

R. I. 4128,  
September 1947.

REPORT OF INVESTIGATIONS

UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

GASIFICATION OF LIGNITE AND SUBBITUMINOUS COAL  
PROGRESS REPORT FOR 1945-46<sup>1/</sup>

By V. F. Parry,<sup>2/</sup> D. C. Gernes,<sup>3/</sup> E. O. Wagner,<sup>4/</sup>  
J. B. Goodman,<sup>4/</sup> and A. W. Keth<sup>5/</sup>

CONTENTS

	Page
Introduction .....	4
Acknowledgments .....	5
Summary abstract .....	6
Conclusions .....	7
Description of the Grand Forks pilot plant .....	8
Plant site .....	8
Progress of construction of the plant .....	8
Retort building and shop .....	9
Chemical laboratory and services .....	9
Flow diagram and description of operations .....	9
The retort unit .....	11
Instrumentation and method of obtaining data .....	13
The steam drying unit .....	14
Description of the Golden pilot plant .....	15
Objective and description of tests .....	15
Summary of runs at Grand Forks .....	17
Summary of runs at Golden .....	19
Experimental and observed data .....	20
Coals tested .....	20
Operating data .....	24
Properties of chars and dusts .....	35
Analyses of make gases .....	43
Analyses of gases in upper and lower annuli .....	49
Analysis and discussion of tests and experimental data .....	49
Process of distillation and gasification .....	49
Comparison of performance of the pilot plants .....	57
Heat balances and rates of heat transfer .....	60

- <sup>1/</sup> The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Rept. of Investigations 4128."
- <sup>2/</sup> Fuel technologist, supervising engineer, Subbituminous Coal and Lignite Section, Bureau of Mines, Golden, Colo.
- <sup>3/</sup> Formerly chemical engineer, Bureau of Mines, Grand Forks, N. Dak.
- <sup>4/</sup> Chemical engineer, Bureau of Mines, Golden, Colo.
- <sup>5/</sup> Chemical engineer, Bureau of Mines, Grand Forks, N. Dak.

## CONTENTS (cont'd.)

	Page
Operating problems .....	66
Coal handling and charging .....	66
Char discharging .....	66
Gas cooling and scrubbing .....	66
Gas generation and retort changes .....	67

## TABLES

1. Record of operations, Grand Forks plant .....	19
2. Proximate and ultimate analyses of natural lignites used in Grand Forks pilot plant .....	21
3. Proximate and ultimate analyses of coals, chars, and dusts, Golden pilot plant, runs 10, 11, and 12 .....	22
4. Size consist of lignites and chars, Grand Forks pilot plant .....	24
5. Size consist of coals used in Golden pilot plant .....	24
6. Summary data on gasification of subbituminous coal and natural lignite in the Golden pilot plant .....	25
7. Summary data on gasification of natural lignite in Grand Forks pilot plant .....	27
8. Average temperature gradients across reaction zone, Grand Forks pilot plant .....	35
9. Static pressure and flow of materials in the reaction zones, Grand Forks pilot plant .....	36
10. Static pressures in retort unit, inches of water, run 4, Grand Forks pilot plant .....	37
11. Proximate and ultimate analyses of chars from Grand Forks pilot plant .....	38
12. Proximate analyses of residues, run 3, Grand Forks pilot plant .....	40
13. Physical and chemical properties of chars and dusts from Golden gasification runs 10, 11, and 12 .....	41
14. Size consist and ash content of dusts, Grand Forks plant .....	42
15. Analyses of make gases, runs 10, 11, and 12, Golden pilot plant, 1945 .....	44
16. Analyses of make gases, Grand Forks pilot plant .....	45
17. Analyses of upper and lower annuli gases, runs 10, 11, and 12, Golden, 1945 .....	50
18. Analyses of upper and lower annuli gases, Grand Forks pilot Plant .....	51
19. Gasification of coal in small pilot plant, Golden, Colo. ....	58
20. Gasification of coal in large pilot plant, Grand Forks, N. Dak. ....	59
21. Heat and material balance on run 1-B, Grand Forks pilot plant ..	61
22. Heat and material balance on run 2-E, Grand Forks pilot plant ..	62
23. Heat and material balance on run 3-G, Grand Forks pilot plant ..	63
24. Heat and material balance on run 4-H, Grand Forks pilot plant ..	64

## ILLUSTRATIONS

<u>Fig.</u>	Follows page
1. Plan view of Government property and lignite gasification unit, Grand Forks, N. Dak., 1945 .....	8
2. Aerial view of Government property on University of North Dakota campus .....	8
3. Grand Forks, N. Dak., pilot plant .....	8
4. Retort building, Grand Forks; February 1945 .....	8
5. Construction progress, Grand Forks, December 1944 .....	8
6. Retort building and gas piping, Grand Forks, December 1944 .....	8
7. Brickwork lining of the generator, Grand Forks .....	8
8. Pilot plant for complete gasification of coal, Purry retort, Grand Forks, N. Dak. ....	8
9. Arrangement of plant as operated during test 1, June 1945 .....	8
10. Top view of retort and recuperator unit, Grand Forks .....	10
11. Retort unit charging dome, Grand Forks .....	10
12. Lower view of retort and recuperator unit, Grand Forks .....	10
13. Charging hopper on retort, Grand Forks .....	10
14. Charging valves on retort dome, Grand Forks .....	10
15. Annular retort, sectional views of brickwork and combustion chamber .....	10
16. Detail of brickwork in retort, Grand Forks, N. Dak., plant .....	10
17. Char discharge scraper, Grand Forks pilot plant .....	12
18. Bureau of Mines pilot plant for gasification of lignite, Grand Forks, N. Dak., December 1945 .....	12
19. Pilot plant for steam-drying subbituminous coal and lignite, Grand Forks, N. Dak. ....	14
20. Steam drying unit, Grand Forks .....	14
21. Arrangement of generator for tests 3 and 4, Grand Forks, N. Dak., March-May, 1946 .....	14
22. Arrangement and design of plant as operated during September 1945 test 11, Golden, Colo. ....	14
23. Golden pilot plant, retort designs .....	14
24. Detail of thermocouples, Golden pilot plant .....	14
25. Arrangement and design of retort, February 1946, Golden pilot plant .....	14
26. Water-gas reactions .....	56
27. Molal heat content of gases 60° to 3,000°F., Bureau of Stand- ards R. P. 1634 .....	64
28. Grand Forks pilot plant, retort designs .....	66
29. Grand Forks pilot plant, retort designs .....	68
30. Arrangement of generator for tests during 1946-47, Grand Forks, N. Dak. ....	68