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PATENT SPECIFICATION

NO DRAWINGS

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COMPLETE SPECIFICATION

Method for the Regeneration and Reactivation of Deactivated Supported Platinum Catalysts

We, SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ N.V., a Company organised under the Laws of the Netherlands, 30 Carel van Bylandtlaan, The Hague, The Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method for the regeneration and reactivation of a deactivated supported platinum catalyst which is contained in at least one bed and on which carbonaceous deposits have been accumulated.

Platinum catalysts are used extensively in processes for the conversion of hydrocarbons or hydrocarbon mixtures, such as catalytic reforming. Platinum catalysts comprise, platinum, usually supported on a suitable base, such as alumina, and a small amount of halogen, such as chlorine and/or fluorine to improve hydrocracking and isomerization activity.

During the course of the conversion process, catalyst activity gradually declines owing to a build - up of carbonaceous deposits on the catalyst and/or a depletion of halogen from the catalyst. Eventually it becomes necessary to regenerate the catalyst by subjecting the catalyst to an oxidizing atmosphere to remove carbonaceous deposits by burning. Halogen can be added to the catalyst, e.g. during the regeneration procedure or by the addition of a volatile decomposable halogen compound to the feed during operation. Mostly, however, carbon burn and/or halogen replenishment fails to restore the catalyst to initial activity and selectivity, or if so, only temporarily, and activity and selectivity decrease at an increased rate during subsequent use of the catalyst. This decreased activity, even with regenerated and halogenated catalyst, is attributed to agglomeration of platinum crystallites.

It has been proposed to reduce the size of the agglomerated platinum by removal of carbonaceous material from the "spent" catalyst by oxidation, followed by exposing the substantially carbon - free catalyst to an atmosphere containing chlorine, steam and oxygen. In this way, when the catalyst has to be chlorided to a high chlorine content satisfactory platinum redispersal can at the same time be obtained by this process. When the catalyst has to be chlorided to a low chlorine content, however, this combined chlorine, steam and oxygen treatment is insufficient to give effective platinum redistribution. In the latter case the chlorine content of the catalyst must therefore be adjusted to an unnecessarily high level during the treatment, after which chlorine has to be stripped from the catalyst, e.g. by steam, until the chlorine content has been reduced to the proper level.

The above method of obtaining platinum redispersal of a low chlorine - containing catalyst has a disadvantage that chlorine requirements are relatively high. Moreover, considerable time is required to raise the equilibrium chlorine content of the catalyst to a high level, and additional time is lost in stripping the excessive chlorine content to the desired final low chlorine level. In addition, risk of excessive corrosion in the downstream section of the plant where lower temperatures are encountered is considerably increased.

The above disadvantages are obviated by performing the chlorine addition in a two-step operation. The invention therefore relates to a method for the regeneration and reactivation of a deactivated supported platinum catalyst which is contained in at least one bed and on which carbonaceous deposits have been accumulated characterized in that at least a portion of the carbonaceous deposits is removed by burning, after which a gaseous mixture comprising oxygen, steam, chlorine and/or a decomposable chlorine compound is passed through the catalyst bed or beds at a temperature of at least 371°C. in a first step, the molar ratio of steam to chlorine in said gaseous mixture being such as to provide an

equilibrium chlorine content of at least about 0.5% by weight on an upstream portion of the catalyst bed or beds, based on this catalyst portion, said first step being continued until the amount of chlorine deposited on the upstream portion of the catalyst is substantially equivalent to the theoretical amount required to bring the total catalyst to the desired level, whereafter in a second step the steam to chlorine ratio in the gaseous mixture is increased to a value substantially not higher than that which gives the desired final equilibrium chlorine content on the catalyst, this second step being continued until the total catalyst is substantially at equilibrium.

The reactivation procedure is carried out after the catalyst has been regenerated by burning to remove carbonaceous material. The removal of carbonaceous deposits by controlled burning is preferably effected by passing oxygen diluted with nitrogen through the bed or beds of the catalyst. The oxygen concentration in the mixture is preferably controlled so that the temperature of the catalyst does not exceed about 566°C. and more preferably so that the temperature does not exceed about 454°C. It is preferred to purge hydrocarbon material from the system before the controlled burning is initiated. Removal of hydrocarbon is preferably accomplished by purging the system with nitrogen or inert gas, at about atmospheric pressure. Thus, when the system has been purged substantially free from hydrocarbon with inert gas, circulation of inert gas is established and combustion air is injected into the circulating stream to produce an oxygen concentration preferably no greater than about 0.5%m (%m means mol percent) at the first reactor inlet. This produces a combustion front which progressively moves through the catalyst bed. After combustion front has passed through the bed, the reactor temperature is preferably slowly increased to 510°C., and, if no secondary combustion front occurs, oxygen concentration is then preferably increased to about 2%m. Should secondary combustion be encountered, oxygen concentration should be reduced to original levels to avoid excessive temperatures which might damage the catalyst.

Although the reactivation procedure can be initiated at this time, it is advantageous to wait until the CO_2 concentration of the circulating gas has been reduced to a low volume, since at constant pressure this is the only way oxygen concentration can be increased by mechanical means. The removal of CO_2 from the system can be accomplished by a purge with air, preferably at a reduced pressure. When oxygen concentration has risen to preferably about 15%m, system pressure is increased to the maximum at which the air can be injected and recycle gas circulation is established at a maximum rate, catalyst temperature being preferably about 510°C. A high concentration of oxygen is advantageous also in inhibiting the reaction of chlorine with steam in the following reactivation procedure.

After the removal of the carbonaceous deposits from the catalyst and preferably after the CO_2 concentration of the circulating gas has been reduced to a low extent the two-step reactivation is started. For this purpose a gaseous mixture comprising oxygen, steam, chlorine and / or a decomposable chlorine compound is passed through the catalyst bed or beds. This may be effected by injecting chlorine and/or a decomposable chlorine compound and water and/or steam into the circulating gas. The reactivation of the catalyst is carried out at an elevated temperature, preferably at a temperature in the range of from about 371°C. to about 566°C. and more preferably at a temperature in the range of from about 482°C. to about 510°C.

Reactivation of the catalyst is preferably carried out at superatmospheric pressure. The time required for the reactivating procedure will vary in inverse ratio with the mass flow circulation rate. Thus, increasing system pressure allows circulation of appreciably more gas. In commercial units, pressure is generally limited by the installed recycle compressor facilities. Therefore the reactivation pressure will preferably be of the order of 5 to 7 atm. gauge.

Chlorine, or any volatile, decomposable chlorine compound, can be used for the chloriding. It is preferred to use trichloroethylene as the source of chlorine since it is low in cost and is readily available. Moreover, decomposition of this material into chloride and HCl readily occurs at the conditions to which it is subjected, and the proportion of chlorine formed with respect to the HCl formed is relatively high.

The amount of chlorine contained by a platinum reforming catalyst in equilibrium with a reactivating gas is a function of the ratio of steam to chlorine in the gas and to a certain extent a function of temperature. Thus, at a given temperature the equilibrium chlorine content of the catalyst decreases as the H_2O/Cl_2 mole ratio is increased. Therefore, to replenish chloride on a catalyst, a mixture of steam and chlorine, or a volatile decomposable chloride compound, is passed over the catalyst for a period of time, the H_2O/Cl_2 ratio being such as to give the desired chloride content at the temperature of the chloriding step, until equilibrium has been established.

Mere steam / chlorine treatment is ineffective to redisperse agglomerated platinum crystallites since platinum redispersal does not occur during chlorination in the absence of oxygen. While the chemistry involved in reactivating the catalyst is not well understood, it appears that the platinum redispersal step requires a chemical reaction between platinum, chlorine and oxygen. On the other hand, treat-

ment of regenerated catalyst by exposure to a high partial pressure of oxygen at a relatively high temperature effects little, if any, redispersion of platinum. The extent of platinum redispersion during a high temperature oxygen treatment has been found to be a function of the chloride content of the catalyst. Really satisfactory platinum redispersions do not occur unless the chloride content of the catalyst during the air soak period is at least about 0.5%w (%w means percent by weight) and preferably greater. For example, at a chloride level of 0.5%w, platinum redispersion is about 85% of that of fresh catalyst. Below this value the degree of dispersion falls off rapidly. At a chloride content of 0.6%w, redispersion is substantially complete.

Therefore in the first step of the reactivating procedure the molar ratio of steam to chlorine in the gaseous mixture is preferably chosen such as to provide an equilibrium chlorine content of at least about 0.6% by weight on the upstream portion of the catalyst bed or beds. In the first step the stoichiometric amount of chlorine required to increase the chlorine content of the total quantity of catalyst to substantially the desired final level is suitably introduced at the maximum allowable chlorine injection rate at low water / chlorine mole ratio. The water / chlorine mole ratio should be sufficiently low to provide a chlorine content of at least 0.5%w, and preferably higher, at the temperature which is employed. For example, at temperatures of 482°C. to 510°C., the water/chlorine mole ratio should preferably be less than about 150/1. At lower temperatures, higher ratios can be used. The lower the ratio, of course, the higher will be the equilibrium content of chlorine on the catalyst. This causes a local high concentration of chlorine, referred to as a peak of high catalyst chlorine content, to deposit on the upstream part of the catalyst. Although the rate of chlorine addition is relatively fast, there will not be a sharp line of demarcation between chlorided catalyst and spent catalyst at the front edge of the treating gas because as chlorine is transferred from the treating gas to the catalyst the water / chlorine ratio in the treating gas increases as the gas passes through the bed and eventually reaches the level corresponding to that which is in equilibrium with the chloride content of the spent catalyst.

To reduce time required for reactivating the catalyst, the chlorine concentration in the gaseous mixture should preferably be at a maximum as limited by metallurgical or other reasons. Sufficient steam should then be introduced into the treating gas to give a low H_2O/Cl_2 ratio, the lower the ratio the higher the amplitude of the peak of catalyst chlorine content. For example, for a catalyst quantity of 18,000 kg, a chlorine content of 0.15%w on the spent catalyst, and a desired final chlorine content of 0.35%w on the catalyst, the amount of chlorine required to bring the total catalyst quantity to the desired chlorine level is 36 kg. In adding this 36 kg to the catalyst at 482°C. and a water / chlorine ratio of about 25, the equilibrium catalyst chlorine content would be about 0.95%w and only approximately the first 25% of the catalyst bed would be chlorided. At a lower water / chlorine mole ratio, e.g. about 10, the equilibrium catalyst chloride content would be about 1.05%w, and even less of the catalyst quantity would be chlorided to the higher level.

In many commercial platforming units, the maximum chlorine concentration in the treating gas should be limited to about 0.05%m because of metallurgical reasons. Therefore, after the catalyst has been regenerated, chlorine and/or the chlorine compound, preferably trichloroethylene may be injected into the circulating gas at a rate to produce a chlorine concentration not higher than 0.05m. Steam or water is in this embodiment then injected into the circulating gas stream to produce the desired steam / chlorine ratio at the reactor inlet. Preferably sufficient water or steam is injected to produce 2.0%m water at the bed inlet. With high water concentrations in the treating gas, the time required to dry the system becomes greater. Also, excessive chlorine loss from the catalyst during the drying step, if employed, can result.

As soon as the total desired quantity of chlorine has been added the second, or "smoothing", step is commenced, by increasing the water / chlorine mole ratio in the gaseous mixture to a value substantially not higher than that required to produce the desired chlorine content on the catalyst at equilibrium. This is preferably accomplished by reducing the chlorine injection rate at constant water concentration in the reactor inlet gas. The "smoothing" gas serves to push the peak of high catalyst chlorine content on through the bed. In its passage the peak supplies chlorine to the catalyst downstream which is deficient in chlorine, which results in a continual reduction of peak amplitude as it traverses the bed. Thus, if the correct amount of chlorine is added during the first step, the chlorine content on the catalyst at the crest of the peak at the moment the peak is due to pass out of the last bed outlet is substantially equal to the desired final chlorine content on the catalyst. In this manner, all of the catalyst is exposed to a chlorine content sufficient to give a high degree of platinum dispersal.

If less than the required amount of chlorine were added during the first step the chlorine content of the catalyst at the outlet of the last bed would not be as great as desired at the moment the peak passes that point. This would require continuation of the "smoothing step" for a longer period of time to bring the catalyst to the desired chlorine content and

would mean a proportion of the catalyst quantity would not be exposed to high chlorine concentration required for a high degree of platinum dispersal. If more than the required amount of chlorine were added during the first step, a substantial chlorine peak would pass out of the last reactor, which would cause unnecessary corrosion in the cold end of the plant, would require continuation of the "smoothing" step to reduce the catalyst to the required chlorine content, and would increase overall chlorine consumption.

Therefore the first step of the reactivation is preferably continued until the amount of chlorine deposited on the upstream portion of the catalyst bed or beds (in the peak) is 0.9 to 1.1 times the theoretical amount required to bring the total catalyst to the desired final chlorine content. This content is preferably in the range from 0.1 to 3% by weight. The first step of the reactivation is preferably continued during about 1 to 3 hours.

When the total quantity of chlorine or decomposable chlorine compound has been injected which is sufficient to substantially provide the desired chlorine content for the total catalyst quantity the second or "smoothing" step is preferably initiated by reducing the chlorine quantity to that which will give the water / chlorine ratio necessary to provide the desired equilibrium chloride content on the total catalyst, as was already indicated above. The change from the high to low chlorine quantity should preferably be made without stopping the gas flow. The steam quantity is preferably continued at the same level. In this second step also, it is preferred to hold a steam concentration of 2%m in the gaseous mixture at the inlet to the bed.

It is desirable to use a slightly lower steam/chlorine ratio in the second step than is required to give the exact final desired chlorine content of the catalyst, since some of the chlorine may be lost during subsequent stages of the procedure, such as a reduction and/or drying stage. Thus, if a final chlorine content of 0.35%w is desired, it is advantageous to use a water / chlorine ratio during the "smoothing" step which will provide a chlorine content of about 0.4—0.5%w to compensate for the chlorine which may subsequently be lost in a drying operation. Preferably the second step the molar ratio of steam to chlorine in the gaseous mixture (the "smoothing" step) of the reactivation is above about 150 to 1. To obtain a good platinum redispersal the second or "smoothing" step is preferably continued during about 12 to 20 hours.

Upon completion of the two - step reactivating operation, water and chlorine injection is discontinued. Completion of the operation can be determined by any suitable means, such as analyzing the exit gases and/or water condensed from these gases. For example, when analysis of the exit gas from the "smoothing" operation is substantially the same as that of the entering gas, the catalyst bed is substantially at equilibrium. The system is then preferably purged, while hot, with air and then, while still hot, preferably with nitrogen to remove oxygen. Inert gas containing a considerable amount of carbon oxide is not suitable for purge material at this stage. The plant is partially dried with these hot purges. Further drying may be effected after the introduction of hydrocarbon feed into the catalyst bed or beds.

After the possible purge with nitrogen, the catalyst is preferably subjected to a reducing treatment by passing hydrogen over it while still hot. If impure hydrogen is used, such as from a catalytic reforming unit, it is preferred to cool the catalyst bed to about 330°C. to 316°C., e.g., while circulating nitrogen during the purge step, to avoid hydrocracking relatively heavy hydrocarbon gases contained in the hydrogen gas from the catalytic reforming. Reduction of any oxidized platinum is easily effected and normally takes place while bringing the catalyst to conditions of temperature and pressure for the subsequent catalytic reforming operations. If desired, a decomposable sulphur compound can be injected into the hydrogen stream to sulphide the catalyst in order to reduce excessive hydrocracking when hydrocarbon feed is introduced to initiate a new process period.

The invention will now be illustrated in greater detail by the following Example.

EXAMPLE

A commercial reforming catalyst was deactivated after extensive use in reforming a hydrotreated naphtha. A total catalyst life was reached of about 69000 litres of feed per kg of catalyst. The catalyst had been regenerated several times during this period, catalyst life for the operating cycle since the last previous regeneration being about 2700 litres of feed per kg of catalyst. Operating conditions during the last cycle were as follows:

Liquid hourly space velocity	1.4—1.7 litres of feed per hour per litre of catalyst
Reactor outlet pressure	23 atm. gauge
H_2/oil mole ratio	14/1 to 20/1
Weighted average bed temperature	477—496°C.
Research octane number of the reformate, after addition of 3 ml tetraethyllead, per 3,785 l of reformate	101

Composition of the fresh catalyst was 0.75%w Pt, 0.30%w Cl and 0.40%w F on alumina.

The deactivated catalyst was regenerated and reactivated by the following procedure. After injection of the hydrocarbon feed was terminated, hydrogen circulation was maintained for two hours to remove residual hydrocarbons. Hydrogen was then removed from the system by a purge with flue gas. The catalyst temperature during the purges reduced to about 385°C., the circulation rate of the flue gas being about 700,000 nm³ per day. Sufficient air was injected into the flue gas to provide 0.5%v (%v means percent by volume) oxygen at the reactor inlet. Carbon was burned from the catalyst with the dilute air, temperature of the catalyst not exceeding about 454°C. Time required for this carbon burn-off at a low temperature was about six hours. The temperature was then increased to 510°C. and the oxygen concentration was increased from 0.5%v to 2.0%v to complete burn-off of the carbon. This carbon burning was at a high temperature completed in about 14 hours. Upon completion of the carbon burn at a high temperature, air injection rate was increased to purge CO_2 from the system. The CO_2 purge required approximately two hours.

After the oxygen concentration of the recycle gas had reached 15%v, trichloroethylene and steam were injected into the circulating gas upstream of the reactor in an amount to provide 0.05% m chlorine and 2% m water. The flue gas circulation rate had been increased to approximately 1,130,000 nm³ per day. This peak injection period was continued until the total amount of chlorine injected was equivalent to that required to bring the total catalyst quantity to about 0.5%w chlorine, based on the catalyst. This injection was completed in 1.5 hours, after which the chlorine injection rate was reduced by a factor of about 6 to provide a water - to - chlorine mole ratio of 250/1. This chlorine "smoothing" phase was completed in about 11.5 hours. The temperature and the pressure during the reactivation step were about 510°C. and 5 atm. gauge, respectively. A considerable quantity of water containing a corrosion inhibitor was injected into the inlet of the product condensers to reduce excessive corrosion in the cold end of the plant.

Upon completion of the reactivation operation injection of water and trichloroethylene were discontinued and the system was purged with air and then with nitrogen to remove CO_2 and oxygen. Hydrogen was then introduced into the system to purge the nitrogen and reduce the platinum prior to admitting hydrocarbon feed. The activity and selectivity of the regenerated and reactivated catalyst were substantially that of the fresh catalyst. It is to be realized that the time required for the regeneration - reactivation of the catalyst may vary somewhat depending upon, for example, the particular size of the unit involved, and the particular chlorine levels desired.

Although the method of the invention has been described primarily with respect to platinum catalysts used in the catalytic reforming of naphthas, the invention is not limited as to the conversion process in which the catalyst is used. The invention is applicable also to platinum catalysts which are widely known for such other conversion reactions as the isomerization of light hydrocarbons, e.g. pentanes and hexanes; hydrocracking of high boiling hydrocarbons, e.g. catalytically cracked gas oils; hydrotreating light distillates, e.g. furnace oils, for reduction of the pour point of the oil.

WHAT WE CLAIM IS:—

1. A method for the regeneration and reactivation of a deactivated supported platinum catalyst which is contained in at least one bed and on which carbonaceous deposits have been accumulated, in which at least a portion of the carbonaceous deposits is removed by burning, after which a gaseous mixture comprising oxygen, steam, chlorine and/or a decomposable chlorine compound is passed through the catalyst bed or beds at a temperature of at least 371°C. in a first step, the molar ratio of steam to chlorine in said gaseous mixture being such as to provide an equilibrium chlorine content of at least about 0.5% by weight

Liquid hourly space velocity	1.4—1.7 litres of feed per hour per litre of catalyst
Reactor outlet pressure	23 atm. gauge
H_2/oil mole ratio	14/1 to 20/1
Weighted average bed temperature	477—496°C.
Research octane number of the reformate, after addition of 3 ml tetraethyllead, per 3,785 l of reformate	101

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After the oxygen concentration of the recycle gas had reached 15%v, trichloroethylene and steam were injected into the circulating gas upstream of the reactor in an amount to provide 0.05% m chlorine and 2% m water. The flue gas circulation rate had been increased to approximately 1,130,000 nm^3 per day. This peak injection period was continued until the total amount of chlorine injected was equivalent to that required to bring the total catalyst quantity to about 0.5%w chlorine, based on the catalyst. This injection was completed in 1.5 hours, after which the chlorine injection rate was reduced by a factor of about 6 to provide a water - to - chlorine mole ratio of 250/1. This chlorine "smoothing" phase was completed in about 11.5 hours. The temperature and the pressure during the reactivation step were about 510°C. and 5 atm. gauge, respectively. A considerable quantity of water containing a corrosion inhibitor was injected into the inlet of the product condensers to reduce excessive corrosion in the cold end of the plant.

Upon completion of the reactivation operation injection of water and trichloroethylene were discontinued and the system was purged with air and then with nitrogen to remove CO_2 and oxygen. Hydrogen was then introduced into the system to purge the nitrogen and reduce the platinum prior to admitting hydrocarbon feed. The activity and selectivity of the regenerated and reactivated catalyst were substantially that of the fresh catalyst. It is to be realized that the time required for the regeneration - reactivation of the catalyst may vary somewhat depending upon, for example, the particular size of the unit involved, and the particular chlorine levels desired.

Although the method of the invention has been described primarily with respect to platinum catalysts used in the catalytic reforming of naphthas, the invention is not limited as to the conversion process in which the catalyst is used. The invention is applicable also to platinum catalysts which are widely known for such other conversion reactions as the isomerization of light hydrocarbons, e.g. pentanes and hexanes; hydrocracking of high boiling hydrocarbons, e.g. catalytically cracked gas oils; hydrotreating light distillates, e.g. furnace oils, for reduction of the pour point of the oil.

WHAT WE CLAIM IS:—

1. A method for the regeneration and reactivation of a deactivated supported platinum catalyst which is contained in at least one bed and on which carbonaceous deposits have been accumulated, in which at least a portion of the carbonaceous deposits is removed by burning, after which a gaseous mixture comprising oxygen, steam, chlorine and/or a decomposable chlorine compound is passed through the catalyst bed or beds at a temperature of at least 371°C. in a first step, the molar ratio of steam to chlorine in said gaseous mixture being such as to provide an equilibrium chlorine content of at least about 0.5% by weight

on an upstream portion of the catalyst bed or beds based on this catalyst portion, said first step being continued until the amount of chlorine deposited on the upstream portion of the catalyst is substantially equivalent to the theoretical amount required to bring the total catalyst to the desired level, whereafter in a second step the steam to chlorine ratio in the gaseous mixture is increased to a value substantially not higher than that which gives the desired final equilibrium chlorine content on the catalyst, this second step being continued until the total catalyst is substantially at equilibrium.

2. A method as claimed in claim 1, in which the carbonaceous deposits are removed at a temperature below about 566°C.

3. A method as claimed in claim 2, in which the carbonaceous deposits are removed at a temperature below about 454°C.

4. A method as claimed in any one of the preceding claims, in which the gaseous mixture is passed through the catalyst bed or beds at a temperature up to 566°C.

5. A method as claimed in claim 4 in which the gaseous mixture is passed through the catalyst bed or beds at a temperature in the range 482°C. to 510°C.

6. A method as claimed in any one of the preceding claims, in which the gaseous mixture is passed through the catalyst bed or beds at a pressure in the range of from 5 to 7 atm. gauge.

7. A method as claimed in any one of the preceding claims, in which the gaseous mixture comprises trichloroethylene.

8. A method as claimed in any one of the preceding claims, in which during the first step the molar ratio of steam to chlorine in the gaseous mixture is such as to provide an equilibrium chlorine content of at least about 0.6% by weight on the upstream portion of the catalyst bed or beds.

9. A method as claimed in claim 5 in which during the first step the molar ratio of steam to chlorine of the gaseous mixture is less than about 150 to 1.

10. A method as claimed in any one of the preceding claims, in which during the first step the chlorine content of the gaseous mixture is not higher than 0.05%m.

11. A method as claimed in any one of the preceding claims, in which during the first step the steam content of the gaseous mixture is about 2.0%m.

12. A method as claimed in claim 1, in which the first step is continued until the amount of chlorine deposited on the upstream portion of the catalyst bed or beds is 0.9 to 1.1 times the theoretical amount required to bring the total catalyst to the final desired chlorine content.

13. A method as claimed in any one preceding claims, in which the desired chlorine content of the catalyst is in the range of from 0.1 to 3% by weight.

14. A method as claimed in any one of the preceding claims, in which the first step is continued during about 1 to 3 hours.

15. A method as claimed in any one of the preceding claims, in which during the second step the steam content of the gaseous mixture used is about 2.0%m.

16. A method as claimed in any one of the preceding claims, in which during the second step the molar ratio of steam to chlorine in the gaseous mixture is slightly lower than is required to give the desired final chlorine content of the catalyst.

17. A method as claimed in any one of the preceding claims, in which during the second step the molar ratio of steam to chlorine in the gaseous mixture is above about 150 to 1.

18. A method as claimed in any one of the preceding claims, in which the second step is continued during about 12 to 20 hours.

19. A method as claimed in any one of the preceding claims, in which the system containing the catalyst having substantially the desired final chlorine content is purged, while hot, with air and then, while still hot with nitrogen.

20. A method as claimed in any one of the preceding claims, in which after the purge with nitrogen hydrogen is passed over the catalyst.

21. A method for regenerating and reactivating a catalyst, substantially as described herein.

22. Supported platinum catalysts whenever regenerated and reactivated with the method according to any one of the preceding claims.

23. A process for the conversion of hydrocarbons or hydrocarbon mixtures in which a supported platinum catalyst which is regenerated and reactivated according to any one of claims 1—19, is used therein.

24. Hydrocarbons, or hydrocarbon mixtures, whenever obtained by the process according to claim 21, or mixtures comprising them.

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* C L M S *

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