

The Investigation of New Process for Propane Sweetening

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Abstract

Desulphurization is a set of technologies used to remove sulphur compounds from sour. So, this process can called as environmental friendly. Application of nano cobalt oxide catalyst in propane sweetening is studied, in this work. Experiments are held to evaluate the operating and geometrical parameters in the adsorption process. The quality of process is defined as the ratio of final concentration of sulphuric compounds on the initial concentration of sulphuric compounds. Results show the optimum pressure and temperature for both type of spherical and cylindrical is 16 bar and 85 °C.

Keywords

Optimum Conditions, Proposed Process, Sweetening, Gas, Catalyst

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1. Introduction

Desulphurization is a set of technologies used to remove sulphur dioxide (SO_2) sour fuel and from the emissions of other sulphur oxide emitting processes.

1.1. Review on the Desulphurization Process

Methods of removing sulfur dioxide from sour oil and furnace exhaust gases have been studied for over 150 years. Early ideas for sour oil and flue gas desulfurization were established in England around 1850 [1]. With the construction of large-scale power plants in England in the 1920s, the problems associated with large volumes of SO_2 from a single site began to concern the public. The SO_2 emissions problem did not receive much attention until 1929, when the House of Lords upheld the claim of a landowner against the Barton Electricity Works of the Manchester Corporation for damages to his land resulting from SO_2

emissions. Shortly thereafter, a press campaign was launched against the erection of power plants within the confines of London [1]. This outcry led to the imposition of SO_2 controls on all such power plants. The first major desulfurization unit at a utility was installed in 1931 at Battersea Power Station, owned by London Power Company. In 1935, a desulfurization system similar to that installed at Battersea went into service at Swansea Power Station [2]. The third major desulfurization system was installed in 1938 at Fulham Power Station. These three early large-scale desulfurization installations were abandoned during World War II. Large-scale desulfurization units did not reappear at utilities until the 1970s, where most of the installations occurred in the United States and Japan. Desulphurisation of crude oil is an important process used in a petroleum refinery to reduce the sulphur concentration and production of fuel products such as gasoline, jet fuel, kerosene, diesel and heating oil. So, the resulting fuels meet environmental protection standards. The challenge of fulfilling the world's growing transportation energy needs is no longer a simple issue of producing enough liquid hydrocarbon fuels [3]. This challenge is instead

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accentuated by a complex interplay of environmental and operational issues. Environmental issues include societal demands that liquid hydrocarbon fuels be clean and less polluting [4]. The emergence of new refining processes and the increasing use of new forms of energy production, e.g., fuel cells, exemplify operational issues. Together, these trends are driving the need for deep desulfurization of diesel and jet fuels.

This paper focuses on the configuration of synthesized nano particles which are affected on the sweetening of sour propane.

1.2. Desulphurization Processes

In the past two decades gas refining has changed extensively and the fortunes of hydro treating, in particular, have witnessed a sea change [5]. Hydro-treaters now occupy a central role in modern refineries and more than 50% of all refinery streams now pass through hydro-treaters for conversion, finishing, and pre-treatment purposes [6]. Hydro-desulfurization is the largest application of catalytic technology in terms of the volume of material processed [7]. On the basis of usage volume, HDS catalysts are ranked third behind catalysts used for automobile emission control and FCC [8]. Commercial hydro treating catalysts are, typically, Cobalt, Molybdenum or Zinc. Cobalt and Molybdenum, are known for its high hydrogenation activities, is preferred as a promoter when feed stocks containing high amounts of nitrogen and aromatics need to be processed [9].

It seems nano particles such as metal oxides can promote the heating and cooling process [10]. For example, the nano substances like; metal oxides can enhanced the thermal stability of some of materials [11].

In this study, cobalt oxide nano catalyst (spherical and cylindrical) is used for propane sweetening process. So, the operating and geometrical parameters are evaluated in this paper. Therefore, the gained results can be interesting for related industries and can be applicable in process optimization.

2. Materials and Method

Figure 1 shows the propane sweetening experimental set up. All equipments are made up of stainless steel since it is non-corrosive material. Sour propane feed tank contains sulphuric compounds and propane gas is used and the flow rate is adjusted by the valves. After passing a filter an electrical heater the sour propane stream flows through a compressor.

The gas is compressed and passes through a filter again and then is fed into the reactor with an adjusted flow rate. Changing the operating conditions in synthesis of cobalt

oxide causes different structures of this metal oxide.

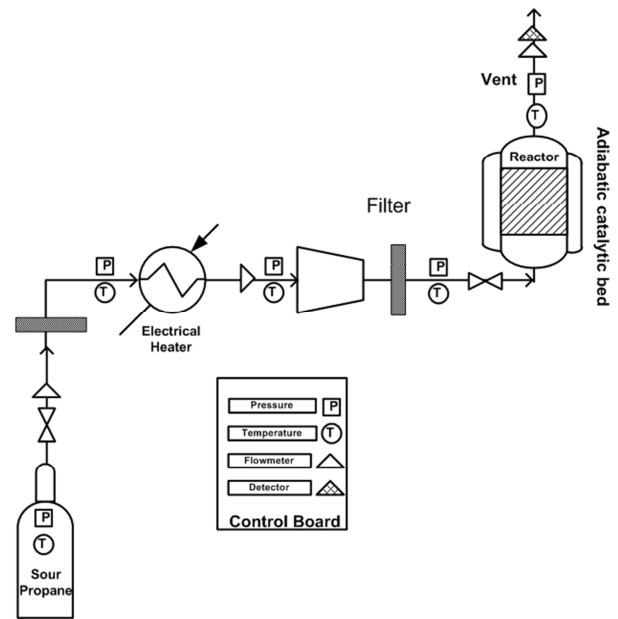


Figure 1. Schematic diagram of the experimental set up.

3. Results and Discussion

Experiments are held to evaluate the effect of process operating conditions and geometrical conditions of the nano catalytic bed and also nano particle diameter on the process performance. The ratio of the sulphuric compounds final concentration on the initial concentration of sulphuric compounds is considered as the criteria of the performance quality of the sweetening process. Experimental results are presented in this section and the optimum conditions which leads to the higher performance quality can be surveyed by analyzing the curves.

3.1. The Geometrical Conditions

The geometrical conditions are important beside the operation conditions. The previous literatures have not focused on this items, so the author evaluate the parameters which are related to geomaterials conditions.

3.2. The Effect of Operating Conditions

The changes in the operating pressure and operating temperature on the performance quality are illustrated in Figure 2 and 3, respectively. The feed stream contains 58 ppm of sulphuric compounds. Commonly, the high ranges of pressure and low ranges of temperature are introduced as the operating conditions in the contactor towers. Operating pressure are changed in values of 10, 13, 16 and 19 bar and operating temperature are varies in values of 65, 75, 85, 87 and 89 °C considering to the usual conditions in the adsorption reaction of sulphuric compounds, strength of

equipment and safety regulations in the laboratory. Two types of nano catalyst cylindrical and spherical shape with 77 nm in diameter are applied in the catalytic bed. According to the Figure 2, the increase in the operating pressure decreases the process quality at 65 and 75 °C and at all amounts of pressures, generally using cylindrical type. However, this trend is changed for 13 bar and 89 °C, 19 bar and 85, 87 and 89 °C. This may show the proper range of low temperature at the applied pressure in the sulphuric compounds adsorption process. So, 89 °C and temperatures higher than 75 °C are not proper operating temperatures at 13 bar and 19 bar, respectively. Also, the increase in the amount of pressure from 13 bar to 16 bar shows the considerable

decrease in the amount of C/C_0 . The higher pressures 16 bar and 19 bar present the lower value of C/C_0 at the lower temperature. So, the case of determination of the minimum values of energy consumption can be discussed, here. However, considering the strength of reactor vessel, the higher temperatures (85, 87 °C) results better amounts of C/C_0 at lower pressures of 10 bar and 13 bar.

Operating conditions of 16 bar and 85 °C can be introduced as the optimum operating conditions in the experiments. This is determined due to the marketing standard value of amount of sulphuric compounds in the sweet gas stream which is lower than 4 ppm which is 3.54 ppm at 16 bar and 85 °C.

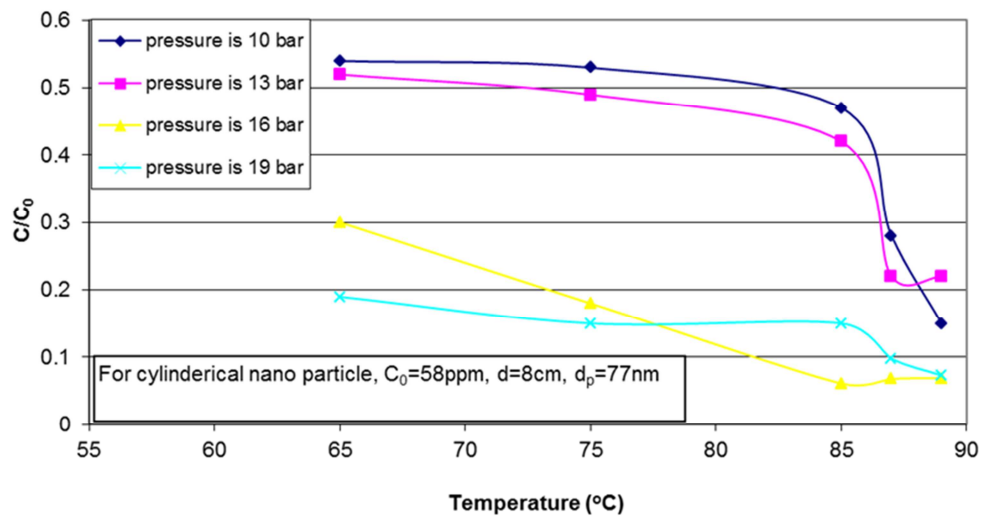


Figure 2. Performance quality versus operating conditions using cylindrical nano catalyst.

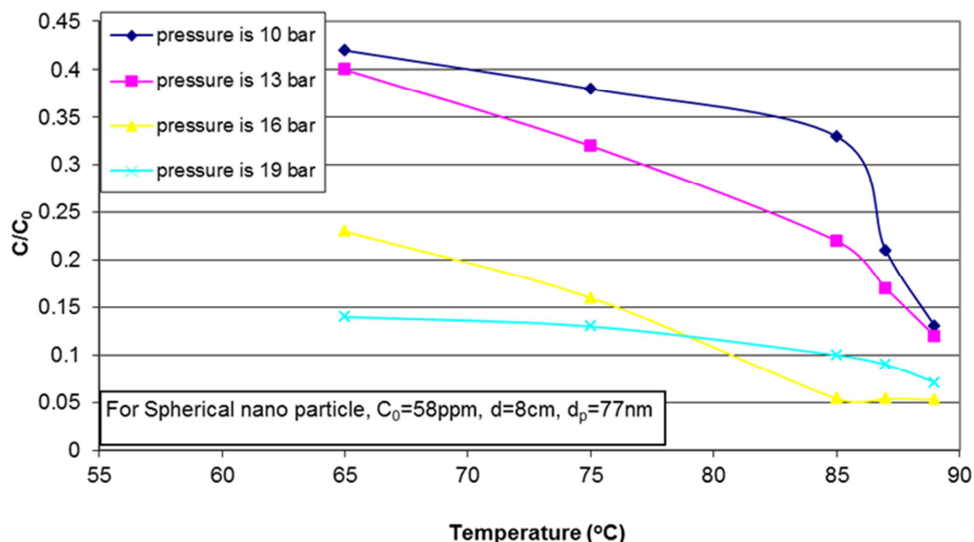


Figure 3. Performance quality versus operating conditions using spherical nano catalyst.

Figure 3 shows the changes in the amounts of C/C_0 according to the changes on the operation temperature and pressure using the spherical type of nano catalyst. The lower

amounts of C/C_0 are obtained at higher temperatures and constant pressure. The increase in the pressure value from 13 bar to 16 bar decreases the amount of C/C_0 considerably,

comparing with the changes from 10 to 13 bar or 16 to 19 bar. The higher pressure values obtain lower amounts of C/C0 using 75 and 85°C, however this is not obtained at temperatures higher than 75 °C initializing the operating pressure of 16 bar and 19 bar. This may relates to the effective operation pressure of gas stream in the nano catalytic bed which provides the proper effective gas diffusion into the catalyst at the adjusted temperature.

4. Conclusion

The performance quality of nanocatalytic gas sweetening process is surveyed in this study. The effect of parameters which are responsible in mass transfer phenomena such as dimensions of catalytic diameter, diameter of nano catalyst, shape of nano catalyst and initial driving force are surveyed. Also, the effect of temperature and pressure on the amount of process quality is considered in this work. The main experimental results are presented as follows: the optimum pressure and temperature for both type of spherical and cylindrical is 16 bar and 85 °C. Although the obtained amount of C/C0 for spherical type is 0.054 and lower than that is obtained (0.061) using cylindrical type with the same diameter of 77 nm.

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