

The Fuel Processing Research Facility – A Platform for the Conduct of Synthesis Gas Technology R&D

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Introduction

Vision 21 is the U. S. Department of Energy's initiative to deploy high efficiency, ultra-clean co-production coal conversion power plants in the twenty-first century. These plants will consist of power and co-production modules, which are integrated to meet specific power and chemical markets. A variety of fuel gas processing technology issues involving gas separations, cleanup, gas-to-liquid fuels production and chemical synthesis, to mention a few, will be addressed by the program. The overall goal is to effectively eliminate, at competitive costs, environmental concerns associated with the use of fossil fuels for producing electricity and transportation fuels.

Objective

The Fuel Processing Research Facility (FPRF) was developed as a fuel-flexible platform to address many of these technology needs. The facility utilizes a simplified syngas generator that is capable of producing 2,000 standard cubic feet per hour of 900 degree Celsius and 30 atmosphere synthesis gas that can be tailored to the gas composition of interest. It was built on a "mid-scale" level in an attempt to successfully branch the traditionally difficult scale-up from laboratory to pilot scale. When completed, the facility will provide a multi-faceted R&D area for the testing of fuel cells, gas separation technologies, and other gas processing unit operations.

Facility Description

The facility is located at the U.S. DOE National Energy Technology Laboratory in Morgantown, WV where it currently occupies approximately 5000 square feet of combined project and control room area. Major components of the facility, as shown in Figures 1 and 2, include a mixing manifold system, carbon desulfurizer, hydro-desulfurizer, zinc oxide bed, reformer, separation membrane and a component test stand. These components can be grouped into five basic fuel processing areas that perform the following functions:

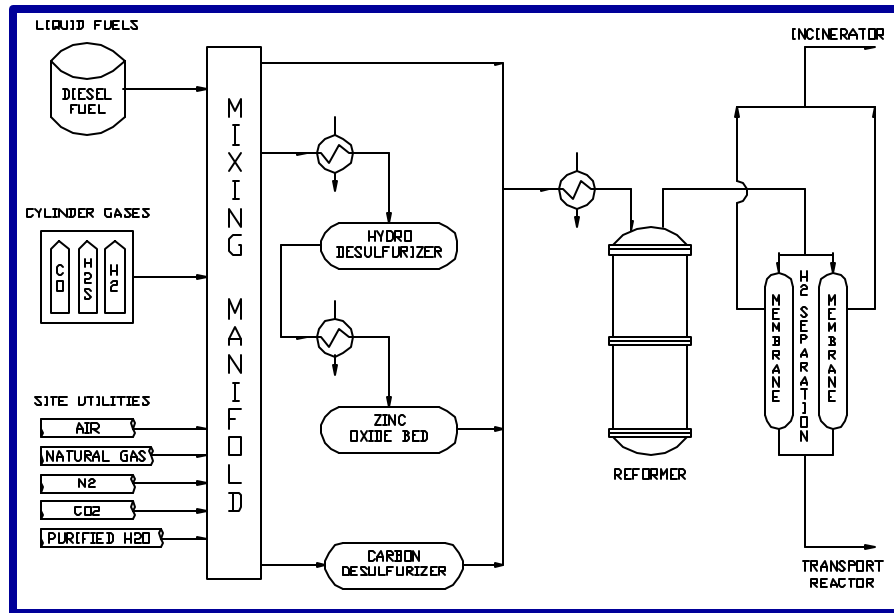


FIGURE 1: FPRF SIMPLIFIED FLOW DIAGRAM

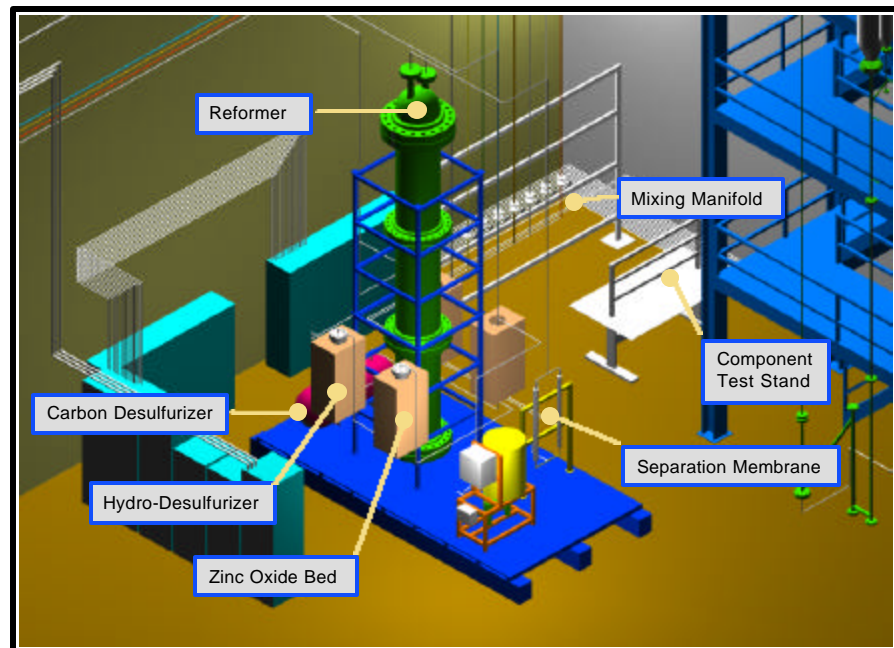


FIGURE 2: FPRF MAJOR COMPONENTS

Process Gas Production – Liquid and gaseous components of the syngas, are made available to a mixing manifold system through the use of cylinder gases, liquid fuel holding tanks and on-site utility services. The mixing manifold blends the inlet gases through the use of a series of valves to produce the required process gas composition. At present, diesel fuel, carbon monoxide, hydrogen sulfide, hydrogen, air, natural gas, nitrogen, carbon dioxide and de-ionized water are available for use by the facility. Other liquid fuels and cylinder gases can easily be added when and if necessary.

Sulfur Removal – Several different methods are used to remove sulfur species that are present in various gaseous and liquid fuels. An activated carbon bed can be used to remove sulfur compounds found in odorants or occurring naturally in gaseous fuels. Those sulfur species present in most liquid fuels can be removed through the use of a hydro-desulfurizer and zinc oxide bed.

Reforming – Depending on the desired test conditions, reforming of the process gas can be accomplished using one of three different methods; steam, partial oxidation, and auto-thermal. Zoned resistance heating, as shown in Figure 3, is used to control reactions that take place within the industry standard 3 ½ in U-Tube reformer.

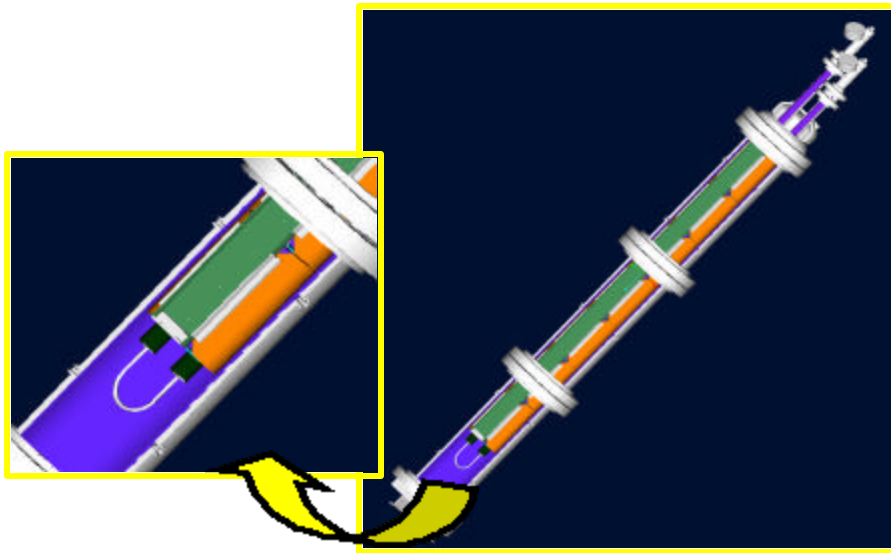


FIGURE 3: FPRF REFORMER CONFIGURATION

Gas Separation – To add flexibility to the system, a gas separation system utilizing both commercially available and novel membrane devices, such as that shown in Figure 4, can be employed to further tailor the reformed process gas for use in on-site transport reactor studies. This separation system also provides an excellent method to obtain performance data on novel membrane configurations under varying process conditions.

Miniaturized Component Testing – Future expansion of the facility will include a test stand that can be used to provide performance data for new miniaturized fuel cell concepts.

Future Activities

Construction activities are continuing and are on schedule. Shakedown of the facility is expected to start in the second quarter of 2003 followed by full-scale operation in the

fourth quarter of the same year. Facility activities during full-scale operations are detailed in Figure 5.

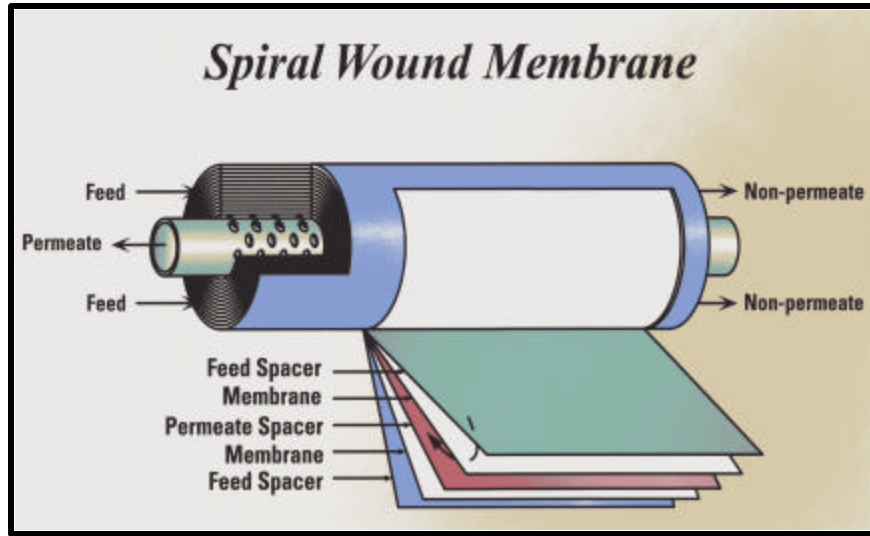


FIGURE 4: UOP SEPARATION MEMBRANE (COURTESY UOP)

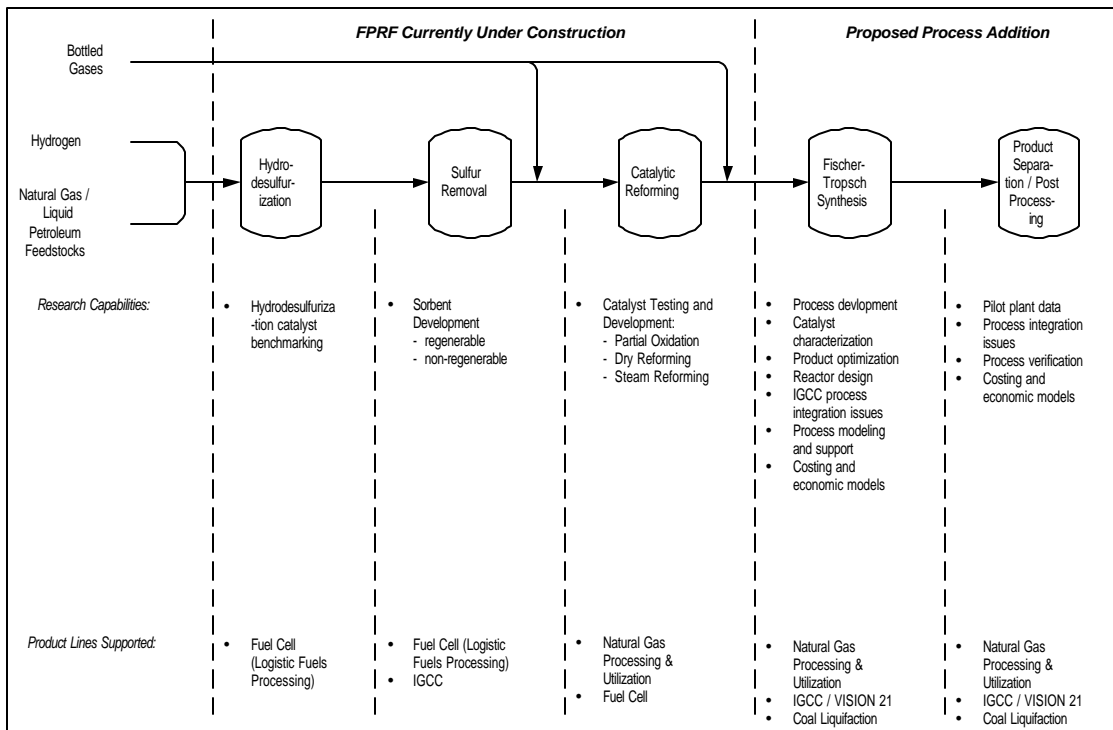


FIGURE 5: FPRF PLANNED ACTIVITIES