EPA-450/3-76-013
March 1974

COST OF RETROFITTING COKE OVEN PARTICULATE CONTROLS

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

EPA-450/3-76-013

COST OF RETROFITTING COKE OVEN PARTICULATE CONTROLS

by

Vulcan-Cincinnati, Inc.
1329 Arlington Street
Cincinnati, Ohio 45225

Contract No. 68-02-0299

EPA Project Officer: Justice Manning

Prepared for

ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

March 1974

This report is issued by the Environmental Protection Agency to report technical data of interest to a limited number of readers. Copies are available free of charge to Federal employees, current contractors and grantees, and nonprofit organizations - as supplies permit - from the Air Pollution Technical Information Center, Environmental Protection Agency, Research Triangle Park, North Carolina 27711; or, for a fee, from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

Publication No. EPA-450/3-76-013

TABLE OF CONTENTS

I INTRODUCTION

The intent of this study is three fold:

1. Estimate the total investment required to retrofit pollution control devices to existing coke ovens.

2. Estimate the operating costs of these devices and evaluate the effects of these costs on the return on the investment.

3. Review the problems related to retrofitting pollution control equipment and the relative effectiveness of each control device.

II ESTIMATE BASIS

In order to establish a basis for estimating the cost of coke oven pollution control equipment it was necessary to assume the capacity and number of ovens in the battery considered.

The following was considered to be a typical battery for purposes of this report.[1]

1. 80 ovens - producing furnace coke.
2. Capacity of each oven is 16 tons blended coal.
3. Capacity of each oven is 12 tons coke.
4. Capacity of each oven is 10.1 tons furnace coke.
5. With larry car charging - 16 hours gross coking time.
6. With pipeline charging - 11 hours.

	Larry Car Charging	Pipeline Charging
Gross Coking Time - Hrs.	16	11
Daily Coal Req. - Tons	1,920	2,770
Annual Coal Req. - Tons (.95 x 365 days)	665,000	960,000

---

(1) Fuels and Combustion Handbook - A.J. Johnson, G.H. Auth, McGraw Hill - 1951, p. 144-145.

	Larry Car Charging	Pipeline Charging
Daily Coke Prod. - Tons	1,440	2,075
Annual Coke Prod. - Tons	500,000	720,000
Daily Furnace Coke - Tons	1,210	1,740
Annual Furnace Coke - Tons	420,000	605,000
Light Oil Prod. - M Gal./Yr.	2,128.0	3,072.0
Tar Prod. - M Gal./Yr.	5,685.7	8,208.0
Ammonium Sulphate - Tons/Yr.	6,996	10,099.0
Coke Breeze and Pea Coke - Tons/Yr.	80,000	115,000

In order to make a realistic economic evaluation of the capital costs of retrofitting coke ovens with the "Pipeline Charging System" it was necessary that the total coke production be divided into furnace coke and coke breeze - pea coke. The calculation of the annual return on investment is the total of the gross revenue (revenue from sale of furnace coke + revenue from sale of pea coke + coke breeze and other by-products) less the operating costs (operating cost + interest charges) plus the annual depreciation. Without this differentiation the revenue from coke sales would include the sales of coke breeze and pea coke at the same cost per ton as furnace coke. Realistically the price of coke breeze and pea coke should compete with other fuels. For purposes of this report its cost is $12.00/ton.

III DESCRIPTION - CONTROL SYSTEMS

A Pipeline Charging

Pipeline charging is a system of charging preheated coal to by-product coke ovens licensed by Coaltek Associates of Morristown, New Jersey. The system consists of a preheating section and a pipeline system.

The preheating system drys, preheats, stores and removes particulate matter from the flue gas vented to the air.

Wet crushed coal is fed to the preheater where it is dried by hot flue gas and carried by the flue gas to a cyclone system to remove particulates. The flue gas stream is then recycled to the preheater where its temperature is increased prior to contacting the wet coal. A small stream of flue gas is vented to the air continuously. This vent to the air is water scrubbed and the water stream filtered and reused. The coal fines recovered in the filter are returned to the preheater.

The pipeline charge system conveys the coal from the charge bins to the individual ovens as required. The preheated coal is conveyed in the pipeline by a system of jets supplied with superheated steam.

It has been demonstrated that ovens utilizing this process have reduced coking times and it is claimed by the licensee ovens producing furnace coke could increase production by as much as 50%.[2]

It has also been demonstrated that lower quality coals may be satisfactorily utilized to produce furnace coke. A blend of 75% Illinois (Sesser) and 25% Bishop coal was successfully tested by Inland Steel.[3]

---

(2) Pipeline charging preheated coal to coke ovens - Marting and Auvil - Rome, Italy - United Nations sympostum on "Developments in European and World Markets for Coking and Coke."

(3) Preheating and Pipeline Charging of High Illinois - Coal Blends - Underwood and Knoerzer for By-Product Coking - AISI - Regional Technical Meeting Nov. 9, 1972.

B Halcon Pushing Pollution Control System

This system is licensed by the Interlake Steel Company and is supplied by the Aeronetics Corporation of Houston, Texas.

This system utilizes an eductor to create a vacuum under a hood mounted on the coke guide and the hot car. The motive force for the eductor is hot water. The water in turn is sprayed on to the coke as it is pushed into the hot car. The vacuum from the eductor collects the vapors and particulates from the quenched coke, condenses the vapors and recirculates the water.

A separate unit fitted with rail trucks contains the necessary pumps, eductor, valves, water heater and scrubber units. This unit is attached to the hot car and is fully controlled by the hot car locomotive operator. The hot car and coke guide are equipped with hoods which are connected to the eductor in the pump car. Sprays are installed under the hoods to quench the coke. The entire system travels back and forth with the hot car locomotive.

C Pushing Control System As Used On The Great Lakes Steel Company Ovens

The basic principle of this system is to collect the emissions from the pushing operations into a moveable hood over the coke quench car and gather it into a stationary duct system which draws the gas into a Venturi Scrubbing System, where it is cleaned and passed to the atmosphere.

A stationary main collecting system is constructed over the center line of the track for the full length of the battery. This main system is connected in parallel to two Venturi Water Scrubbers. Two large fans of about 75,000 cfm each draw the gases from the quench car into the main and through the scrubbers before discharging it to the air. The water used in the scrubbers is recirculated to the quench sump.

A moveable collecting hood, connected to the coke guide on the battery side of the quench track, and riding on a rail beam supported by bents on the other side of the track, is located over the quench car and connected to the stationary main with hydraulically operated sleeves. The dampers for that position are opened to the main before pushing. The coke guide is also covered with a hood integral with that over the quench car. Two cooling fans force air into the area immediately around the coke guide and up into the main hood which is under a negative draft from the large fans.

The collecting main is supported by the same structure upon which the moveable hood rides.

The hood cover plate is stainless steel and fabricated in easily removeable panels. The collecting duct is made from Cor-ten Steel.

D Double Main

The double main is considered as a possible system of pollution control of charging emissions. A second main collecting system is installed on the coke oven battery. This permits the induction of charging emissions into two collecting mains instead of one, therefore, in theory doubling the gas handling capacity and reducing emissions. In addition to the collecting main, new standpipes must be installed as well as flushing liquor piping and pumps.

IV ESTIMATES AND ECONOMIC EVALUATION

A Pipeline Charging System

This estimate includes the cost of all equipment and materials and the installation of a system to feed 2,770 tons/day of coal to the battery. It also includes the cost of installing the pipeline connection through the wall of the oven, (80 ovens) the cost of installing a separate charging main, as well as the engineering construction coordination and the start-up costs of the owner. The estimate does not include any allowance for increasing the by-product plant capacity.

Equipment, Materials Direct Labor		$ 8,427,500
Indirect Labor and Overhead		2,865,000
Fee and Profit		2,259,000
Sub Total Preheat and Pipeline Charging		$13,551,500
Modify Ovens to Install Charging Connections		250,000
Fabricate and Install Charging Main		374,000
Sub Total		$14,175,500
Owners Coordination Cost		105,000
Start-Up Cost at 2.5% of Pipeline Capital $13,551,500		338,785
TOTAL INSTALLED COST		$14,619,285
	Say	$14,620,000

B Operating Costs and Revenues Incremental

The operating costs and revenues for the "Pipeline Charging System" are based on the following:

1. Incremental Annual Operating Costs:

a)	Additional Utilities $0.38/Ton Coal	$	364,800
b)	Additional Operators at 72 MHR/Day		262,000
c)	Maintenance Costs at 4% of Total Installed Cost		584,800
	Sub Total	$	1,211,600
d)	Interest on T.I.C. at 10%		1,462,000
	Sub Total	$	2,673,600
e)	Coal Delivered to Preheater at $12.00/Ton		3,540,000
f)	Coal Delivered to Preheater at $17,50/Ton		5,162,500
g)	Annual Operating Cost at $12.00		6,213,600
h)	Annual Operating Cost at $17.50		7,836,000

2. Incremental Annual Revenues:

a)	Light Oils 944,000 gals. at $0.41	$	387,040[4]
b)	Tar 2,522,300 gals. at $0.20		504,460[4]
c)	Ammonium Sulphate 3,103 tons at $15.00/Ton		46,551[4]
d)	Coke Breeze and Pea Coke 35,000 Tons/Yr. at $12.00/Ton		420,000
	Sub Total	$	1,358,051
e)	Furnace Coke Sales at $54.00/Ton[5]		9,990,000
f)	Furnace Coke Sales at $40.00/Ton		7,400,000
g)	Total Revenues at $54.00/Ton		11,348,051
h)	Total Revenues at $40.00/Ton		8,758,051

(4) Unit Prices from "Chemical Marketing Reporter" Feb. 18, 1974.

(5) Gasp Task Force Report.

C Economic Evaluation

When it is assumed that no additional investment is required to process the additional by-products produced from the pipeline charging system an evaluation of the return on investment can be made.

For this evaluation several cases are studied. Two cases vary the selling price of the coke from \$54.00/ton[5] to \$40.00/ton, and two cases vary the purchase price of the coal from \$12.00/ton to \$17.50/ton when the incremental production is 185,000 tons/year (44% increase in production), and 124,600 tons/year (30% increase in production).

For the calculation of the ROI, the preheating and pipeline investment is depreciated over 15 years and the opportunity cost or interest on the investment is 10%. It is further assumed that all costs, capital and operating are chargeable to the incremental production.

Fig. I plots the percent return on investment for two coal prices against the selling price of furnace coke, as well as the effect of the incremental furnace coke production. In the ranges studied the ROI is positive and therefore there exists a payout for the investment. In fact at \$54.00[5] for

---

[5] Gasp Task Force Report.

furnace coke and $17.50 for coal the payout, even at the lower incremental production rate, is good.

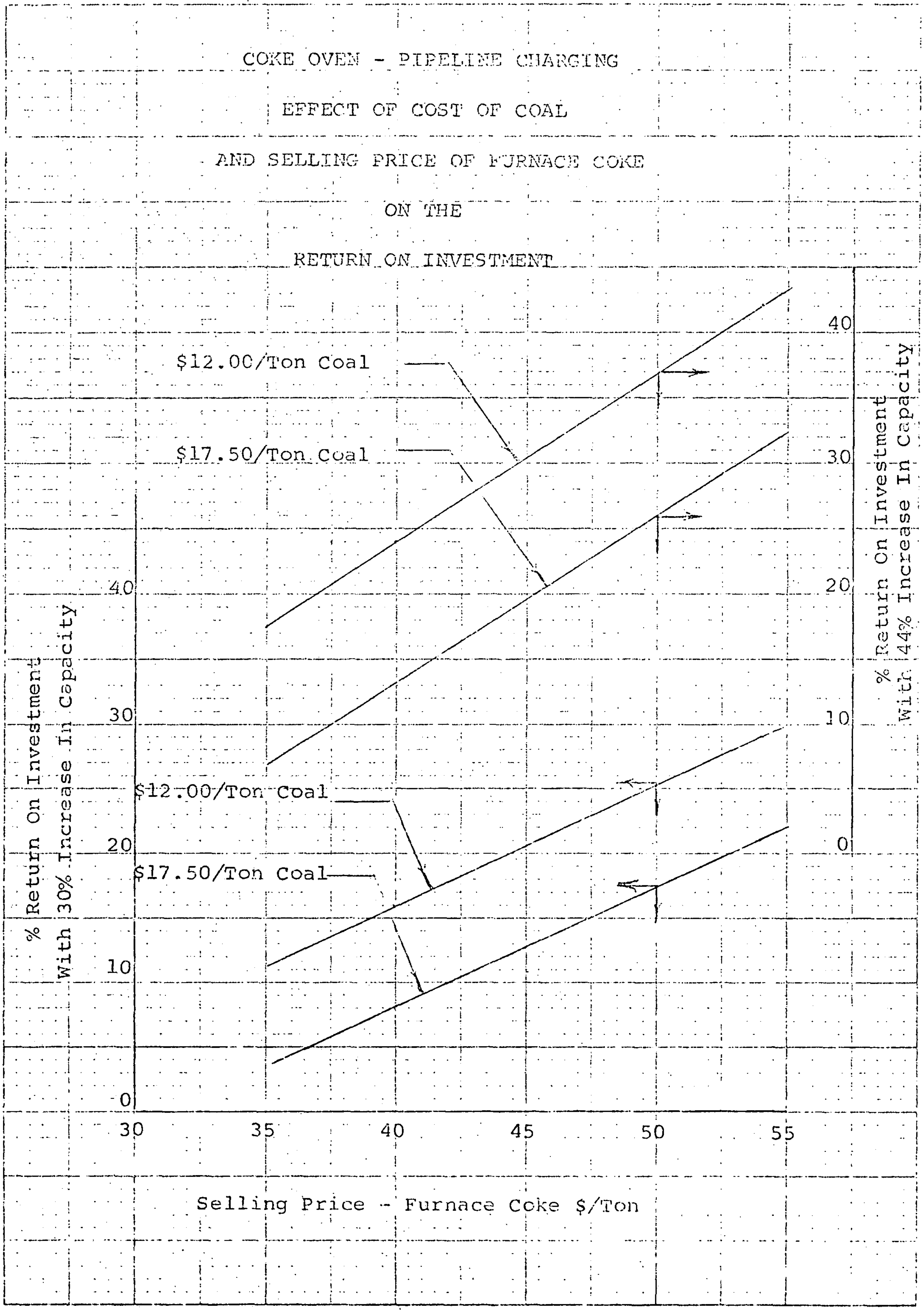
It could be argued that the estimated capital costs are too low. For the basis used here an increase in the capital costs of 30% would reduce the percent return on investment by one percentage point.

The percentage increase in capital costs for retrofitting existing plants with the pipeline charging system is in the range of 60-70%. However, this percentage does not represent a true picture. An 80 oven battery with an annual coke capacity of 500,000 tons/year could be expected to cost between $28,000,000 to $30,000,000. But in fact we are saying that a 55 oven battery plus the pipeline costs could produce the same amount of coke. A 55 oven battery with pipeline charging would cost in the range $28,000,000 to $32,000,000. The cost comparisons above are on the basis of retrofitting the pipeline charging. Since comparable work is less expensive when building a new oven, the construction cost for a 55 oven battery with pipeline charging could be somewhat lower.

The cost of retrofitting ovens with coal preheating and pipeline charging will vary with the capacity of the preheating system.

The ultimate size of any preheating system would be dependent on its location in relation to the ovens being served and the distance of the coal feeding lines from the storage hoppers to the ovens. The cost would also be significantly lower if the ovens were built with pipeline charging connections already installed in the oven. Therefore any mathematical relationship of capacity to cost would not necessarily be meaningful.

FIG. I


COKE OVEN - PIPELINE CHARGING
EFFECT OF COST OF COAL
AND SELLING PRICE OF FURNACE COKE
ON THE
RETURN ON INVESTMENT
$12.00/Ton Coal
$17.50/Ton Coal
$12.00/Ton Coal
$17.50/Ton Coal
% Return On Investment With 30% Increase In Capacity
% Return On Investment With 44% Increase In Capacity
0
10
20
30
40
30
35
40
45
50
55
Selling Price - Furnace Coke $/Ton

D **Halcon System - Total Installed Cost**

This estimate includes two eductor - scrubber cars, preassembled and ready to set on track, two sets of hoods and related hardware prefabricated to suit the operating and spare hot car and coke guide. The estimate includes the cost of installing these hoods and hardware on each hot car and coke guide as well as a track drainage system. It also includes the cost of start-up and owners coordination costs.

a)	Equipment and Material	$1,850,000
b)	Field Assembly Costs - Direct Labor	54,000
c)	Sub Total	$1,904,000
d)	Contractors Overhead	18,900
e)	Contractors Profit	10,800
f)	Sub Total	$1,933,700
g)	Owners Coordination Cost	11,000
h)	Sub Total	$1,944,700
i)	Start-Up Costs 4.5%	87,512
j)	TOTAL INSTALLED COST	$2,032,212

E Halcon System - Operating Costs

The operating cost of this system is based on power requirement of 80 kw and heat requirement of 12.6 x 10^6 BTU/hr. No additional manpower is required.

a)	Power Cost $/Year	$ 8,400
b)	Heat	99,800
c)	Maintenance Cost at 6%	121,933
d)	Sub Total	$230,133
e)	Interest on TIC at 10%	203,221
f)	ANNUAL OPERATING COST	$433,354

F Halcon System - Economic Evaluation

The return on investment with 15 year depreciation is a negative $297,874.

This amounts to $0.71 per annual ton of furnace coke or $0.60 per gross annual ton of coke.

Unless the effectiveness of controlling pushing emissions with this method is proven, the negative return on investment does not justify any expenditure of funds.

The cost of the Halcon System is a function of the number of quench cars required for a given battery. For example, the case estimated in this report is near the number of ovens which would be limiting for one quench car to handle. In this report a push must be made approximately every 12 minutes. Therefore, additional coke production would require an additional Halcon System. But for less production one system is still required.

V G Great Lakes Pushing Control System - Total Installed Cost

Installed Costs:

a)	Collecting Duct, Stacks, Scrubber Interconnecting Duct and Hardware	$ 785,224
b)	Civil - Structure and Concrete	143,190
c)	Hood and Miscellaneous Steel	102,670
d)	Venturi Scrubbers, Blowers, Water Piping	809,116
e)	Sub Total Installed Cost	$1,804,200
f)	Engineering	184,000
g)	Fees	30,000
h)	Sub Total	$2,054,200
i)	Start-Up Costs at 9%*	186,000
j)	TOTAL INSTALLED COST	$2,240,200

* Because of the exposed hydraulic cylinder linkages and bearings for sleeves and dampers it is expected that start-up costs will be higher than normal.

H Operating Costs For Great Lakes Steel Pushing Control System

a)	Power	$111,900
b)	Operating Labor (24 MH/Day)	87,337
c)	Maintenance and Operating Supplies	156,800
d)	Annual Interest at 10% TIC	224,000
e)	ANNUAL OPERATING COST	$580,037

I Great Lakes Pushing Control System - Evaluation

The return on investment when the above investment is depreciated over 15 years is a negative $430,691/Year. This amounts to $1.025 per annual ton of furnace coke or $0.86 per annual gross ton of coke.

Unless this method can demonstrate a positive effect on the reduction of emissions from the coke oven pushing operation, the negative return on investment does not warrant the expenditure involved.

The many variables which affect the cost of this type of system do not lend themselves to meaningful mathematical relationships between capacities and cost. For example, if two batteries of 80 ovens each were located end to end the incremental cost of adding this system to the second battery would be 75% of the cost of the first battery. But those same two batteries in any other position relative to one another would be 100% of the cost of the first battery.

J Double Main - Estimate

a)	Duct Cost	$ 450,000
b)	Flushing Liquid Piping, Pumping, etc.	150,000
c)	Modify Ovens - New Structure	280,000
d)	Tie In To Boosters	30,000
e)	Flushing Piping and Pumps	100,000
f)	Sub Total	$1,010,000
g)	Engineering Cost	98,000
h)	TOTAL INSTALLED COST	$1,108,000

K Double Main - Operating Costs

a) Total Annual Operating Costs
10% of Total Installed Cost $110,800

L Double Main - Economic Evaluation

The return on investment when the installed cost is depreciated over 15 years is negative $36,933. Since the installation of a second main does not assure an effective charging emission control the expense of this capital is not justified.

V EFFECTIVENESS OF RETROFITTING COKE OVENS FOR POLLUTION CONTROL

A General

Little information is available concerning the actual particulate losses resulting from charging and pushing operations of coke ovens. Some opinion exists that the pollutants from an oven are split about 60% from the charging operation, 30% from the pushing operation and the remainder from the quenching operation.

This split however should not be considered as representative or typical. There is a wide variation from plant to plant, depending on age of the ovens, quality and quantity of maintenance, types of coal used and operating practices.

Considerable leakage can occur from doors whose seats have been damaged by improper handling or maintenance. Leakage can also occur from warped or improperly luted charging hole covers. A common source of leakage, particularly in older ovens, is from cracks from the coke side of the oven into the flues. This is more common at the end flues near the doors which are subject to rapid cooling after the pushing operation. Smoke leaks into the flues and leaves via the flue stack. This leakage is difficult to control.

The temperatures throughout the coke oven battery are constantly changing as one oven is pushed and filled with coal. This temperature fluctuation is continuous. However, if coal blends are changed or not kept uniform or the moisture in the coal charged varies, these temperature fluctuations can be more severe. The movement which constantly goes on because of these factors can cause leakage from many points other than from charging, pushing and quenching.

Retrofitting operating coke ovens adds considerable cost to any installation. All work which involves the insertion of opening into the oven must be very carefully planned and executed so as to minimize the hazards to those performing the work as well as minimizing any lost production. Other construction work in the vicinity of any coke oven battery is constantly exposed to the movement of the coal and coke handling equipment and results in work interruptions.

B Pipeline Charging

In principle it appears that the pipeline charging system minimizes many of the possibilities for leakages which can occur during the charging cycle. The charging hole covers do not have to be removed normally and therefore can be more permanently luted. The charging hole covers are also not subject to damage by constant handling. The pipeline system would also tend to eliminate the temperature fluctuations due to varying moisture content of the coal. This system also eliminates the constant vibration caused by larry car travel over the battery.

It appears that the pipeline charging system should be an effective means of reducing pollution from the charging operation, when operated properly.

However, it is not free of all problems. For example, the standpipe performance can still be restricted by carbon plugged steam jets, the charging connection to the oven can also be partially blocked. Each of these could result in malfunction and possibly smoky charges.

Pipeline charging also does not eliminate the problems discussed under V-A.

As of the end of 1973 there were 192 ovens either equipped or in the process of being retrofitted with coal preheating and pipeline charging systems. Twenty-four of these ovens are on the Allied Chemical coke oven battery at Ironton, Ohio. These have been in operation since October of 1970. Seventy ovens were scheduled to be in operation with this system at the Allied Chemical Co. ovens in Detroit, Michigan late 1973. Seventy-eight ovens at Tarrant (Birmingham) are to be retrofitted by early 1974 and an additional 20 in Carling, France by the second quarter 1974.

An objective evaluation of the emission control effectiveness of retrofitted pipeline charging systems should be made when the ovens listed above are debugged and in operation. Until then the economic evaluations made in Section IV-C can only be considered as a guide.

C Halcon Pollution Control System

In principle the Halcon System could be an effective method of controlling emissions from the pushing operation. It collects the gas vapors from the operation as well as the emissions from the quenching operation. When coke is quenched in a conventional system emission entrainment results in its spread around the vicinity of the quench tower and is finally washed off by rain into the water shed. The Halcon System would partially control this by keeping the emissions in the circulating water system. Excess water from the quench car is drained to the quench sump and recirculated to the scrubber car. It also has the advantage of requiring the least interference with operation during the construction period.

However, in practice the system must demonstrate that the suction into the scrubber system is adequate to handle all the gases and vapors from the push and quench operation independantly of wind direction and velocity. It also must demonstrate that it can withstand the severe erosion and corrosion from circulating the quench water. If these can be demonstrated it will be a relatively simple and effective control device. To date these requirements have not been demonstrated.

D **Great Lakes Steel Pusher Control Device**

In principle this system should also be an effective pusher emission control device. However, it seems to be relatively complex since there are many hydraulic cylinders and damper linkages in the immediate vicinity of the ovens. The general atmosphere in the immediate vicinity of the ovens can be relatively corrosive and would subject the linkage pins and bearings to adverse conditions and make maintenance very high.

As noted in the Halcon System, this system must also demonstrate that the negative draft can contain emissions from pushing independant of wind direction and force. To date this system has not adequately demonstrated that it can effectively reduce emissions resulting from the coke oven pushing operation.

V E Double Collecting Mains

In order to increase the capability of the gas removing facilities i.e. the risers and main, some operators are considering installation of a second gas main with its related auxiliaries. This solution would most likely be considered for the longer ovens. However, if space allows, it could be considered for shorter ovens. In effect the capacity to remove gas and smoke during the charging operation doubles when this approach is used. The double gas main also minimizes the effects of momentary closing the gas passage in the oven top, because of improper charging procedures. In the single uptake oven a blockage in the middle of the oven top would pressurize the passage opposite the uptake. With the double main, both sides would still have free passage to an uptake.

The installation of a second main requires that a penetration be made through the roof of each oven. This requires adequate sheilding of the heat from the immediate work area. It also requires that once the roof has been penetrated that the work continue until it can be closed properly to allow continued operation.

Like any repair or modification to an operating coke oven the work must be very carefully planned to minimize hazards to the men performing the work, the effects on production and the mechanical effects on the oven itself.

The double main increases the capacity of the system to handle the oven gases by lowering the pressure in the oven, both during charging operations and normal coking. It therefore tends to minimize emissions during charging and allows less back pressure build up in the oven during the coking period and therefore reduce leakages to the air. However, the principle advantage of this system is that it in effect provides an additional outlet for the emissions generated during charging. If one gooseneck is carbonized the opposite member would perform the function. Where only one gooseneck is provided this condition would result in a greater emission of particulates.

VI COST UPDATING

Updating the costs for the type estimate made for installed costs in this report can best be done by utilizing the Engineering News Record Cost Indexes for Skilled Labor and Materials as follows using December 27, 1973 as the base index. Divide the Engineering Index for Skilled Labor for the period desired by the Engineering Skilled Labor Index for December 27, 1973, add to this Engineering Index for Materials for the period desired divided by the Materials Index for December 27, 1973. Multiply this sum by one half the total installed cost of the item in question.

For Example: Pipeline Charging TIC = $14,620,000 updated to January 31, 1974.

$$\frac{14,620,000}{2} \left(\frac{1781.8}{1774.2} + \frac{770.9}{785.1} \right) = \$14,517,660$$

VII STATE AND LOCAL REGULATIONS RESULTING IN COKE OVEN CONTROL

Alabama - Charging: Opacity greater than 40% or No. 2 Ringelman for 5 minuter per coking cycle.

Pushing: Opacity greater than 40% or No. 2 Ringelman for more than 1 minute.

Quenching: Quenching towers require baffles.

Miscellaneous: (a) Each coke oven is considered as an individual oven, (b) Each oven operator must maintain oven equipment in good condition and exercise good operting practice, and (c) maintains inventory of coke oven doors 1 for 12 coke ovens operated.

Illinois - No visible emission from charging port except 15 seconds during any one charging operation. During that period opacity no greater than 30%.

Quench Tower: No greater than 30% opacity.

After December 31, 1974 all coke facilities to be equipped with enclosed pushing and quenching systems.

Work rules must be approved by A.P.C. Agency.

Emission from doors limited to 10 minutes after start of coking cycle. During that period opacity no greater than 30%.

Michigan - Opacity no greater than No. 2 Ringelman for not more than 3 minutes in any 30 minute period. No greater than No. 3 Ringelman for not more than 3 minutes in any 60 period but not more than 3 occassions during any 24 hour period.

Ohio	-	Opacity 20% or No. 1 Ringelman except 60% or No. 3 Ringelman for not more than 3 minutes in any 60 minute period.
Pennsylvania (Allegheny County)	-	Opacity no greater than No. 2 Ringelman not to exceed 8 minutes in any 60 minute period.
Texas	-	Opacity of 30% averaged over 5 minute period if built prior to January 31, 1972.
Virginia	-	Opacity no greater than No. 1 on Ringelman except during charging and Ringelman No. 2 for periods no more than 2 minutes per charge and 1 minute per push.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-450/3-76-013	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Cost of Retrofitting Coke Oven Particulate Controls		5. REPORT DATE March 6, 1974
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Vulcan-Cincinnati, Inc.		8. PERFORMING ORGANIZATION REPORT NO. JN-687
9. PERFORMING ORGANIZATION NAME AND ADDRESS Vulcan-Cincinnati, Inc. 1329 Arlington Street Cincinnati, Ohio 45225		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO. 68-02-0299
12. SPONSORING AGENCY NAME AND ADDRESS EPA, OAQPS, SASD, CAB N. C. Mutual Bldg. Research Triangle Park, NC 27711		13. TYPE OF REPORT AND PERIOD COVERED Final
		14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Support for the Preferred Standards Path Analysis for Polycyclic Organic Matter.

16. ABSTRACT

This report provides estimates of the total investment required to retrofit pollution control devices on existing coke ovens based on the state-of-the-art in 1973. Projected operating costs of these devices are estimated along with an evaluation of their effects on the return on investment. In addition some of the problems related to retrofitting pollution control equipment are reviewed in relation to the expected relative effectiveness of the control device.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Coke ovens Particulate controls Costs Pipeline Charging Pushing Controls		

18. DISTRIBUTION STATEMENT Release unlimited	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 36
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE -

EPA Form 2220-1 (9-73)