United States Patent

Rieve

[15] **3,660,054**

[45] **May 2, 1972**

[54] COAL UPGRADING

[72] Inventor: **Robert W. Rieve,** Springfield, Pa.

[73] Assignee: **Atlantic Richfield Company,** New York, N.Y.

[22] Filed: **Sept. 29, 1970**

[21] Appl. No.: **76,601**

[52] **U.S. Cl.** ..... **44/1 R**

[51] **Int. Cl.** **C10l 9/00**

[58] **Field of Search** ..... 44/1 R, 4; 23/224, 227

[56] **References Cited**

UNITED STATES PATENTS

51,231	11/1865	Smith	44/1 R
2,726,148	12/1955	McKinley et al.	44/1 R
3,249,402	5/1966	Smyers et al.	23/224

FOREIGN PATENTS OR APPLICATIONS

747,730	4/1956	Great Britain	44/4

Primary Examiner—C. F. Dees

Attorney—Blucher S. Tharp and Roderick W. MacDonald

[57] **ABSTRACT**

A method for upgrading coal to a higher quality fuel or feed stock by mixing coal with water and heating the mixture in a non-oxidizing atmosphere at a temperature near the critical temperature of water and under a pressure sufficient to maintain substantially all of the water in the liquid state. By this process at least the sulfur and/or ash content of the coal is reduced.

4 Claims, No Drawings

COAL UPGRADING

BACKGROUND OF THE INVENTION

Heretofore coal has been extensively used as a fuel for the generation of electricity, and the like and has also been employed as the feed stock in processes for its conversion to gaseous and liquid hydrocarbonaceous products from which fuel gas, gasoline, residual fuel oil, and the like can be obtained. One process utilizing coal as a feed stock is the hydrogenation of coal to gasify and liquify same, a particularly suitable process being that disclosed by U.S. Pat. No. Re. 25,770, the disclosure of which is incorporated herein by reference.

It is highly desirable for evironmental purposes to reduce the sulfur and ash content of any coal utilized as a fuel or as a feed stock for a process which produces a fuel. Although sulfur reduction can take place during the treatment of a coal feed stock to convert the coal into a liquid or gaseous product from which fuels can be obtained and although it is possible to reduce the sulfur and ash content of stack gases after the coal or fuel product obtained therefrom has been burned, it is most desirable to reduce the content of these materials in the coal initially. This is desirable because it renders the conditions of subsequent burning or processing of the coal more flexible since they do not have to provide extensive sulfur and ash treating facilities at each location.

Accordingly, it is very desirable to be able to substantially reduce at least the sulfur and/or ash content of a coal before it is burned as a fuel or otherwise gasified and/or liquified for further processing into specific fuels.

SUMMARY OF THE INVENTION

It has now been found that if coal is mixed with water and heated in a non-oxidizing atmosphere at a temperature near the critical temperature of water, but not above the critical temperature of water, at least the sulfur and/or ash content of that coal is reduced.

Accordingly, it is an object of this invention to provide a new and improved process for upgrading coal. It is another object to provide a new and improved process for the removal of at least a portion of at least one of sulfur and ash from raw coal. It is another object to provide a new and improved method for rendering a raw coal more acceptable as a fuel or feed stock for further processing into a fuel.

Other aspects, objects, and advantages of this invention will be apparent to those skilled in the art from this disclosure and the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

According to this invention a coal, which can be one or a mixture of two or more of anthracite, bituminous, semi-bituminous, sub-bituminous, lignite, peat, and the like, is subdivided, for example so that substantially all of the coal particles are no larger than one inch in their largest cross-sectional dimension (effective diameter), and mixed with water.

The mixing can be carried out in any desired manner so long as an intimate mixture of coal particles and water is achieved and can be conducted at sub-ambient, ambient, or super-ambient conditions of temperature and pressure. Preferably, the coal and water are simply mixed together at ambient conditions of temperature and pressure. The mixture is preferably composed of coal and water in the weight ratio range of coal/water of from about 2 to about 0.1.

The mixture is then heated in a non-oxidizing atmosphere, e.g., steam, inert gas, reducing gas, and the like, at a temperature of from about 600° F to about the critical temperature of water, i.e., 706° F. Although a broad temperature range of from about 600° to about 706° F. can be employed, a presently preferred range is from about 650° to about 706° F. It is important that the temperature of the water during the reaction be near but not above the critical temperature so that the water will be more monomeric than polymeric and more adidic than normal. It is also important that the water not be in the vaporous state to any substantial extent. The pressure should be maintained sufficiently elevated so that substantially all of the water will be maintained in a liquid state at the temperature prevailing. The pressure therefore can be the autogenous pressure of water vapor at the temperature of reaction and will generally range from about 1,545 to about 3,226 p.s.i.a.

By following the above conditions substantial amounts of sulfur and/or ash can be removed from the coal. The reaction should therefore be carried out for a time sufficient to achieve these results. This time will generally be at least about one minute, preferably at least about five minutes, e.g., from about five minutes to about sixty minutes.

The coal, after completion of the reaction time, can be recovered with or separate from the water present in the reaction. The recovered coal can be utilized, either with or without drying, as a solid fuel or as a feed stock for a coal gasification and liquifaction process.

EXAMPLE

Pittsburg No. 8 seam coal subdivided so that substantially all passes a 100 mesh sieve and is retained on a 200 mesh sieve (Tyler) was mixed with water in a weight ratio of coal/water of 0.25 by simple stirring at ambient conditions of temperature, pressure and under one atmosphere of nitrogen to provide an intimate mixture of the coal particles and water.

The mixture was then heated in an autoclave at 650° F. under an autogenous pressure of 2,350 p.s.i.g. for 1 hour after which the autoclave was vented to the atmosphere and most of the water thereby expelled.

The standard coal analysis for the coal before and after treatment was as follows:

Analysis, Wt. % MAF Coal	Raw Coal	Treated Coal
Carbon	76.16	80.77
Hydrogen	5.21	4.76
Oxygen	5.96	5.49
Nitrogen	1.55	1.61
Sulfur	2.74	1.27
Ash	8.38	6.10
Volatile Matter	39.06	33.66
Fixed Carbon	52.56	60.24

It can be seen from the above data that the sulfur content was reduced by 53.6 percent and that the ash was also reduced by 27.3 percent. With such a substantial reduction in both sulfur and ash content, the treated coal was a much more acceptable burning fuel and liquid fuel feed stock since it would introduce substantially less sulfur and ash into the combustion products or other liquid and gas products obtained therefrom.

Reasonable variations and modifications are possible within the scope of this disclosure without departing from the spirit and scope of this invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method for upgrading coal comprising mixing subdivided coal and water in the weight ratio range of coal/water of from about 2 to about 0.1, heating said mixture in a nonoxidizing atmosphere at a temperature of from about 600° to about 706° F., said heating being under a pressure sufficient to maintain substantially all of the water in the liquid state and for a time sufficient to reduce at least one of the sulfur and ash content of said coal, and recovering the treated coal.

2. A method according to claim 1 wherein said pressure is in the range of from about 1,545 to about 3,226 p.s.i.a.

3. A method according to claim 1 wherein said coal is subdivided to be substantially all no greater than about 1 inch effective diameter particles.

4. A method according to claim 1 wherein said coal is at least one of bituminous and lignite and is subdivided to be substantially all no greater than about 1 inch effect diameter particles, said temperature is from about 650° to about 706° F., and said time is for at least about 1 minute.

* * * * *