METHOD AND SYSTEM FOR INTRODUCING FUEL OIL INTO A STEAM REFORMER WITH REDUCED CARBON DEPOSITION

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention generally relates to systems steam reforming of hydrocarbon fuels to generate hydrogen rich reformate for use in fuel cells.

2. Background Information

As a part of the overall strategy to try and find cleaner and more efficient methods of providing power, new fuels and systems have and continue to be developed. Among these technologies and devices are so called fuel cells, particularly polymer electrolyte fuel cells (PEFCs). These devices generally require hydrogen fuel to operate and when provided with these materials provide a clean and reliable energy source. However, the difficulty in safely and efficiently storing and distributing hydrogen typically limits the practical use of such devices.

To attempt to remedy this problem a fuel processor using the steam reforming reaction can be used to liberate hydrogen from a hydrocarbon fuel to provide hydrogen at the point of use for a fuel cell. Among the potential hydrocarbon sources that may be reformed to generate hydrogen are lower volativity fuels with high boiling ranges such as home heating oil, diesel fuel, JP-8, and other similar hydrocarbon fuels.

The reformation process typically involves the conversion of a hydrocarbon to a mixture of carbon dioxide, carbon monoxide and hydrogen, along with residual amounts of methane. Before introducing the fuel into the reforming reactor, the fuel must be brought into the vapor phase and mixed with steam. However, the boiling range of these hydrocarbons is close to the temperatures at which breakdown of the hydrocarbons may begin to occur which increases the potential for formation of carbon deposits within the reforming system. The formation of carbon deposits may adversely affect the reformer performance by reducing catalyst activity or by obstructing flow passages.

The tendency for the formation of deposits increases as the temperature increases. Because the typical reformation process requires elevated temperatures to vaporize, preheat and then react these materials, the formation of carbon deposits is a frequent problem. Furthermore, once these processes of contaminant creation and carbon deposition begin, it is very difficult for these processes to be reversed, and the susceptibility of the system to further influence by these materials is increased.

SUMMARY

The present invention is a method and system for reducing carbon deposits in reformate fuel systems thus increasing the efficiency of the reformate system as well as reducing the production of unwanted by products such as methane. The method may include any of a variety of various novel steps including: utilizing superheated steam to provide sufficient energy to vaporize relatively small quantities of cooled fuel into a hot mixture; rapidly achieving intimate mixing of steam and fuel; passing this mixture through a prereformer to partially treat the mixture prior to passing this mixture into a reformer, and passing the material through a reformer that has a catalyst within its header.

The system for performing such steps may be configured in any of a variety of ways but is typically characterized by a system that has at least one of the following items: a steam source, configured to produce a steady source of steam; a superheater for superheating the steam, a mixing tube extending between the steam source and a prereformer, the mixing tube having an inlet configured to receive a preselected quantity of a preselected fuel into a stream of steam passing through said mixing tube; the mixing tube being of sufficient proportions so as to allow thorough mixing of the preselected quantity of the preselected fuel within the stream of steam so as to form an even mixture; a prereformer operatively connected to the mixing tube, so as to receive the mixture within the prereformer and to treat a portion of the mixture with at least one catalyst; and a reformer operatively connected to the prereformer.

In the preferred embodiment of the invention which is set forth hereafter, the preferred combinations of the elements which are set forth above are arranged in the form and to comply with the embodiment which is the best mode known by the inventor to practice the invention as defined by the claims. The purpose of the foregoing abstract is to enable the United States Patent and Trademark Office and the public generally, especially the scientists, engineers, and practitioners in the art who are not familiar with patent or legal terms or phraseology, to determine quickly from a cursory inspection the nature and essence of the technical disclosure of the application. The abstract is neither intended to define the invention of the application, which is measured by the claims, nor is it intended to be limiting as to the scope of the invention in any way.

Various advantages and novel features of the present invention are described herein and will become further readily apparent to those skilled in this art from the following detailed description. In the preceding and following descriptions I have shown and described only the preferred embodiment of the invention, by way of illustration of the best mode contemplated for carrying out the invention. As will be realized, the described embodiment is capable of modification in various respects without departing from the invention as defined by the claims. Accordingly, the drawings and description of the preferred embodiment set forth hereafter are to be regarded as illustrative in nature, and not as restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic of a first preferred embodiment of the system of the present invention

FIG. **2** is a detailed cut away view of a portion of the mixing tube portion of the embodiment shown in FIG. **1**.

FIG. **3** is an assembly view of the fuel delivery and mixing tube portions of the preferred embodiment of the present invention.

FIG. **4** is an assembled view of the portions of the preferred embodiment of the invention which are shown in FIG. **3**.

FIG. **5***a* is a perspective view of the prereformer of the present invention.

FIG. **5***b* is a detailed cut away view of the header portion of the prereformer/reformer portions of the preferred embodiment of the invention with the catalyst strip in place.

DETAILED DESCRIPTION OF THE INVENTION

The following description includes the preferred best mode of one embodiment of the present invention. It will be clear from this present description of the preferred embodiment that the invention is not limited to these illustrated embodiments but that the invention also includes a variety of other embodiments and modifications thereto. Therefore the present description should be seen as merely illustrative and