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PARTIAL HYDROGENATION OF AROMATIC COMPOUNDS

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ABSTRACT OF THE DISCLOSURE

Process for the partial hydrogenation of aromatic compounds by contacting the compounds with hydrogen at elevated temperatures and pressures in the presence of a catalyst consisting of a metal hydrogenation component and a Friedel-Crafts metal halide-hydrogen halide component.

This invention relates to a method for the partial hydrogenation of aromatic compounds having polynuclear structures. More particularly this invention relates to a method for the partial hydrogenation of aromatic hydrocarbons and heterocyclic aromatic compounds having condensed polynuclear structures, employing a catalyst consisting essentially of a metal hydrogenation catalyst component in combination with a Friedel-Crafts metal halide-hydrogen halide component together with temperatures and pressures below those employed in hydrogenation reactions utilizing the metal hydrogenation component as the sole catalyst.

The processing of heavy hydrocarbon fractions such as residua, viscous crudes, tars, shale oils and the like is particularly difficult since these fractions contain considerable quantities of both mononuclear and polynuclear aromatic hydrocarbon and heterocyclic aromatic compounds and particularly condensed polynuclear aromatic hydrocarbon compounds and condensed polynuclear heterocyclic aromatic compounds. When these condensed ring compounds are subjected to catalytic cracking they produce large amounts of coke and gas with only a relatively small yield of useful liquid product as compared to the yield of liquid product obtained from conventional distillate cracking stocks. Moreover, these compounds have a high viscosity and in the case of the heterocyclic compounds they have a tendency to form chelate structures with metals, which compounds when cracked deposit the metals on the cracking catalyst, which in turn deleteriously affects the cracking characteristics of the catalyst with respect to product distribution.

In order to obviate these disadvantages it has been suggested to hydrogenate these condensed polynuclear aromatics and condensed polynuclear heterocyclic compounds. The results to be expected from such a process would be that the hydrogenated compounds could be catalytically cracked more selectively with the production of less coke and a higher yield of useful liquid products. As a further result, the hydrogenated compounds would have a lower viscosity and therefore could be handled more readily at lower temperatures and in addition the hydrogenation process would remove at least a large proportion of the metals from the chelate structures thus subsequently providing a lower cracking catalyst contamination and a better product distribution from the cracking catalyst.

Heretofore the problems of hydrogenating such high molecular weight compounds have been the high pressures required when conventional hydrogenation catalysts are employed and, in addition, the high hydrogen consumption resulting from over-hydrogenation.

A method now has been found, however, which permits

the hydrogenation of these compounds, i.e. increases their molecular weight by the addition of hydrogen, at relatively low temperatures and pressures in the presence of a catalyst and which adds the hydrogen to a condensed polynuclear molecule in positions where the maximum beneficial effects are obtained with the minimum consumption of hydrogen. Thus the aforementioned heavy hydrocarbon fractions containing considerable quantities of condensed polynuclear aromatic compounds and condensed polynuclear heterocyclic compounds are partially hydrogenated at low temperatures and pressures with small amounts of hydrogen so that subsequently when these heavy hydrocarbon fractions are subjected to cracking in the presence of conventional cracking catalysts the partially hydrogenated compounds crack more readily with the production of higher yields of useful liquid products and smaller quantities of coke. Moreover, the additional advantages heretofore enumerated of lower viscosity and less metal contamination also are obtained.

It is an object of this invention to provide a method for the partial hydrogenation of aromatic organic compounds and heterocyclic organic compounds utilizing a catalyst and low temperatures and pressures.

It is another object of this invention to provide a method for the partial hydrogenation of condensed polynuclear aromatic compounds and condensed polynuclear heterocyclic compounds utilizing a catalyst and low temperatures and pressures.

It is another object of this invention to provide a method for the partial hydrogenation of condensed polynuclear aromatic compounds and condensed polynuclear heterocyclic aromatic compounds utilizing a catalyst consisting essentially of a metal hydrogenation catalyst component in combination with a Friedel-Crafts metal halide-hydrogen halide component.

Other objects of this invention will be apparent from the description and claims that follow.

In carrying out the method of this invention the charge stock containing the aromatic compounds or the heterocyclic compounds, in particular the condensed polynuclear aromatic compounds and the condensed polynuclear heterocyclic aromatic compounds, is contacted in the presence of hydrogen with a catalyst consisting of a metal hydrogenation catalyst component and a Friedel-Crafts metal halide-hydrogen halide component.

In order to obtain the partial hydrogenation as has been described, the reaction temperatures are in the range of from 20° C. to 225° C. and the reaction pressures are in the range of from 100 p.s.i. to 3,000 p.s.i. Preferred reaction temperatures are in the range of from 50° C. to 200° C. and preferred pressures are in the range of from 500 p.s.i. to 2000 p.s.i. for most of the described compounds. The reaction may be carried on either in batch or continuous operation.

The metal hydrogenation catalyst component may be nickel, palladium, platinum, ruthenium or other conventional transition metal hydrogenation catalysts either in the form of a supported or unsupported component. When a supported component is employed it is preferably supported on activated carbon although other conventional supports such as alumina also may be employed. The amount of metal on the supported catalysts ordinarily ranges from 0.1 percent to 10 percent of the total weight of the catalyst. The unsupported catalysts include platinum oxide, palladium black. Raney nickel, Raney cobalt and the like. All of these catalysts are available commercially and their preparation has been described in both the literature and patents.

The metal hydrogenation catalyst component is physically admixed with the Friedel-Crafts metal halide. Friedel-Crafts metal halides which may be employed are those which are well-recognized in the art, e.g. the metal

may be aluminum, tin, boron, titanium, iron, zinc, zirconium, beryllium and germanium, and the halides may be fluorine, chlorine, bromine or iodine.

It will be understood, however, as is well known in the art, that not every possible metal halide is a Friedel-Crafts metal halide. This is particularly true of the fluorides. In the case of the fluoride the most preferred compound is the boron trifluoride, whereas with the other metals the chloride is the most preferred halide. The hydrogen halide used in conjunction with the Friedel-Crafts metal halide has preferably the same halogen atom as is utilized in combination with the metal. Thus, for example, if aluminum chloride is the metal halide, hydrogen chloride is used in conjunction therewith, if aluminum bromide is utilized as the metal halide hydrogen bromide is employed, or if boron trifluoride is employed hydrogen fluoride is utilized therewith. Certain exceptions to these preferred combinations are permissable however, for example, hydrogen chloride may be utilized in combination with aluminum bromide, hydrogen bromide may be utilized in combination with aluminum chloride, or hydrogen chloride may be utilized in combination with boron trifluoride.

It is also well known in the art that if traces of moisture, oxygen, olefins, sulfur compounds and the like, are present in the reaction system they will react with the anhydrous metal halide to produce the hydrogen halide, thus if aluminum chloride is introduced into a system that contains even small traces of moisture, sufficient hydrogen chloride will be produced to be sufficient to activate the metal halide for the catalytic purposes of this reaction. With boron trifluoride it also has been found that traces of moisture are sufficient to produce the boron trifluoride-hydrogen fluoride component.

The metal hydrogenation catalyst is required only in catalytic amounts as is well known in the hydrogenation art. For example, in batch hydrogenation experiments a mole ratio of metal to reactant hydrocarbon of 1:100 is completely sufficient and amounts of metal of 1/10 or less of this amount also can be used. In continuous operation wherein the hydrocarbon is passed over a bed of the supported metal a much higher ratio of hydrocarbons to metal obviously can be employed. The amount of Friedel-Crafts metal halide also is in the catalytic range, i.e. mole ratios of metal halide to reactant hydrocarbon of 1:10 and less. With heterocyclic compounds it has been found that the metal halide to heterocyclic mole ratios must be sufficiently high to provide a catalytic amount of free metal halide in excess of the amount complexed by the hetero-atom.

The ratio of hydrogen halide to metal halide as has been pointed out may be very low, i.e. since traces of moisture may be sufficient to produce sufficient amounts of the hydrogen halide from the metal halide in situ, mole ratios of hydrogen halide to metal halide as low as 1:1000 may be sufficient, although, of course, higher mole ratios including ratios of 1:1 or even higher also may be employed.

In batch hydrogenation processes the material to be hydrogenated, the metal hydrogenation catalyst component and the anhydrous Friedel-Crafts metal halide may be introduced into the reactor under nitrogen and after additional purging to remove all traces of air and moisture the reactor is sealed and the anhydrous hydrogen halide is added. Thereafter the reactor is pressurized with excess hydrogen. The amount of hydrogen employed in the reaction is sufficient to provide the desired reaction pressure and in addition is in excess of that which is consumed by the reaction. Thus the only requirement as far as the amount of hydrogen is concerned is that there be present a sufficient excess to provide the desired pressure and amount necessary for that consumed by the reaction.

The following examples are provided to illustrate certain important characteristics of the invention and specific embodiments of the invention, but it will be understood that these examples are not to be construed as limiting the invention thereto.

EXAMPLE I

In order to demonstrate that each component of the catalyst is required in accordance with the objects of this invention, a number of runs were carried out utilizing pyrene as the charge hydrocarbon. In these runs the pyrene, palladium-on-activated carbon catalyst (10 weight percent Pd) and anhydrous aluminum chloride were admixed in 250 ml. of cyclohexane solvent and added to an autoclave under nitrogen to exclude air and moisture. The autoclave was sealed and purged with additional nitrogen. Hydrogen chloride gas from a gas burette was added and thereafter the system was pressurized to 500 p.s.i. with hydrogen. The reaction mixture was agitated and heated to reaction temperature and held at reaction temperature with continuous agitation for 3 hours.

In certain of the runs it will be noted that one or more of the catalyst components was omitted in order to demonstrate the criticality of employing all the catalyst components. In each run the amount of pyrene employed was 12.5 grams (0.06 moles). The amounts of the catalyst components, when employed were: palladium-on-activated carbon, 0.6 grams (the palladium-on-activated carbon catalyst was an ordinary commercial catalyst wherein the palladium amounted to 10 weight percent of the total weight of the catalyst); anhydrous aluminum chloride, 0.8 gram (0.006 mole); and anhydrous hydrogen chloride, 2.6 ml. (0.0001 mole).

The products obtained after hydrogenation in all the examples were analyzed by gas chromatography, ultraviolet spectrophotometry and nuclear magnetic resonance spectrometry. Conversions and product distributions in all of the examples are given in weight percent based on the charge.

TABLE I

	Run Nos.				
	1	2	3	4	5
Conditions:					
Pd-on-act. carbon	None	Yes	Yes	Yes	Yes
$AlCl_3$	Yes	None	None	Yes	Yes
HCl	Yes	None	Yes	None	Yes
React. Temp. ° C.	125	100	100	100	100
Conversion	0	4.7	7.0	26.4	83.8
Product Distribution:					
Dihydropyrene	0	4.7	7.0	17.1	32.7
Tetrahydropyrene	0	0	0	2.8	19.8
Hexahydropyrene	0	0	0	6.4	26.6
Perhydropyrene	0	0	0	0	3.6
Pyrene (unreacted)	100	95.3	93.0	73.6	16.2

The dihydropyrene was identified as the compound wherein the hydrogens were substituted in the 9.10 positions based on the numbering system as set forth in "The Ring Index," Second Edition, by A. M. Patterson, L. T. Capell and D. F. Walker, page 720. American Chemical Society, Washington, D.C. (1960).

The tetrahydropyrene had the hydrogens substituted at the 4, 5, 9, 10 positions according to the same numbering system and the hexahydropyrene had the hydrogens substituted in the 1, 2, 3, 6, 7, 8 positions as designated by the same system. The perhydropyrene was completely saturated.

It will be seen from the data set forth in Table I that each component of the catalyst is necessary to obtain the desired hydrogenation of pyrene. Moreover, it will be noted that the isomers wherein the lowest consumption of hydrogen is realized, i.e. the dihydro- and tetrahydro- compounds predominate and it is known from catalytic cracking data that such compounds may be readily cracked with a higher production of useful liquid products and a lower production of coke.

EXAMPLE II

Another run, number 6, was carried out which was identical to run number 5 of Example I except that 2.4

grams (0.018 mole) of anhydrous aluminum chloride and 7.8 ml. (0.0003 mole) of gaseous anhydrous hydrogen chloride were employed in combination with 0.6 gram of the palladium-on-activated carbon catalyst. The product distribution in weight per cent is shown in Table II.

TABLE II

Product:	Weight percent
Dihydropyrene	22.0
Tetrahydropyrene	33.3
Hexahydropyrene	27.1
Perhydropyrene	11.5
Unreacted pyrene	6.0

This run demonstrates that by increasing the proportion of the Friedel-Crafts metal halide-hydrogen halide component of the catalyst, in the same reaction time, the total conversion is increased but the hydrogen consumption is also increased with the production of larger amounts of the less desirable hexahydro- and perhydro-isomers.

EXAMPLE III

In order to show the effect of varying the temperature and pressure additional runs were made utilizing the same catalyst employed in run No. 5 of Example I but varying the temperature and the pressure. The conditions and the results obtained are shown in Table III.

TABLE III

	Run Nos.				
	5	7	8	9	10
Conditions:					
Temp., ° C.	100	75	50	50	50
Press., p.s.i.	500	500	500	700	1,000
Conversion, wt. percent	83.8	15.6	0	4.5	8.6
Product Distribution:					
Dihydropyrene	32.7	9.0	0	2.9	4.7
Tetrahydropyrene	19.8	2.5	0	0.4	0.5
Hexahydropyrene	26.6	4.2	0	1.2	3.4
Perhydropyrene	3.6	0	0	0	0
Pyrene (unreacted)	16.2	84.4	100.0	95.5	91.4

It will be seen that as the temperature is decreased from 100° C. to 50° C. the conversion is decreased to zero at a constant pressure of 500 p.s.i., however, if the pressure is increased from 500 p.s.i. to 1000 p.s.i. at 50° C. an appreciable conversion is obtained. In all cases the combination of the dihydro- and tetrahydro-isomers predominate because of the catalytic amount of metal halide-hydrogen halide present.

EXAMPLE IV

Another series of runs was carried out utilizing pyrene as the charge stock, palladium-on-activated carbon as the metal hydrogenation catalyst component and boron trifluoride-hydrogen fluoride as the Friedel-Crafts metal halide-hydrogen halide component. The amount of pyrene employed in each run was 12.5 grams (0.06 mole), the amount of palladium on activated carbon was 0.6 gram (10 wt. percent palladium on the catalyst) the amount of boron trifluoride was 143 ml. (0.0060 mole) and the amount of gaseous hydrogen fluoride was 14.3 ml. (0.0006 mole).

In these runs the pyrene and palladium-on-activated carbon catalyst were admixed in 250 ml. of cyclohexane solvent and added to a rocking autoclave under nitrogen to exclude air and moisture. The autoclave was sealed and purged with additional nitrogen. The boron trifluoride and the hydrogen fluoride were added respectively from gas burettes. Finally the system was pressurized to 500 p.s.i. with hydrogen. The reaction mixture was heated to reaction temperature and rocked in the autoclave at reaction temperature for three hours. The products were analyzed as described in the previous examples. The experimental conditions and results obtained are shown in Table IV.

TABLE IV

	Run Nos.		
	11	12	13
Conditions:			
Pd-on-act. carbon	Yes	Yes	Yes
BF_3	None	Yes	Yes
HF	Yes	None	Yes
React. Temp., ° C.	100	100	100
Conversion, wt. percent	7.3	0	24.6
Product Distribution:			
Dihydropyrene	7.3	0	21.6
Tetrahydropyrene	0	0	3.0
Hexahydropyrene	0	0	0
Perhydropyrene	0	0	0
Pyrene (unreacted)	92.7	100.0	75.4

These data demonstrate the necessity of utilizing both BF_3 and HF in combination with the palladium-on-activated carbon catalyst to obtain hydrogenation.

EXAMPLE V

In order to show the effect of temperature and pressure on the reaction a number of runs were carried out wherein these conditions were varied. The results obtained are set forth in Table V. The amount of pyrene and the amounts of catalyst are the same as for run 13 of Example IV.

TABLE V

	Run Nos				
	14	15	16	17	18
Conditions:					
React. Temp., ° C.	150	125	100	100	100
Pressure, p.s.i.	500	500	500	1,000	2,000
Conversion, wt. percent	78.3	53.7	24.6	36.7	56.1
Product Distribution:					
Dihydropyrene	48.6	42.1	21.6	25.4	46.9
Tetrahydropyrene	21.3	9.6	3.0	5.9	7.6
Hexahydropyrene	8.1	2.1	0	5.0	1.6
Perhydropyrene	0	0	0	0	0
Pyrene	21.7	46.3	75.4	63.3	43.9

These data, as in Example III, show that as the temperature increases the conversion increases at constant pressure and as the pressure increases the conversion increases at constant temperature. The dihydro- and tetrahydro-isomers predominate in all of these runs.

EXAMPLE VI

An experiment was carried out wherein 174 grams of biphenyl were charged to the rocking autoclave together with 2.0 grams of the palladium on activated carbon catalyst, 2.0 grams of anhydrous aluminum chloride and 0.6 gram of gaseous anhydrous hydrogen chloride. The autoclave was pressurized to 1800 p.s.i. with hydrogen and the temperature raised to 75° C. and the reaction continued for 35 hours with continuous rocking. It was found that 32.3 weight percent phenylcyclohexane had been produced.

EXAMPLE VII

In this experiment 200 grams of diphenyl ether were charged to the autoclave together with 2.0 grams of the palladium-on-activated carbon, 2.0 grams of anhydrous aluminum chloride and 1.0 gram of gaseous anhydrous hydrogen chloride. The autoclave was pressurized to 1800 p.s.i. with hydrogen and heated to 50° C. It was held at this reaction temperature for 39 hours. It was found that 3.9 weight percent phenyl cyclohexyl ether and 2.1 percent other partially hydrogenated compounds were produced.

EXAMPLE VIII

A 50 gram sample of phenanthrene was charged to the rocking autoclave together with 2.0 grams of the

palladium-on-activated carbon, 2.0 grams of anhydrous aluminum chloride and 0.6 gram of gaseous anhydrous hydrogen chloride. After purging with nitrogen the autoclave was pressurized to 900 p.s.i. with hydrogen and raised to a reaction temperature of 105° C. It was held at this temperature for 16.5 hours. A conversion of 25 weight percent was obtained. The conversion product was found to be 9,10-dihydrophenanthrene.

In another experiment 50 grams of anthracene together with 2.0 grams of the palladium-on-activated carbon, 2.0 grams of anhydrous aluminum chloride and 0.6 gram of gaseous anhydrous hydrogen chloride were charged to the rocking autoclave and after purging with nitrogen the autoclave was pressurized with hydrogen to 900 p.s.i. The temperature was raised to 50° C. and held at this level for 18 hours. An 89 percent conversion was obtained were 28.4 weight percent perhydroanthracene; 2.9 weight percent 9.10-dihydroanthracene; 23.4 weight percent 1,2,3,4,5,6,7,8-octahydroanthracene; 6.9 weight percent 1,2,3,4-tetrahydroanthracene and 28.4 weight percent of a variety of hydrogenated products which were not identified with 11 percent unreacted anthracene. These experiments demonstrate that it is not necessary to employ a solvent when partially hydrogenating normally solid materials.

EXAMPLE IX

A 12.5 gram sample of dibenzothiophene together with 0.6 gram of the palladium-on-activated carbon and 9.1 grams of anhydrous aluminum chloride in 250 ml. of cyclohexane were charged to a rocking autoclave under nitrogen. After purging with nitrogen 80 ml. of gaseous anhydrous hydrogen chloride were added and thereafter the system was pressurized to 500 p.s.i. with hydrogen. The reaction mixture was brought to 150° C. and the reaction carried on for 3 hours at this temperature. It was found at the end of this time that a conversion of 52.6 weight percent had been obtained. The products were 37.2 weight percent hexahydrodibenzothiophene; 4.4 weight percent other hydrogenated thiophene compounds and 11.0 weight percent desulfurized compounds which ranged from partially saturated to completely saturated hydrocarbons but were not further identified. There was 47.4 weight percent dibenzothiophene unreacted.

EXAMPLE X

A 12.5 gram sample of pyrene and 0.6 gram of the palladium-on-activated carbon in 150 ml. of methyl cyclopentane were charged to the rocking autoclave. After the autoclave was purged with nitrogen, 1.1 gram of anhydrous titanium tetrachloride and 2.6 ml. of gaseous anhydrous hydrogen chloride were added. The system was pressurized to 500 p.s.i. with hydrogen and the temperature raised to 100° C. The reaction was carried on for three hours. A 13.1 weight percent conversion was obtained. The products were 6.7 weight percent dihydropyrene, 3.7 weight percent tetrahydropyrene and 2.7 weight percent was hexahydropyrene with 86.9 weight percent unconverted pyrene.

EXAMPLE XI

In order to demonstrate the utility of other metal hydrogenation catalysts in combination with the Friedel-Crafts metal halide-hydrogen halide component an experiment was carried out wherein 12.5 grams of pyrene, 6.0 grams of Raney nickel and 0.8 gram of anhydrous aluminum chloride in 250 ml. of cyclohexane were charged to a rocking autoclave. The autoclave was sealed and purged with nitrogen and thereafter 2.6 ml. of gaseous anhydrous hydrogen chloride were introduced. The autoclave was then pressurized to 500 p.s.i. and the temperature raised to 100° C. The reaction was carried out at this temperature for 3 hours. At the end of this time it was found that a conversion of 48 weight percent had been obtained. The product distribution was:

	Weight percent
Perhydropyrene	1.7
Hexahydropyrene	14.0
Tetrahydropyrene	6.7
Dihydropyrene	18.4
Unreacted pyrene	59.2

This experiment demonstrates that nickel may be utilized in combination with the Friedel-Crafts metal halide-hydrogen halide component as the catalyst for the process of this invention.

EXAMPLE XII

In order to show that the catalyst of this invention must be a combination of a metal hydrogenation catalyst with a Friedel-Crafts metal halide-hydrogen halide component an experiment was carried out wherein a reforming catalyst was halogenated in order to give a catalyst having the same elemental ingredients as the catalysts of this invention. In this experiment 5 grams of a commercial reforming catalyst, i.e. eta-alumina platinized with 0.55 weight percent platinum (Engelhard Industries, Inc. RD–150) was heated in a nitrogen atmosphere for 20 hours at 1000° F. then transferred to the rocking autoclave under nitrogen. After purging with additional nitrogen, 1.5 grams of gaseous anhydrous hydrogen chloride were introduced into the autoclave and the autoclave heated to 400° F. and held at this temperature for four hours. The autoclave was then cooled and purged with nitrogen and it was found that 1.1 grams of HCl had reacted. A 50 gram sample of 2-methyl-naphthalene was introduced into the autoclave and the autoclave was then pressurized to 900 p.s.i. with hydrogen. The autoclave was heated to 125° F. and held at this temperature for 21 hours. At the end of this time it was found that no hydrogenation had occurred, showing that this type of catalyst is completely inactive and cannot be substituted for the catalyst of the instant invention.

In a second experiment a sample of eta-alumina was reacted with hydrogen fluoride to give approximately 1 percent fluorine in the alumina. This support was then platinized with choroplatinic acid and reduced to give a catalyst having 1 weight percent platinum on the support. This catalyst when utilized at 500 p.s.i. and 100° C. for 3 hours in an attempt to hydrogenate pyrene gave no conversion.

We claim:

1. A process for the partial hydrogenation of polynuclear aromatic compounds which comprises contacting said compounds with hydrogen at a temperature of from 20° C. to 225° C. and pressure in the range of from 100 p.s.i. to 3000 p.s.i. in the presence of a catalyst consisting essentially of a metal hydrogenation catalyst component combined with an aluminum chloride-hydrogen chloride catalyst.

2. The process according to claim 1 where the aromatic compounds are condensed polynuclear aromatic compounds.

3. The process according to claim 1 wherein the aromatic compounds are condensed polynuclear heterocyclic aromatic compounds.

4. The process according to claim 1 wherein the temperature is in the range of from 50° C. to 200° C., the pressure is in the range of from 500 p.s.i. to 2000 p.s.i. and the metal hydrogenation catalyst component is palladium on activated carbon.

5. The process according to claim 1 wherein the temperature is in the range of from 50° C. to 200° C., the pressure is in the range of from 500 p.s.i. to 2000 p.s.i. and the metal hydrogenation catalyst component is nickel on activated carbon.

6. The process according to claim 1 wherein the temperature is in the range of from 50 C. to 200° C., the pressure is in the range of from 500 p.s.i. to 2000 p.s.i.

and the metal hydrogenation catalyst component is Raney nickel.

7. The process according to claim 1 wherein the polynuclear aromatic hydrocarbon is pyrene, the temperature is in the range of from 50° C. to 200° C., the pressure is in the range of from 500 p.s.i. to 2000 p.s.i. and the metal hydrogenation catalyst component is palladium on activated carbon.

8. The process according to claim 1 wherein the aromatic compound is dibenzothiophene the temperature is in the range of from 50° C. to 200° C., the pressure is in the range of from 500 p.s.i. to 2000 p.s.i. and the metal

hydrogenation catalyst component is palladium on activated carbon.

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