

Method for Purifying a Synthetic Crude Oil Stream

The present invention relates to methods for purifying a synthetic crude oil stream.

Synthetic crude oil, sometimes also referred to as syncrude, can be obtained from different processes. For example, synthetic crude oil may be shale oil, which is obtained from oil shale by pyrolysis. Another source is hydrocarbons obtained from oil sand, in particular bitumen, from which synthetic crude oil can be obtained by upgrading. In addition, synthetic crude oil can also be produced from plastic material, for example plastic waste, by cracking.

Synthetic crude oils typically contain different impurities, which can have adverse effects on refining processes and refinery systems or can make the crude oil completely unsuitable for certain refining processes. The type and content of the impurities can vary greatly depending on the source and method for obtaining the synthetic crude oil.

A particularly big problem in the further processing of synthetic crude oils is the so-called gum formation. Pyrolysis oils usually contain different chemical compounds that can tend to form deposits. Such deposits can subsequently clog or otherwise damage refinery systems, increase the cleaning effort and shorten the life of plants.

The problem of gum formation in connection with synthetic crude oils has not yet been satisfactorily solved. There is still a need for methods to reduce the tendency of synthetic crude oils to form gum. It is therefore an object of the present invention to provide methods for reducing the gum formation of synthetic crude oils.

The present invention therefore relates to a method for purifying a synthetic crude oil stream, the method comprising the following steps:

- Providing the synthetic crude oil stream, wherein the synthetic crude oil stream contains diene compounds and has a diene number of at least 0.1 g/100 g;
- Contacting the synthetic crude oil stream with a polysulfide

stream containing at least one polysulfide compound to form a mixture, thereby converting at least a portion of the diene compounds into diene-free products; and

- Separating the diene-free products from the mixture in order to obtain a purified synthetic crude oil stream.

In connection with the present invention, it has been found that synthetic crude oils have an increased tendency to form gum, in particular when they have a high content of diene compounds. Reactive dienes can therefore act as gum formers and lead to harmful deposits in refinery systems. For example, dienes can sometimes undergo Diels-Alder reactions and thus lead to crosslinking between molecules and ultimately to deposits. In addition, dienes can form stable complexes with catalysts in hydrotreating units. It has therefore been found to be advantageous within the scope of the invention to reduce the diene content of synthetic crude oils.

In the method according to the invention, this is achieved by reacting the synthetic crude oil stream with polysulfide compounds. It has been shown that polysulfide compounds are excellently suited for converting reactive dienes into insoluble products or solids, which can easily be separated from the synthetic crude oil stream. Dienes can react with polysulfide compounds in an addition reaction to form a thiol, which can then react with other molecules, for example alkenes. This results in the crosslinking of several molecules and thus in targeted precipitation. The gum formation is thus brought about in a targeted manner in the method according to the invention and the "gum" - i.e. the insoluble reaction products of the diene compounds and the polysulfide compounds - is separated. The purified synthetic crude oil stream therefore has a lower diene content and is therefore less prone to gum formation as a result.

US 5,417,844 A mentions certain polysulfides in another context, namely in connection with the pretreatment of catalysts.

The use of sulfur-containing compounds to remove olefins from hydrocarbon products is generally known from the prior art. For example, WO 2021/021449 A1 describes methods for removing olefins from light hydrocarbon streams by mercaptanization with hydrogen sulfide in the presence of a catalyst. Olefins are to

be converted into mercaptans, which are then oxidized in a so-called MEROX process step and finally separated. However, WO 2021/021449 A1 relates neither to the treatment of synthetic crude oils nor to the diene compounds that are particularly problematic in connection with gum formation.

The present invention is also based on a completely different approach. It specifically targets the removal of dienes in synthetic crude oils and uses polysulfide compounds to specifically precipitate the diene compounds as diene-free products and thus remove them.

Treatment with polysulfide compounds also has further positive effects on the quality of the synthetic crude oil stream. Thus, neutral compounds such as esters, aldehydes, ketones, organohalogen compounds, amides and nitriles, among others, can be converted and subsequently removed. Such compounds may, for example, be basic hydrolysed, resulting in polar or charged compounds that can be removed in a wash with an aqueous phase.

The diene compounds contained in the synthetic crude oil stream are preferably compounds containing conjugated or cumulative carbon-carbon double bonds, in particular conjugated carbon-carbon double bonds. Such compounds tend in particular to form gum, for example by Diels-Alder reactions, and can be removed particularly well by the method according to the invention.

The person skilled in the art is familiar with methods for determining the diene number. Preferably, the diene number is determined according to the ASTM UOP326-07 standard.

The synthetic crude oil stream has a diene number of at least 0.1 g/100 g, preferably at least 0.2 g/100 g, more preferably at least 0.3 g/100 g, more preferably at least 0.4 g/100 g, more preferably at least 0.5 g/100 g, more preferably at least 0.6 g/100 g, more preferably at least 0.7 g/100 g, more preferably at least 0.8 g/100 g, more preferably at least 0.9 g/100 g, more preferably at least 1.0 g/100 g, more preferably at least 1.1 g/100 g, more preferably at least 1.2 g/100 g, more preferably at least 1.3 g/100 g, more preferably at least 1.4 g/100 g, more preferably at least 1.5 g/100 g, more preferably at least 1.6 g/100 g, more preferably at least 1.7 g/100 g, more

preferably at least 1.8 g/100 g, more preferably at least 1.9 g/100 g, more preferably at least 2.0 g/100 g. The synthetic crude oil stream preferably has a diene number in the range from 0.1 g/100 g to 15 g/100 g, more preferably from 1.0 g/100 g to 12 g/100 g, in particular from 1.5 g/100 g to 10 g/100 g.

The purified synthetic crude oil stream preferably has a lower diene number than the synthetic crude oil stream. The purified synthetic crude oil stream preferably has a diene number of less than 5 g/100 g, more preferably less than 4 g/100 g, more preferably less than 3 g/100 g, more preferably less than 2 g/100 g, more preferably less than 1.5 g/100 g, more preferably less than 1 g/100 g, more preferably less than 0.9 g/100 g, more preferably less than 0.8 g/100 g, more preferably less than 0.7 g/100 g, more preferably less than 0.6 g/100 g, more preferably less than 0.5 g/100 g. The purified synthetic crude oil stream preferably has a diene number in the range from 0.01 g/100 g to 5g/100 g, more preferably from 0.1 g/100 g to 2 g/100 g, in particular from 0.2 g/100 g to 1 g/100 g.

It has proven advantageous if the contacting of the synthetic crude oil stream with the polysulfide stream takes place at a temperature of at least 80 °C, preferably at least 100 °C, more preferably at least 120 °C, more preferably at least 140 °C, more preferably at least 160 °C, more preferably at least 180 °C. In particular, it is preferred if the contacting of the synthetic crude oil stream with the polysulfide stream takes place at a temperature in the range from 80 to 450 °C, preferably from 100 to 400 °C, more preferably from 120 to 350 °C, more preferably from 140 to 300 °C, more preferably from 160 to 260 °C, more preferably from 180 to 220 °C. A higher temperature can promote the reaction between the diene compounds and the polysulfide compounds and therefore lead to an even greater reduction in the diene content.

In a preferred embodiment, the contacting of the synthetic crude oil stream with the polysulfide stream takes place for a period of at least 0.5 minutes, preferably at least 1 minute, more preferably at least 2 minutes, even more preferably at least 5 minutes, most preferably at least 12 minutes. The provision of a longer duration allows a more complete course of the reactions between the diene compounds and the polysulfide

compounds, so that the diene content can be reduced even more. In particular, it is therefore preferred if the duration is between 0.5 and 180 minutes, preferably between 1 and 120 minutes, more preferably between 2 and 60 minutes, even more preferably between 5 and 30 minutes, most preferably between 12 and 20 minutes. The duration is preferably the average period of time between the first contacting of the synthetic crude oil stream with the polysulfide stream and the separation of the diene-free products from the mixture in order to obtain the purified synthetic crude oil stream. If the method is carried out as a continuous process, the duration preferably corresponds to the average residence time in a washing device used, e.g. in a mixer-settler.

In a preferred embodiment, the contacting of the synthetic crude oil stream with the polysulfide stream takes place in a pressure vessel. Providing a pressure vessel allows treatment at higher pressures and temperatures and may facilitate removal of diene compounds.

The synthetic crude oil stream is preferably washed with the first aqueous wash solution at a pressure of more than 2 bar, preferably more than 3 bar, more preferably more than 5 bar, even more preferably more than 7 bar, most preferably more than 10 bar. Providing such a high pressure allows for a high temperature, as mentioned. It is particularly preferred if the washing of the synthetic crude oil stream with the first aqueous wash solution takes place at a pressure in the range from 2 bar to 50 bar, preferably from 3 bar to 35 bar, more preferably from 5 bar to 25 bar, even more preferably from 7 bar to 20 bar, most preferably from 10 bar to 18 bar.

The polysulfide stream may be an anhydrous stream, for example, it may be obtainable from sulfur dissolved in an amine. However, it is preferred if the polysulfide stream is an aqueous solution. This has the advantage, among other things, that further impurities, for example certain salts and polar compounds, can be removed particularly efficiently. In addition, the use of an aqueous solution favors the removal of neutral compounds such as esters, aldehydes, ketones, organohalogen compounds, amides and nitriles by basic hydrolysis. The impurities can then be easily removed with the aqueous phase.

The concentration of the polysulfide compounds in the polysulfide stream is preferably at least 1 % (w/w), more preferably at least 5 % (w/w), more preferably at least 10 % (w/w), more preferably at least 15 % (w/w), more preferably at least 20 % (w/w), more preferably at least 25 % (w/w). The concentration is preferably between 1 % (w/w) and 80 % (w/w), more preferably between 5 % (w/w) and 60 % (w/w), more preferably between 10 % (w/w) and 50 % (w/w), more preferably between 15 % (w/w) and 40 % (w/w). The use of such high polysulphide concentrations favours the reaction with the diene compounds contained in the synthetic crude oil stream and can thus lead to an even greater reduction in the diene content.

In a preferred embodiment, the polysulfide stream has a pH of more than 8, preferably more than 9, more preferably more than 10, more preferably more than 11, more preferably more than 12, more preferably more than 13. The pH value is preferably in the range from 8 to 14, preferably from 10 to 13. An advantage of such a basic pH value is that the polysulfide compounds are present in a higher degree of deprotonation and are therefore more nucleophilic. This promotes the basic hydrolysis of neutral compounds such as esters, aldehydes, ketones, organohalogen compounds, amides and nitriles.

Any type of polysulfide compound may be used in connection with the method according to the invention. The polysulfide compound is preferably an inorganic or an organic polysulfide, in particular an inorganic polysulfide. Preferably, the at least one polysulfide compound is an amine polysulfide, an alkali metal polysulfide, or an alkaline earth metal polysulfide. Calcium polysulfide, sodium polysulfide and potassium polysulfide, in particular sodium or potassium polysulfide, have proven to be particularly suitable. A sodium or potassium polysulfide may be prepared, for example, by dissolving sulfur in NaOH or KOH lye. Amine polysulphides may be prepared, for example, by dissolving sulfur in amines, e.g. ethanolamine or diethanolamine.

In a preferred embodiment, the volumetric mixing ratio between the synthetic crude oil stream and the polysulfide stream is from 10:1 to 1:5, more preferably from 5:1 to 1:2.5, more preferably from 1.5:1 to 1:1.5. Such mixing ratios have proven to be particularly good for treating the synthetic crude oil

stream.

In a preferred embodiment, the mixture formed from the synthetic crude oil stream and the polysulfide stream has a polar phase and a non-polar phase, the diene-free products being predominantly present in the polar phase. Preferably, the separation of the diene-free products from the mixture is achieved by separating the polar phase. If the polysulfide stream is an aqueous solution, the polar phase may be an aqueous phase. The diene-free products can thus be separated in a particularly simple manner.

It has proven to be particularly advantageous if the contacting with the polysulfide stream and the subsequent separating of the polar phase is carried out in a mixer-settler. Typically, mixer-settlers comprise a continuously operated mixing zone and a continuously operated settling zone and therefore allow the mixing of the synthetic crude oil stream with the polysulfide stream, as well as the subsequent settling process for separating the phases and separating the purified synthetic crude oil stream in a continuous process.

In an advantageous embodiment, the separated polar phase is at least partially recycled and reused at least as part of the polysulfide stream. It has been found that the separated polar phase often still contains a significant proportion of unconsumed polysulfide compounds. If the wastewater stream is partially circulated, the polysulfide compound can therefore be better used. For example, the circulation may comprise from 1 to 25 revolutions. This recirculation can have energy advantages and lead to lower costs and also enables a smaller version of the system. The proportion of chemicals consumed can also be compensated by dosing in the circuit with fresh medium.

In a preferred embodiment of the method according to the invention, the purified synthetic crude oil stream is washed with an aqueous wash solution to obtain a second purified synthetic crude oil stream. By means of such an additional washing step, impurities contained in the synthetic crude oil stream can be removed even more thoroughly.

The aqueous wash solution is preferably an acidic aqueous wash solution. In particular, it is preferred if the pH of the

aqueous wash solution is less than 6, preferably less than 5, more preferably less than 4, more preferably less than 3.5. Such a pH value is particularly preferred if the polysulfide stream has a basic pH value. Thus, a basic wash in the form of treatment with the polysulfide stream may be followed by an acid wash.

Washing the purified synthetic crude oil stream with an acidic wash solution can improve the removal of basic compounds such as amines, pyridines and other basic impurities. If a basic hydrolysis of neutral compounds has taken place as part of the treatment with the polysulfide stream, basic hydrolysis products, e.g. amines, can additionally be removed. In particular, polycyclic amines can also be efficiently removed by this step. Polycyclic amines can be present to a greater extent in synthetic crude oils, in particular in pyrolysis oils. They can form, for example, in cracking processes in the presence of a nitrogen source, for example additives or polymers such as polyamide (PA), polyacrylonitrile (PAN) or acrylonitrile-butadiene-styrene copolymer (ABS). Polycyclic amines may be, for example, polycondensed - saturated, mono- and polyunsaturated or aromatic ring systems. They may be partially dissolved in the synthetic crude oil or suspended in the colloidal area and often result in undesirable deposits and thus in difficult cleaning of the system. In addition, they can lead to a laying of active surfaces of catalysts in subsequent applications. In addition, they can dissolve undesirable compounds such as salts, chloride, heavy metals or sulfides in the organic product phase. It has been shown that polycyclic amines can be efficiently removed by the acidic washing step. For the removal of polycyclic amines, it has proven advantageous if the acidic washing step is carried out at a temperature of at least 20 °C. The removal is particularly efficient if the temperature is at least 50 °C.

However, in the course of the invention, it has surprisingly been found to be advantageous if the temperature in the acidic washing step is not too high, in particular lower than the temperature of the contacting with the polysulfide stream. It has been shown that high temperatures in the acidic washing step can lead to a reduction in product yield and the formation of impurities. It has therefore proven advantageous to carry out the acidic washing step at a temperature of less than 120 °C. In

particular, these adverse effects can be minimized if the temperature is less than 100 °C, even more preferably less than 95 °C.

An additional advantage of the lower temperature in the acidic washing step is that the requirements for the material of the washing device are significantly lower. The presence of acidic solutions at high temperatures often requires the use of special materials or coatings, which would lead to a significant increase in costs. In a preferred embodiment, the scrubbing of the purified synthetic crude oil stream with the acidic wash solution is therefore performed at a lower temperature than the contacting of the synthetic crude oil stream with the polysulfide stream.

In a preferred embodiment, the aqueous wash solution contains sulfuric acid. The concentration of sulfuric acid is preferably between 0.5 and 10 % (w/w), in particular between 1 and 5 % (w/w).

It has also proven advantageous if the volumetric mixing ratio between the purified synthetic crude oil stream and the aqueous wash solution is from 10:1 to 1:5, preferably from 5:1 to 1:2.5, even more preferably from 2.5:1 to 1:1.5. Such a mixing ratio enables particularly efficient removal of basic impurities.

The method according to the invention may also contain further washing steps. For example, it is possible for the purified synthetic crude oil stream to undergo further washing or purification steps before washing with the aqueous wash solution takes place. However, it is preferred if no further purification step, in particular no washing step, no filtration step and/or no hydrotreating step, takes place between the separation of the diene-free products in order to obtain the purified synthetic crude oil stream and the washing of the purified synthetic crude oil stream with the aqueous wash solution. This has the advantage, among other things, that basic products formed from neutral compounds by basic hydrolysis can be removed in the preferably acidic washing step immediately following the basic washing step.

In a further preferred embodiment of the method according to

the invention, the second purified synthetic crude oil stream is washed with a further aqueous wash solution in order to obtain a third purified synthetic crude oil stream. The provision of such a further washing step enables a particularly thorough removal of impurities, which may still be present after the acidic washing step.

In this context, it is particularly preferred if the pH of the further aqueous wash solution is in the range from 3 to 13, preferably from 4 to 12, more preferably from 5 to 11, even more preferably from 6 to 10, even more preferably from 6.5 to 9, most preferably from 7 to 8. A pH in this range is particularly effective for removing small polar neutral molecules as well as inorganic and organic salts. It is particularly advantageous if the further aqueous wash solution is basic or substantially neutral, in particular substantially neutral.

In a preferred embodiment of the method according to the invention, the purified synthetic crude oil stream, the second purified synthetic crude oil stream or the third purified synthetic crude oil stream is fed into a hydrotreating unit. It has been found that the reduction of the diene content in the synthetic crude oil stream is particularly advantageous, especially in the course of hydrogenation in a hydrotreating unit, since dienes in such systems can form stable complexes with catalysts. The use of the method according to the invention in combination with a hydrogenation can thus considerably improve the service life of the hydrotreating units and in particular of the catalysts used.

In connection with the invention, it is preferred if the method for purifying a synthetic crude oil stream is a continuous method. Compared to a batch process, this has the advantage that higher productivity and shorter downtimes are achieved.

Washing the respective crude oil streams with the respective wash solutions as described herein may include mixing the crude oil stream with the wash solution followed by separating the purified crude oil stream from the aqueous wash solution. Preferably, the washing steps of the method according to the invention are carried out in a mechanical mixer, in a static mixer and/or in a mixer-settler. It has proven to be particularly

advantageous if the washing steps are each carried out in a mixer-settler, as described above for the treatment with the polysulfide stream.

In connection with the invention, a "synthetic crude oil stream" is preferably understood to mean a material stream containing a synthetic crude oil or a fraction of a synthetic crude oil. Preferably, the synthetic crude oil stream consists of synthetic crude oil or a fraction thereof. Within the scope of the invention, it is particularly preferred if the synthetic crude oil stream comprises, in particular consists of, a pyrolysis oil or a fraction thereof. The pyrolysis oil is preferably a pyrolysis oil obtained from biomass, in particular wood, and/or plastic. The method according to the invention has proven to be particularly suitable if the synthetic crude oil stream is a hydrocarbon mixture obtained from the depolymerization of biomass or plastic material, in particular plastic material. The synthetic crude oil stream is therefore preferably a plastic pyrolysate or a fraction thereof, or a biomass pyrolysate, in particular wood pyrolysate, or a fraction thereof. However, the method according to the invention is also well suited for other synthetic crude oils and fractions thereof. In further preferred embodiments, the synthetic crude oil stream therefore comprises, preferably consists of, shale oil or upgraded bitumen.

In a particularly preferred embodiment, the synthetic crude oil stream is therefore generated by depolymerization of plastic material, in particular plastic waste. The person skilled in the art is familiar with the production of a synthetic crude oil stream by depolymerization of plastic material. Such methods are known, for example, from WO 2012/149590 A1 and US 6,060,631 A.

In a preferred embodiment, the plastic material comprises polyethylene (PE), polypropylene (PP), polystyrene (PS), polyvinyl chloride (PVC), polyethylene terephthalate (PET), polyamide (PA), styrene-acrylonitrile (SAN), and/or acrylonitrile-butadiene-styrene (ABS). The method according to the invention has proven to be particularly suitable for purifying pyrolysis oils from the plastic materials mentioned.

It is particularly preferred if the plastic material contains PVC. This typically leads to impurities in the form of

organochlorine compounds in the crude oil stream obtained from the plastic material. Organochlorine compounds can be removed particularly well by basic hydrolysis, for example if the polysulfide stream is a basic aqueous solution.

It is also preferred if the plastic material contains PET. This typically leads to impurities in the form of ester compounds in the crude oil stream obtained from the plastic material, which can also be removed particularly well by basic hydrolysis.

In particular, it is preferred if the plastic material comprises PA, SAN, and/or ABS. These plastic materials typically lead to impurities in the form of amides and nitriles. In the course of the method according to the invention, these compounds can likewise be hydrolyzed under basic conditions. If the method according to the invention contains an acidic wash, the basic compounds formed from the basic hydrolysis, in particular amines, can also be removed particularly efficiently. PA, SAN and ABS can also serve as nitrogen sources and contribute to the increased formation of polycyclic amines through rearrangement reactions, condensation reaction and/or radical reactions, for example with PE, PP and PS. These can also be removed efficiently in an acidic wash.

All parameters mentioned herein refer, unless otherwise indicated, to SATP conditions according to IUPAC ("Standard Ambient Temperature and Pressure"), in particular to a temperature of 25 °C and a pressure of 101,300 Pa.

Unless otherwise indicated, all percentages (%) herein refer to percentages by weight.

Unless otherwise indicated, all mixing ratios specified herein relate to volumetric mixing ratios, i.e. to volume ratios (volume:volume).

The present invention is illustrated by the following Figure, to which, of course, it is not limited.

Figure 1 shows a method flow diagram of a preferred embodiment of the method according to the invention.

In the embodiment shown in Figure 1, the synthetic crude oil stream 1 is obtained by depolymerization of plastic material.

The plastic material is compacted, degassed and melted in an extruder 12. The plastic melt emerging from the extruder 12 is mixed in a static mixer 13 with an external solvent 14, preferably heavy oil, and/or with already cracked plastic material, which is recycled as recycling stream 15, in order to reduce the viscosity of the plastic melt. The resulting mixture is introduced into a depolymerization reactor 16, in which the plastic material is depolymerized, preferably at a temperature between 400 °C and 440 °C. Cracked plastic material is obtained as the top product of a column 17. After separating a gas stream 18 in a further column 19, the synthetic crude oil stream 1 is obtained, the synthetic crude oil stream 1 having a diene number of at least 0.1 g/100 g.

In the embodiment shown, the synthetic crude oil stream 1 is mixed with a polysulfide stream 2 in a mixing zone of a first mixer-settler 8, preferably in a volumetric mixing ratio of 1:1. The polysulfide stream 2 is preferably a basic aqueous solution containing sodium or potassium polysulfide. The mixture of the synthetic crude oil stream 1 and the polysulfide stream 2 preferably has a temperature of at least 80 °C. The diene compounds contained in the synthetic crude oil stream 1 react at least partially with the polysulfides and form insoluble diene-free products. Subsequently, the oil phase is separated from the water phase in a settling zone of the mixer-settler 8. The diene-free products are separated together with the water phase. The average residence time in the first mixer-settler 8 is preferably between 5 and 30 minutes. The water phase is removed as part of the wastewater stream 11 and the oil phase is separated as a purified synthetic crude oil stream 3.

The purified synthetic crude oil stream 3 thus obtained is then mixed with an aqueous wash solution 4 in a second mixer-settler 9. The aqueous wash solution 4 is preferably aqueous sulfuric acid with a pH between 0 and 5. As a result, the purified oil phase is again separated from the water phase in a settling zone of the mixer-settler 9, the water phase is removed via the wastewater stream 11, and a second purified synthetic crude oil stream 5 is obtained from the oil phase. In the embodiment shown, the second purified synthetic crude oil stream 5 is washed with a further aqueous wash solution 6 in a third mixer-

settler 10. The further aqueous wash solution 6 is preferably a neutral wash solution, preferably substantially water. After washing, the water phase is again removed as part of the wastewater stream 11, and the third purified synthetic crude oil stream 7 is obtained from the oil phase.

Claims:

1. A method of purifying a synthetic crude oil stream (1), the method comprising the following steps:

- providing the synthetic crude oil stream (1), wherein the synthetic crude oil stream (1) contains diene compounds and has a diene number of at least 0.1 g/100 g;
- contacting the synthetic crude oil stream (1) with a polysulfide stream (2) containing at least one polysulfide compound to form a mixture, thereby converting at least a portion of the diene compounds into diene-free products; and
- separating the diene-free products from the mixture in order to obtain a purified synthetic crude oil stream (3).

2. The method according to claim 1, wherein contacting the synthetic crude oil stream (1) with the polysulfide stream (2) occurs at a temperature of at least 80 °C.

3. The method according to claim 1 or 2, wherein the polysulfide stream (2) is an aqueous solution.

4. The method according to any one of claims 1 to 3, wherein the concentration of the polysulfide compounds in the polysulfide stream (2) is at least 1 % (w/w).

5. The method according to any one of claims 1 to 4, wherein the polysulfide stream (2) has a pH greater than 8.

6. The method according to any one of claims 1 to 5, wherein the at least one polysulfide compound is an amine polysulfide, an alkali metal polysulfide, or an alkaline earth metal polysulfide.

7. The method according to any one of claims 1 to 6, wherein the at least one polysulfide compound is sodium or potassium polysulfide.

8. The method according to any one of claims 1 to 7, wherein the volumetric mixing ratio between the synthetic crude oil stream (1) and the polysulfide stream (2) is from 10:1 to 1:5.

9. The method according to any one of claims 1 to 8, wherein the mixture formed from the synthetic crude oil stream (1) and the polysulfide stream (2) has a polar phase and a non-polar phase, wherein the diene-free products are predominantly present in the polar phase, and wherein the separation of the diene-free products from the mixture is achieved by separating the polar phase.

10. The method according to any one of claims 1 to 9, wherein the purified synthetic crude oil stream (3) is washed with an aqueous wash solution (4) to obtain a second purified synthetic crude oil stream (5).

11. The method according to claim 10, wherein the pH of the aqueous wash solution (4) is less than 6.

12. The method according to claim 10 or 11, wherein the second purified synthetic crude oil stream (5) is washed with another aqueous wash solution (6) to obtain a third purified synthetic crude oil stream (7).

13. The method according to any one of claims 1 to 12, wherein the purified synthetic crude oil stream (3), the second purified synthetic crude oil stream (5), or the third purified synthetic crude oil stream (7) is fed into a hydrotreating unit.

14. The method according to any one of claims 1 to 13, wherein the synthetic crude oil stream (1) is generated by depolymerization of plastic material, in particular plastic waste.

15. The method according to claim 14, wherein the plastic material comprises polyethylene (PE), polypropylene (PP), polystyrene (PS), polyvinyl chloride (PVC), polyethylene terephthalate (PET), polyamide (PA), styrene-acrylonitrile (SAN), and/or acrylonitrile-butadiene-styrene (ABS).