PRELIMINARY

# DRY COKE-QUENCHING
## Proven, Profitable, Pollution-Free Quenching Technology

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Environmental control and energy crisis have become household words in many industries and there is no doubt that the underlying problems are very serious, especially in the iron and steel industry and in the related coke industry.

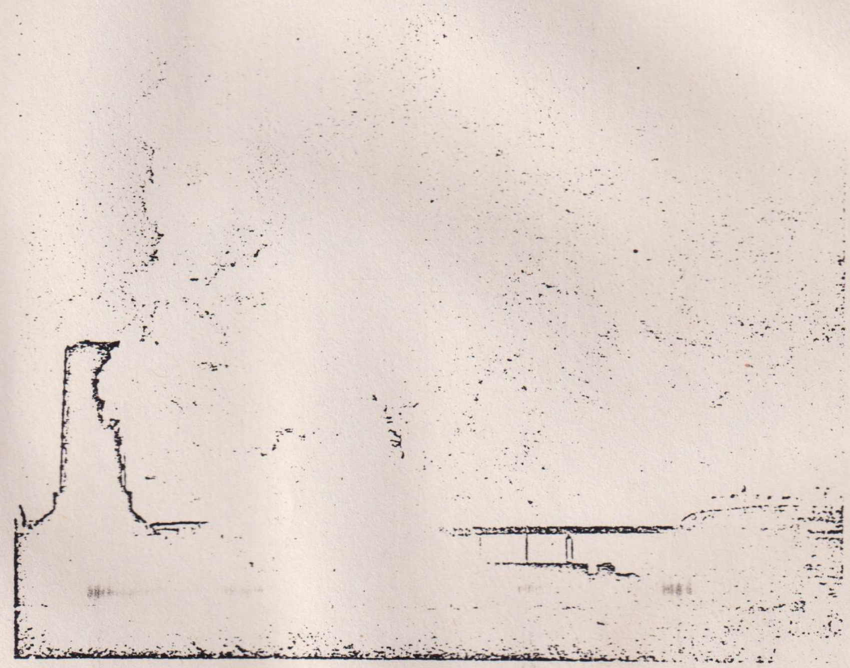

Figure 1: Pollution From Typical Wet Coke-Quenching Plant

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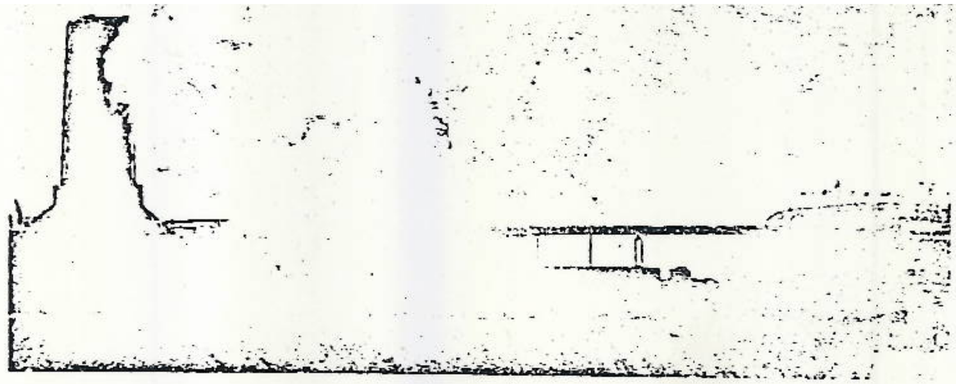

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Considerable interest has been focused in recent months on dry coke-quenching because this technology offers significant advantages for coke plants in the fields of pollution control as well as energy recovery. As a matter of fact, it is this combination, pollution control/energy recovery, that makes the process economically attractive. Few, if any, other pollution control technologies offer a return on the initial investment; that is, most pollution control installations are non-revenue producing and require in addition relatively high operating and maintenance costs.

Dry coke-quenching is not a new process. It is actually an old art, developed shortly after World War I by Sulzer Brothers, Winterthur, Switzerland. At that time the process was used mainly for the purpose of energy recovery, which always has been a big issue with the traditionally more economy-minded Europeans. Over 70 coke plants in gas works and some steel mills were equipped with dry coke-quenching units up to 1950. Although most of these gas works installations were shut down when natural gas became readily available, there are still some dry quenching units in operation in European steel mills today, two of them with more than 40 years of trouble-free service. One of these two is located at Ford-Dagenham in England (Figure 2), the other at Wendel-Sidelor, Homecourt, France (Figure 3).

Russia adopted the dry quenching technology in the early sixties and has now made it mandatory for all new coke plants. There are to date 28 dry quenching plants in operation in Russia and 24 more in the construction or design stage. The Russian units, as a rule, are larger than the

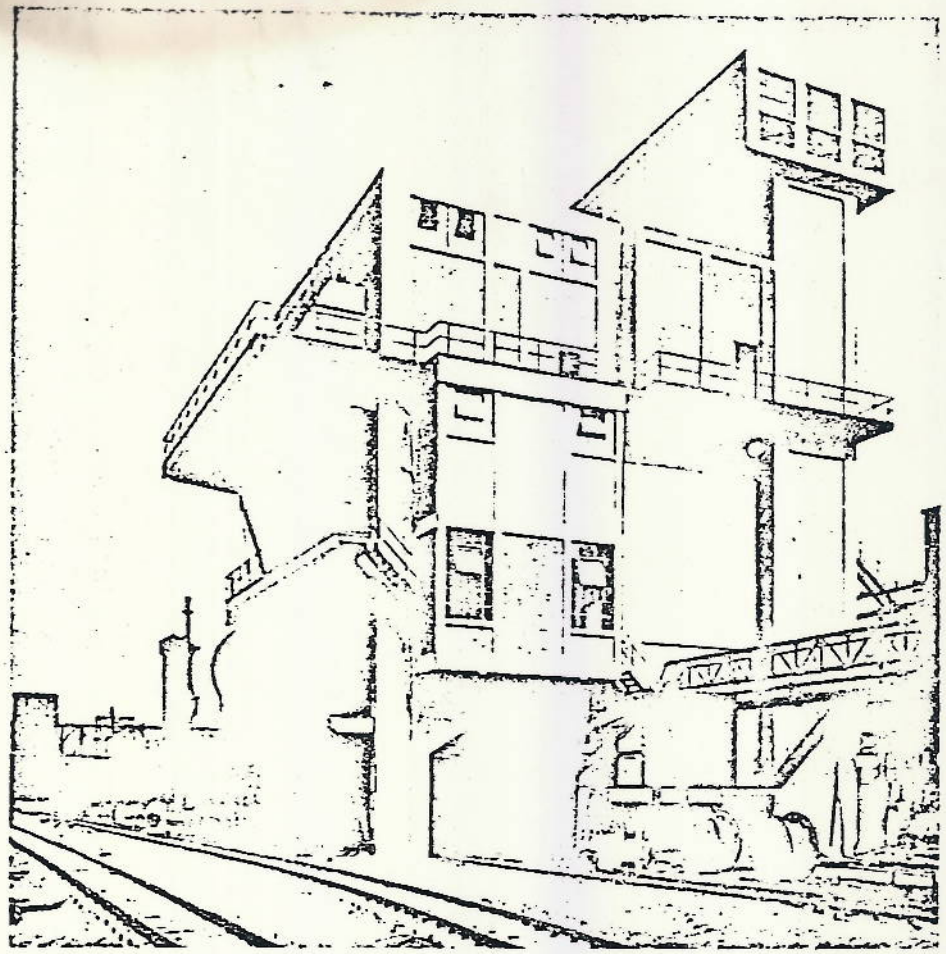


Figure 2: Dry Coke-Quenching Plant In The Coke Works Of The Ford Motor Company, Dagenham, England

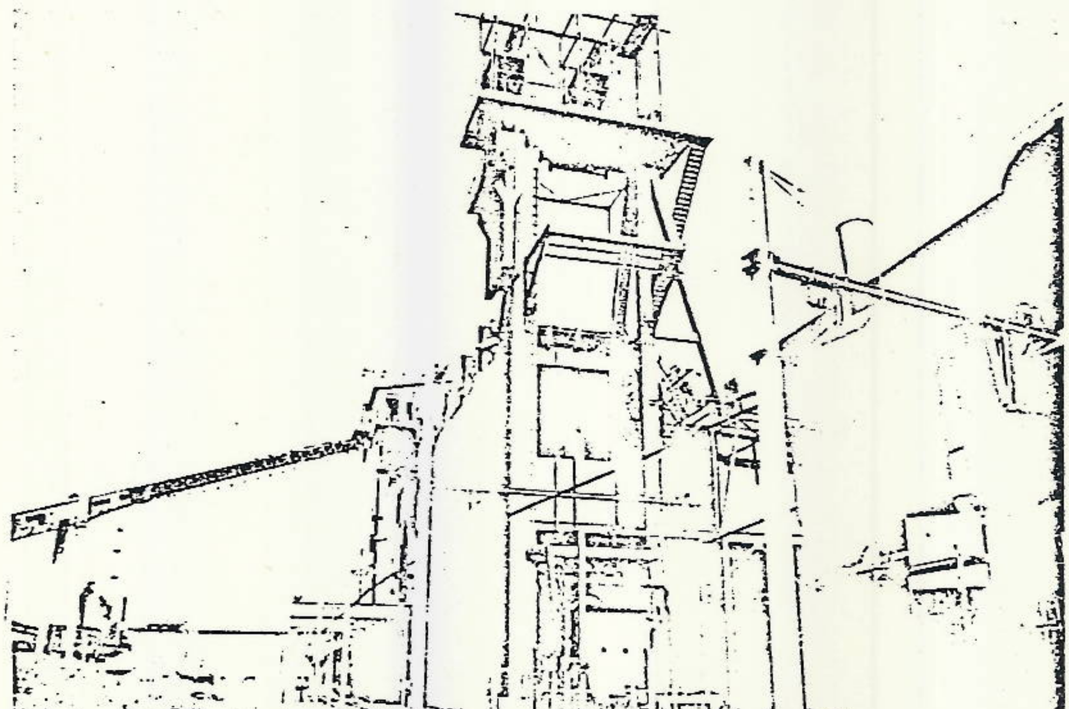


Figure 3: Wendel-Sidelor Dry Coke-Quenching Plant Homecourt, France

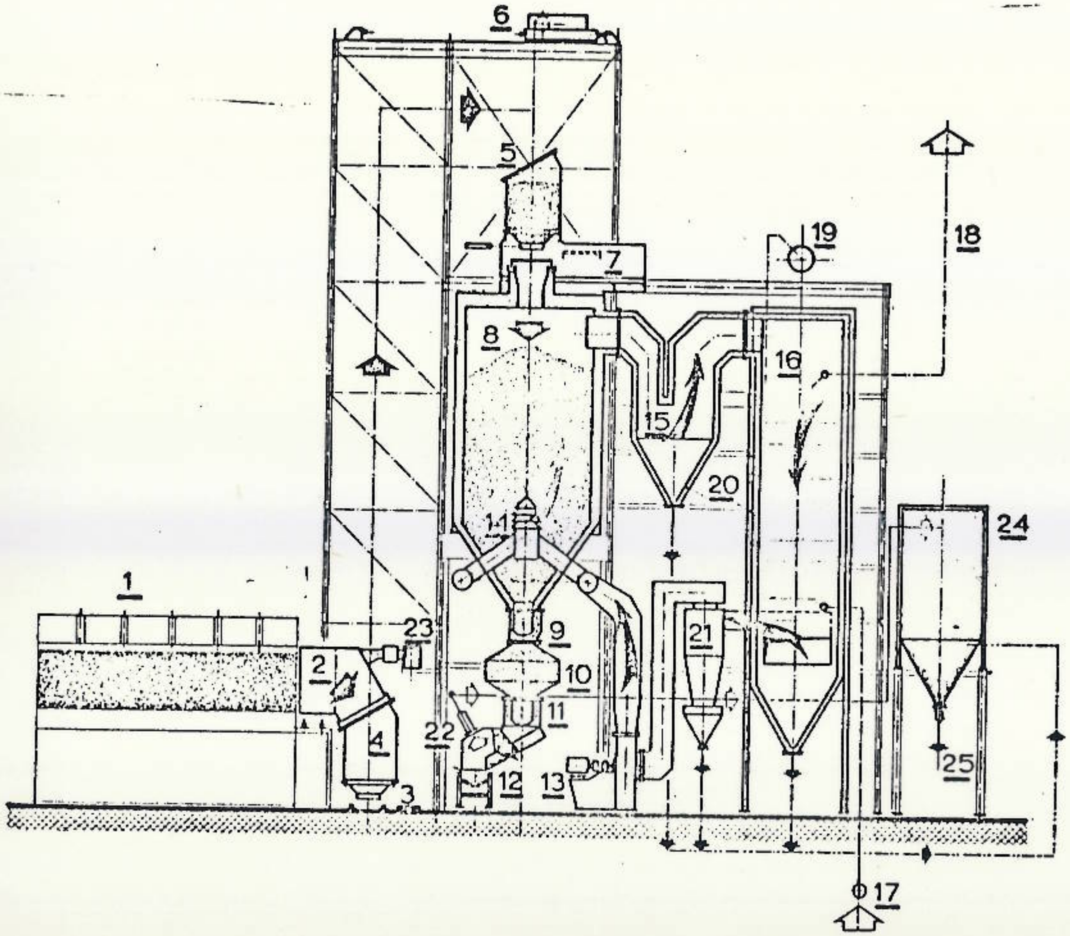
other European units but follow essentially the same design and operating principles developed by Sulzer. Whereas the European installations were built primarily with the energy recovery aspects in mind, Russian sources indicate that the improved coke quality resulting from the dry quenching was, at least in the beginning, the driving force behind the adoption of the dry quenching technology. In the USA, stringent air pollution regulations are probably the main reason more and more coke producers are looking into dry quenching, whereas the energy recovery, improved coke quality, etc., are considered as desirable side benefits.

Although most of the side benefits are real, substantial, and can be measured, only the energy recovery in the form of steam generation or gas preheating has received full recognition in the economic evaluation of the process. The other benefits, such as increased coke hardness, strength, stability and size uniformity, reduced breeze and blast furnace coke rates, to name just a few, are either not taken into account at all or are applied very cautiously, i.e., with a very high uncertainty or safety factor, when the economics of the technology are investigated. This attitude reflects the lack of, or very limited experience with dry coke-quenching in this country, and also the fact that only a few long-term, systematic tests have been carried out to determine the improvements that can be expected in actual plant operation. Nevertheless, the measurements and tests have yielded results that establish a clear improvement pattern, although there are some differences depending on the coal mix and other factors.

Dry coke-quenching is basically a simple process. Nevertheless, it requires considerable knowhow and operating experience to design a plant which, by necessity, must operate 24 hours a day for many years with an absolute minimum of repair and maintenance work. Dry quenching, as the name indicates, is a dry process. Commonly used quenching media, such as water or flushing liquor, are replaced by an inert gas. This inert gas acts as cooling and heat transfer medium. It is continuously recirculated in a closed-cycle operation, taking the heat out of the incandescent coke and dissipating it in a waste heat boiler. This heat can be used for steam generation and/or, in a gas-to-gas heat exchanger, for preheating gas. This preheated gas may, in turn, be used profitably in other phases of the coking process, for instance, for coal drying and/or preheating.

The flow sheet (Figure 4) gives the basic process characteristics. The incandescent coke is brought to the dry quenching station in a transfer car or a specially designed bucket located on the transfer car. The car or the bucket is then lifted to the top of the cooling bunker by means of a skip hoist arrangement or crane trolleys. The bunker top is designed in a way that positively prevents air pollution during the charging operation. This is accomplished by special seals, varying fan speeds, and exhaust equipment in connection with appropriate dust collectors.

The dry quenching station consists, in essence, of the refractory lined cooling bunker; the hoisting equipment for lifting the incandescent coke to the top of the bunker; the steam generator (waste heat boiler) for heat recovery; the fan for recirculating the inert gas; the double-seal



'DRY COKE-QUENCHING, FLOW SHEET

1 COKE OVENS
2 HOODED COKE GUIDE
3 TRANSFER CAR
4 HOT COKE BUCKET
5 BUCKET LID
6 CRANE TROLLEY
7 BUNKER TOP SEAL
8 COOLING BUNKER
9 BUNKER BOTTOM SEAL
10 MEASURING HOPPER
11 DISCHARGE EQUIPMENT
12 CONVEYOR
13 INERT GAS FAN
14 GAS DISTRIBUTOR
15 DUST DROP OUT CHAMBER
16 WASTE HEAT BOILER
17 FEED WATER SUPPLY
18 STEAM MAIN
19 STEAM DRUM
20 REFRACTORY LINING
21 CYCLONE
22 COKE TRANSFER POINTS EXHAUST
23 PUSHING EMISSION EXHAUST DUCT
24 BAG HOUSE
25 DUST DISCHARGE

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Figure 4

measuring-hopper discharge equipment for releasing the cooled coke at the bottom of the bunker onto a conveyor; the dust extraction equipment for removing the particulate matter from the circulating gas stream; and auxiliary equipment and controls required for a smooth, semi-automatic operation of the plant. Since the plant is operated in a completely closed cycle and is sealed off from the atmosphere, even during charging and discharging, there is no air pollution.

The inert gas cooling and heat transfer medium is free, i.e., the inert gas is formed from an initial intake of air whereby the oxygen content of the air reacts with the coke to form $CO_2$. This creates an inert circulating gas of the following composition:

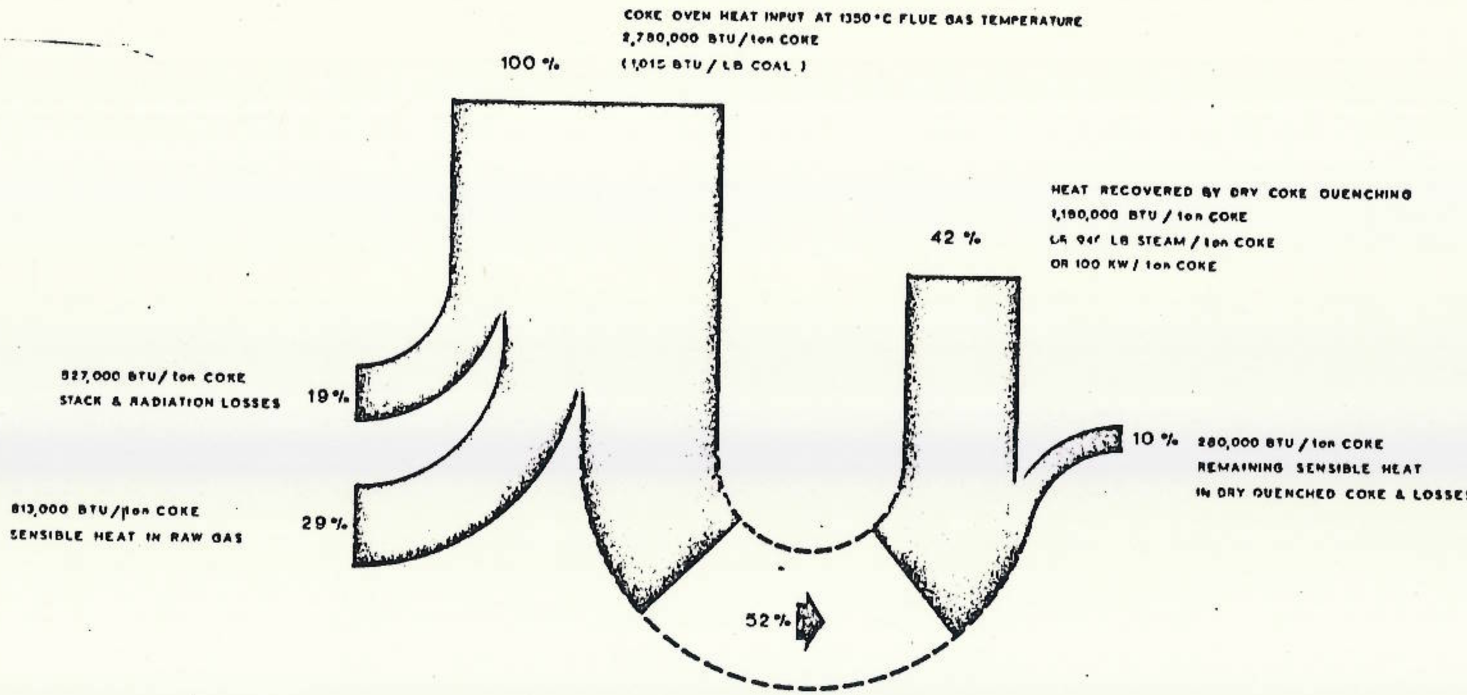
| | % |
|---|---|
| $CO_2$ | 14.5 |
| $O_2$ | 0.4 |
| CO | 10.6 |
| $H_2$ | 2.0 |
| $N_2$ | 72.5 |

There might be slight variations from case to case, and cyclic fluctuations, but the above figures can be assumed to be average, representative values. The almost total absence of oxygen eliminates the danger of explosion, and there is no case on record that a dry quenching unit ever developed explosion hazards or had an explosion. It is, nevertheless, good design practice and adds to the safety considerations of the operation to equip the dry quenching station with strategically located pressure relief doors.

The heat recovery from the incandescent coke in the dry quenching process is substantial, and it is amazing that the concept of recovering heat from the quenching operation has not caught on in this country on a larger scale, especially in view of the fact that great efforts have been made in other phases of the coking process to recover heat from waste gas streams. For example, by employing regenerators, modern coke batteries reach efficiencies of up to 80%. Figure 5 gives a heat balance for the coking process.

For carbonizing one pound of coal 1,015 BTU, or 2,780,000 BTU per ton of coke, are required, 19% of which is radiation and stack losses. Fifty-two percent or 1,440,000 BTU per ton of coke remain as sensible heat in the incandescent coke. Assuming that the hot coke is cooled to 400°F in a dry coke quenching unit, 1,180,000 BTU per ton of coke will be recovered, which is equivalent to 940 pounds of steam.

If electric power generation is considered, the recovered heat would be equivalent to about 100 kW per ton of coke. Again, it is interesting to compare this figure with the energy requirements for the coking process. Energy consumption varies in a fairly wide range from plant to plant. Average values are 8 to 12 kWh for one ton of coke produced. These figures, however, do not include any power requirements for pollution control equipment which, because of federal, state or county air pollution regulations, will have to be installed in new as well as in old batteries in the foreseeable future.




HEAT UTILIZATION WITHIN COAL CARBONIZATION & DRY COKE-QUENCHING

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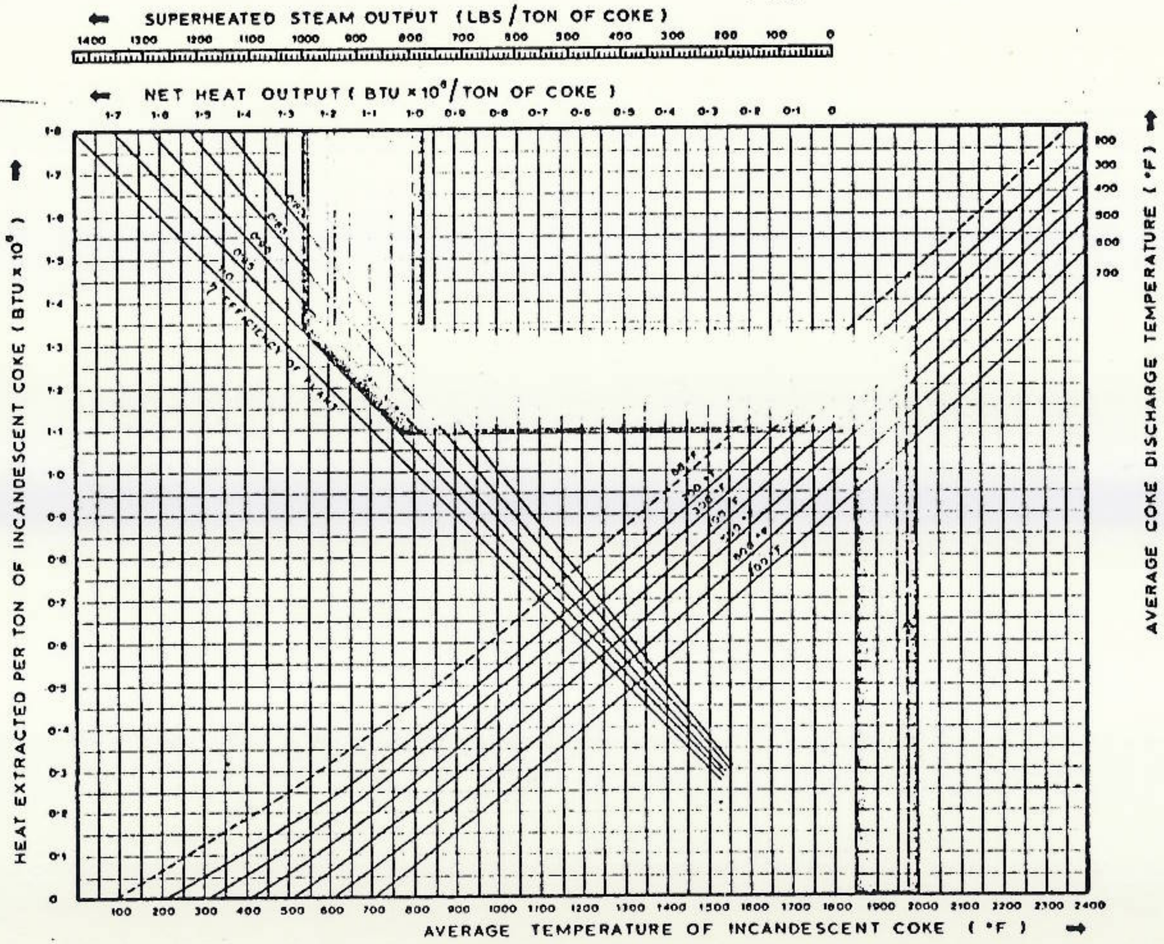
Figure 5

It is an unfortunate fact that most pushing emission control systems now being marketed have a relatively high power consumption and therefore add noticeably to the operating costs of the plant. For instance, installations providing an exhaust hood over the wet quenching car or a shed for the entire coke side of the battery, have about 2000 HP installed, which means that the power consumption for the battery will double.

As indicated before, one ton of incandescent coke yields about one thousand pounds of steam in a properly designed waste heat boiler, or a million usable BTUs. Steam generation, of course, is not a necessity. The waste heat could also be utilized for heating another gas (in a gas-to-gas heat exchanger), which in turn could be used for drying or preheating coal. The shaded area of the heat recovery diagram (Figure 6) shows the ranges in which dry coke-quenching plants operate. The arrows follow a typical example in a modern plant. In the cooling bunker the coke is cooled from the initial 1900°F to approximately 400°F at the discharge gate. The gas temperature at the distributor inlet and boiler outlet is 300°F and at the top of the cooling bunker 1400 - 1600°F.

The residence time of the coke in the bunker varies from two to four hours, depending on the coke plant cycle time, size and number of batteries, bunker size, fan speed, and other basic design criteria. There is no universally accepted optimum that can be applied to any plant. The optimum must be determined for each individual case, taking into consideration the prevailing conditions at the plant. It can be said, however, that development in the more modern plants seems to tend toward larger bunker sizes, shorter




STEAM GENERATING CONDITIONS :
300 PSI, 800 °F SUPERHEATED STEAM
80 °F FEED WATER TEMPERATURE

η = OVERALL EFFICIENCY

EXAMPLE :
WHEN INCANDESCENT COKE AT 1975 °F IS DRY QUENCHED TO 400 °F APPROX. 1,180,000 BTU'S ARE EXTRACTED PER TON. WITH AN OVERALL EFFICIENCY OF η = 0·95, 840 LBS OF SUPERHEATED STEAM CAN BE GENERATED.

HEAT OUTPUT FROM DRY COKE-QUENCHING

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Figure 6

residence times, and a corresponding increase in cooling gas volume. Cooling bunkers with throughputs up to 120 metric tons per hour are now under construction.

Dry quenching units can be employed in any existing or new coke plant because they require a relatively small plot area, are flexible with regard to the physical arrangement of the components, and do not necessarily have to be located in the immediate vicinity of the battery, although this may be desirable and the most economical solution.

Figure 7 gives an example of how dry quenching units can be fitted into existing plants and also shows track configurations for various coke battery line-ups.

It should also be mentioned that since dry quenching is a separate process and not directly interconnected with the battery, a dry quenching facility for an existing coke plant can be built without interfering in any way with the current coke production, which is an important economic factor. Even the switch-over from wet quenching to dry quenching does not require any interruption in production or any alterations on the battery or other existing equipment. The wet quench tower can be left in place, because it normally has sufficient clearance to accommodate the dry quenching transfer car, including bucket, if any, in case the dry quenching station is located at the far side of the wet quench tower, which could, by the way, serve as backup facility in an emergency.

Dry quenching not only does away with air pollution as far as the quenching operation is concerned, it also facilitates considerably the

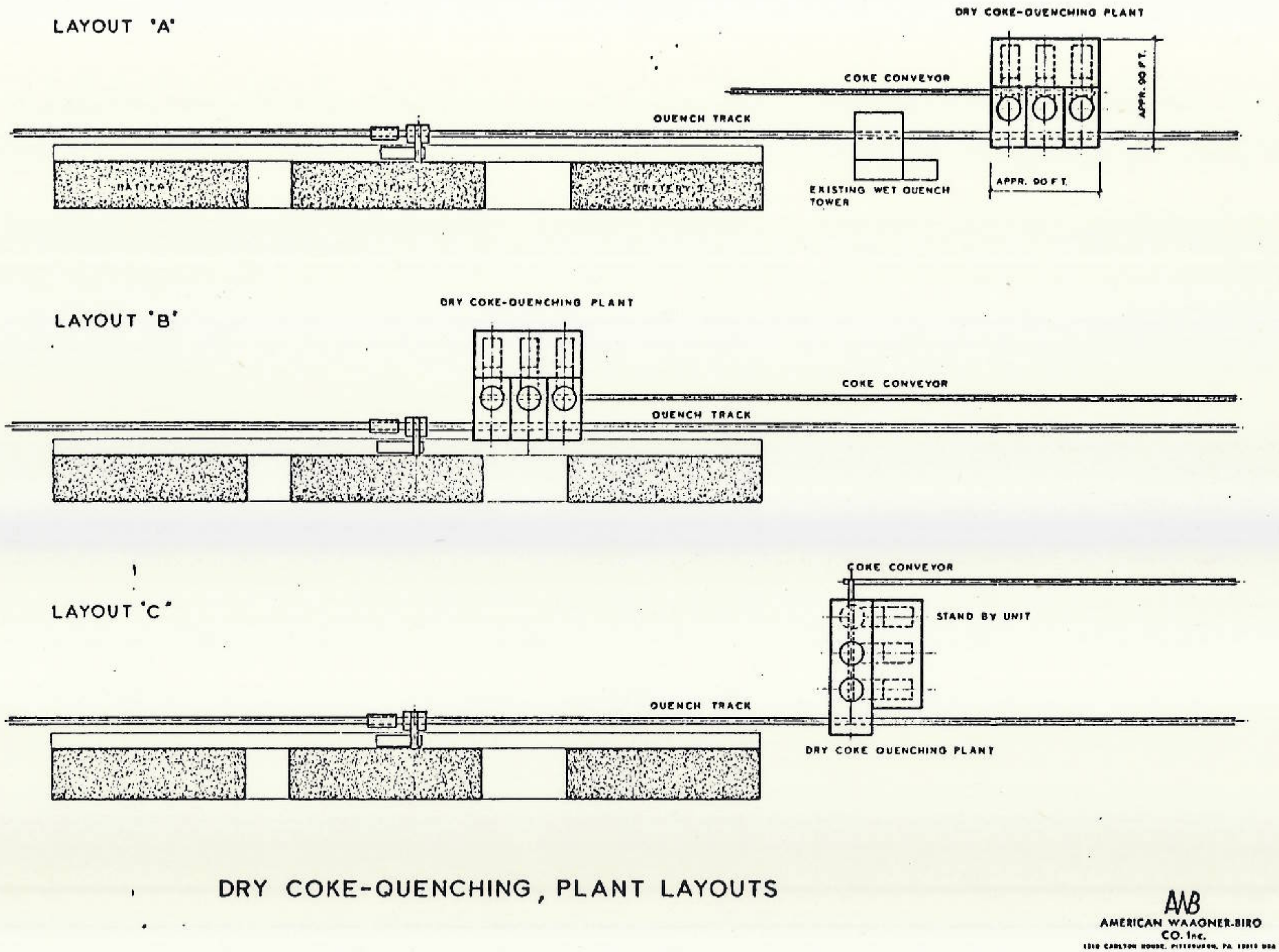
LAYOUT 'A'
DRY COKE-QUENCHING PLANT
COKE CONVEYOR
QUENCH TRACK
APPR. 90 FT.
APPR. 90 FT.
EXISTING WET QUENCH TOWER
LAYOUT 'B'
DRY COKE-QUENCHING PLANT
COKE CONVEYOR
QUENCH TRACK
LAYOUT 'C'
COKE CONVEYOR
STAND BY UNIT
QUENCH TRACK
DRY COKE QUENCHING PLANT
DRY COKE-QUENCHING, PLANT LAYOUTS
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Figure 7

pushing emission control on the coke side of the battery, mainly because of the different transfer car or transfer bucket design (Figure 4). While wet quenching requires a relatively long transfer car with a slanted bottom, over which the incandescent coke is spread out in a 2 to 3 foot layer, transfer buckets for the dry quenching process can be very compact and deep, because the slanted bottom for discharging the quenched coke at the wharf is not needed. Thus the compact dry quenching transfer bucket allows one-spot pushing; i.e., the transfer car does not have to be moved during the push, which reduces the possibility of coke spillage to almost zero. It is obvious that this configuration also makes it much easier, in comparison with the commonly used wet quench car, to catch the pushing emissions with a properly designed exhaust hood and interconnected dust collecting equipment. Furthermore, the compact bucket permits sealing with a sliding door or similar device, thus completely eliminating air pollution and burn-off losses that would normally occur with an open car while travelling to the dry quenching station. But, even if the compact bucket is left open, air pollution and burn-off are reduced substantially because a much smaller surface of the incandescent coke is exposed to the atmosphere than with the wet quenching car. For the same reason, the burn-off in the dry. quenching facility itself from the initial intake of air and occasional seepage -- normally below 0.1% -- has no effect in the overall economic evaluation in comparison with wet quenching.

The basic design features and components of all existing dry quenching plants are the same. There are, however, variations as far as design details are concerned. Cooling bunker cross sections can be circular or rectangular. Both configurations provide for an even distribution of the cooling gas and an even flow of the coke from the top to the bottom of the bunker if the gas distributor is designed accordingly. Many modern plants have a drop-out chamber between the cooling bunker and the waste heat boiler in order to catch the heavier coke dust particles and keep the number and size of cyclone separators comparatively small. Fans, cyclones, bunker top and bottom design, discharge gates and measuring hoppers vary in shape and size in the various existing installations but, of course, have the same function.



Most of the Russian installations are equipped with a so-called pre-chamber (Figure 8), which is located on top of the actual cooling bunker section. The stated main purpose of the pre-chamber is to provide for more stable steam generating conditions. At the same time, the pre-chamber could, to a certain extent, accommodate green coke, thus cutting down on the coking time in the ovens and increasing the battery capacity accordingly. Therefore, the coking process would be completed in the pre-chamber rather than in the oven. With the advent of coal preheating and pipeline charging, however, it is doubtful whether the pre-chamber, which perforce complicates the dry quenching unit, would be justified for these reasons. The reduction in coking time (in the oven) is not too significant (up to one hour), and the steam generation does not fluctuate greatly to begin with if the predetermined pushing schedule is maintained within certain limits. In this connection, it should be mentioned that the originators of the dry quenching

1. Hot Coke Car
2. Hoist
3. Charging Device
4. Cooling Chamber
5. Discharge Device
6. Boiler
7. Recirculation Fan
8. Pre-Chamber

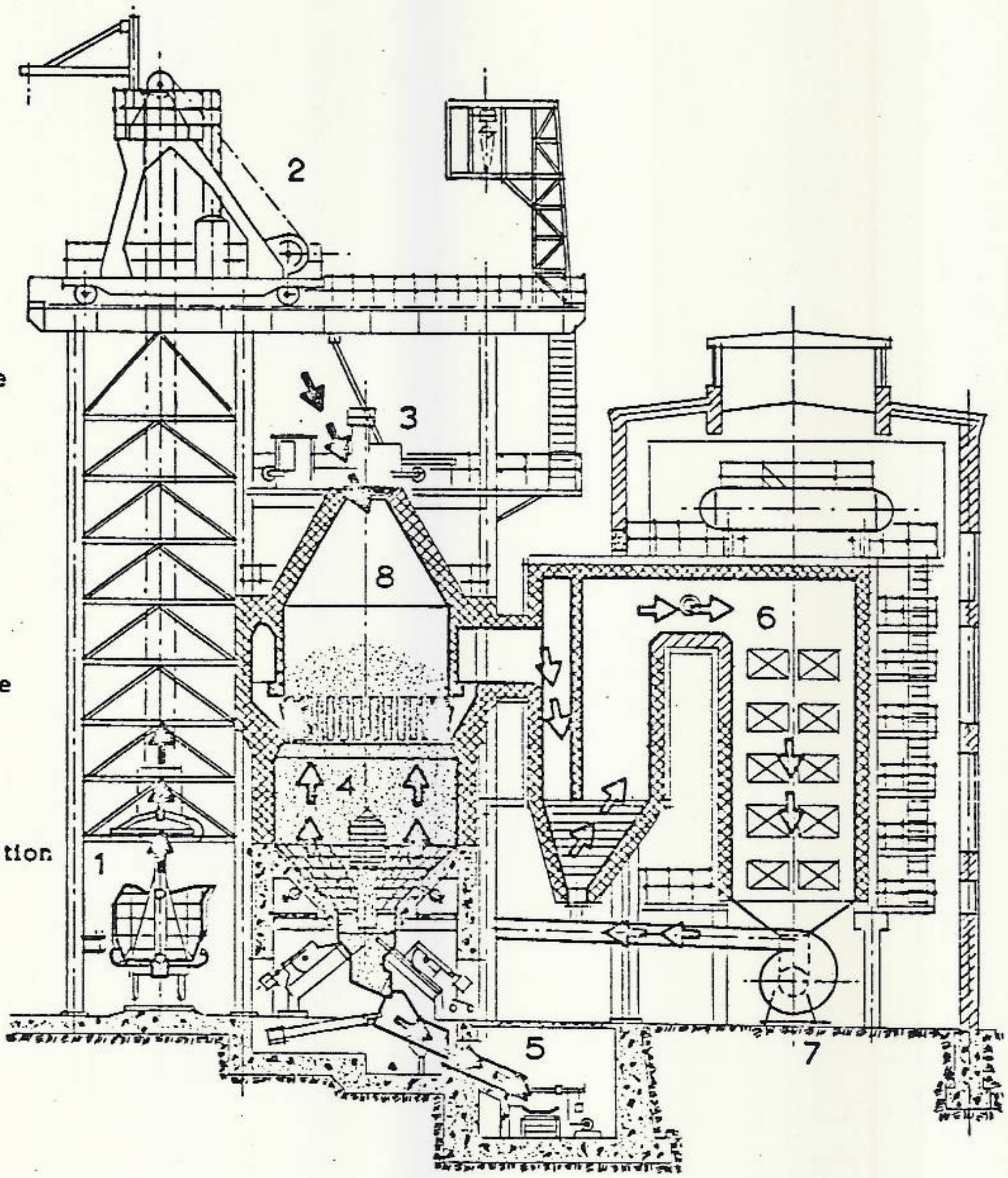



Figure 8

# DRY COKE - QUENCHING

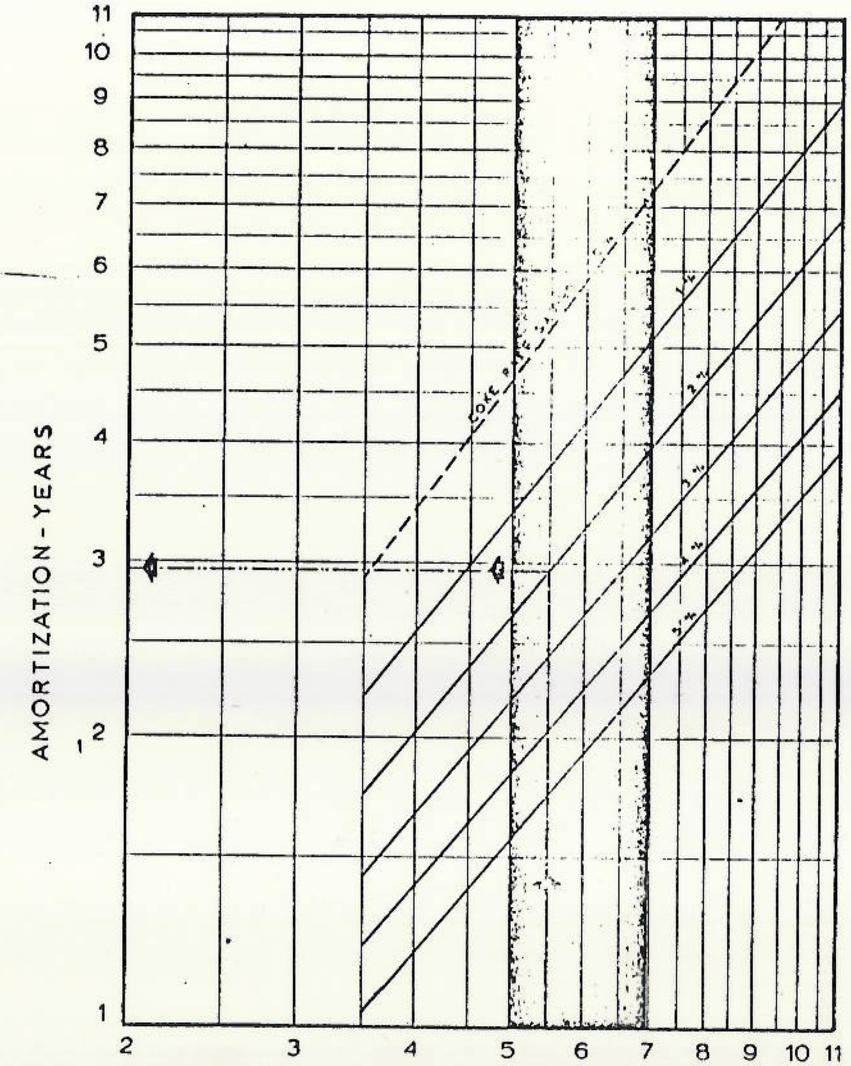
## CHEREPOVETS USSR.

| | | |
|---|---|---|
| Coke Capacity | : | 52 - 56 tons/hr |
| Superheated Steam Output | : | 28 tons/hr |
| | | 707° F |
| | | 310 psig |

system, Sulzer Brothers of Switzerland, entertained for some time the pre-chamber idea and even had it patented. But after a thorough analysis of the pros and cons, the idea was dropped for practical applications. It was felt that further equalization in the steam supply could be accomplished much more easily and simply by gearing the fan speed to the coke input or by the use of an accumulator.

As far as the economics of the dry coke-quenching process are concerned, it is difficult to establish firm numbers because of the complexity of the coking process and the prevailing technical, energy and raw material conditions, which change from country to country, even from coke plant to coke plant. Furthermore, the ramifications of the dry quenching process itself necessarily involve related operations, such as coke screening and the blast furnace operation in the case of metallurgical coke. It must also be kept in mind that, while some advantages or results of the dry quenching process are very tangible, steam generation, for instance, others are more difficult to determine in dollars and cents. Some of these are the influence on the blast furnace operation, the elimination of air pollution and ecology problems in general, which can hardly be expressed in monetary values.

The diagram shown in Figure 9 is an attempt to present as objectively as possible, for practical purposes in the U.S.A., the economics of the process, based only on the tangible advantages and averaged data collected from the pertinent literature and actual operation. The economic picture will naturally change when the less tangible, but nevertheless significant, benefits are also taken into account.




AMORTIZATION CONSIDERS :

OPERATING COSTS INCLUDING

- MAINTENANCE ( 2% OF INITIAL COST )
- ELECTRIC ENERGY ( $ .01 PER KWH )
- DEPRECIATION ( 20 YEARS )

SAVINGS INCLUDE

- STEAM GENERATION - 940 LB / TON OF COKE ( $ 1.50 PER 1000 LB STEAM )
- BREEZE REDUCTION 25 % EQUALS 1% INCREASE OF BLAST FURNACE COKE YIELD ( COKE PRICE $ 40 PER TON AND BREEZE PRICE $ 13 PER TON )
- COKE RATE SAVING IN BLAST FURNACE ( VARIABLE )

DRY COKE - QUENCHING , AMORTIZATION PERIOD VS SPECIFIC INITIAL CAPITAL COSTS .

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Figure 9

This diagram shows the amortization period in years versus the specific cost of the plant (cost per ton annual coke throughput) at various blast furnace coke saving rates. Plant costs generally range from \$5 to \$7 per ton of annual coke throughput, depending mainly on the capacity of the plant, the number of cooling bunkers (determined for the most part by the number of coke batteries to be served and the respective pushing schedules), and the desired reserve capacity. The lower values refer to large units (bunker sizes) up to 3000 tons per day capacity; i.e., 1,100,000 tons per year. The higher values refer to smaller units or plants with standby capacity.

The stated costs are complete, including installation. For the determination of the amortization periods, all expenses, such as operating, maintenance, power and depreciation costs, were taken into account.

The figures for the savings are based on current market prices, that is, \$1.50 per 1000 lbs. of steam, \$40 per ton of coke and \$13 per ton of breeze. The diagram reflects the variations in coke rate savings recorded in existing plants, so that the amortization time can be determined on the basis of the coke rate saving percentages. Higher savings observed on occasion were not considered.

In general, however, the diagram shows that amortization periods are comparatively short regarding blast furnace coke rates, even in the lower saving percentage ranges. The Russians, for instance, report amortization periods of approximately three years for their dry quenching installations.

In summary, the advantages of dry coke-quenching can be listed as follows:

1.) <u>No Air or Water Pollution</u>

Dry quenching is carried out in a completely closed-cycle operation. There are no emissions of any kind into the atmosphere or rivers.

2.) <u>Revenue Producing Investment</u>

Anti-air-pollution installations, as a rule, are non-revenue producing. In view of the mounting legal and public pressure for stricter environmental control, dry coke-quenching, which combines legal necessities with economic advantages, becomes especially attractive.

3.) <u>High Amortization Rates</u>

Due to the energy recovery, improvement in coke quality and other savings, amortization rates are high and amortization periods short, normally only a few years.

4.) <u>Energy Recovery</u>

Using the dry coke-quenching process, over 1,000,000 BTU's per ton of incandescent coke can be recovered and used for steam generation and/or for drying and preheating coal or other useful purposes such as power generation. An average dry quenching plant yields 1,000 pounds of superheated steam per ton of incandescent coke. In many cases, this amount of steam could satisfy the steam requirements of the whole by-product plant. Typical steam parameters are:

a. Process steam : 200 psig, 600 $^{\circ}$F (superheated)

b. Power generation : 550 psig, 850 $^{\circ}$F (superheated)

5.) <u>Flexible Design</u>

The dry quenching process can easily be adapted to existing or new coke plants and effectively tied into a total pollution abatement program for all phases of the coking process.

6.) Increased Operating Safety

Safety hazards and production interruptions due to poor or impaired visibility are eliminated or greatly reduced. With dry quenching there is no formation of steam clouds in the quenching station, on the hot track or on the wharf. Pushing emissions and fumes emanating from the quench car can either be eliminated or effectively controlled. Compliance with OSHA standards is facilitated accordingly.



7.) Low Operating and Maintenance Costs

There are no expenditures for quenching water, pumping plant, breeze reclamation or track maintenance due to coke spillage and water drainage associated with wet quenching. The energy consumption runs considerably below one-tenth of the energy recovered. Operating manhours are low; one to two men are sufficient to run a dry quenching plant of the largest size.

8.) Long Service Life

Dry quenching plants have been in operation for more than 40 years without any major interruption or overhaul. Preventive maintenance programs, which as a rule, provide for a predetermined once-a-year thorough inspection, have become routine in dry quenching plants.

9.) Corrosion Cutback

Wet quenching contributes substantially to the corrosive atmosphere in coke plants. With the dry quenching process, there is a strong reduction in the corrosion rate. Therefore, maintenance and replacement costs for transportation equipment, steel and concrete structures and conveyors drop accordingly because they are no longer exposed to the corrosive influence of the acid content in the water and steam.

10.) No Winterization Necessary

Trouble due to ice formation on conveying equipment, etc. during the winter months is no longer encountered. Screen heating becomes unnecessary.

11.) Better Coke Quality

a. Mainly because of its absolute dryness, dry quenched coke has a higher heating value than wet quenched coke.

b. Dry quenched coke, in comparison with wet quenched coke, is of higher strength and greater stability. Stabilization is achieved by the coke handling in the cooling bunker. Reported improvements are as stated in Figure 10; for example, the improvements according to the Micum 40 Test are 8%, and the improvements according to the Micum 10 Test, 5%.

c. Dry quenched coke is more uniform in size, thus narrowing the lump size range for use in the blast furnace and eliminating the necessity for crushing. The percentage of desirable size fractions increases appreciably. In general, compared to wet quenching, there is less coke larger than 3", more coke in the 1.5" to 3" range, and less coke smaller than 1.5".

d. Dry quenched coke has a more uniform content of volatile constituents, as parts of the coke in which degassing is incomplete are further degassed in the dry quenching plant.

e. Dry quenched coke is clean and practically free from adhering dust or breeze.

f. Dry quenched coke forms less breeze than wet quenched coke due to the steady, smooth cooling procedure in the dry quenching process. The average breeze percentage is reduced from 6 to 4%.

g. Dry quenched coke is less susceptible to additional breakage after quenching.

h. Dry quenched coke yields breeze which is absolutely dry and can therefore be used as a valuable fuel, for example, sinter fuel, with equivalent improvements in the sintering process.

COMPARISON OF WET QUENCHED AND DRY COOLED COKE
'COKE & CHEMISTRY U.S.S.R. 3-1968

| Data | Single comparative tests | | Commercial tests | |
|---|---|---|---|---|
| | wet quenched coke | dry cooled coke | wet quenched coke | dry cooled coke |
| Moisture % . . . . . | 2.5 | 0.15 | 2.0 | 0.4 |
| Mechanical strength: | | | | |
| large-drum residue, kg . . . . | 334 | 343 | 334 | 337 |
| <10-mm content of through-drum product, kg . . . . | 33 | 38 | 26 | 35 |
| $M_{40}$ . . . . . . . . . | 73.1 | 79.2 | 73.6 | 79.3 |
| $M_{10}$ . . . . . . . . . | 7.7 | 7.2 | 7.6 | 7.2 |
| Size analysis by mm fractions,% . | | | | |
| >80 . . . . . . . | 19.2 | 13.4 | 12.6 | 11.0 |
| 60--80 | 32.8 | 31.6 | 28.2 | 30.1 |
| 40--60 | 43.7 | 52.0 | 52.0 | 54.3 |
| 25--40 | 3.0 | 2.1 | 4.3 | 3.3 |
| <25 . . . . . . . . | 1.3 | 0.9 | 2.9 | 1.3 |
| Structural strength, % . . . . | 84.6 | 84.3 | 85.3 | 85.9 |
| Reactivity, ml/g.s . . . . . . | 0.629 | 0.541 | 0.717 | 0.534 |
| True density, $g/cm^3$ . . . . . . . | 1.877 | 1.882 | 1.897 | 1.908 |
| Apparent density, $g/cm^3$ . . . . | 1.028 | 1.031 | 1.108 | 1.108 |
| Porosity, % . . . . . . | 45.2 | 45.2 | 41.7 | 41.9 |
| Ultimate chemical analysis of the coke, %: | | | | |
| C (d.a.f.b.). | -- | -- | 97.6 | 97.7 |
| H (d.a.f.b.). | -- | -- | 0.38 | 0.30 |
| S (d.a.f.b.). | -- | -- | 0.58 | 0.58 |
| P (d.a.f.b.). . | -- | -- | -- | 0.13 |
| O + N (d.a.f.b.) | -- | -- | 1.56 | 1.46 |
| Chemical analysis of the ash, % | | | | |
| $SiO_2$ . . . . . . . . | -- | -- | 58.64 | 60.70 |
| $Al_2O_3$ . . . . . . . | -- | -- | 23.44 | 23.54 |
| $Fe_2O_3$ . . . . . . . | -- | -- | 8.18 | 7.08 |
| CaO . . . . . . . . | -- | -- | 3.43 | 2.65 |
| MgO . . . . . . . . | -- | -- | 1.81 | 1.54 |

Figure 10

i. Dry quenched coke is of lower reactivity, a phenomenon which has been found beneficial in recent studies for improving the blast furnace performance.

j. Dry quenched coke has excellent screening qualities and absolutely prevents blinding of the screens.

11.) Improvement of Blast Furnace Operation

a. The improved coke quality, along the lines of the properties listed above, provides for better and more even bed permeability in the blast furnace, thus reducing or eliminating choking.

b. For the same or similar reasons, reduced coke rates per ton of pig iron can be obtained through the use of dry quenched coke. Savings reported in literature and in actual operating logs range from 2 to 10%.

c. Because of smoother blast furnace operation with the use of dry quenched coke, substantial productivity increases (pig iron rates) can be expected; 4% for instance, according to Russian experiences.

12.) Use of Lower Grade Coking Coal

The improved coke quality resulting from dry quenching opens the alternative for the use of lower grade coal.

13.) Better Pig Iron Quality

For a given coke quality, an increase in the moisture content of the coke in the amount of 1% increases the sulfur content in the pig iron from 0.030 to 0.035. Thus, using dry quenched coke, the sulfur content in the pig iron can be minimized.

Where there are so many advantages, there must be some drawbacks, too. In technical and commercial evaluations of the process, the considerably higher initial investment costs are cited in comparison with wet quenching and a somewhat dustier atmosphere in the screening station due to the dryness of the dry quenched coke. But these disadvantages do not seem to carry too much weight in the light of the energy recovery and in view of the fact that a properly designed exhaust system can solve the dust problem that might develop in the screening station.

As mentioned before, all the above advantages are real, but they should be considered at this time more as trends or tendencies rather than as absolutely firm numbers. To establish such firm numbers and correlated blast furnace performance figures, a systematic, long-term test program with precise measurements should be carried out in order to quantify better or more conclusively the stated improvements and to determine quality and operation parameters which would allow the full utilization of the inherent advantages of the process. Of course, such an effort would require close cooperation between the engineering department or company and the operating departments of the coke and blast furnace plants. Furthermore, it would seem that the first full-size commercial plant in this country would very well deserve not only moral support or indirect assistance through tax exemptions, investment tax credits, tax rebates or accelerated depreciation, but also active financial participation of the government agencies concerned with environmental control and energy conservation. It is indeed an extremely serious question, how many more years this country can afford to blow trillions of BTU's into the atmosphere every day, not only wasting valuable energy, but at the same time hampering environmental control efforts.

In conclusion, it can be said that dry coke-quenching as a long-proven, fool-proof technology, deserves new intensive consideration in this and all industrialized countries. As far as the economics are concerned, especially in view of the energy crisis, it can be stated with certainty that, to quote a Russian source, "With the fuel prices moving upwards, the profitability of dry coke quenching will become even greater in the future and the capital cost of the equipment will be recovered sooner than expected."