An approach to H_2S removal from light crude oils using synthetic scavengers based on long chain alkylated ionic liquids

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Un método para la eliminación de H_2S del petróleo crudo ligero usando depuradores sintéticos a base de líquidos iónicos alquilados de cadena larga

Un mètode per la eliminació de H_2S del petroli cru lleuger utilitzant depuradors sintètics a base de líquids iònics alquilats de cadena llarga

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SUMMARY

In this research, the effect of imidazolium based ionic liquids as scavengers on reducing and minimizing the amount of hydrogen sulfide in Iranian crude oils has been studied. To improve the quality of crude oil and increasing the value added of producing and exporting of crude oil, firstly, cold stripping was performed and effective parameters of process on the efficiency was investigated. In the next step, four imidazolium-based ionic liquid samples, were synthesized and their effects on reduction of H_2S from four samples of Iranian light crude oils were tested. The design of the experiments and the results of the study were done using the software Minitab 14. For this purpose, the effect of the parameters of the ratio of scavenger concentration, temperature and contact time with crude oil on the reduction of H_2S was studied. The results of the study show that ionic liquid scavenger yields a better efficiency; with optimal conditions (concentration of 1200 ppm, temperature of 45 ° C in 20 minutes of time) H_2S reduces in crude oil from 550 to less than 15 ppm.

Keywords: scavenger, crude oil sweetening, Hydrogen sulfide, stripping processes, desulfurization.

RESUMEN

En esta investigación se ha estudiado el efecto de los líquidos iónicos a base de imidazolium para reducir y minimizar la cantidad de sulfuro de hidrogeno en el petróleo crudo iraní. Para mejorar la calidad del petróleo crudo y aumentar el valor añadido a la producción y exportación de petróleo crudo, en primer lugar se realizaba una destilación en frio y se investigaban los parámetros eficientes del proceso. En la siguiente etapa, se sintetizaban cuatro muestras líquidas iónicas a base de imidazolium y se comprobaban sus efectos en la reducción del H_2S de las cuatro muestras de petróleo crudo ligero iraní. El diseño de los experimentos y los resultados del estudio se llevaban a cabo usando el software Minitab 14. Con esta finalidad, se estudiaba el efecto de parámetros como la concentración de depurador, la temperatura y el tiempo de contacto con el petróleo crudo en la reducción del H_2S. Los resultados del estudio demuestran que el depurador líquido iónico consigue una mayor eficiencia; en condiciones óptimas (concentración de 1200 ppm, temperatura de 45 ° C en 20 minutos) el H_2S se reduce en el Petróleo crudo de 550 a menos de 15 ppm.

Palabras clave: Depurador, endulzante de petróleo crudo, Sulfuro de hidrógeno, procesos de destilación, desulfuración.

RESUM

En aquesta investigació s'ha estudiat l'efecte de líquids iònics a base de imidazolium per reduir i minimitzar la quantitat de sulfur d'hidrogen en el petroli cru iranià. Per millorar la qualitat del petroli cru i augmentar el valor afegit a la producció i exportació de petroli cru, en primer lloc es realitzava una destil·lació en fred i s'investigaven els paràmetres eficients del procés. En la següent etapa, es sintetitzaven quatre mostres liquides iòniques a base de imidazolium i es comprovaven els seus efectes en la reducció del H_2S de les quatre mostres de petroli cru lleuger iranià. El disseny dels experiments i els resultats del estudi es realitzaven mitjançant el

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software Minitab 14. Amb aquesta finalitat, s'estudiava l'efecte de paràmetres com la concentració de depurador, la temperatura i el temps de contacte amb el petroli cru en la reducció del H_2S. Els resultats del estudi demostren que el depurador líquid iònic aconsegueix una major eficiència; en condicions òptimes (concentració de 1200 ppm, temperatura de 45 ° C en 20 minuts) el H_2S es redueix en el petroli cru de 550 a menys de 15 ppm.

Paraules clau: Depurador, endolçant de petroli cru, sulfur d'hidrogen, processos de destil·lació, dessulfuració.

INTRODUCTION

Because of the corroding effect of hydrogen sulfide on refining, facilities, air pollution control, poisoning of catalysts and effects of their toxicity on living organisms, it is extremely important to have technical sweetening methods for the removal of H_2S and some organosulfurs from crude oils [1-4]. According to the European Union's strict environmental adopted regulations, tankers will not be licensed to ship crude oil with a high hydrogen sulfide content of 15 ppm at the ports of Europe. The world demand for lowering the emitted pollutants from crude oil derivatives is growing to meet international protocols.

In surveying the literature several methods are used to remove H_2S preliminary from crude oil [5-8]. The most common method for extracting the dissolved gas from the oil phase is separating them based on the flash drum process called multi-stage separation or MSS. The MSS process is commonly used at the National Oil Company of the South of Iran. In this approach the removal of hydrogen sulfide is carried out using cold or hot natural gas stream. Hydrogen sulfide tends to enter in the vapor phase because of its volatility between ethane and propane, in a gas-oil separator [9-11]. In the process of disposal, the crude oil moves from top to bottom on the trays of a "multi stage" tower. Natural gas moves upwards in a disjoint to separate hydrogen sulfide from crude oil. The gas may be supplied from a fresh gas stream, or steam produced by the reboiler of the crude oil at the end of the tower. In theory, MSS offers many advantages such as high recovery, high H_2S removal and produces LPG, but it's not suitable for heavy crude oils because the stabilizer bottom temperature is too high.

Among other processes, the removal of H_2S in crude oil can be achieved by extraction, one of the oldest methods being the cheapest and, at the same time, a fast process for the removal of hydrogen sulfide and mercaptan [12,13]. Although alkaline salts such as Sodium and Potassium have increased salt content and emulsion stability between water and oil, there are problems with their recycling. However, the modification of this process by using amine and ammonia solutions greatly reduces the problems of these processes [14-18].

In addition to the methods of removing H_2S from crude oil such as cold and hot stripping technologies and oxidation reduction processes, scavengers are always used as simple economic approach when the crude oil is slightly sour [19-21]. Recently big companies such as Baker, BASF and NALCO produce a variety of chemical scavengers. Scavengers are used in hydrocarbon and petrochemical processing facilities. Scavenger is defined as a class of chemicals that, by increasing its specific concentration during acid-free chemical processes, complex formation, sediment production and oxidation-reduction are capable to eliminating or blocking hydrogen sulfide in a preferably irreversible manner [22].

So far, various chemicals have been used as commercial scavengers in oil fields to reduce hydrogen sulfide. In this regard, zinc, iron and copper based scavengers can be mentioned. Also, scavengers such as triazines with ring formation of thio nitrogen, amines, acroleins, formaldehyde and nitrates are common chemicals used for this purpose [23-26]. Since ideal properties of a scavenger is the irreversibility of its reaction, suitable reaction kinetic, thermal stability, green, availability and its selectivity, it is necessary to design a material that covers the most properties [24].

There is no doubt that in recent years ionic liquids due to their specific properties (low vapor pressure, high thermal stability, high ionic conductivity and mobility), have become a noticeable subject of wide variety of studies such as extraction, separation, adsorption and as additives in upgrading some products in industry [27-29].

One of the most important advantages of ionic liquids is that their structures can be designed to approach a given property for the required application. Thus, they are called "task-specific" solvents [30-33]. Selection of appropriate ionic liquids can provide the needed properties of H_2S scavengers. Imidazolium based ILs with high basicity due to N atom in imidazolium ring can interact with H_2S in acid-base reaction. The hydrophobicity of the added IL can help to permeate in the crude oil matrix. Thus the ILs with long alkyl side chain and hydrophobic anion would be the best choice as scavengers of H_2S. Herein four ionic liquids (1-alkyl-3-methylimidazolium bis(trifluoromethanesulfonyl) imide as n = 8, 10, 12, and 14) were synthesized as given in previous paper [29], and then their ability as H_2S scavenger was studied.

The results revealed that 1-tetradecyl-3-methyl imidazolium bis(trifluoromethanesulfonyl)imide [TDMIM][NTf_2] exhibited a better efficiency in comparison with other tested scavengers for reducing H_2S from the investigated light crude oils.

Under the optimal conditions, [TDMIM][NTf_2] shows nearly 36 times reduction in H_2S content of the studied light crude oils, so that it is ideally suited for H_2S removal of light crude oils with H_2S content up to 550 ppm.

EXPERIMENTAL

Reagent and Materials

All the solvents and reagents (1-methylimidazole 1-chloroalkane and lithium bis(trifluoromethanesulphonyl) imide) were purchased from Merck co. (Germany) without further purification.

Nitrogen gas with a purity of 99.999%, electrode silver with silver sulfide coating, concentrated chloridric acid (37% by weight), potassium hydroxides purity of (86%), stock standard solution silver nitrate (0.1N aqueous), isopropanol, toluene, sodium chloride with analytical purity, ammonia (25% aqueous solution) were supplied. Combination silver electrode model was supplied from Metrohm Company (Germany). The electrode was aged in order to create a coat film from silver sulfide. By a 1%wt solution of sodium sulfide.

Crude oil samples were obtained from Iran oilfields without further treatment. The samples maintained in a cold room at 5°C before use.

Synthesis of ionic liquids

1-alkyl-3-methylimidazolium bis(trifluoromethanesulphonyl) imide ILs were synthesized according to the similar procedure described in the previous paper [34].

As described, 0.055 mol of 1-chloroalkane (chlorooctane, chlorodecane, chlorododecane and chlorotetradecane) was added dropwise to 0.5 mol 1-methyilmidazole under vigorous stirring. The mixture was stirred in 70 °C for 72 hours under nitrogen atmosphere. The final product was washed with diethyl ether and dried at 60 °C under vacuum to achieve a purified IL without any moisture and impurities were summarized in table 1.

To accomplish the synthesis of NTf_2 salts the anion exchange was done in the aquatic phase. The chloride IL and $LiNTf_2$ were dissolved in deionized water. The $LiNTf_2$ solution was added to the IL solution for 15 min stirring. Then nonaqueous phase containing 1-alkyl-3-methylimidazolium bis(trifluoromethanesulphonyl) imide was separated and washed with water. Finally it was dried at 60 °C under vacuum.

Apparatus

Scheme 1 shows a flow diagram of the constructed homemade cold stripping set up. The system comprise from a glass scrubber unit with a height of of 1 meter and an alcoholic bath thermostated in -30°C, liquid nitrogen flask, automated potentiometer and glasswares such as stripper balloon receiver and condenser. All stripping experiments were performed with the constructed setup under the optimal conditions. Glass column equipment with a height of about 1 m, two solid distillation column with a height of 1 m and an equivalent of 15 theoretical trays, alcohol condenser up to -20 ° C, liquid nitrogen trap to-170 °C, potentiometer, the memotitrator and glass cells which include the reaction balloon, acid and absorbent growth storage tank.

H_2S Removal by Stripping Procedure

Regarding the standard methodology for measuring H_2S in crude oil in 2000, the Analyst Journal for the first time published a precise, sensitive, and reliable potentiometric and voltametric method for measuring the amount of hydrogen sulfide and elemental sulfur in crude oil and its products. Here, it referred to the RIPI (Research Institute of Petroleum Industry method [35]).

Although the stripping method is a physical procedure and can be applied in both cold and hot state, nowadays light and sour hydrocarbons with hydrogen sulfide are also absorbed in chemical absorption columns, usually based on amines or metal oxides such as iron, copper, zinc and cobalt [36-38]. This method is also applicable to hydrocarbon sweetening industry as a package (including degassing and sweetening of the gaseous phase and light hydrocarbons) and is considered to reduce hydrogen sulfide as a physicochemical process. Therefore, in this laboratory-based research, we designed the experiment to study the experimental parameters affecting sweetening process using the Minitab 15 software. The variables given to this software include four types of crude oil, which are related to the western and southern oilfields in Iran. Also, the temperature, time and flow of stripper gas were considered as major variables in a cold stripping process. The levels of factors were selected according to the operating conditions. The range of values for each of the variables is as follows: Temperature: 25-70 ° C, Time: 15-60 min, Stripper gas flow rate: 0.5-2 lit/min. the software was predicted 17 training set and 5 validation set in order to verification of the model.

All measurements were performed with an automated potentiometric titrator, Metrohm Co. (Titrando 888 model) and the H_2S content of standards and samples were calculated of standards and samples were calculated as described in UOP-163 standard method

H_2S Removal by Scavenger Procedure

a) Static Method

In this method, H_2S content of the studied crude oil was initially determined by a published reliable method by RIPI [35]. Then an excess amount of the investigated ILs was added to complete reaction between H_2S and the scavenger. In order to presence of some interferences

Table 1. *Formula, molecular weight, density, viscosity and impurities of synthesized samples.*

Abbreviation	Formula	Molecular weight (g/mol)	Density (g·cm⁻³)	Viscosity (mPa·s)	Water content (ppm)	Chloride content (ppm)
$[C_8mim][NTf_2]$	$C_{14}H_{23}F_6N_3O_4S_2$	475.47	1.3079	47.15	221	<10
$[C_{10}mim][NTf_2]$	$C_{16}H_{27}F_6N_3O_4S_2$	503.52	1.2653	50.86	260	<10
$[C_{12}mim][NTf_2]$	$C_{18}H_{31}F_6N_3O_4S_2$	531.577	1.2322	63.54	249	<10
$[C_{14}mim][NTf_2]$	$C_{20}H_{35}F_6N_3O_4S_2$	559.63	1.1876	83.54	230	<10

species of probable side reactions between scavengers and the sample matrix, it was necessary to addition of an excess of the scavenger usually between 1.5-2.7 times greater than H_2S concentration of the real sample. In a general evaluation, 100 g of crude oil with a specified H_2S was treated by a suitable amount of ILs during vigorous stirring and under the same condition as measured for the untreated samples.

b) Dynamic method

In this procedure, the scavenger was added stepwise and gradually and the H_2S measurement was performed during addition of the synthetic scavengers. This method was more rapid and reliable in order to avoid from H_2S loss of the samples during measurements.

RESULTS AND DISCUSSION

Characterization of ionic liquids

NMR results of the synthesized ILs are given here in brief [28].

1-octyl-3-methylimidazolium bis(trifluoromethanesulphonyl) imide $[C_8mim][NTf_2]$: ^1H NMR ($CDCl_3$, 500MHz): δ 0.83 (t, 3H), 1.23 (d, 10H), 1.75 (d, 2H), 3.85 (s, 3H), 4.11 (q, 2H), 7.33 (d, 2H), 8.66 (s, 1H).

1-decyl-3-methylimidazolium bis(trifluoromethanesulphonyl) imide $[C_{10}mim][NTf_2]$: ^1H NMR ($CDCl_3$, 500MHz): δ 0.84 (t, 3H), 1.23 (d, 14H), 1.74 (d, 2H), 3.76 (s, 3H), 4.11 (q, 2H), 7.33 (d, 2H), 8.66 (s, 1H).

1-dodecyl-3-methylimidazolium bis(trifluoromethanesulphonyl) imide $[C_{12}mim][NTf_2]$: ^1H NMR ($CDCl_3$, 500MHz): δ 0.85 (t, 3H), 1.24 (d, 18H), 1.74 (d, 2H), 3.73 (s, 3H), 4.11 (q, 2H), 7.35 (d, 2H), 8.69 (s,1H).

1-tetradecyl-3-methylimidazolium bis(trifluoromethanesulphonyl) imide $[C_{14}mim][NTf_2]$: ^1H NMR ($CDCl_3$, 500MHz): δ 0.87 (t, 3H), 1.23 (d, 22H), 1.74 (d, 2H), 3.70 (s, 3H), 4.12 (q, 2H), 7.37 (d, 2H), 8.71 (s, 1H).

The published data from characterization of synthesized ILs shows the high purity of them and low water content. Therefore they are good candidates to use as scavengers of crude oil.

H_2S removal process

Before synthesizing the scavengers, preliminary studies were carried out with regards to cold stripping (stripping-absorption) on four crude oil samples from sour western and southern fields in Iran. Some of the major parameters of the crude oil samples are given in table 2.

Table 2. *Hydrogen sulfide content and important parameters of investigated crude oils*

Sample	°API	Sulfur (wt. %)	H_2S (ppm)	RVP (psi)
Crude oil A	45.3	0.54	510	7.50
Crude oil B	43.6	0.57	71	10.30
Crude oil C	41.5	0.64	344	9.25
Crude oil D	34.5	1.43	950	7.90

As shown in table 2, crude oils are light and sour. RVP (Reid Vapor Pressure) of these crude oils are stabilized within the limits that are issued or processed in local refineries. High hydrogen sulfide in the crude oil of A, C and D are due to poor efficiency of stripper unit at the facility known surface.

All of these results are obtained in the system used in the irrigation process of Figure 1. An quantitative sample of crude oil was charged into the stripper flask and the temperature was adjusted up to 50 °C. Then a suited stream of nitrogen flow (as gas stripper) was carried to the stripping flask so that gases, Liquefied Petroleum Gas (LPG) and slightly light hydrocarbons was escaped as light end. As shown in fig.1, the heavier species was condensed within a distillate collection vessel.

Light end were consisted of methane, ethane, LPG, and light organic sulfur compounds such as COS, CS_2, light Mercaptans and H_2S. To avoid from any leaking H_2S into atmosphere, liquid absorber 1 containing a 10% caustic solution was considered. Besides, it was an ideally suited electrolyte for control and monitoring H_2S, potentiometrically [35]. On the other hand, to ensure complete absorption of H_2S and measurement absorption capacity of absorber 1, a second absorber (absorber 2) was set up sequentially.

Finally, a gas collection vessel was designed in the last part of the set up in order to collection of light end hydrocarbon in outlet of absorption column. The results of stripping studies are presented in table 3. The results of measurements of four crude oils before and after degradation were obtained under certain conditions. After obtaining the results of each experiment, the software identifies the optimal results. The analysis of the data shows that among the tests, rows 2, 13 and 15 have achieved the best results.

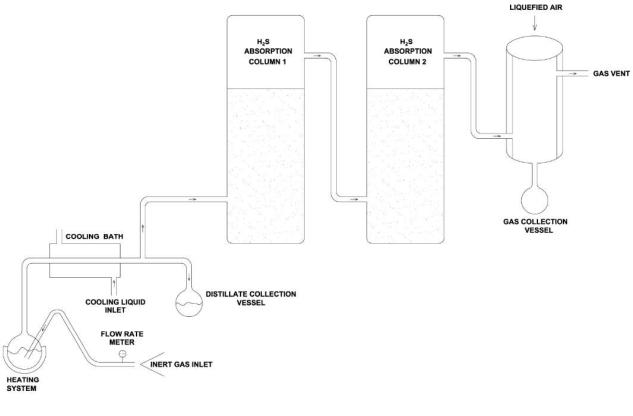

Figure 1. *Laboratory set up for a cold stripping process (stripping-absorption) as a batch*

Table 3. *Optimization of Parameters Effecting on the Process of Hydrogen Sulphide Removal Using Stripping –absorption Technology*

No.	Crude Oil Sample	H_2S Content (ppm)	Time (min.)	Temp. (°C)	Flow (L/min.)	H_2S Content after treatment (ppm)
1	A	510	15	25	0.5	0.9
2	A	510	30	40	1	0.5
3	A	510	45	55	1.5	0.8
4	A	510	60	70	2	0.7
5	B	78	15	40	1.5	0.9
6	B	78	30	25	2	0.6
7	B	78	45	70	0.5	0.9
8	B	78	45	60	2	0.7
9	B	78	60	55	1	0.9
10	C	344	15	55	2	0.6
11	C	344	30	70	1.5	0.5
12	C	344	45	25	1	0.7
13	C	344	60	40	0.5	0.3
14	D	950	15	70	1	0.8
15	D	950	30	55	0.5	0.4
16	D	950	45	40	2	7.9
17	D	950	60	25	1.5	0.8

For example, crude oil D has 950 ppm of hydrogen sulfide at 0.5 ppm Stripper gas flow, 55 °C and 30 minutes, and its hydrogen sulfide content is about 0.4 ppm. Measurements were performed using the RIPI method.

According to the results, although in the cold and hot stripping method, it is possible to reduce hydrogen sulfide to less than 5 ppm, but the costs of the installation and process are very high. Also, in the absence of the installation of additional processes for the condensation of LPG gases, in addition to the loss of gases such as crude oil's propane and butane, causes economic losses. It also directs these gases into the flare which will cause environmental pollution.

In figure 2, a comparison of the losses of light cut of LPG for the four crude oils studied before and after the process is shown.

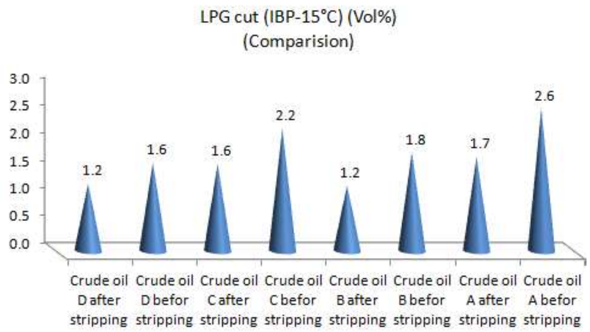

Figure 2. *Light gas dissipation results before and after the Cold Stripping-Absorption process*

As shown in Fig. 3, some of the light gases such as propane and butane, as well as hydrogen sulfide, are removed from the oil in the process of stripping. For example, for crude A, this amount is about 0.9% volume will be 900 bpd for a 100,000 barrels process. On the other hand, in the same crude oil as in table 2, the concentration of hydrogen sulfide is about 510 ppm that is burned with waste gases of the stripping process in the flare or purged into the air. The calculations show that the amount of hydrogen sulfide in the outlet gas of this process will be about 50,000 ppm. Hence, the need to sweeten gases and light petroleum cuts and return them to crude oil in the process of stripping is essential.

In these cases, and where there are problems in the process, such as equipment failure, design flaws, and the lack of optimal operating conditions or the burnout of facilities and corrosion, other methods such as extraction or applying additives as short-term methods to reduce sulfide hydrogen to permissible rate (less than 15 ppm) for the export purposes of crude oil. One of these methods is the use of scavengers.

Therefore, in order to reduce of hydrogen sulfide from crude oil the effectively and increase the speed of scavenger, 4 samples were formulated and synthesized and evaluated. Given the fact that scavenger's use is based on time, temperature, type of crude oil, and the type of reaction mechanism. In the preliminary study, four IL samples were tested for four crude oil samples A, B, C and D. Table 4 shows the results of measurements of hydrogen sulfide before and after applying scavengers using the RIPI method.

The results show that all synthesized ILs have high speed and are able to reduce the amount of hydrogen sulfide by an appropriate mixing at 600 to 1000 rpm in less than 5 minutes at 25°C .Table 4 shows the amounts of each IL for different crude oils. $[C_n mim][NTf_2]$ n=10, 12 and 14 have the best results, respectively. In spite of the high concentration of hydrogen sulfide in crude oil samples, the amounts of synthesized scavengers were very small and for the first three scavengers and the ratio of $[H_2S]$ / [IL] reached 3.1 at most. In addition to the high speed and low volume of synthesized scavenger, their selectivity for hydrogen sulfide and mercaptan removal is another advantage of these scavengers.

The effect of temperature on the efficiency of scavenger

Experimental experiments were carried out at a temperature range of 25-70 ° C to investigate the effect of temperature on the synthesized scavenger performance. The results of these evaluations are presented in figure 3.

Table 4. *Evaluation of the Efficiency of Formulated Scanners to Reduce Hydrogen Sulphide to Less than 15ppm*

Crude Oil	Hydrogen sulfide before pumping scavenger (ppm)	Scavenger consumption in ppm			
		$[C_{14}mim][NTf_2]$	$[C_{12}mim][NTf_2]$	$[C_{10}mim][NTf_2]$	$[C_8mim][NTf_2]$
A	510	700	1110	2390	5950
C	344	350	615	1060	2715
D	950	590	910	1610	4640

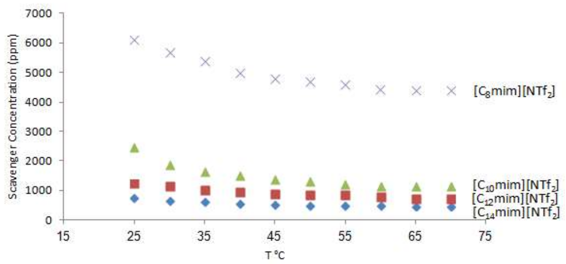

Figure 3. *The Effect of temperature on the rate of scavenging on crude oil D*

As shown in figure 3, with the increase in temperature, the reaction speed is increased and the rate of scavenging consumption is reduced to about a third. Therefore, the best results are achieved at the highest temperatures. However, the highest temperature is selected due to limitations of operating conditions and thermal stability of materials. The duration of the test was 5 minutes and the speed of mixing with the crude oil was 1500 rpm.

Kinetically, Scavenging reaction rate is depended on temperature. According to Arrhenius equation as given in the following

$$k=A\ e^{(-Ea/RT)}$$

Ea is the activation energy and R is the gas constant. Since at temperature T the molecules have energies given by a Boltzmann distribution, one can expect the number of collisions with energy greater than Ea to be proportional to $e^{(-Ea/RT)}$. A is the pre-exponential factor or frequency factor. The values for A and Ea are dependent on the reaction. There are also more complex equations possible, which describe temperature dependence of other rate constants that do not follow this pattern. A chemical reaction takes place only when the reacting particles collide. However, not all collisions are effective in causing the reaction. Products are formed only when the colliding particles possess a certain minimum energy called threshold energy. As a rule of thumb, reaction rates for many reactions double for every 10 degrees Celsius increase in temperature [36].

Among the studied ionic liquids based scavenger, the scavenger 1 was showed the best results for removal of H_2S from crude oils.

The effect of time on the efficiency of scavenger

In this study, $[C_{12}mim][NTf_2]$ and $[C_{14}mim][NTf_2]$ were evaluated using RIPI method, operating conditions were 50 ° C, mixing speed of 1500 rpm and optimum concentration of each scintillation at 50 ° C for scavengers 1 and 2 are 1100 ppm and 1100 ppm respectively. The results of kinetic studies are presented in table 5.

The results presented in table 5 show that both $[C_{12}mim][NTf_2]$ and $[C_{14}mim][NTf_2]$ are of high speed, so that the amount of hydrogen sulfide are reduced in less than 5 minutes ($[C_{14}mim][NTf_2]$) and 7 minutes ($[C_{12}mim][NTf_2]$) to less than 15 ppm from 950 ppm respectively. These results indicate that time plays a more fundamental role in the performance of the scavenger than temperature.

Apparently, an interaction between nitrogen in imidazolium ring and hydrogen sulfide and subsequently an adduct form of the cation part is responsible for H_2S scavenging of the studied samples.

Table 5. *The effect of time on the reduction of hydrogen sulfide in crude oil (50 ° C, mixing speed of 1500 rpm) and optimal scavenging concentration at 50 ° C, crude oil D.*

Time (min)	H_2S Content (ppm) $[C_{14}mim][NTf_2]$	H_2S Content (ppm) $[C_{12}mim][NTf_2]$
0	950	950
1	630	840
2	171	488
3	34	208
4	11	84
5	5	42
6	2	21
7	0.5	15
8	0.5	6.2
9	0.5	3.6
10	0.5	1.4
11	0.5	0.5
12	0.5	0.5
13	0.5	0.5
14	0.5	0.5
15	0.5	0.5

CONCLUSIONS

Nowadays attention to personnel health, environmental issues, and the prevention of corrosion of the facility has required the removal or reduction of hydrogen sulfide in crude oils to less than 15 ppm. Although hot or cold coating processes have been used in crude oil processing plants to reduce hydrogen sulfide, however, due to the nature of these processes, in some cases such as operating problems, changes in feed flow, the problems of sedimentation on the open-air tower trays supplemental processes or chemicals are needed to control and remove hydrogen sulfide. One of the quickest methods is the use of chemical scavenger. In this study, four ILs as scavengers have been synthesized and the results show that $[C_{12}mim][NTf_2]$ and $[C_{14}mim][NTf_2]$ have been able to reduce H_2S in crude oil l to 15 ppm in less than 15 minutes.

Based on the experiments carried out, the following results can be mentioned:

1. The efficiency of scavenger is highly dependent on the type of reaction mechanism, so that acid reactive and oxidation-reduction reactions are of the highest speed.
2. Scavenger driver performance is highly dependent on operating conditions, especially time, temperature, mixing speed and type of crude oil. Among these parameters, the effect of time is much more evident and more effective.
3. Using scavenger in limited conditions and in low concentrations of hydrogen sulfide for crude oil sweetening.
4. Imposed costs, lack of dilemmas in refining processes and environmental issues should be considered.
5. Due to the fact that the chemical composition of the existing crude oil is different, the selectivity of the scavengers in the selective reaction with H_2S is very effective in minimizing chemical interactions and less consumption.

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