Fine Spray Generation for Single-Wall Carbon Nanotubes (SWCNT) Production

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Abstract

Gas flaring is the burning of natural gas, which cannot be processed or sold during oil and gas production and processing operations. In past decades, gas flaring was believed to be environmentally tolerable. On the contrary the flaring of gas has been found to be an impediment to the environment; this has led to attempting to tackle the problem of gas flaring to advance it to an acceptable level worldwide.

There are currently over 700,000 gas wells worldwide and according to World Bank about 110 billion cubic meters (bcm) of natural gas are flared annually. If all the flared gas is stopped and instead converted to hydrogen (H_2) and carbon (C) nanotubes, the reduction of CO_2 emissions which stands at 400 million metric tonnes per annum could be drastically reduced. The hydrogen component produced from the reaction could then be used for power generation and the irregular carbon nanotubes as composite materials.

The main aim of this investigation was to develop an alternative approach to continuous gas flaring in oil and gas industry. Sprays and atomisation techniques were experimentally employed as a promising option for the production of Single-Walled Carbon Nanotubes (SWCNT).

Laboratory experiments were performed to test the concept of using this technique to study the effects of the related parameters on its behaviour by spraying simulated catalyst solution (i.e. water) droplets into a hydrocarbon gas stream (methane as a carbon source) using a specially designed “atomiser device” that incorporates a number of pressure swirl atomisers.

A furnace was installed underneath of the “atomiser device” and the stream of droplet particles fell down through the furnace (400 - 800^o C). Reactions which took place inside the furnace produced the Single-Wall Carbon Nanotubes (SWCNT) material from natural gas stream. The effect of water flow rate (0.001- 0.005 l/min) and water supply pressure (≤12MPa) as well as the gas flow rate (0.3-0.4 l/min) together with the downstream distance of the corresponding atomiser device on the droplet size distribution (≤ 5µm) were also characterised. The qualitative and quantitative analysis of the results obtained from the series of trials demonstrated that the production of SWCNT is certainly possible by using a combination of pressure swirl atomisers.

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