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Investigation of operating and geometeric as major conditions on the efficiency of desulfurization of process

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ABSTRACT

Sulfuric compounds of petroleum are broadly defined as the compounds naturally present in various fractions of crude petroleum. Originally, they were considered as by products in the desulfurization of sour oils, but, today they are valuable products for many industrial applications. In the present work, we report on the application of some ionic solutions for desulphurization of various petroleum fractions. The comparative study of the various aqueous ionic solutions on the extraction of the sulphur compounds has also been carried out. As known, the operating condition and geometric conditions are affected on the efficiency of desulfurization process. Therefore, the effect of changing in pressure and and bed diameter are evaluated on the performance yield of desulfurization process.

KEYWORDS

Sour;
Operating conditions;
Diameter;
Pressure.

INTRODUCTION

The presence of sulphur compounds in petroleum is always objectionable due to their process and environmental problems. Sulphur occurs in many forms in petroleum like free sulphur, H_2S, marcaptans, sulphides, disulphide and thiophenes[1]. These compounds are undesirable in the petroleum because of their potential corrosión problems in refining process[2]. Further more, these compounds are responsible for environmental problems[3]. Keeping in view the hazardous effects of the sulphur in petroleum, much attention is being paid to desulphurization in the recent years to protect the environment Primitive techniques such as doctor sweetening was developed in 1860's, while the others developed later on were based on the oxidation of thioles to sulphides and disulphides These processes were used to eliminate the corrosion and bad odour but not the sulphur compounds[4]. Later on desulphurization in the presence of hydrogen was practiced. In conventional hydrodesulphurization (HDS), severe operating conditions of high temperature and pressure are unavoidable. Moreover, high consumptions of hydrogen and expensive cobalt molybdenum catalysts are other disadvantages of the method. Research is underway to improve the profitability of the process[5]. Even with the conventional processes, it is difficult to reduce the sulfur content to less than 15 ppm. Therefore, new economical and more effective methods are sought through out the world. Among the new methods, desulphurization through ionic solutions is gaining importance due to no hydrogen consumption, and much less sever condi-

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TABLE 1 : Charactristics of oil samples used in this work

Type of crude oil	API	Amount of sulphur (wt%)
Heavy Iranian crude	29.6	2
Light Iranian crude	33.4	1.37

tions are required. The process is limited to desulphurization of lighter petroleum products[6]. In case of high boiling fractions, only small degree of desulphurization is achieved due to increase in viscosity which alters the interfacial properties and solubility of these fractions[22]. The process awaits further development for meaning full desulphurization of heavy petroleum fractions.

This work is devoted to using experimental design methodology to identify the optimum conditions for H_2S removal by nano zinc oxide catalysts. Clearly, the nano-sized ZnO is more reactive than the same material in bulk form, enabling complete sulphur removal with less material, allowing for a smaller reactor. The nano particles stay stable and active after several cycles.

MATERIALS AND METHOD

Figure 1 shows the oil sweetening experimental set up. All equipments are made up of glass since it is non corrosive material and makes the oil tracking in catalytic bed possible. Storage tank is equipped with a hot water jacket and a stirrer to increase the oil temperature uniformly, moving easily through the set up. Surely, temperature and pressure is controlled in feed tank, necessarily. The oil is pumped upward and passes through a filter and then is fed into the reactor with an adjusted flow rate. Feed oil is distributed on the catalytic bed by a glass distributor.

RESULTS AND DISCUSSION

Desulphurization of jet fuel, diesel oil, heavy residue and commercial furnace oil is carried out through extraction with nano-metal such as ZnO nanoparticles. Undoubtedly, the operating and geometric conditions are basic parameters which are affected on the sweetening process.

The effect of operating pressure

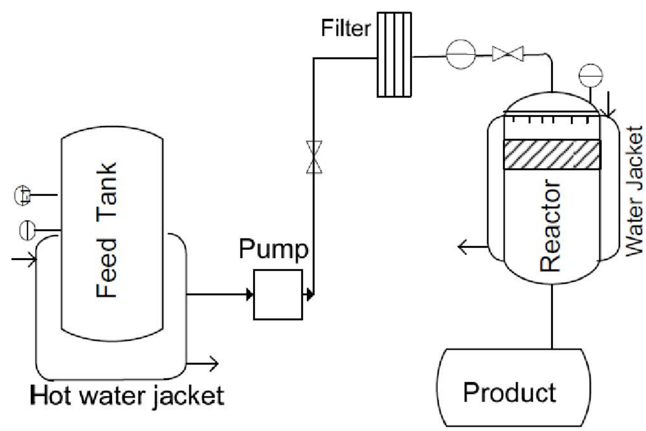

Figure 1 : Schematic of proposed sweetening process

The peroformance of catalyst at $70\,^{o}C$ and in bed with 10 cm diameter is surveyed in the correlation numbers 9 and 10. The appropraite operating pressure for sweetening of heavy and light oils are in the range of 1.2 atm to 1.25 atm. Decreasing- increasing trend in the amount of C/C_0 versus operating pressure is obtained for all samples. Equations number 1 and 3 are illustrated in this part.

$$(C/C_0)_{lightoil} = 7.8513P^2 - 19.911P + 12.591 \quad (1)$$

$$R^2 = 1.0 \quad (2)$$

$$(C/C_0)_{heavyoil} = 12.326P^2 - 28.25P + 17.597 \quad (3)$$

$$R^2 = 1.0 \quad (4)$$

The effect of bed diameter

The bed diameter correlation is shown in this part. In this section, considering the optimum conditions which are obtained in previous experiments, the effect of bed diameter and bed surface toward the oil stream is investigated on the amount of C/C0. The increase in bed diameter from 5 cm to 12 cm decreases the amount of C/C0, with 35 nm ZnO at 70, 1.2 atm and through 6 cm bed height.

$$(C/C_0)_{lightoil} = 0.0006D^2 - 0.0152D + 0.1033 \quad (5)$$

$$R^2 = 0.897 \quad (6)$$

$$(C/C_0)_{heavyoil} = 0.0014D^2 - 0.0335D + 0.2089 \quad (7)$$

$$R^2 = 0.9828 \quad (8)$$

Equations number 5 and 7 are represented in this section.

CONCLUSION

Desulphurization of petroleum by extraction with nano metal is an economic, simple and an efficient process. The sulphur contents of the crude oil can be lowered, severely. The process has advantage of easy handling and use of less expensive reagents over the conventional hydrodesulphurization, oxidative desulphurization and adsorptive desulphurization etc, which make use of expensive chemicals, equipments, difficult to process and are more time consuming.

Oil sweetening by nanocatalyst has been not developed industrially, yet. So, finding the optimum conditions of this operation is interesting. Oil catalytic sweetening is investigated experimentally using 35 nm ZnO catalyst. Respectively, four types of heavy and light oil with density of 29.6 and 33.4 are sweetened catalytically. The initial amount of sulphur in the light and heavy crude oils are 1.37 wt% and 2 wt%, respectively. Experiments are conducted to survey the effect of operating temperature and pressure of sour oil, bed diameter and bed height on the amount of outlet H_2S concentration. The quality of the sweetening process is shown by the fraction of outlet concentration of H_2S on the amount of inlet H_2S. The optimum conditions obtained are 1.2atm as operating pressure and 10cm as bed diameter. According to the mentioned optimum conditions, the amount of C/C_0 decreases in 0.0067 and 0.0036 for heavy and light oil, respectively.

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