Retrofit of State of Art Coke Oven Machinery Technology in Existing Coke Plants [1]

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Summary
The retrofit of coke plants, in particular of older plants, more frequently includes the supply of new coke plant service machines. Moreover, environmental protection requirements force more and more plant owners to install environmental protection facilities such as hood cars or coke transfer machines. But coal charging cars and pusher machines, too, are increasingly equipped with appropriate facilities to come up to the latest state of the art in cokemaking technology. An exchange of machines often confronts plant owner and vendors of new machines or new machinery components with hardly solvable problems. Primarily it matters to continue coke production despite substantial interventions, e.g. the installation of efficient environmental protection facilities. This paper is meant to help recognize the problematic aspects of such projects and find ways for their proper solution.

Keywords:
Coke Oven Machinery, Replacement, Retrofit, Modernization, Environmental Protection

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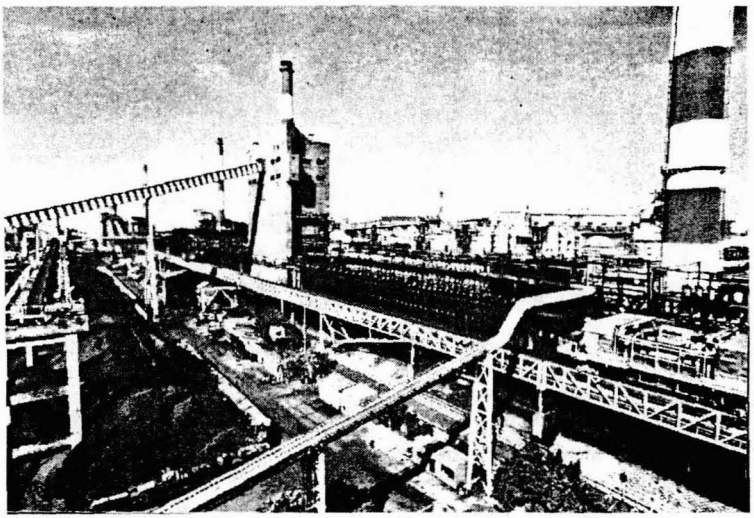
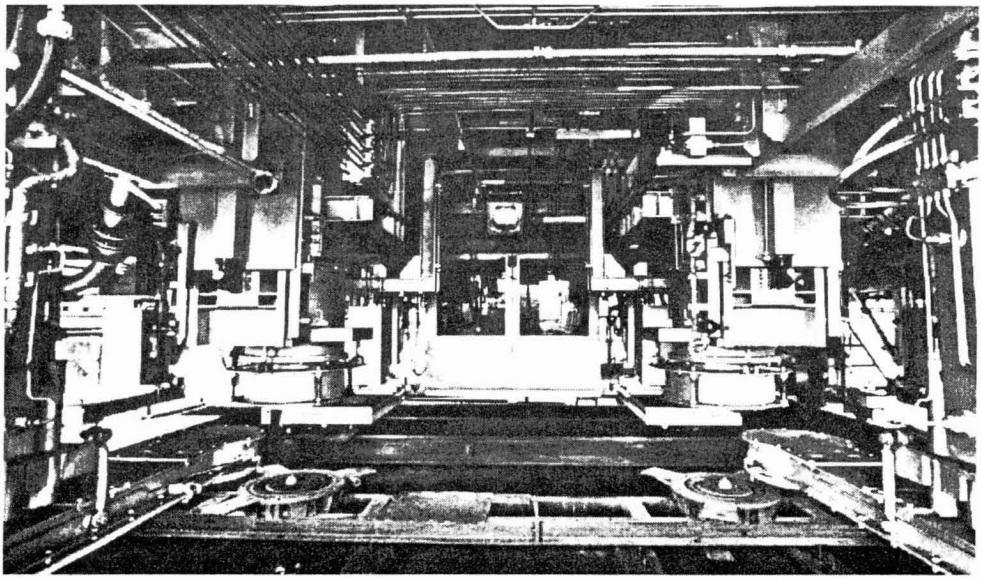


China Steel Corporation Coke Plant in Kaohsiung Taiwan – Total View

What causes plant owners to think about new machines? As a consequence of the development of high-capacity coke ovens being over 6 m tall, plant owners changed their attitude towards equipment maintenance. Meanwhile, the service life of coke oven plants can virtually be doubled by preventive maintenance as compared with formerly usual values.

But as a result hereof, plant owners are more frequently bothered by the question for whether or not to replace their machines

- because they are worn-out and do no longer meet the latest state of the art in technology
- because they fail to be operationally safe, thus necessitating tremendous expenditure on maintenance, while operation failure times constantly entail huge costs
- because they do not dispose of practical oven service devices, thus calling for additional operation personnel
- because they do not allow for an oven operation that protects the oven and contributes to environmental protection, so that the plant as a whole suffers and plant personnel as well as the environment are exposed to dust, gas, and noise burdens.



View Against Charging Car Driver's Cabin for a 6 m Tall Battery

What does plant owner have to consider before inviting tenders for new machines?

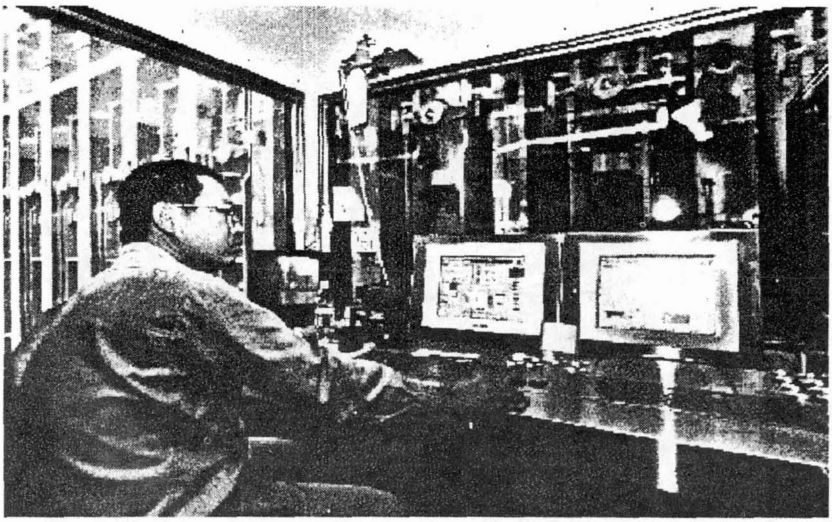
New machines are often much heavier than existing ones. Dimensions in length, width, and height have been enhanced. Space conditions such as parking lots and service positions fail to exist as required.

- Not all of these additional loads can be offset by a distribution of loads onto more wheels. A new construction of tracks, foundations, and even entire plant units might be required.
- And if space conditions are too tight, it might even be impossible to find and implement the optimal solution.
- Production must not be disturbed at all, and if so, just as little as possible.

Hence, before getting concrete on a replacement or new construction of machines, respectively, one will have to elaborate a feasibility study which investigates and evaluates all those restrictions and obstructions outlined above.

The outcome of this study will furnish competent information on whether a replacement can be effected only in a design and construction identical with the existing one or whether an optimization, e.g. implementing a new technology, is feasible.

These are some of the reasons why plant owners contemplating such a replacement measure should closely cooperate already at this stage with a machinery manufacturer or plant builder for coke oven facilities.



Coke Transfer Machine - Control Station

If the prerequisites for an inquiry are settled, and if it has been submitted to competent companies, bidders will have to familiarize themselves with local conditions.

Depending on bidder's background, he will either just look after a solution of the actual machinery problem if he is a mere manufacturer or, respectively, take care of the overall plant problems, if he is a plant builder for cokemaking technology.

What is called for is a bidder solving problems rather than a vendor supplying equipment.

The relevant bids will consequently be quite different. And plant owners should realize that the evaluation of such bids calls for special care and diligence.

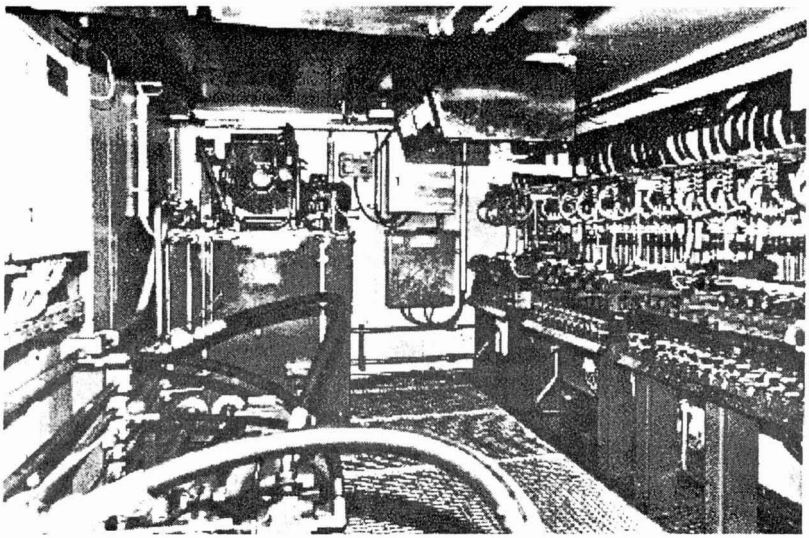
The examples given below will elucidate how TKEC performed replacements of machinery on producing plants in the past:

- supply of a new coal charging car to Sidmar, Gent, in Belgium
- supply of a new complete set of machines for the plant Triest in Italy and
- supply of 3 new coal charging cars and 3 new coke transfer machines to CSC in Taiwan.

The task set for the new coal charging car to be delivered to Sidmar called for:

> automatic operation of all oven functions, emission-free coal charging, and installation of the coal charging car while causing no interruption in coke production, to be accomplished by delivery of a complete unit and erection of this unit onto oven top ready for commissioning, in one day only.

The demand for an automatic operation of all oven functions was surely met.



Hydraulic Station of a Modern Coke Oven Service Machine

Measures to be done at the oven, for example standpipe and oven top alignment as well as installation of automatically operable actuation devices, were already accomplished by TKEC within the scope of an oven repair which had been part of an overall problem solution.

But satisfying the demand for an emission-free charging of coal would have necessitated extensive reconstruction work on oven top. Apart from the actual construction work and the relevant cost thus entailed, it would have involved a high loss of coke production, too.

The plant suffered from very serious graphite formation which was due to the oven design and to very steep charging hole outlets, making it nearly impossible to ensure optimal coal charging into the oven chambers.

Nevertheless, in order to achieve the maximum possible emission-free coal charging, it had to be tried to realize a complex system of measures.

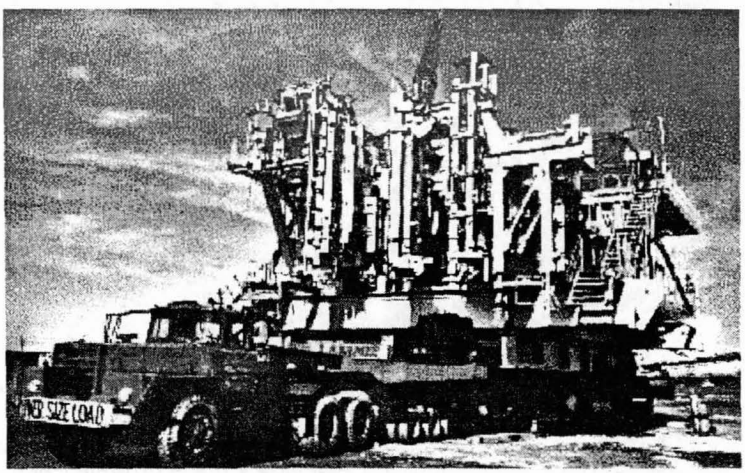
The coal discharge elements were built as gastight units which were not yet state of the art at that time.

The control of the coal conveyor screws were so designed that each oven could be charged with its proper coal volume that was determined individually in advance because the oven chambers differed in their charging volume by up to 1.5 m^3.

The coal level bar area was provided with a device making it possible to minimize the intake of air into the oven while the leveler door was open.
Activation of the leveler bar drive was so reconstructed that it could be effected from the coal charging car.

The actual coal charging procedure was properly arranged so as to allow for free discharge of charging gases to the standpipe during the entire charging time. Thus it was managed to charge the chambers up to a higher level, reducing the formation of graphite and moreover leading to a higher throughput rate.

Operation later-on demonstrated that these measures brought a substantial reduction in emissions.

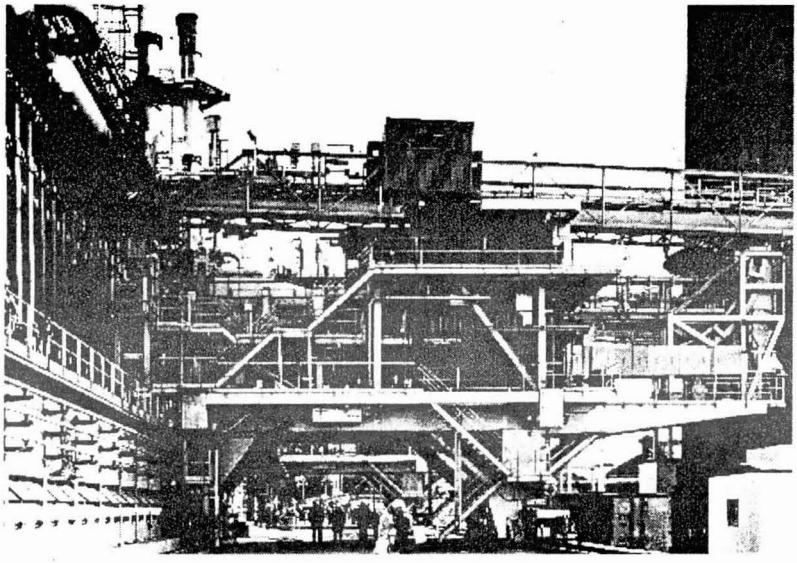


Transport of a Completely Assembled Ready-to-Operate Coke Pusher Machine to the Plant

Finally it was still required to meet client's wish for an assembly and installation of the coal charging car that would not obstruct coke production. The machine was completely assembled at manufacturer's works and all the functions including the machine travel on tracks temporarily laid at manufacturer's works were tested.
Then, the ready-assembled machine, having a weight of approx. 160 tons, was mounted on a transport structure and loaded onto a marine pontoon and transported via the North Sea and certain channels to the quay of the Sidmar plant. Transportation from there was effected on a heavy truck to the coke oven battery. By the aid of a special crane with a mast length of over 60 m, the charging car was then lifted onto the oven top. In advance, one of the two existing coal charging cars was taken away from the oven top.

It was managed to execute the whole process of machinery exchange within a single work shift without any interruption in normal production. Once the coal charging car was plugged to electric power supply, adjustment and fine tuning work could be started. After approx. one week the machine was taken over into production operation.

To obtain a further operation permission from public authorities in Triest, the client obligated himself to elevate environmental protection there to the latest state of the art in technology. To this effect an existing battery and one set of machines, comprised of a coal charging car, a pusher machine, a coke transfer machine and a quenching car were replaced in the first phase.



View of a Coke Pusher Machine with Hinged Pusher Ram on a 6 m Tall Battery

The difficulty of this replacement measure lay in the need of having to integrate new one-spot machines into very limited space conditions during running production and at ovens of different dimensions.

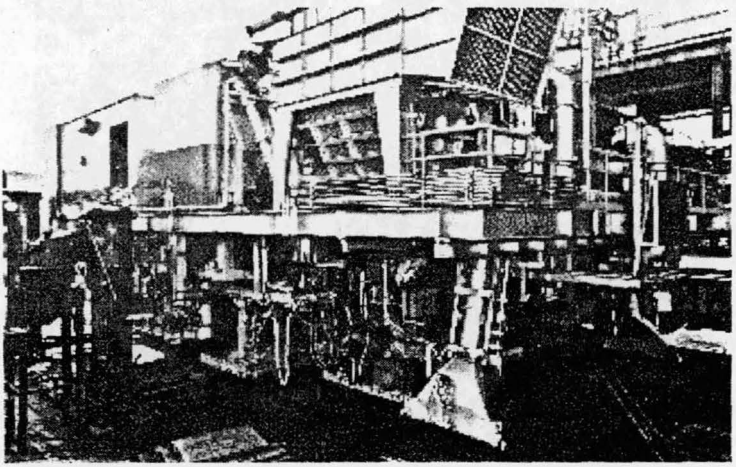
Similar to the approach gone for Sidmar, the machines for this application here were also assembled completely and tested at manufacturer's works, delivered as a complete unit and placed by cranes onto the tracks. The battery with a lower oven height which was not renovated received a track chair on oven top. The charging car drop sleeves and hoppers were so designed that the different levels and oven charging quantities could be reached. To be able to accomplish oven operation in end oven areas despite the standby machines parked there, the new machines had have to be of such a design that they fitted well into the profile of the standby machine.

The pusher machine was equipped with a leveler equipment which is adjustable in height in order to allow for its automatic adaptation to the different level of the batteries. The door cleaner had to be made slightly sinkable in order to allow for passage under existing building structures.

The coke side service platform of the new battery received a supporting structure to make oven operation possible even with standby coke guide cars. It was planned to dismantle this support structure during the second construction phase because the service platform height would then match the level of the new battery. Therefore, the support of the battery-side chassis structures of the coke transfer machine was so designed and constructed that the new level of the service platform could be reached by way of appropriate adapters.

As the positions of the existing coke quenching tower and the plant boundaries were so unfavorable that the quenching locomotive would always have had to travel through the quenching tower in conventional mode of operation (with locomotive), a rope winch system was implemented for the quenching car operation.

Though conditions prevailing on this plant were very complicate, solutions were found and implemented with have meanwhile enabled a trouble-free, safe coke plant operation for more than years.



View of Coal Charging Car - China Steel Corporation in Kaohsiung Taiwan

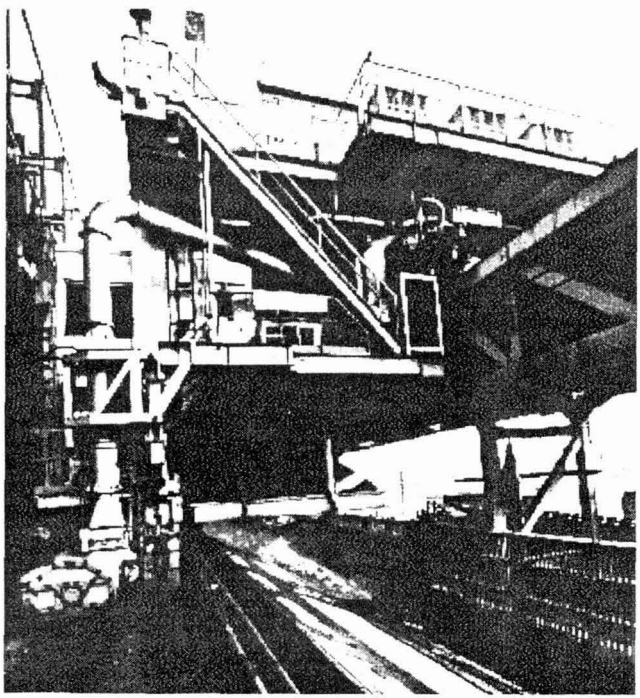
Apart from the two examples of a very successful problem solution as described above which were realized long time ago, the next example will describe a case which at the time of this paper still undergoes final measures of job execution.

The set of problems existing here called for extreme wealth of ideas and very strong willingness for cooperation from both plant owner and plant builder. It is a retrofit measure implemented on the coke plant of China Steel Corporation in Kaohsiung, Taiwan.

The 6 m tall batteries existing there were built by TKEC in 1977, 1981, and 1993. The task demanded by client was to standardize environmental protection, operational safety, and technology on the whole plant, particularly for coke guide cars and hoods which were to be replaced by modern coke transfer machines to ensure a higher rate of dust acquisition at source.

Moreover, coal charging emissions were to be eliminated by way of a modern coal charging technology including charging gas combustion in conformity with the relevant codes applicable in Taiwan and through an optimization of existing facilities for charging gas suction.

Furthermore, a successful implementation of new machines at existing facilities demanded a catalogue of measures to be effected at the ovens and in the machinery design, too.



Coke Transfer Machine during Coke Pushing

The rails on coke side service platforms were renewed.

For example, Battery A received new standpipe elbows, while batteries 1,2,3, and 4 were equipped with new standpipes. Additionally, at batteries 3 and 4, it was necessary to install a new gas collecting main. Within the scope of an oven top repair on batteries 1 to 4, the charging hole frames were newly positioned and aligned in appropriate arrangement to each other. All 5 batteries required alignment of charging car tracks to a new mean standard.

As the oven fronts had displaced against each other by up to 120 mm, the oven service facilities of the coke transfer machines were so designed and built that they allowed for a trouble-free operation at all batteries.

The revamping work done to the crude gas system of the batteries was accomplished during the 14 days' standstill of the batteries which had already been planned before. All the other work was carried-out in running operation.

The wharf-side bogies of the coke transfer machines were equipped with hydraulically actuated level offset devices because the difference in height of the old hood tracks accounted for up to ± 100 mm, measured over their entire length.

During each oven cycle, these devices bring the machine into a horizontal position by way of an automatic actuation of the hydraulics.

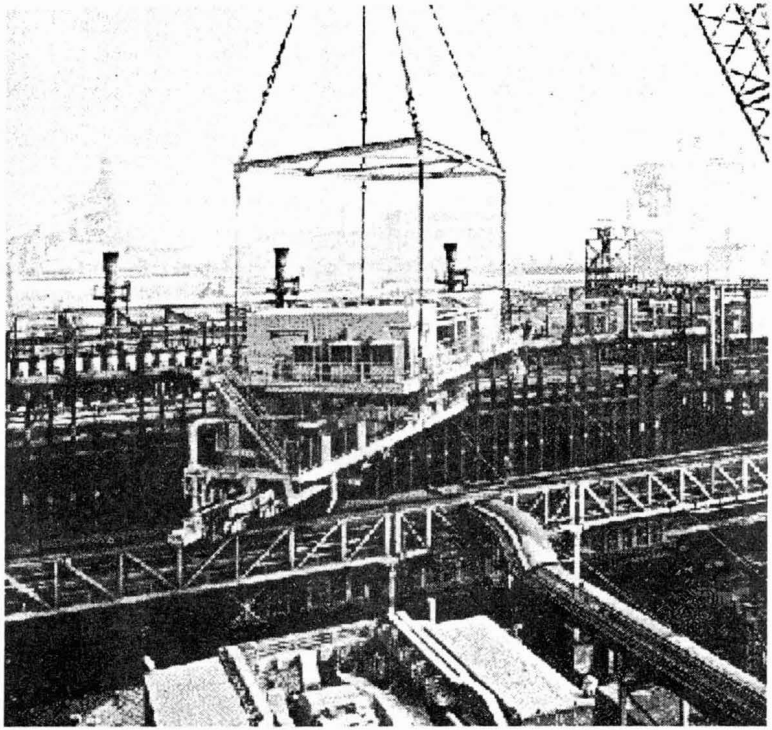
Jointly with TKEC, CSC decided to opt for this solution because if the track had been re-aligned one would have had to put up with substantial interferences to operation and losses of production.

Similar to the approach pursued on Sidmar and in Triest, the 3 coal charging cars and 3 coke transfer machines were completely mounted, tested and adjusted at the point of assembly. In this case, however, the point of assembly was in the immediate vicinity of the point of use. By the aid of a crawler-type crane the machines were placed onto their tracks, ready for operation. It was possible to move the crane carrying the machine by up to 10 m.

Already 40 minutes after put onto the tracks, each coke transfer machine was able to move independently to its proper position for adjustment.

The assembly spots of all machines were equipped with test stations so that the adjustment work as well as all the training courses for operation and maintenance crews could be carried-out there.

The intensive co-operation with the client and the nearly unlimited willingness to collaborate within a perfect team of all engineering divisions concerned both with the client and TKEC led to an optimal overall solution of the set task.



Coke Transfer Machine Lifted To Point Of Use

The examples for solution as described in this paper outline the problems associated with a replacement of machinery during running coke plant operation. The proposals and suggestions given herein should be helpful to solve similar problems successfully.