even flowed through the 1,000 °C hot waste gas collecting duct and into the construction pit. Sump pumps had to be installed and at times did not always cope with the immense volume of water – thus an oven shelter also had to be installed.

Due to the rain the initial progress on the ovens was much slower than planned and the original canvas shelter was later replaced with a permanent steel structure. After the phase of familiarizing with the work, nearly 1 tonne of normal bricks per bricklayer and one helper were laid in wall construction within a shift lasting 10 to 12 hours.

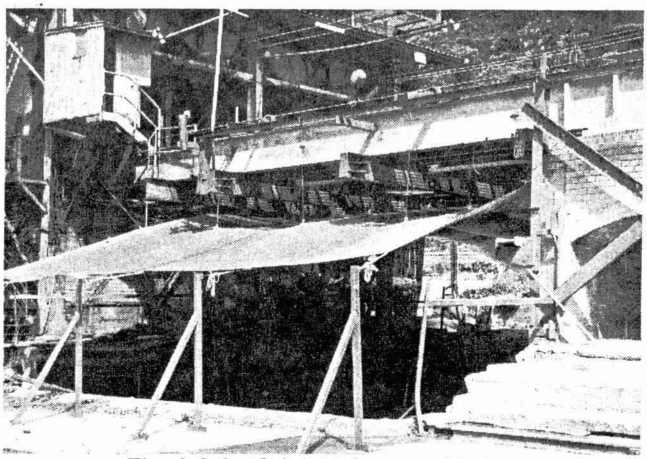

Fig. 3.2.2 –Original Canvas Shelter

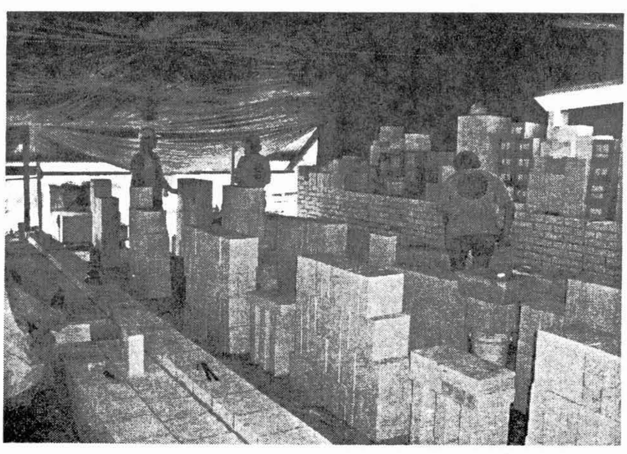

Fig. 3.2.3 – Bricklaying

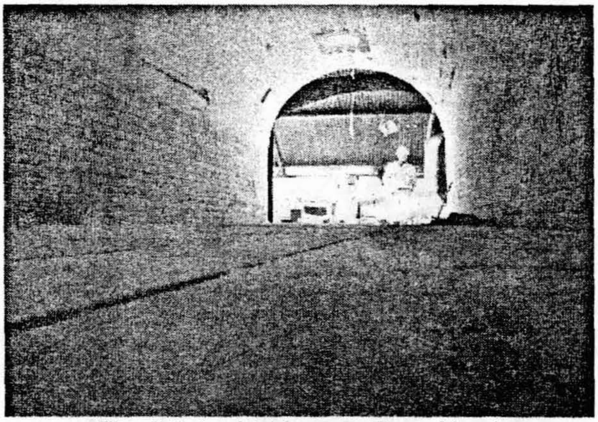

Fig. 3.2.4 – Inside new Oven No. 1

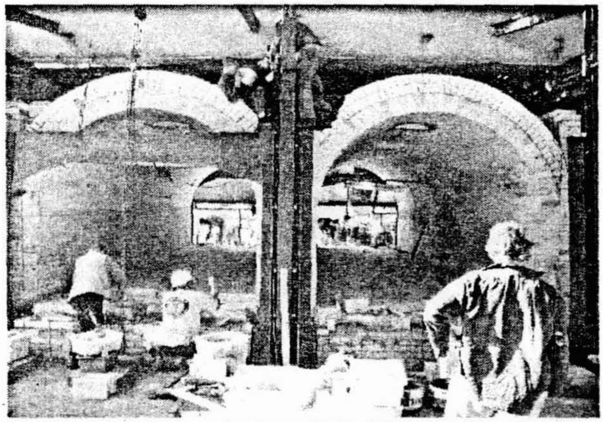

Fig. 3.2.5 – Installation of Wall Protection Plates

In most instances, 4 to 6 bricklayers plus 4 to 5 helpers were assigned to the job. The small number of brick shapes- i.e. 8 different shapes - and the far-reaching use of normal bricks in principle made refractory build-up an easy job, though expenditure on cutting in view of this small number of shapes was comparably high. Essential brick shapes were merely the arched bricks and the abutments in the sole area. Silica bricks and mortar were delivered by Dr.-C. Otto, Germany. Fireclay, grouting compounds, etc. were supplied by Bulli Refractories, Australia.

The Ovens were heated up with two burners per oven to approx. 1000°C and have been in full operation since 4th of June 2001.