

CONTROL TECHNOLOGY ASSESSMENT
FOR
COAL GASIFICATION AND LIQUEFACTION PROCESSES

Dravo Corporation
Pittsburgh, Pennsylvania

Case Study Report

Contract No. 210-78-0084

Submitted to

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FOREWARD

On April 4, 1979, Enviro Control, Inc., visited the Dravo Corporation in Pittsburgh, Pennsylvania. The purpose of the visit was to discuss with Dravo, an architectural, engineering and construction firm, the control technology which they have incorporated, or are considering for incorporation, into the design of synthetic fuels plants.

The following persons attended the meeting:

Dravo Corporation

Stanley Kasper, Technical Manager
Albert C. Mengon, Process - Project Engineer
Fred Abel, Senior Process Engineer
K. C. Baczewski, Manager, Process Design

Enviro Control, Inc.

James M. Evans, Project Manager
Donato R. Telesca, Principal Investigator
Russell K. Tanita, Senior Industrial Hygienist

Dravo Corporation
Pittsburgh, Pennsylvania

Site Visit Report

Contents

| | <u>Page</u> |
|--|-------------|
| SUMMARY | 1 |
| INTRODUCTION | 1 |
| DISCUSSION | 2 |
| Philosophy | 2 |
| Illinois Coal Gasification Group | 3 |
| Low-Btu Gasification | 6 |
| CONCLUSION | 8 |

SUMMARY

Dravo Corporation, an architectural, engineering, and construction firm, is a major contributor to the synthetic fuels' field. The Dravo design philosophy is to design for a zero emission rate in plants that process or produce toxic materials.

In 1965, Dravo constructed the Synthetic Fuels Pilot Plant at Cresap, West Virginia. Other projects in which Dravo has been involved include the COED Pilot Plant in Princeton, New Jersey; and the Steam-Iron hydrogen conversion facility located at IGT's HYGAS Pilot Plant in Chicago, Illinois. They have been involved in such studies as the preliminary design of the Hydrane facility and the COALCON project. They have also made detailed conceptual and economic studies of coal liquefaction and gasification processes for private clients. Currently, Dravo is the prime contractor for the Illinois Coal Gasification Group COED/COGAS demonstration plant in Chicago, Illinois; they are also possessors of the McDowell-Wellman technology for low-Btu gasification.

Dravo concluded that appropriate technology exists for handling waste streams; however, there are mechanical-related problems within the operating coal conversion plant that are under constant study. Similarly, there are also areas of control technology that will be further improved. These are subject to resolution by engineering design and demonstration using commercially available components.

INTRODUCTION

Dravo Corporation, a major A&E Firm, is headquartered at One Oliver Plaza, Pittsburgh, Pennsylvania. Dravo and its Synthetic Fuels Department of the Chemical Plants Division has been a major contributor to the synthetic fuels scene for over twenty-five years.

In 1965, Dravo constructed the Synthetic Fuels Pilot Plant at Cresap, West Virginia. They also designed and constructed the COED Pilot Plant in Princeton, New Jersey (which is one of the more successful pilot plant operations). More recently, Dravo designed the Steam-Iron hydrogen conversion facility located at IGT's HYGAS Pilot Plant in Chicago, Illinois.

The Synthetic Fuels Department at Dravo has also been involved in a number of other studies, including the preliminary design of the Hydrane facility and the COALCON contract, as technical support for ERDA's COALCON contract. During this period a number of detailed conceptual and economic studies of coal liquefaction and gasification processes were made for private clients.

Currently, Dravo and the Synthetic Fuels Department are the prime contractor for the Illinois Coal Gasification Group (ICGG) COED/COGAS demonstration plant. They are also interested in the commercial market for low-Btu coal gasification utilizing McDowell-Wellman technology.

DISCUSSION

Philosophy

The Dravo design philosophy incorporates the concept that plants processing or producing toxic materials must be designed for "zero" emissions. Such a design is, on occasion, difficult because insufficient information is available to permit a definitive prediction of leakage.

Careful attention to proper design concepts, coupled with adequate personnel instruction in, and the conscientious supervision of, well-developed and continually updated operating, maintenance, safety and hygiene programs, has resulted in no incidents of exposure in several Dravo-built plants which produce an intensely toxic material (for example, nickel carbonyl).

To achieve the goal of "zero" leakage design, Dravo first makes an intensive literature search to find existing (operating) designs for the desired subprocess goal. The designs are then evaluated to determine whether they are compatible with the specific overall process and especially with the zero-leakage concept. Generally, acceptable commercially-operating design data is available on which to base a design on conceptual ideas.

Illinois Coal Gasification Group

The ICGG plant, as currently defined for Dravo, will include coal preparation, pyrolysis (COED) and gasification (COGAS at 50 psig), flue gas power recovery, oil recovery and treatment, gas purification, hydrogen generation, shift and methanation, bulk carbon dioxide removal, sulfur dioxide removal, ammonia recovery, sulfur recovery, waste treatment and disposal, utilities, and water treatment systems.

Lockhopper

The lockhopper design for the gasifier has not been finalized. Dravo is presently considering the use of a double lockhopper for feeding coal. The alternate feed system under consideration is the Fuller-Kinyon solids pump.

Valves

With the exception of the lockhoppers, most of the valves will be low-pressure installations. Double-sealed ball or plug valves are used for on-off operation. The ball valve design will require that both sides be kept wet.

Relief Valves

Because of the three-phase systems found in many coal conversion units, a great deal of research will be required in order to develop a reliable relief valve which can be used successfully in the coal conversion industry.

Health and Safety

The tentative plans for the ICGG operations include information on staff requirements on a proposed health and safety program. It was estimated that the final health and safety program would not be formulated for about a year. In the interim, discussion of details in these areas is considered premature.

Some information was provided that is applicable to the health and safety of the employee. For example, the ICGG process is designed as a closed-system operation which will reduce or eliminate contact with both the plant products and waste. Adequate containment, based on the toxicity of the process stream contents, is to be designed into the system.

Pumps and Seals

If a mechanical seal is used, it could be flushed with a process-compatible fluid.

Vents

All vessels and enclosed areas will be vented into a header which leads to a thermal oxidizer. Where there may be entrained liquids in the vented gas, a knockout pot will be installed upstream of the thermal oxidizer. The physical location of the thermal oxidizers will be downstream of the process systems.

Wastewater

The design for handling the wastewater streams will incorporate the best design technology available today. (There are a number of proven wastewater systems available.) The wastewater treatment plant will be designed for zero liquid discharge.

Dravo is aware of possible health problems resulting from the aerosols produced by mechanical bio-aeration, and will design the unit to minimize production and the area of influence of aerosols so generated.

The plant design will call for ammonia recovery, but phenols will not be recovered. The reasons that phenols will not be recovered are many and complex (technical, economic, etc); however, they will be removed. The ICGG design will use proven means for removing phenols. (The system which will be used was proprietary information at the time of this visit.)

Solid Waste Disposal

Concern was expressed several times about two specific operating areas of the ICGG plant:

- In particular, discharge and disposal of the solids, because problems are anticipated with volatile wastes at the discharge end of the treating plant; and
- Evaporation from the cooling towers.

For the disposal of solids, it is anticipated that a lined solid waste landfill, incorporating the most advanced landfill concepts known to provide protection of both surface and underground waters, will be used. The present plan calls for the use of the cell principle. This will consist of three active cells--the first cell will be used for ash, slag, and miscellaneous sump solids; the second cell will be used for the collection of sewer catch-water solids and the biowaste sludge from the wastewater treatment plant; and material from the sulfur dioxide scrubbers and evaporator solids will be collected in the third cell. Reagent materials may be recovered for reuse. Upon closing a cell (or a cell system), it will be lime sealed and a leachate collection system will be installed around the cell. Any leachate collected will be sampled to determine proper treatment before the leachate is pumped back into the water treatment system. It is planned that the ground water in the vicinity of the landfill will also be monitored to determine the degree of leachate dispersion.

Little potential employee exposure is anticipated in this area, with only a slight potential exposure possible when the employee moves the solids from the evaporator to the burial spot by truck.

Trace elements are a special area of concern because as coal feed changes, there could be a change in the sludge trace element content. Further, there is no way to determine the exact trace element content from the solids of a single vein of coal because tests of coal from different parts of a mine will indicate numerous differences, particularly in the parts-per-billion portion of these trace elements.

Low-Btu Gasification

In the area of low-Btu gasification, Dravo is primarily interested in the use of the Wellman-Galusha gasifier.

Industrial Hygiene

The conceptual design for these low-Btu facilities includes the clean-dirty locker room as outlined in the Criteria for a Recommended Standard... Occupational Exposures in Coal Gasification Plants.

Pokeholes

The problem of potential exposure to the employee from gasifier product escaping from the pokeholes is recognized. The Dravo design is not finalized. The Dravo Synthetic Fuels group will monitor and may aid developments in this area. Best technology as of date of design will be used. Aspirators are presently strong contenders to prevent leakage, etc.

Tar Removal

The Wellman-Galusha gasifier produces tar when coals other than US anthracite are gasified. The Dravo conceptual plans for the low-Btu plant will use a water scrubber to quench the gas and to knock down tars (as with

other gasification systems). The water scrubber will be followed by an electrostatic precipitator to remove tar fogs (scrubber generated). As far as possible, scrubber water will be recirculated from the tar separator.

The gas liquor will be separated from the tar and/or oils by decantation. Emulsions that could form will be broken by chemical, physical or mechanical means; by use of conservative residence-time design factors; or by a combination of these methods. Decanted tar/oil will be stored for sale or for in-plant use as fuel.

Ductwork

All ductwork for transfer of gas will be traced and/or insulated to reduce condensation in the ductwork. The need for duct burnout to eliminate tar that collects in the ducts will be minimized by increasing the intensity of the scrubber fluid. If required, steam blows will be used to help keep transfer lines open.

Leak Testing

Recommendations for startup will include that the integrity of the system, including all joints and moving parts, be proven before startup.

Instrumentation

Carbon monoxide monitors will be used in sections of the plant where there is a potential for carbon monoxide leak into the work area. Hydrogen sulfide monitors will be used in the sulfur removal area.

Hydrogen Sulfide Removal

Some conceptual designs made to date include a Stretford unit for the removal of hydrogen sulfide for the gas stream. The feed rate to this unit would depend upon the gas make. The Stretford adsorbent solution

could also pick up hydrogen cyanide and carbon monoxide. The hydrogen cyanide could react with the Stretford solution reagent (thus reducing the reagent concentration in the solution). Gases removed from the oxygen tanks will be collected and treated as needed.

Vanadium recovery from the Stretford purge stream could be accomplished by a reductive incineration system. Off-gases from this system could be sent to a thermal oxidizer.

Solid Waste Disposal

The use of coal mines as solid waste disposal sites may not be practical because ground water flow prevalent in many of these mines could leach trace elements from the waste. Rather, the solids wastes, particularly the ash, will be trucked to a proper landfill. The ash itself will be sprayed to allay dust problems.

Hazardous Material

Dravo expressed concern about dissolved salts concentrated in the ash. If ash is classified as a hazardous agent (by EPA), the Dravo studies indicated that such classification would have an adverse effect on the economics of low-Btu gas production.

CONCLUSION

It was recognized by Dravo that all areas of control technology for coal conversion plants have not been explored to equal degrees. Based on the statements made at the meeting, ECI would conclude that appropriate technology does exist for handling waste streams, but that there are many mechanical-related problems within the operating coal conversion plant that have yet to be dealt with adequately.