

**Evaluation of SHEC Labs Technological Innovations
Conducted October 2 -6, 2000
Wardrop Project Number 0024240100**

By

Henry K. Miyamoto, P. Eng, C.Chem, FCIC
Wardrop Engineering Inc.
6725 Airport Road, Suite 600
Mississauga, Ontario L4V 1V2

Evaluation of SHEC Labs Technological Innovations

Executive Summary

A process has been conceived by SHEC Labs to produce hydrogen using Solar Radiation. Most of the process operations which can be used in the process train are viable existing technologies. The one unit operation which is not known in the prior art is the use of a catalyst produced by SHEC Labs which leads to the productions of hydrogen.

Beneficial applications of the technology are described in the following areas:

- Reduction in greenhouse gas emissions;
- Replacing a fossil fuel technology with a renewable resource technology;
- Reuse of waste streams.

Potential advantages of the technology appear to be

- Storage of solar energy in a relatively non-polluting form;
- Long life of catalyst;
- Relatively inexpensive activation and regeneration chemicals and procedures;

Wardrop conducted an evaluation of the investigations conducted by SHEC Labs and found that their proprietary catalyst when properly activated and regenerated could produce for many regeneration cycles using one technique. Investigations into improving the catalyst formulation and additional regeneration techniques are on-going.

Evaluation of SHEC Labs Technological Innovations

1 Introduction

A process train has been proposed by SHEC Labs to use solar energy to convert water and separate gases into relatively pure hydrogen.

SHEC Labs have been investigating the possibility of using specially-designed catalysts to promote a reaction leading to the production of pure hydrogen.

1.1 Scope of Feasibility Evaluation

This evaluation includes a review of

- the process design of the laboratory experiments,
- laboratory procedures used and
- the instrumentation used to generate and monitor the reactions leading to the production of hydrogen.

1.2 Exclusion from the Evaluation

This evaluation does not include the solar energy requirements nor the production of such energy since this is known or practiced in the prior art and need not be reviewed.

The use of hydrogen either as a fuel or as a method of generating electricity are also known in prior art.

2 Process Design Evaluation of the Laboratory Study

A laboratory scale reactor has been designed to study the reaction with a variety of catalysts. A study of the laboratory set up confirmed that the process would proceed as described by SHEC Labs. Instrumentation used by SHEC Labs to monitor the process and follow the reactions are

- a set of commercially available flowmeters, specially built flow indicators and flow meters;
- a Hewlett-Packard Model 5700A gas chromatogram with various size packed columns;
- thermocouples placed in the reactor tubes to monitor the temperature;
- controllers to control the temperatures to various set points;
- timers manually set and alarmed;
- output from the gas chromatograph are collected and reduced by a program called Labview;
- a review of the Labview program indicated that the program had been written to adequately summarize and store the data provided by the gas chromatograph.

Wardrop confirmed that the instrumentation indicated flows, time and temperature adequately and analyzed and recorded as stated by SHEC Labs, the standard analytical gases used for calibration were adequate, safely stored and correctly monitored and calibrated. SHEC Labs recorded the dates on which various instruments were calibrated. Wardrop confirmed that adequate records were kept to maintain good quality control on the results generated by the laboratory instruments.

The procedures used by SHEC Labs to study the reaction were reviewed by Wardrop. One problem noted by SHEC Labs with the outside laboratory used to confirm their own analyses was identified. The sample bags provided by the outside lab contained air and this would dilute the samples collected by SHEC Labs during the experimental runs. A technique was developed in discussion with SHEC Labs to ensure that the bags could be properly evacuated prior to collecting the samples. Although this would not guarantee elimination of all contaminants in the sampling bags, it would reduce the contaminants and reduce the problem of dilution of the sample during collection.

Evaluation of SHEC Labs Technological Innovations

Wardrop identified a problem with the sampling technique used by the outside laboratory. Results provided by the outside laboratory indicated that their sampling technique introduces some air. The results, however, confirmed that the system produced product as claimed by SHEC Labs and demonstrated by their gas chromatograph. SHEC Labs methodology provides quantification as well as qualification of the products produced, whereas the independent laboratory could only identify and qualify the products generated.

3 Technological Review by SHEC Labs

A cursory review of the scientific papers and patents collected and reviewed by SHEC Labs indicates that their search has been thorough. All reference papers, which have been reviewed by SHEC Labs, are summarized and catalogued using a program called Papyrus release 7, which produces a database which can be sorted by keyword, subject, author or title. The database includes a short abstract of the paper where necessary and provides the location in the SHEC Labs filing system. The papers and patents are stored in a four-drawer legal size filing cabinet. To date 347 pertinent references have been retained in the technological review.

Wardrop believes that the technological review has been thoroughly conducted and is on-going as new papers are reviewed and entered daily into the system.

4 Feasibility of the Proposed Process

All stages of the process to produce hydrogen are known in prior art are currently being applied industrially except for the process developed by SHEC LABS. This stage is currently under investigation by many researchers. The main problems have been

- the high temperature required to produce the desired products;
- the separation and or purification of these by-products once the reactions have taken place;
- regeneration of the catalyst;
- optimization of the catalyst formulation.

SHEC Labs have been able to produce these products using proprietary catalysts, which they have formulated and produced themselves.

SHEC Labs have also been able to separate the by-products to provide a relatively pure product.

Investigations continue into refining the catalyst properties and being able to regenerate the catalyst in an effective manner. At this time, investigations continue into regeneration of the catalyst.

5 Advantages and Potential Applications of the Technology

The process train as conceived by SHEC Labs is a viable method of producing hydrogen as a fuel as a renewable resource using solar power. Once the process is optimized, the overall process has the potential for being an economically feasible process for producing hydrogen.

The use of hydrogen either as a fuel or as a method of generating electricity are also known in prior art

Evaluation of SHEC Labs Technological Innovations

6 Current Investigations

The present investigations are in the following areas:

1. modification of catalyst properties to maximize the production and separation of products;
2. optimal regeneration of the catalyst.

At the present time, further investigation is required into the actual behaviour of the catalyst. It is felt that various modifications to the geometry, impurities required and size of the catalyst may be required to improve the production of products.

6.1 Catalyst Regeneration

Investigation is required to improve upon the construction of the catalyst and may provide information on the improvement of regeneration techniques.

7 Potential Applications of the SHEC Process

The SHEC process utilizes solar power to eventually produce hydrogen as a source of energy. Benefits for the process are

- the reduction of green house gas emissions to the environment,
- the production of hydrogen in a sustainable renewable method.