Fuel 132 (2014) 27–35

Contents lists available at ScienceDirect

Fuel

journal homepage: www.elsevier.com/locate/fuel

Study of effective parameters in the Fischer Tropsch synthesis using monolithic CNT supported cobalt catalysts

Somayeh Farzad [a,*], Alimorad Rashidi [b], Ali Haghtalab [c], Mohsen Ali Mandegari [d]

[a] Department of Chemical Engineering, University of Environment, P.O. Box 31746-118, Karaj, Iran
[b] Nanotechnology Research Center, Research Institute of Petroleum Industry (RIPI), P.O. Box 14665-1998, Tehran, Iran
[c] Department of Chemical Engineering, Tarbiat Modares University, P.O. Box 14115-143, Tehran, Iran
[d] Department of Chemical Engineering, Science and Technology, University of Mazandaran, Behshahr, Iran

HIGHLIGHTS

- Monoliths prepared from CNT supported cobalt catalyst have been evaluated for FTS.
- Pressure affects the product selectivity more than *T*, GHSV and cobalt loading.
- The CO conversion is highly affected by *T* in comparison with *P*, GHSV and Co%.
- The effect of parameters interaction on conversion and selectivity is demonstrated.
- Pressure augmentation increases CO conversion and heavier hydrocarbon production.

ARTICLE INFO

Article history:
Received 28 January 2014
Received in revised form 3 April 2014
Accepted 17 April 2014
Available online 5 May 2014

Keywords:
Monolithic catalyst
Fischer Tropsch synthesis
Carbon nanotubes
Two factorial design method

ABSTRACT

In this work monolithic catalysts have been prepared using carbon nanotubes as the support material. In order to screen the effective factors on CO conversion, C_5^+ selectivity and C_1 selectivity, fractional factorial design method have been used. Considering temperature, pressure, Gas Hourly Space Velocity (GHSV) and cobalt loading as the four effective parameters, different runs have been designed for experiments. Quadratic models for CO conversion and product selectivity have been developed based on the experimental results. Furthermore, the analysis of variance (ANOVA) was implemented as a significant tool in order to evaluate the accuracy of the model. The ANOVA results of the developed model showed that they are significant with a 95% confidence limit. The main effective parameters have been declared for CO conversion, heavier hydrocarbon and methane selectivity. It is clear that the importance of parameters vary from one response to another. The interaction of parameters has been studied as well. The results demonstrate that temperature is the most effective parameters on CO conversion while its interaction with pressure is more important than other parameter interactions. Pressure affects C_5^+ and C_1 selectivity more than other parameters whereas interaction of pressure with cobalt loading are the most effective interactions for these two responses.

1. Introduction

The Fischer Tropsch synthesis (FTS) is polymerization-like reaction which converts syngas (H_2 and CO) to liquid fuels. So many studies have been carried out considering different aspects of FTS such as, reactor type, active metal of catalyst, catalyst support and structure. Fixed-bed reactors are constrained to catalyst particle size in order to stay below an acceptable pressure drop and a structured catalyst such as monolith may provide the solution of such a problem [1]. Since the introduction of monolithic catalysts in the mid-1970s, they have become the standard catalyst in most environmental applications. Evaluating the performance of monolithic catalysts for multiphase reaction systems has been the focus of several research groups [2]. The results show that monolithic reactors have some advantages over packed reactors such as low pressure drop, higher specific surface area, higher productivity, better mass transfer performance, evenly distributed flow and better heat transfer [3–5]. Generally there are two types of monolithic catalysts; Washcoated Monolithic Catalyst (WMC) and Bulk Monolithic Catalyst (BMC) which are prepared from the bulk catalyst [6]. Performance of monolithic catalyst for FTS has been examined by

* Corresponding author. Tel.: +98 2632804213; fax: +98 2632827542.
E-mail address: Somayeh_Farzad1980@yahoo.com (S. Farzad).

http://dx.doi.org/10.1016/j.fuel.2014.04.056
0016-2361/

different research groups considering the WMC type. Generally catalyst is coated on the microchannels walls, but in order to increase the catalyst hold-up, structured supports have been proposed [7].

Washcoated monolithic catalysts may be prepared through coating the active metal on the monolithic structure or coating the prepared catalyst on the surface of monolith [8]. There are a few works which investigated the BMC type catalysts [9]. Of course, monoliths have some disadvantages such as no interconnectivity between the channels and a poor radial conductivity [10], limited control of temperature and lower loading of active metal in comparison with conventional packed bed reactors [9] which caused limited application of these structured catalysts. On the other hand, different catalyst supports have been investigated and the use of catalysts supported on novel carbon nanostructured materials like Carbon Nanotubes (CNTs) and

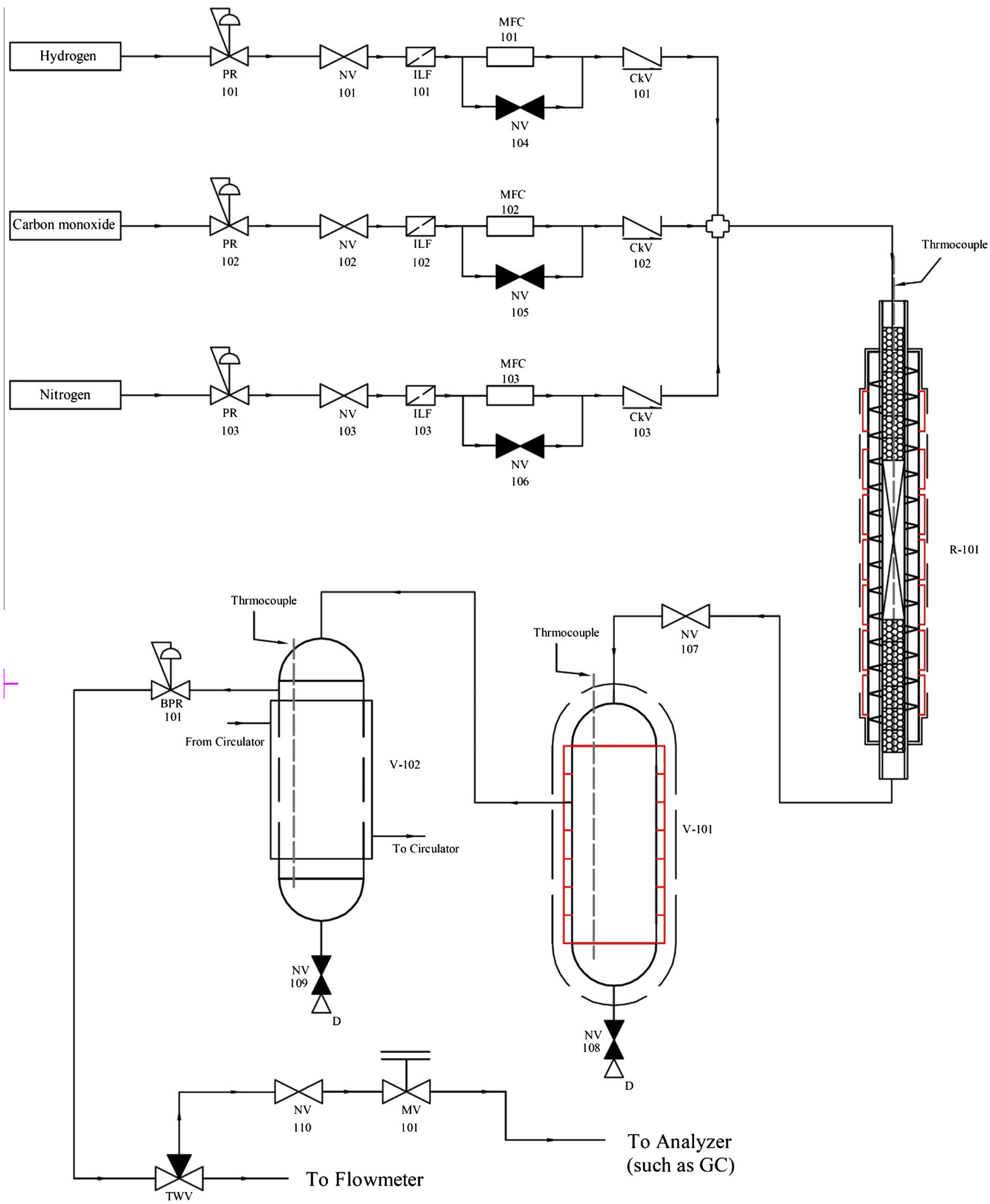

Fig. 1. The schematic diagram of FTS set-up.