

28.23:5045
Bureau of Mines
Report of Investigations 5045



DETERMINATION OF SOLID AND LIQUID
IMPURITIES IN SYNTHESIS GAS

BY L. J. KANE, H. W. WAINWRIGHT, C. C. SHALE,
AND A. E. SANDS

United States Department of the Interior—March 1954

LIBRARY
LOUISIANA STATE UNIVERSITY

APR 27 1954

DETERMINATION OF SOLID AND LIQUID IMPURITIES IN SYNTHESIS GAS

BY L. J. KANE, H. W. WAINWRIGHT, C. C. SHALE,
AND A. E. SANDS

* * * * * **Report of Investigations 5045**



UNITED STATES DEPARTMENT OF THE INTERIOR
Douglas McKay, Secretary
BUREAU OF MINES
J. J. Forbes, Director

Work on manuscript completed December 1953. The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Report of Investigations 5045."

The work upon which this report is based was done under a cooperative agreement between the Bureau of Mines, United States Department of the Interior, and the West Virginia University.

March 1954

DETERMINATION OF SOLID AND LIQUID IMPURITIES IN SYNTHESIS GAS

by

L. J. Kane,^{1/} H. W. Wainwright,^{1/} C. C. Shale,^{2/}
and A. E. Sands^{3/}

CONTENTS

| | <u>Page</u> |
|--|-------------|
| Summary and conclusions..... | 1 |
| Introduction..... | 1 |
| Acknowledgments..... | 2 |
| Sampling the gas stream..... | 3 |
| Laboratory-scale equipment for testing sampling methods..... | 3 |
| Procedure..... | 3 |
| Selection of sampling point..... | 3 |
| Sampling methods..... | 5 |
| Sampling in pilot plants..... | 6 |
| High temperature sampling..... | 7 |
| Separation of the solid and liquid impurities from the sample gas stream..... | 8 |
| Crude gas..... | 9 |
| Filters..... | 9 |
| Highly purified gas..... | 12 |
| Large-area filter papers..... | 13 |
| Designs for large-area filter-paper holders..... | 14 |
| Gas under superatmospheric pressures..... | 14 |
| Examination of the solid and liquid impurities..... | 15 |
| Weighing procedure..... | 15 |
| Weighing large-area filters..... | 17 |
| Use of automatic instruments..... | 17 |
| Moisture determination..... | 17 |
| Particle-size determination..... | 18 |
| Dispersion..... | 19 |
| Particle-size measurement..... | 21 |
| Microscopic examination..... | 23 |
| Petrographic methods..... | 23 |

-
- 1/ Chemical engineer, Synthesis Gas Branch, Bureau of Mines,
Morgantown, W. Va.
- 2/ Chemist, Synthesis Gas Branch, Bureau of Mines, Morgantown,
W. Va.
- 3/ Assistant chief, Synthesis Gas Branch, Bureau of Mines,
Morgantown, W. Va.; now with Carbide and Carbon Chemicals
Corp., Oak Ridge, Tenn.

TABLES

| | <u>Page</u> |
|---|-------------|
| 1. Resistance to air flow of various filtering materials | 11 |
| 2. Absorption of gases by anhydrous calcium sulfate..... | 12 |
| 3. Precision of methods for dust determination..... | 16 |
| 4. Accuracy of test method developed for moisture determination..... | 18 |
| 5. Comparison of different methods for particle size measurement..... | 22 |

ILLUSTRATIONS

| <u>Fig.</u> | <u>Follows page</u> |
|---|-------------------------|
| 1. Summary of methods suitable for determining dust and moisture in synthesis gas..... | 2 |
| 2. Apparatus for testing dust-sampling methods..... | 2 |
| 3. Photograph of apparatus for testing dust-sampling methods..... | 2 |
| 4. 50-pound-per-hour coal-gasification unit showing dust-sampling points..... | 6 |
| 5. 500-pound-per-hour coal-gasification unit showing dust-sampling points..... | 6 |
| 6. Apparatus for determining dust and moisture in crude, hot synthesis gas containing condensable moisture..... | 6 |
| 7. Small filter-thimble holder..... | 10 |
| 8. Large, glass, filter-paper holder..... | 10 |
| 9. Large, cylindrical, metallic, filter-paper holder... | 10 |
| 10. Metallic holder for large-area filter-paper strips (cross-sectional diagram)..... | 14 |
| 11. Design of large-area filter-paper holder..... | 14 |
| 12. Simple filter-thimble holder for high pressure..... | 14 |
| 13. Large-area filter-paper holder for high pressure.... | 14 |
| 14. Apparatus for preparation of dry dust dispersions... | 20 |
| 15. Typical dust dispersion..... | 20 |
| 16. Typical dust dispersion showing meniscus effect..... | 20 |
| 17. Dispersion of fine particles showing agglomeration.. | 20 |
| 18. Residue from gas leaving atmospheric gasifier (No. 1)..... | 22 |
| 19. Typical slag particles..... | 22 |
| 20. Interior of slag particle..... | 22 |