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| RESEARCH AND DEVELOPMENT PROJECT CARD (NEW PROJECTS) | | 2. SEC. [REDACTED] | 3. PROJ. NO. 4-08-03-05 |
| 1. PROJECT TITLE Agents of the G Series | | 4. | |
| 6. BASIC FIELD OR SUBJECT Chemical Warfare | | 5. REPORT DATE 31 Mar 49 | |
| 8. COGNIZANT AGENCY Chemical Corps, Res & Eng Div. | | 7. SUB FIELD OR SUBJECT SUB GROUP Agents | |
| 9. DIRECTING AGENCY Technical Command | | 12. CONTRACTOR AND/OR LABORATORY University of Michigan | |
| 10. REQUESTING AGENCY Chemical Corps | | CONTRACT/W. O. NO. W-18-108-CM-817 | |
| 11. PARTICIPATION AND/OR COORDINATION None | | 13. RELATED PROJECTS 4-04-15-05, 4-92-03-02 4-08-03-02, 4-93-14-01 4-08-03-01 | |
| | | 14. DATE APPROVED 5 July 45, CWTC Item 1445 | |
| | | 15. PRIORITY 1-G 16. | |
| 19. Supersedes Project Card 25 May 1948 | | 17. EST. COMPL. DATES | |
| | | RES. Cont. | |
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| 20. REQUIREMENT AND/OR JUSTIFICATION | | | |
| <p>The search for the most effective of the agents of the G series is of great importance, since they are characterized by rapidity of action, high toxicity, and difficulty of detection. They are more toxic by inhalation than the other known strictly "chemical" agents, and although nonvesicant, they are highly toxic by absorption of liquid agent through the skin.</p> | | | |
| 21. BRIEF OF PROJECT AND OBJECTIVE | | | |
| <p>The search for the most effective agents in this series will be conducted as follows: Analogs and compounds similar in structure will be synthesized for toxicity evaluation by the Medical Division. On those agents warranting further study, research will be continued and laboratory process development studies made in order to develop methods of synthesis which are practical and suitable for pilot-plant use.</p> <p>Methods for the detection and estimation of these agents, previously a part of this project, will be reported under project 4-08-03-02 in future.</p> <p>Their physical constants, corrosive effect on metals, and stability in storage and in the presence of moisture will be investigated as aids in selecting the best agent for standardization. Work on physical constants will be reported under project 4-08-03-01 and results obtained on corrosion will be submitted under project 4-93-14-01.</p> | | | |
| 22. JRDB SN. | | FC. | IC & P. |
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Funds: 140 M
Priority: 1-C

4-08-03-05 AGENTS OF THE G SERIES

a. Results Prior to 1949: The German opinion on the over-all greater effectiveness of GB over GA was confirmed on the basis of stability, toxicity and volatility. GD and GE were chosen for further study as possible improvements on GB. A program for preparation of other GB analogues was initiated. The five step conversion process for GB production was developed to the point of practicability. The aluminum chloride process, which shortens the route to GB, was discovered but early results did not appear promising. The detection and analysis of G agents were brought to the stage of field usefulness and development of continuous and automatic analyzers started.

b. 1949 Results: The program for preparation of GB analogues was continued and compounds prepared for comprehensive toxicity tests, and for determination of physical properties and stability (TCIR 455). The work was interrupted in mid-year to free personnel for work on the aluminum chloride process.

Development of the five step process was continued. The pyrolysis reaction mechanism (Step 2) was studied (TCR 16) and a continuous chlorination (Step 3) invented (TCR 20). Development of the first four steps is now under contract (Project 4-92-03-02). Intensive study of the aluminum chloride process was started and data obtained for evaluation comparison with the conversion (Step 5) process under contract (Project 4-92-03-02). Cooperative work on Phase I studies of GB production potential was completed. A continuous fifth step was operated in the process laboratory and its superiority to batch production demonstrated.

Preliminary work has been done on the infrared spectra of G-agents. Results to date are insufficient to correlate toxicity and chemical and physical properties. Two methods of detection were tested against G-agents and were found to provide more rapid detection than present methods, but neither reaction is specific.

Observations indicated instability of some BG samples. A program has been initiated with the object of development of specification analyses insuring a stable grade of GB and/or effective stabilizers. Correlation with manufacturing modifications is the primary objective.

c. 1950 Plans

(1) Continue development and study of the fifth step of the GB synthesis, extend the work to GD and GE production and correlate process details with product analysis and stability.

(2) Continue development of the AlCl₃ process until its value is proven and it is ready for industrial contract should that prove desirable.

(3) Determine the impurities in various GB lots and the mechanism of the storage decomposition reactions as influenced by the amount and nature of the impurities. The objects will be to improve specification analysis, correlate chemical and physical analyses with toxicity, and develop useful stabilizers.

(4) Resume the search, as opportunity offers, for more effective agents of the G type.

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RESEARCH AND DEVELOPMENT PROJECT CARD (NEW PROJECTS) 2. SEC. 4. PROJ. NO. 4-92-03-02

1. PROJECT TITLE
GB Plant, Process Development

6. BASIC FIELD OR SUBJECT
Processing Methods, Manufacturing Techniques & Equipment

7. SUB FIELD OR SUBJECT SUB GROUP
Chemicals

8. COGNIZANT AGENCY
Chemical Corps

12. CONTRACTOR AND/OR LABORATORY
Technical Command

CONTRACT/W. O. NO.

9. DIRECTING AGENCY
Chemical Corps (Res & Eng Div)

Monsanto Chemical Company
Plants Div./Design Branch

4-18-108-CM-732

10. REQUESTING AGENCY
Chemical Corps

13. RELATED PROJECTS

17. EST. COMPL. DATES

11. PARTICIPATION AND/OR COORDINATION
None

4-04-15-05
4-08-03-05

RES.
DEV. Jan. 1950

14. DATE APPROVED
16 Apr 46 - CWTC Item 1611

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15. PRIORITY 1-C

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20. REQUIREMENT AND/OR JUSTIFICATION
G-series compounds are some of the most toxic compounds ever investigated by the Chemical Corps. The higher toxicity and better stability of GB compared to GA require that development emphasis be placed on GB.

21. BRIEF OF PROJECT AND OBJECTIVE
The object of this project is to develop a manufacturing technique together with the necessary equipment and operating directives for designing a plant capable of producing GB in the quantities necessary for use in military operations.

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Funds: 75M
Priority: 1-C

4-92-03-02 GB PLANT, PROCESS DEVELOPMENT

a. Results Prior to 1949: Based on a process developed in the laboratory, a pilot plant was built and operated step-wise to produce about 400 lb. of GB. During the operation of the pilot plant, minor difficulties, chiefly pertaining to equipment corrosion, were encountered.

b. 1949 Results: The pilot plant was re-designed to eliminate the difficulties experienced in the early operation. Additional equipment was procured and the plant was modified to provide increased capacity and to allow the simultaneous operation of the several steps. Pilot plant production of the first intermediate, dimethyl hydrogen phosphite, was made unnecessary by the procurement of 10 tons of this material from industry. Conversion of this material to GB was begun in the pilot plant with apparently satisfactory results. Sufficient GB was produced to meet the requirements for field tests for the 1949 season.

A contract was executed with the Monsanto Chemical Company, under which the contractor undertook to develop through the pilot plant stage suitable processes for the first four steps of the GB process, and to obtain data for the design of production plants. Work on this contract is due to be completed in February 1950, and is proceeding on schedule.

A new process has been developed through the laboratory stage by which the first three steps of the original process was replaced by a single Friedel-Crafts type (AlCl₃ process) reaction. This new process appears to offer the advantages of higher yield and simplified operation over the original process. The Monsanto Chemical Company has accepted a supplemental contract to make a prospectus evaluation of the two processes to determine the advisability of conducting development work on the new process in preference to the original process.

c. 1950 Plans:

(1) Continue the operation of the Pilot plant and convert the available supply of intermediates to GB. Obtain all necessary data for the preparation of complete plant designs for Steps IV and V.

(2) Based on the work and recommendations of the contractor, and results obtained at Army Chemical Center, determine the advisability of conducting pilot plant development of the aluminum chloride process to replace the first three steps of the 5-step process.

d. Changes in Data for JRDB Form 1A: None.

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| RESEARCH AND DEVELOPMENT PROJECT CARD (NEW PROJECTS) | | 2. SEC | 3. PROJ. NO. 4-72- |
| 1. PROJECT TITLE GB Unit Plant Design | | 4. | |
| 6. BASIC FIELD OR SUBJECT General Engineering | | 5. REPORT DATE | |
| 7. SUB FIELD OR SUBJECT SUB GROUP Plant Design | | | |
| 8. COGNIZANT AGENCY Chemical Corps | 12. CONTRACTOR AND/OR LABORATORY Technical Command Plants Division, Design Branch | CONTRACT/W. O. NO. | |
| 9. DIRECTING AGENCY Chemical Corps (Res & Eng Div) | 13. RELATED PROJECTS | 17. EST. COMPL. DATES | |
| 10. REQUESTING AGENCY Chemical Corps | 14. DATE APPROVED 4-92-03-02 | RES. | |
| 11. PARTICIPATION AND/OR COORDINATION None | 15. PRIORITY ? | DEV. Dec. 1950 | |
| 19. | 16. | TEST | |
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| 20. REQUIREMENT AND/OR JUSTIFICATION No unit plant design exists for manufacturing GB, one of the most toxic compounds available for use as a chemical agent. | | | |
| 21. BRIEF OF PROJECT AND OBJECTIVE The object of this project is to prepare a unit manufacturing plant design for the GB process, with capacity to produce GB in quantities suitable for military operations. | | | |
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Funds: 50M
Priority: 1-C

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GB UNIT PLANT DESIGN

a. Results Prior to 1949: Certain design data were obtained during the preliminary operation of a GB pilot plant.

b. 1949 Results: Extended operation of a GB pilot plant yielded additional design data for all 5 steps of the GB process. The Monsanto Chemical Company contracted to develop a suitable process for the first four steps of the GB process and to obtain design data therefrom. A new manufacturing process, in which the first three steps of the 5-step process would be replaced by a single step, was investigated. Until a decision can be made between the two processes, the preparation of designs for a production plant will be limited to Steps IV and V, which will be necessary in both processes. The execution of a Step IV design will necessarily be delayed until the completion of the Monsanto contract, scheduled for February 1950. It is expected that required design data for Step V will be available by September 1949 from the operation of the pilot plant.

c. 1950 Plan:

(1) Initiate the design of a unit GB plant, covering the 5th step of the process, with a capacity of 25 tons per day, as soon as data therefore are available, and complete the design as soon as practicable.

(2) Based on data obtained by the Monsanto Chemical Company under its contract, and on data obtained in the operation of the Technical Command pilot plant, initiate the design of a unit GB plant, covering the 4th step of the process and integrated with the other steps of the process.

d. Changes in Data for JRDB Form 1A: None.

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