EPA-600/2-77-058
February 1977

Environmental Protection Technology Series

SEALING COKE-OVEN CHARGING LIDS, CHUCK DOORS, AND STANDPIPE ELBOW COVERS: SURVEY OF CURRENT U.S. STATE OF THE ART

Industrial Environmental Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

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SEALING COKE-OVEN CHARGING LIDS, CHUCK DOORS, AND STANDPIPE ELBOW COVERS: SURVEY OF CURRENT U.S. STATE OF THE ART

by

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Contract No. 68-02-1323, Task 58
ROAP No. 21AQR-042
Program Element No. 1AB015

EPA Task Officer: Robert C. McCrillis

Industrial Environmental Research Laboratory
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Research Triangle Park, NC 27711

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development
Washington, DC 20460

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Introduction

By-product coke ovens have long been recognized as one of the primary sources of emissions within the steel-plant complex.[1] Numerous studies and development/implementation programs have been undertaken to reduce the quantity of emissions associated with the coke-making process. Understandably, most attention has been directed to the parts or steps of the coke-production process which are considered the principal sources of the emissions. Thus, attention has been focused on controlling and/or eliminating the emissions associated with oven charging, pushing, coke quenching, and end-closure leakage.[2-5]

While these are the predominant sources of emissions, other parts of the coking units may also emit pollutants. Little quantitative information is presently available as to the underlying causes, quantity, and temporal duration of these secondary emission sources associated with the coke ovens.

This study was undertaken to provide the U.S. Environmental Protection Agency (EPA) a survey of the current state of the art for sealing coke-oven charging lids, standpipe elbow covers, and chuck doors within the U.S. coke-making industry.

This survey was conducted as part of the EPA program entitled "Technical Support for US/USSR Task Force on Abatement of Air Pollution from the Iron and Steel Industry". The intent of the survey was to establis the current design and operating methodology relating to the sealing of the oven charging lids, elbow covers, and chuck doors. The development of data on the extent and types of emissions associated with these three components of coke ovens was not part of the program's scope. This study was conducted over the period of October 15 through October 31, 1976.

Prior to presenting the results of the survey program, it is advantageous to briefly describe the location and function of the three coke-oven components considered in this study.

Location of Coke-Oven Charging Lids, Chuck Doors, and Standpipe Elbow Covers

An illustrative schematic cross-sectional view of a by-product coke oven is shown in Figure 1. The relative locations of the charging lids (Circle 1), the chuck door (Circle 2), and the standpipe elbow cover (Circle 3), are indicated as part of Figure 1. Most U.S. coke ovens have 4 charging holes (and, in turn, 4 charging lids) located across the top of each oven. A small number of U.S. coke batteries have ovens with 3-charging-hole systems.

The chuck (or leveling) door is the opening in the end-closure door through which the leveling bar is introduced for leveling the coal during and after charging to the oven. Each end-closure door on the pusher side of the oven contains one chuck door near the top of the door (specifically, at a height matching the coal line of the oven).

To permit the escape of volatile matter driven from the coal during coking, an opening exists at the top of the oven at either one or both ends of the coking chamber. Each such opening is fitted with an offtake pipe known as the standpipe or ascension pipe, which connects the oven with the gas-collecting main for the battery. Where one gas offtake is provided, it is through the roof of the oven at one end of the oven, and where two offtakes are used, there is one at each end of the oven. The volatiles pass through the ducts in the oven top into a refractory-lined standpipe which, in turn, is connected to a collecting main through a damper valve. The standpipe is equipped with a cap valve, or "elbow cover" between the damper valve and the oven. The piping associated with the volatile offtake system is generally of a shape similar to a gooseneck, (i.e.,  shaped), with the elbow cover or cap located at or near the top of the standpipe system. A more detailed schematic illustration of a standpipe system with its elbow cover is shown in Figure 2.

For the major portion of a coking cycle, these three components (i.e., charging lids, chuck doors, and standpipe elbow covers) are in place (i.e., in a closed or sealing position). The charging lids are removed from the charging holes during the coal charging operation and during the preceeding decarbonization period. After charging the coal to

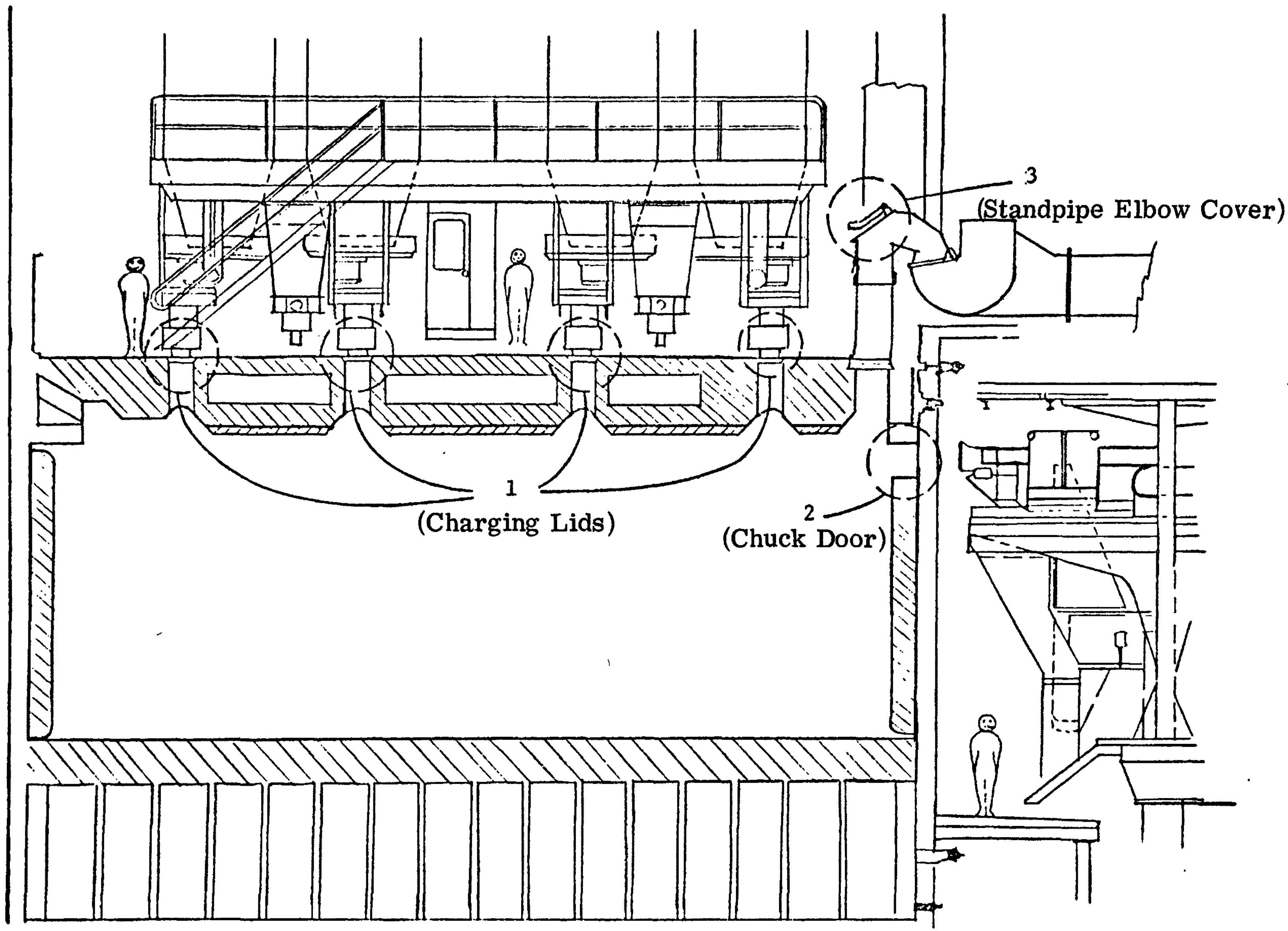


FIGURE 1. SCHEMATIC ILLUSTRATION CROSS-SECTIONAL VIEW OF A BY-PRODUCT COKE OVEN

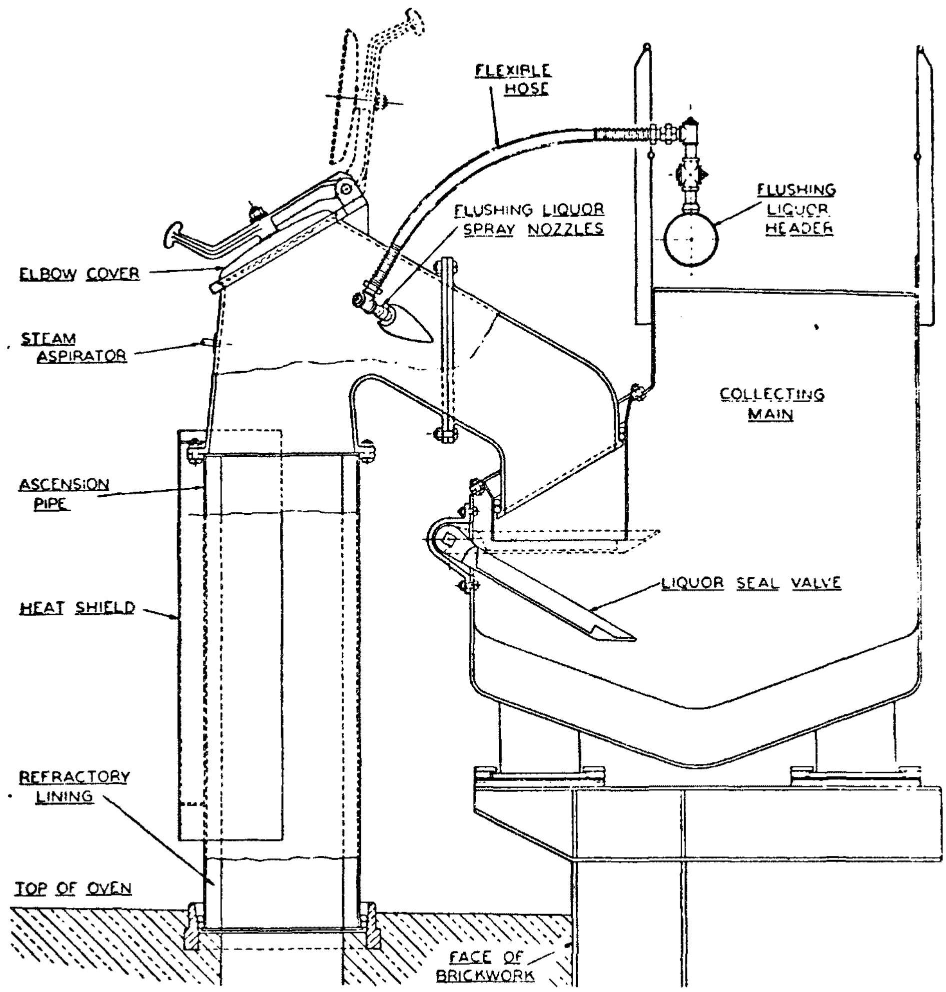


FIGURE 2. SCHEMATIC ILLUSTRATION OF STANDPIPE SYSTEM[6]

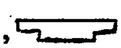
the oven, the chuck door is opened to allow the introduction of the leveling bar to remove the peaks resulting from charging. The standpipe elbow cover is opened to provide access to clean the standpipe (i.e., remove constricting carbonaceous buildups). The elbow cover is also opened to vent the oven to the atmosphere. All these components are closed for the duration of the coking period. If these three components are properly designed, maintained, and placed, they are expected to provide total seals against the emission of pollutants to the atmosphere.

With this brief description of the oven charging lids, chuck doors, and standpipe elbow covers, the current state of the art for sealing each of these components is presented in the next section. For those readers desiring more information on these components, a more detailed description of the location and function of these three components is available in The Making, Shaping and Treating of Steel.[6]

State-of-The-Art Survey on Sealing Charging Lids, Chuck Doors, and Standpipe Elbow Covers

The current techniques and methodology for sealing each of the three components are presented sequentially herein.

Charging Lids

Oven charging lids are typically circular cast iron or steel lids, 16 to 18 inches (40.6 to 45.7 centimeters) in diameter, and 1 to 3 inches (2.5 to 7.6 centimeters) thick. Most charging lid-frame assemblies are designed to seal via a conical or tapered (i.e., ), metal-to-metal contact of lid against frame. Some lids are designed to seal through a shouldered (i.e., ) metal-to-metal joint. Both the charging lid and the frame into which the lid seats may distort during service. The distortion of the lid-frame system is a major factor contributing to the occurrence of emissions from this component. Also, both the lid and frame seating surfaces must be periodically cleaned in order to secure an emission-free operation. While coke-oven designers indicate that the charging-lid-frame systems should, if properly cleaned and maintained, provide an effective seal against emissions, most plants use some type of luting material or slurry to seal the lids after charging. Typically, after the charging lid is replaced in the charging hole, coal and coke dust lying on the top of the oven are swept to the vicinity of the lid/frame surface interface to fill any gaps which may exist. After filling the lid/frame region with carbonaceous material, luting mud, or slurry is applied to the lid/frame interface on the top of the oven. On drying, the mud luting or slurry provides an effective sealant. Good operating practice dictates that the sealing material not be applied to the metal-metal contact area below the oven top surface. The mud/slurry used to seal the charging lids should be inexpensive and readily available with a consistency which can be easily applied to achieve a seal. It is also important that the dried material break cleanly from the lid/frame interface when the lid is removed for the next coal charging.

One slurry used by a coke-producing plant to seal its charging lids consists of a mixture of (1) clean-up materials, such as coke breeze and old mud from the luting of end-closure doors, (2) clay from a local source, and (3) water. A typical batch of this slurry consists of one part clay, 2 parts breeze, and 1.8 parts water, by weight. Another slurry used to seal charging lids in the U.S. consists of 40 percent lime (CaO), 55 percent alumina (Al_2O_3) and 5 percent silica (SiO_2) mixed with water. There are apparently a wide variety of slurry mixtures in use, some based on clays, some on silica flour, etc.

The use of a mud/slurry to obtain an effective seal does not alleviate the need for good cleaning practice. Many operators indicate that dirty lids (i.e., those with a carbonaceous deposit between lid and hole) are difficult to seal via the application of the mud/slurry. Lid cleaning is done every coke cycle or on a periodic, regular basis. Also, the lids may distort in service due to the heating and cooling. As the lids become increasingly distorted, sealing becomes more difficult and the lids must be replaced eventually to eliminate eimssions.

Modern coal charging systems frequently contain automatic (magnetic) lid lifters which oscillate the lids (typically through $\pm$ 15° of the final position) as part of the lid seating placement in the charge hole. Such movement during seating should improve the sealing characteristics of the lid. It is estimated that the lids are manually placed on more than 90 percent of all the U.S. coke ovens (i.e., less than 10 percent are equipped with magnetic oscillatory lifters). Thus, the oscillation during lid seating is not yet a major factor relative to sealing performances in today's operations.

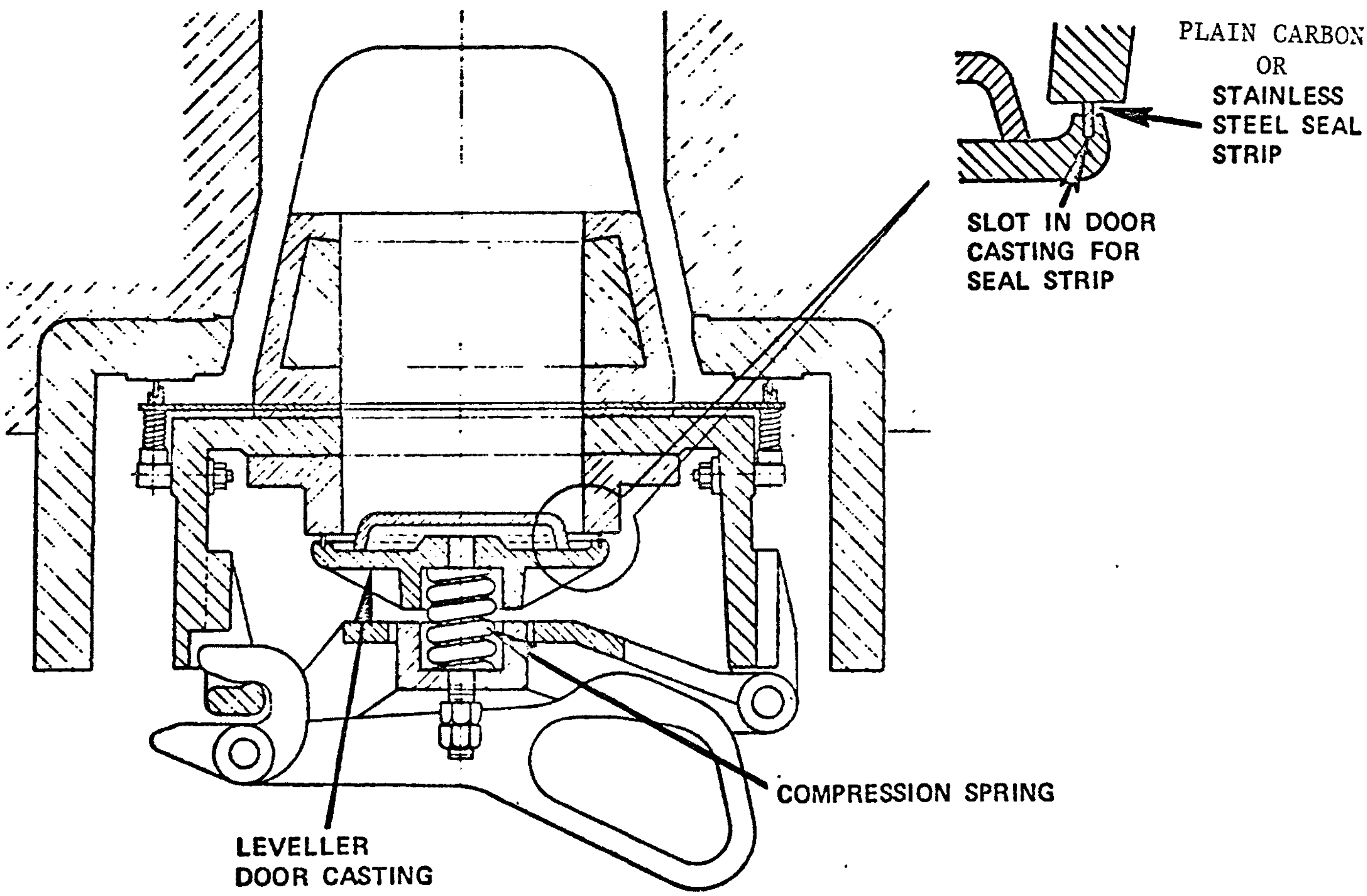
With pipeline charging systems, the charging lids are replaced by valves in the pipeline. These valves are somewhat removed from the oven top, thereby reducing the problems attendant to obtaining an emission-proof seal. Oven lids used in conjunction with the pipeline charging systems will be used only for oven inspection, for decarbonizing the ovens and to vent excessive pressures. In pipeline charging systems, one lid is designed and designated to serve as a safety valve to relieve excessive pressure which may occur in the event of constrictions in the standpipe and/or reduced gas removal from the oven.

It is anticipated that less emissions will occur from oven lids used with the pipeline charging systems.

Chuck (Leveler) Door

Chuck-door seals are similar to the seals used on the oven end-closure doors.* Typically, the seal is a metal-to-metal seal consisting of a plain carbon steel, or stainless steel rib or strip attached to the door, which is pressed against a flat surface portion of the end-closure door. A representative cross-sectional view of a chuck door (and end-closure door) seal system is shown in Figure 3. Just as with the end-closure door seals, the chuck-door-sealing strip design and dimensions, and the methods of applying loads to the sealing strips to effect a seal, vary with the designer and builder of the door system. In general, leakage of chuck doors occurs as a result of the same factors and/or phenomena which cause end-closure-door leakage. Thus, chuck-door leakage may occur because (1) the chuck door--end-closure door are not dimensionally stable under the heating and cooling cycle(s) to which they are exposed, (2) tars and other carbonaceous materials may accumulate or deposit nonuniformly on the seating surface and cause high and low contact points, thus causing emissions,

* Current methods for sealing coke-oven end-closure doors are reviewed in Reference 4.



SECTION THROUGH OVEN DOOR AT LEVELLER DOOR

FIGURE 3. SCHEMATIC ILLUSTRATION OF CHUCK (LEVELER) DOOR SEALING SYSTEM [7]

and (3) the chuck-door-seal elements may not be chemically stable (i.e., they may carbonize, oxidize, and/or sulfidize) in the particular service environment, thereby leading to pitting or other dimensional alterations, which in turn promote leaking.

For example, the sealing strip and its contact surface may warp and/or distort such that when one portion of the sealing edge is closed, an adjacent strip region does not contact the surface of the end-closure door. Many chuck doors are equipped with compression springs and/or screws designed to force the sealing strip against the mating flat surface. In some cases it has been observed that the springs lose their spring characteristics with time. Others have observed that the screws do not deflect the strips to achieve a complete seal around the chuck door perimeter.

As with the general end-closure door sealing problem, proper maintenance and cleaning practices (e.g., removal of the carbonaceous deposits on the chuck door contact surfaces) appear to reduce the quantity of emissions from this component.

Chuck door design is an ongoing development. Several companies have suggested that the door-seal systems of older design were too inflexible to provide adequate sealing performance. As one example, Bloom Engineering Company* has promoted the retrofitting of older, more rigid chuck-door systems with their stress-relieved, more flexible, dome design leveler-door unit made of 400-series stainless steel. The basic seal element of the Bloom chuck-door system is the metal-to-metal contact seal as shown in Figure 4.

Little quantitative data are available with which to judge the performance of one type of door or seal system relative to another under controlled conditions.

When the metal-to-metal contact seal of the chuck door becomes ineffective as a result of distortion of excessive carbonaceous deposits on the sealing surface, some operators resort to luting the door or applying gaskets to effect a seal. Luting materials are made of the same mixtures of materials as used for the charging lid slurries, but with less water. The

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* Bloom Engineering Company, Inc., Horning and Carry Roads, Pittsburgh, Pennsylvania 15236

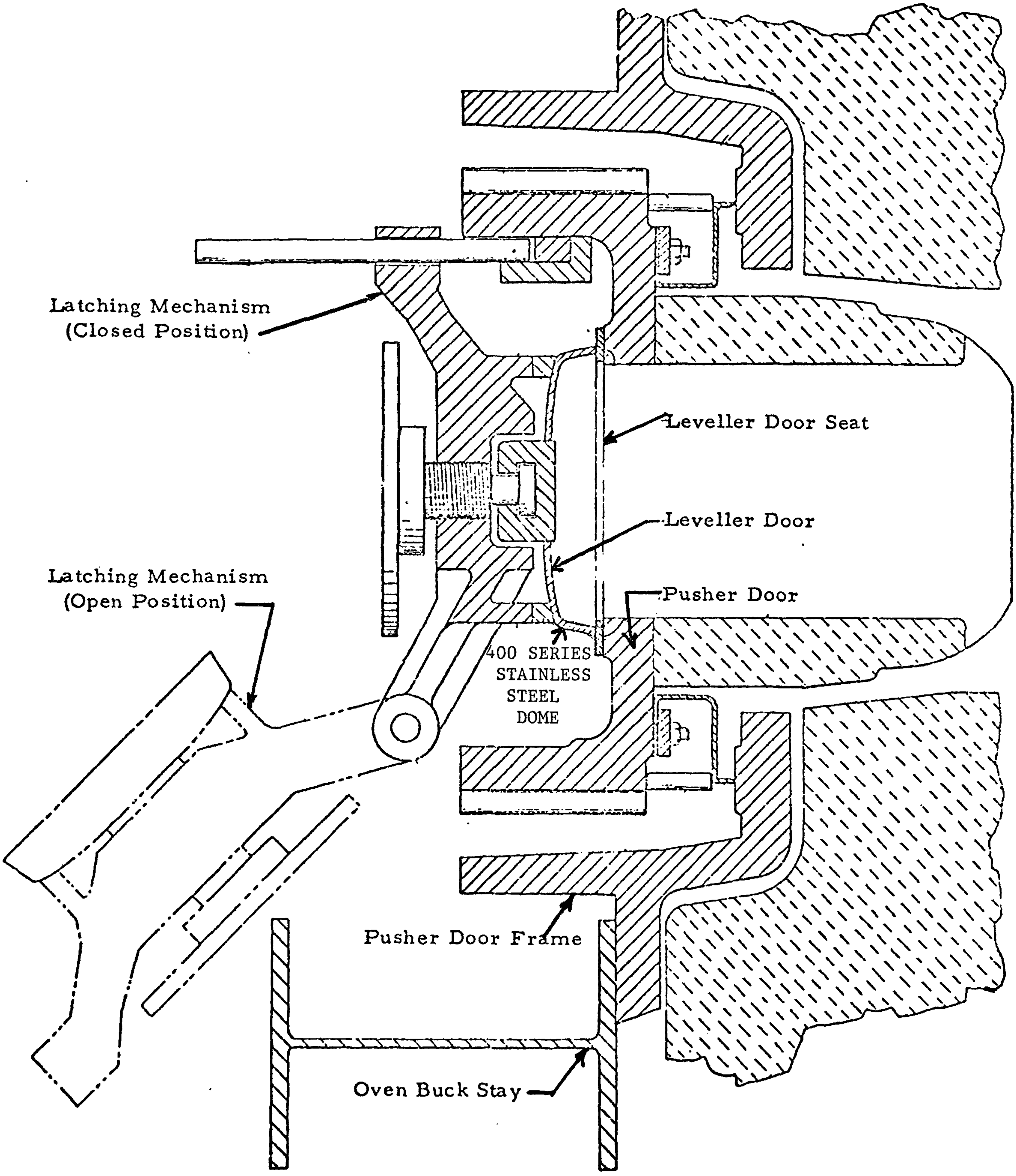

FIGURE 4. SCHEMATIC ILLUSTRATION OF A BLOOM ENGINEERING CO. LEVELER AND PUSHER DOOR ASSEMBLY(8)

luting material is either applied to the flat contact surface of the end-closure door so that the sealing edge becomes encased in the luting or the material is troweled or laid along the outside of the chuck door, end-closure contact line. As with the slurry used to seal the charging lids, the luting material should be inexpensive, readily available, and should be easily removed/cleaned, from the door on opening.

Some companies employ gaskets as a method of sealing chuck doors which do not "self-seal". EPA is currently sponsoring a study on the use of gaskets on coke-oven chuck doors.* The data on chuck-door gasket usage presented herein, are taken largly from information supplied by TRC--The Research Corporation. The preliminary general results of the TRC study are:

"(1) Gaskets are usually employed as a temporary measure until the chuck door can be repaired.

(2) Chuck door design and state of repair are equally as important as gasket use for minimizing visible emissions.

(3) Gaskets in use include:
- (a) Cardboard
- (b) Tarpaper
- (c) Esscolator**
- (d) Fiberfrax***

(4) Gasket use has been limited, but when they have been used, the manufactured gaskets**** have been generally successful as a temporary control measure".

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* Chuck Door Gasket Study, EPA Contract No. 68-01-3154 to TRC - The Research Corporation of New England, 125 Silas Deane Highway, Wethersfield, Connecticut 06109, Mr. Joe Hopkins, EPA

** Esscolator Gaskets are a lamination of steel foil and compressible refractory paper produced and marketed by Essolator Mfg. Co., 727 Pennsylvania Avenue, Pittsburgh, Pennsylvania 15221

*** Trademark, The Carborundum Company

**** Items (c) and (d) of statement (3) above.

The general conclusion from TRC's initial survey is that gaskets have not been used extensively by the industry and therefore experience with gaskets is limited. Chuck door design and preventative maintenance are considered better approaches than gaskets to the visible emission problem.

Standpipe Elbow Covers

Several references[2,5], and personnel of companies contacted during this study, indicated that emissions/leakage from standpipe elbow covers is common in many plants. The leakage from standpipe elbow covers is generally attributed to (1) improper cover positioning, (2) failure to properly clean the cover-seating areas, or (3) distortion of the cover/seat system. The elbow cover is designed to seat against the metal standpipe proper. Thus, the sealing mechanism is by a metal-to-metal contact seal. The design of the seal varies from designer to designer, with some being simply a flat surface on the elbow cover mating to a flat surface on the standpipe, while others use a tapered or conical metal-to-metal seat, and yet others using a shouldered seat. In general, oven designers indicate that such seals will not leak or allow emissions if they are properly cleaned and maintained. As with the charging lids, and chuck doors, when a standpipe elbow cover does become a noticeable source of emissions, operators will effect a seal by the application of a luting material, a slurry, or a gasket. The same or similar luting muds, slurries, or gaskets used to seal the charging lids and chuck doors are also utilized on the standpipe elbow covers.

While operators recognize that standpipe cover leakage may be a rather common occurrence, most operators contacted during this survey felt that cover leakage need not be a significant emission source if the cover were seated properly and/or the cover-standpipe contact area were cleaned prior to replacement of the cover.

Summary

The seals associated with coke-oven charging lids, chuck doors, and standpipe elbow covers are all metal-to-metal contact seals. The charging lids and standpipe elbow covers are typically flat, tapered, or shouldered surface contacts, whereas the chuck door seals are similar to the end-closure door seals, i.e., metal strips pressed against a flat metal surface. Oven designers indicate that all three components should provide an emission-proof seal, if properly cleaned and maintained. Most coke-plant operators augment the inherent seal of these components with luting mud, slurries, and/or gaskets.

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(8) Bulletin C-2790, Bloom Engineering Company, Inc., Horning and Carry Roads, Pittsburgh, Pennsylvania 15236

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

1. REPORT NO. EPA-600/2-77-058	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Sealing Coke-oven Charging Lids, Chuck Doors, and Standpipe Elbow Covers: Survey of Current U.S. State of the Art		5. REPORT DATE February 1977 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) C.E. Mobley, A.O. Hoffman, and H.W. Lownie		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Battelle-Columbus Laboratories, 505 King Avenue, Columbus, Ohio 43201		10. PROGRAM ELEMENT NO. 1AB015; ROAP 21AQR-042 11. CONTRACT/GRANT NO. 68-02-1323, Task 58
12. SPONSORING AGENCY NAME AND ADDRESS EPA, Office of Research and Development, Industrial Environmental Research Laboratory, Research Triangle Park, NC 27711		13. TYPE OF REPORT AND PERIOD COVERED Task Final; 10/76 14. SPONSORING AGENCY CODE EPA/600/13

15. SUPPLEMENTARY NOTES IERL-RTP task officer for this report is R. McCrillis, Mail Drop 62, 919/549-8411 Ext 2557.

16. ABSTRACT The report gives results of a survey of the current U.S. state-of-the-art approach and methodology for sealing coke-oven charging lids, chuck doors, and standpipe elbow covers. The study was part of the program, 'Technical Support for U.S./USSR Task Force on Abatement of Air Pollution from the Iron and Steel Industry.' The survey concluded that: (1) seals associated with coke-oven charging lids, chuck doors, and standpipe elbow covers are all metal-to-metal contact; (2) charging lids and standpipe elbow covers are typically flat, tapered, or shouldered surface contacts, but chuck-door seals are similar to end-closure door seals (i.e., metal strips pressed against a flat metal surface); (3) oven designers indicate that all three components should provide an emission-proof seal, if properly cleaned and maintained; and (4) U.S. coke plant operations augment the inherent seal of these components with luting mud, slurries, and/or gaskets. The study did not develop data relating the extent and type of emissions from these components.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution	Air Pollution Control	13B
Iron and Steel Industry	Stationary Sources	11F
Sealing	Coke Ovens	13H
Coking	Charging Lids	
Ovens	Chuck Doors	13A
	Standpipe Elbow Covers	

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

EPA Form 2220-1 (9-73)