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Project Summary

Preliminary Environmental Assessment on Formcoke Cokemaking Process

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A preliminary environmental evaluation and assessment of formcoking has been made. The work is based on readily available literature sources, a plant visit, formcoke plant proposal and feasibility study data, and discussions with engineers and operators involved with formcoking. Material balances, calculations, and engineering judgement have been used to convert existing data and information into a form that can be used to compare environmental discharges between formcoking and conventional by-product coking. The results of those comparisons are presented. The lack of adequate environmental data on formcoking is noted

This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

This report, prepared in response to a request from the Department of Energy (DOE), is a preliminary environmental assessment of formcokemaking. It was prompted by a proposal from Inland Steel to DOE, soliciting government-funded assistance for the design and construction of a new formcoke plant. The depth of the assessment was limited by the time available to complete the work, and insufficient time to do any sampling and analytical work. The reported conclusions are based on data existing when the study began. Material balances, calculations, and engineering judgement were used to convert existing data into a form that could be used to compare environmental discharges between formcoking and conventional coking.

After completion of this report, DOE recommended that Congress provide initial incremental funding for detailed design of the Inland Steel formcoke plant. While initial funding was approved in Congressional committee action, the project never received funding consideration before the full House or Senate. Inland officially withdrew its proposal in 1981.

Summary

A preliminary environmental evaluation and assessment of formcoking has been made. The work is based primarily on readily available literature sources; a visit to the FMC Corporation formcoking plant in Kemmerer, WY; data available in Inland's proposal; data from a feasibility study of the proposed plant by Davy-McKee Corporation; and discussions with various engineers and operators involved with formcoking.

The FMC formcoke plant consists of a coal preparation section for crushing and sizing incoming coal, a fluid-bed pyrolysis section to distill volatile matter and produce a char, and a briquetting and coking section to shape and finish the product. The fluid-bed pyrolysis section receives coal crushed to minus 4 mesh. The initial fluidized bed, the catalyzer, drys the coal at 149°C and partially oxidizes the coal to reduce agglomerating properties. The conditioned coal then proceeds to the carbonizer where it is heated to 480°C to break the coal into tar, char, gas, and water. The partially devolatilized char then is processed in the calciner at 815°C to release remaining volatiles and produce the solid reactive calcinate.

After cooling, the calcinate is mixed with dehydrated tar and pressed into briquettes. The briquettes are cured in an oven at 232°C. The cured briquettes are then coked in a shaft kiln at temperatures above 800°C.

The fluidizing gas in the pyrolysis section at FMC is air. Waste gas produced in this section has a relatively low heating value, 5.6 MJ/m^3 (150 Btu/ft^3). The proposed Inland plant may operate with air also, or alternatively it may operate with a fluidizing gas enriched with oxygen and steam to produce a by-product gas with higher heating value, 13.0 MJ/m^3 (350 Btu/ft^3).

The existing FMC plant was examined to identify the waste streams leaving the plant and the pollutant levels in those strems. Because of the limited time available to complete the project, it was necessary to depend on pollutant data available from test work previously completed. These available data were not comprehensive; as a result there were many data gaps.

The proposed plant description in the Inland proposal was compared to the existing plant. Differences in the process equipment and pollution control facilities were examined. In particular, the proposed plant would have been about four times larger than the existing plant, and been processing an Illinois (instead of a Wyoming) coal. With Illinois coal the process would not have produced enough tar for binder. Supplementary tar would have had to be processed and added. Inland planned to design the plant to operate in either an air mode similar to FMC or an oxygen/steam mode that would have produced a higher heating value by-product gas stream than at FMC. In either mode the gas would have been recovered for other plant uses.

In the gas recovery process more efficient particulate removal was expected in the Inland plant than is achieved at the FMC plant. Since gas is not desulfurized at FMC, whereas a Stretford system was proposed for the Inland plant, SO_x emissions from the proposed plant would have been much lower. The FMC plant discharges wastewater to a holding evaporation pond. The proposed Inland facility final wastewater would have been treated in a publicly owned treatment plant; pretreatment in the form of ammonia and cyanide stripping was planned, with the recycled wastewater stream cooled by noncontact water streams.

The adequacy of proposed pollution controls for the proposed Inland installation was also studied. (Note that the final plant design was not available, and the proposed equipment was little more than conceptual.) Plans for controlling particulates and SO_x offer the potential for compliance with proper specifications and selection of design parameters. Present NO_x regulations appear to affect none of the proposed plant sources. Ammonia and cyanide incineration, however, was expected to produce more NO_x than would be allowed from the smallest source regulated in Indiana. Ammonia recovery could be practiced to reduce NO_x emissions. No air pollution standards for polycyclic organics currently exist, and no data were available to analyze quantities of potential organic emissions from formcoking.

With respect to potential discharges from the proposed Inland plant, wastewater samples were requested from the FMC plant, but they were not received in time for analysis and inclusion in the report. In qualitative terms many of the components present in conventional coking wastewater were expected to be present in formcoking wastewater, but quantities may be different. Since specific wastewater treatment equipment has not been selected, an assessment of the potential for compliance with pretreatment standards has not been possible. Also, plans for solid waste handling were not defined at that time, again preventing an assessment of the potential for compliance.

Finally, estimated environmental discharges from formcoking were compared with those estimated for conventional coking. Table 1 summarizes the results of the comparisons. No direct measurement of polycyclic organic matter (POM) emissions was available from formcoking for comparison with conventional coking. Worker exposures to benzene-soluble particulates have been measured at the FMC plant. In general the FMC measurements show lower worker exposures than have been found in conventional coke plants. This comparison suggests that POM emissions may also be lower for formcoking.

Not shown in the numerical comparisons is the expected greater ease of maintaining control of air pollution for formcoking as compared to conventional coking. Control of air pollution from the batch conventional coking process (particularly hazardous organic pollutants) is highly dependent on work practice and also tends to deteriorate with coke battery age as a result of battery dimensional

Table 1. *Comparison of Environmental Discharges — Conventional Versus Formcoking*

Environmental discharge	*Conventional coking kg/Mg coke*	*Formcoking kg/Mg coke*
Particulates	*0.7-7.5*[a]	*1.1*[b]
SO_x	*2.2*	*2.2*
NO_x		
from NH_3	*13*[c]	*4-14*[c,d]
from other combustion	—	—
Wastewater	*550-1,460 (Including by-product recovery)*	*630-1,400 Air mode* *1,410-2,210 steam/*O_2 *mode (Including by-product recovery)*
Sludge and solid residues	*38*[e]	*29.8*[f] *Air mode* *24.7*[f] *steam/*O_2 *mode*
POM (as indicated by B(a)P)	*0.004*	*No data*
Occupational exposure to benzene solubles	*150-500* $\mu g/m^3$	*50-161* $\mu g/m^3$

[a]*Low value, for a well controlled battery for all particulate sources, is an ideal case.*
[b]*Conservative estimate; could be decreased if necessary.*
[c]*Zero if recovered instead of incinerated.*
[d]*There are indications that the lower-carbonization-temperature formcoke process will favor lower formation of ammonia.*
[e]*Includes coke breeze (~ 36 kg/Mg) much of which is used as a low value fuel rather than as coke.*
[f]*Does not consider possible reuse of formcoke sludges.*

changes. These factors are not expected to play as big a role in air pollution control for the continuous formcoking process.

For normal operations, particulate emissions are expected to be about the same for formcoking as for a well controlled coke oven battery. A well controlled battery for all particulate sources is an ideal case that may be difficult to achieve because of the batch nature of the process. SO_x emissions are expected to be about equivalent. Since ammonia is usually not incinerated for conventional coking, the actual and proposed formcoking will have higher NO_x emissions from this source. Alternatively ammonia could be recovered from formcoking in the same manner as for conventional coking.

In the air mode, wastewater quantities will equal conventional coking. In the operating mode (steam/oxygen) with high heating value gas recovered, the formcoke process is expected to generate up to 50 percent more wastewater for treatment than conventional coking (when compared on the basis of recovering benzene from both processes). Presumably the wastewater from each can be treated to give the same discharge quality. For plants that might have to provide full wastewater treatment instead of pre-treatment followed by discharge to a publicly owned treatment plant, the cost could be a significant impact to overall process economics.

Sludge/solid waste quantities for which no uses have been identified are also higher for formcoking than conventional coking. Ultimate disposal of the sludge/solid waste is a key issue. In conventional coking an analogous solid by-product is coke breeze. In most cases coke breeze is reintroduced to the iron and steelmaking process or sold. It is not known if calcinate thickener sludge could be handled similarly.

A full assessment of formcoking would necessarily examine trace element emissions (heavy metals, etc.). Though no direct measurements have been made on a formcoke plant, some data from gasification processes with similar fluidized-bed operations were reviewed. The data are presented not to say a problem with trace elements exists, but to establish the importance of a more thorough investigation.

Conclusions

The study led to several conclusions:

1) Formcoke production will eliminate many sources of hazardous air emissions which are present in conventional coking and are difficult to effectively control. The formcoking process is more amenable to air pollution control in that there are fewer potential emission sources and the age deterioration of process equipment is not as severe as that which occurs in conventional coke batteries.

2) Formcoke production has the potential of significantly reducing worker exposure to carcinogenic air emissions, when compared to conventional coking.

3) Formcoking is expected to produce the same amount of (or up to 50 percent more) wastewater to be treated and sludge/solid waste for which it is desirable to find uses.

4) With formcoking some trace element and polycyclic organic matter concentration may occur in the recycled wastewater similar to continuous coal conversion processes. Data are insufficient to determine the extent of buildup and identify satisfactory wastewater treatment technology.

5) Existing data are not sufficient for a complete environmental assessment of formcoking.

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The complete report, entitled "Preliminary Environmental Assessment on Formcoke Cokemaking Process," (Order No. PB 83-259 713; Cost: $10.00, subject to change) will be available only from:
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