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FINAL

CONTROL TECHNOLOGY ASSESSMENT
FOR
COAL GASIFICATION AND LIQUEFACTION PROCESSES

Tosco Corporation
Rocky Flats Research Center
TOSCOAL Coal Pyrolysis Process
Golden, Coloardo

Report for the Site Visit of
September 1981

Contract No. 210-78-0084

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Submitted to:

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FOREWORD

On September 21, 1981, a visit was made to the Tosco Corporation Rocky Flats Research Center located near Golden, Colorado. The purpose of the visit was to discuss the applicable technology for controlling worker exposure to potentially hazardous chemical and physical agents associated with the TOSCOAL Coal Pyrolysis Process. The meeting was attended by the following persons:

Tosco Corporaion

Robert Hall, Vice President, Resources, Golden
Merril Coomes, Manager, Environmental Health, Los Angeles
Jerry Chiaramonte, Managing Engineer, Golden
John Staton, Managing Engineer, Golden
Michael Brisco, Chemical Engineer, Golden
Raj Sharma, Chemical Engineer, Golden
Gerald Faudel, Environmental Control Analyst, Golden

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Donato Telesca, Program Manager
Jan Scopel, Chemical Engineer
Russell Tanita, Industrial Hygienist

TABLE OF CONTENTS

I. INTRODUCTION

A. Contract Background

The objective of the "Control Technology Assessment for Coal Gasification and Liquefaction Processes" program is to study the control technology that is available to prevent occupational exposure to hazardous agents in coal conversion plants. This information is gathered by conducting site visits to architecture and engineering firms and existing gasification and liquefaction facilities.

This report presents the control technology and industrial hygiene information gathered on the TOSCOAL Coal Pyrolysis Process under development at the Tosco Rocky Flats Research Center, Golden, Colorado, during the site visit of September 21, 1981.

B. Development of the TOSCOAL Coal Pyrolysis Process

The TOSCOAL process is a low temperature coal pyrolysis process based on the Tosco II process for oil shale retorting. Investigation into the possibility of applying this process to coal was initiated in 1970.

The principal objectives of the development program are to upgrade coal to increase its heating value and to recover gaseous and liquid products which are more valuable on a per unit energy basis than the coal feedstock. The coal char produced contains sufficient volatile matter to permit utilization in existing power plants without extensive modification of the facilities or need for supplemental fuels.

During the six-year investigation, a 25-ton-per-day pilot plant located at the Tosco Rocky Flats Research Center near Golden, Colorado was used to process a non-swelling Wyoming Wyodak subbituminous coal and a slightly caking Utah bituminous coal. The pyrolysis process was found to be adaptable to such coals.

Since 1976, additional pilot plant tests have been made on low- and high-sulfur Illinois caking coals with free swelling indices in the 3.0 to 4.5 range. The tests established that these coals can be pyrolyzed if the coal is mildly oxidized to reduce the free swelling index to below 1.0 to 1.5. Bench-scale and pilot plant deagglomeration studies in vessels up to 20-inch inside diameter established that Illinois coal could be deagglomerated over a range of conditons to produce a suitable feed for the Tosco retort.

C. Process Description

Figure 1 is a schematic flow diagram of the TOSCOAL Process for non-swelling coals. Crushed dry coal is preheated in lift pipes using hot flue gas from the ball heater. Preheated and/or partially deagglomerated coal is fed to a rotating pyrolysis drum where it is contacted with hot ceramic balls. The ceramic balls are heated in a ball heater fired by clean process derived fuel gas or fuel oil.

In the pyrolysis drum, coal is decomposed at about 900^{o}F to produce coal char and hydrocarbon vapors. The coal char is separated from the balls by a trommel screen and withdrawn from the char hopper. The balls are elevated, reheated and returned to the pyrolysis drum. Hydrocarbon vapors are cooled and condensed to recover light hydrocarbon gases and coal liquids.

D. Potential Hazards

Table 1 is a list of potential hazards associated with the TOSCOAL Coal Pyrolysis Process. Tosco is developing a health and safety program along with the pyrolysis process development. This is to ensure that these potential hazards are controlled so that no major health problems exist.

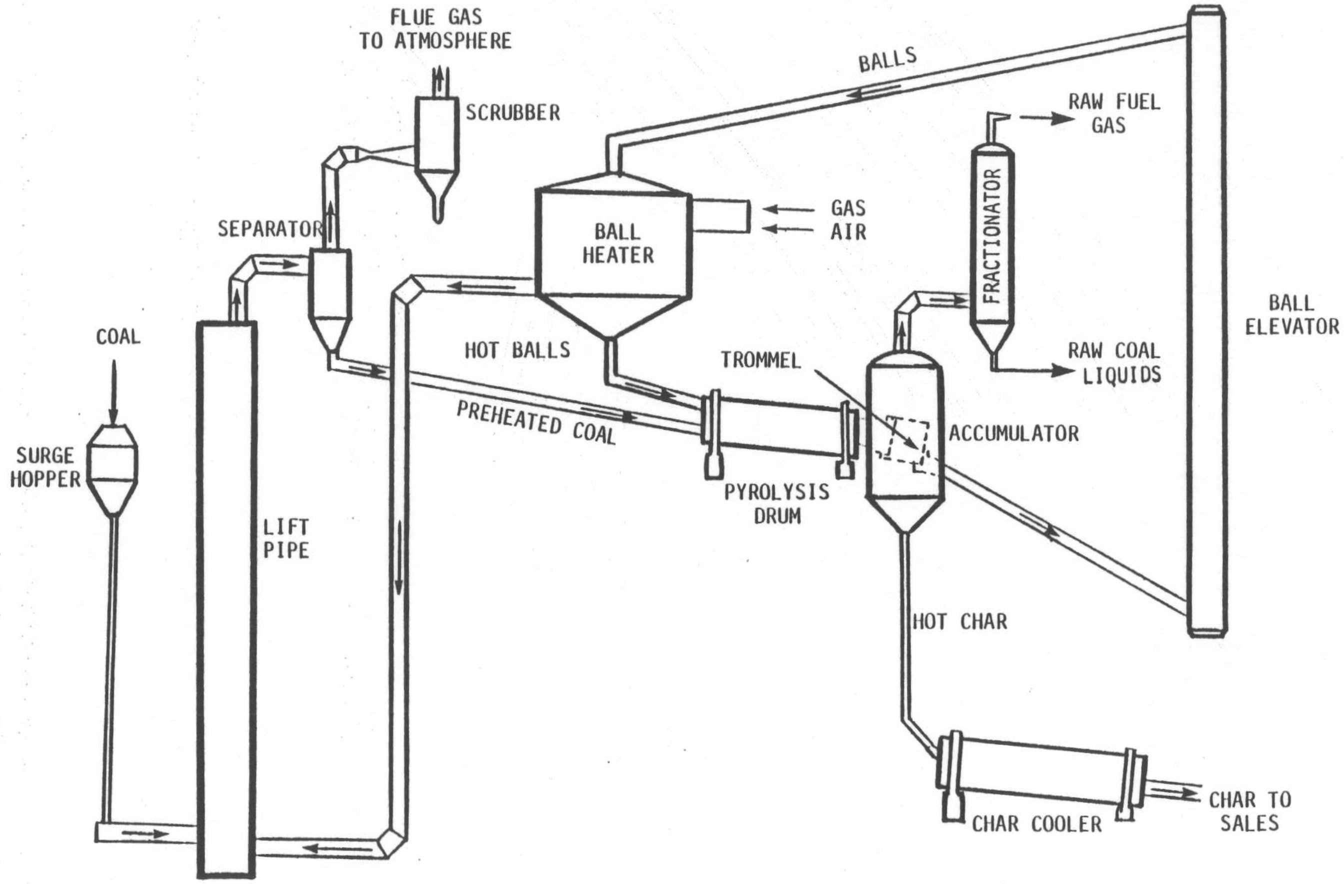

Figure 1. Schematic Flow Diagram of the TOSCOAL Process (from reference 1)

Table 1. Potential Hazards by Process Operation, TOSCOAL Coal Pyrolysis Process

POTENTIAL HAZARD	COAL HANDLING	CERAMIC BALL HANDLING	COAL PYROLYSIS	HYDROCARBON PROCESSING	CHAR HANDLING
Noise	X	X	X		
Heat Stress		X	X	X	X
High Temperatures		X	X	X	X
Flammable/Explosive Materials	X		X	X	X
Respirable Coal/Char Dust	X		X		X
Coal Tar Pitch Volatiles			X	X	X
Toxic Gases:					
Carbon Monoxide		X	X	X	X
Hydrogen Sulfide		X	X	X	X

The potential for fire and explosion are due to the pressure and/or production/generation of coal dust, during coal crushing and handling; liquid and gaseous hydrocarbons, from the pyrolysis process step on; and hot char. Coal processing and ceramic ball handling are potential sources of high noise levels. There is a potential for heat stress and burns where high temperature operations are encountered. These include coal preheating, pyrolysis, hot char, and ceramic ball handling, and high temperature hydrocarbon processing.

Toxic gases and liquids are present or are potentially present in almost every process stream including coal pyrolysis. Equilibrium distribution for particular operating conditions will dictate the concentration of each agent in a particular stream.

II. Engineering Control Technology

The TOSCOAL pyrolysis process is a closed system operation. The primary engineering control used to mitigate potential hazards associated with the process is maintaining the closed system. Various process-related aspects of this operation which enable its maintenance include relatively few operating steps and moderate operating conditions.

From an occupational health control point of view, the TOSCOAL process may offer some advantages over other liquefaction processes. The TOSCOAL process does not involve many of the operations found in liquid-phase liquefaction processes and therefore the potential exposure to those hazards do not apply. As one example, coal is not pulverized, an operation known for its dust generation and explosion potential.

As another example, the feed to the retort is a dried coal rather than a slurry. Slurry preparation and handling operations for most liquefaction processes typically involve mixing pulverized coal with process-derived solvents. These solvents can contain substantial amounts of benzene, toluene, xylene (BTX) and/or polynuclear aromatics (PNAs). Since this operation is not part of the TOSCOAL process, these potential hazards do not apply.

The TOSCOAL processing conditions are such that coal liquids are not separated from mineral matter (ash). Rather, the retort products consist of a hydrocarbon vapor and char, enabling a vapor/solid separation in a single, simple step. Other liquefaction processes to use methods such as distillation, high-pressure filtering, and solvent extraction which have proven to be high maintenance operations.

The process operating conditions are not as severe as many other liquefaction processes. A low operating pressure, less than 10 psi, is used. This means that pressure letdown is not present and thus not a severe maintenance problem as with other processes. In addition, process stream velocities are low so equipment does not experience typical erosion. Therefore, expensive and specialized materials of construction are not required. These aspects of the TOSCOAL process enable the use of off-the-shelf technology and equipment. This, in turn, can lead to less worker exposures by reducing maintenance requirements.

As stated previously, the process is closed. Maintenance will be the only activity, other than process stream sampling, that breaks into the closed system. Tosco noted that heavy coal liquid plugging and/or coal agglomeration are the only process-related problems that may cause excessive maintenance requirements. Tosco uses extensive heat tracing throughout the plant to minimize these problems.

To minimize the potential for fire and/or explosion, a commercial installation would recycle CO_2 from an acid-gas removal unit to the pyrolysis operation for inerting.

III. Occupational Health And Safety

A definitive health and safety program has not been developed for the TOSCOAL Coal Conversion Unit because the process is still in the initial stages of development. However, their experience with the pyrolysis of oil shale has led to a general conclusion that coal conversion should present no major health problems. Tosco has tentative plans for extensive area and personal monitoring during the initial operation of the facility with minimal mandatory requirements for work practices and the use of protective clothing and equipment. The results of this initial survey will be used to develop the elements of the health and safety program.

The initial survey will span the entire process area and will include coal dust; hydrocarbon vapors, such as benzene; toxic gases, such as the oxides of sulfur and nitrogen; and coal tar pitch volatiles. Physical agents, such as noise and heat stress, will also be evaluated during this survey. Substances selected for the survey were chosen on the basis of Tosco's oil shale experience and published literature.

The minimum requirement for protective clothing and equipment is the use of coveralls in the process area. Disposable coveralls and gloves will be available for dirty jobs. Air purifying respirators will be available with a variety of cartridges for use against contaminants such as dust, toxic gases, and hydrocarbon vapors. However, it is anticipated that, at most, only dust protection would be required on the basis of their oil shale experience. Observation and survey results will be used to determine if more stringent requirements are needed.

Work practices during the initial stages of operation are expected to center on worker education and personal hygiene. Worker education informs workers of hazards that may be present in the process stream such as silica and polynuclear aromatics (PNAs). Personal hygiene emphasizes the immediate cleanup of any body surface contaminated with process liquids. This requirement is a general safety factor in the event PNAs are formed in the Toscoal process. Cleanup involves the use of soap and water. Solvents are not allowed since they can facilitate the absorption of the contaminant by the skin. A clean room/dirty room system will be used to keep street clothing apart from the work clothing.

Because of the uncertainty concerning the formation and potential hazard of PNAs, the medical program is expected to include skin examination on a periodic basis. A baseline will be established for all workers in the process area.

IV. CONCLUSIONS

The primary control for mitigating the potential hazards associated with the TOSCOAL Coal Pyrolysis Process is maintaining a closed system operation. Process-related features that are conducive to maintaining a closed system include few operating steps and moderate operating conditions relative to other liquefaction processes. Potential hazards associated with coal pulverizing, slurry preparation, hydrogenation and solids-liquid separation, do not apply to the TOSCOAL process since these operations are not used. The moderate operating conditions can translate into fewer maintenance-related exposures.

TOSCO's plans for extensive area and personal monitoring during initial operations of future facilities will be an important step in developing the elements of a comprehensive health and safety program.

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