Aug. 18, 1953 J. F. SKELLY 2,649,463

PREPARATION OF OLEFIN OXIDES

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FIG. 1

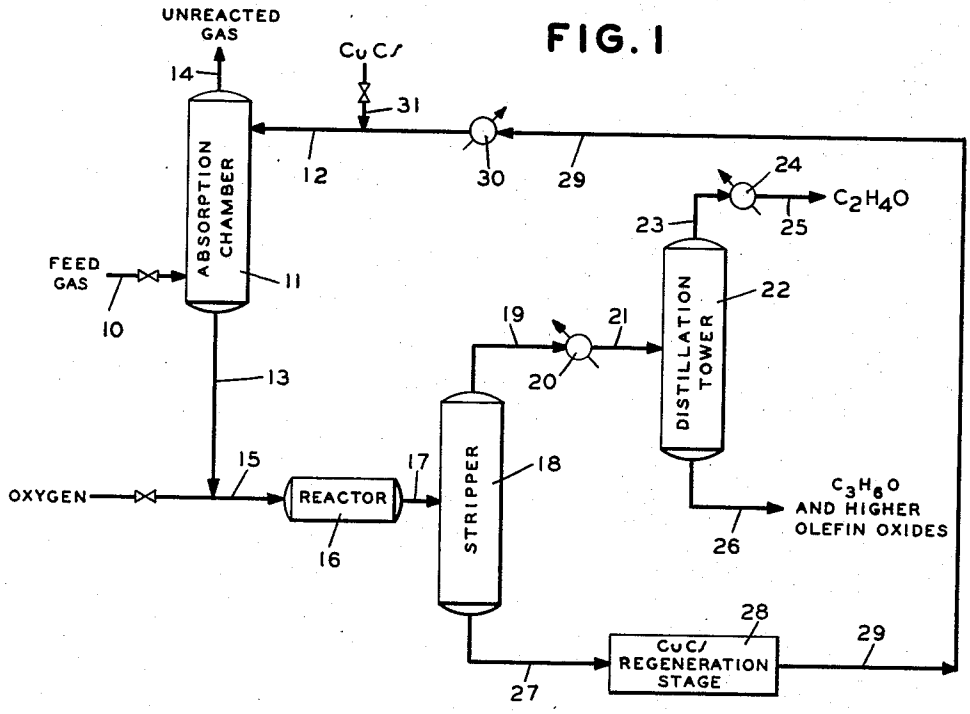
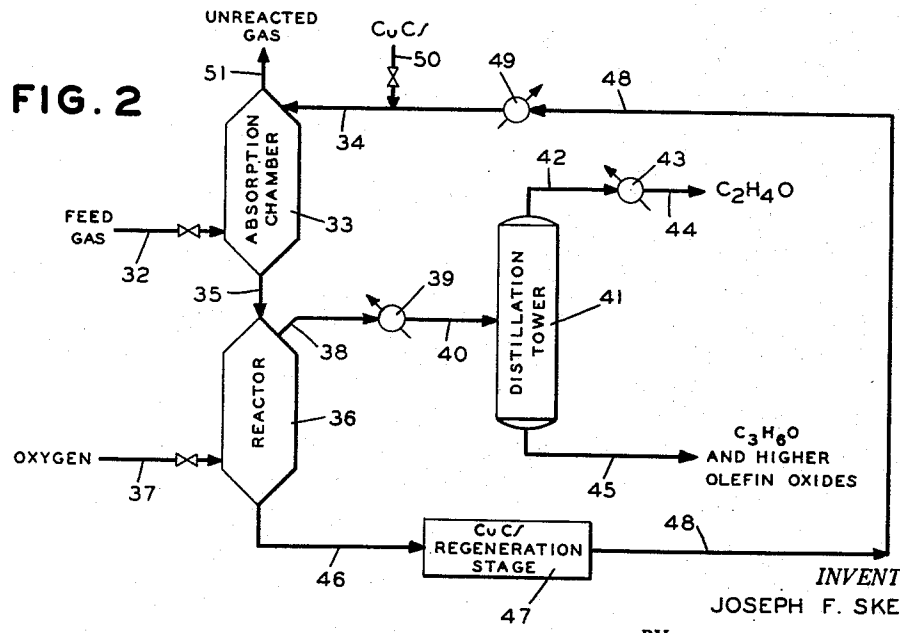


FIG. 2



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PREPARATION OF OLEFIN OXIDES

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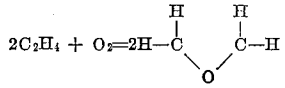
Application September 30, 1949, Serial No. 118,844

20 Claims. (Cl. 260—348.5)

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This invention relates to oxidation processes and relates more particularly to oxidation of olefinic materials. Still more particularly, the invention relates to the oxidation of olefinic gases for the production of olefin oxides. By the term "olefinic gases" is meant gases containing olefins alone, or both olefins and non-olefins such as are obtained in gases produced by the thermal or catalytic cracking of petroleum hydrocarbons.

It is known that in processes for the direct oxidation of olefins to olefin oxides, there are two types of reactions that occur. Thus, with ethylene as illustrative of olefins in general, these reactions may be expressed as follows:

(1) 

(2) $C_2H_4 + 3O_2 = 2CO_2 + 2H_2O$

The foregoing reactions are both exothermic, with the heat evolved in the second reaction being considerably greater than that evolved in the first reaction. There has, therefore, been found to be a tendency in the oxidation of olefins for the reaction to proceed too far so that the final products of combustion, which are carbon dioxide and water, are obtained. In order to counteract this tendency towards over-oxidation, it is therefore highly desirable to carry out the oxidation reaction in such manner that substantially complete conversion of olefin to its corresponding oxide can take place, without any appreciable conversion to carbon dioxide and water taking place as a result of over-oxidation. It has been found, however, that the presence of other hydrocarbons in the olefinic feed results in their oxidation so that they tend to contaminate or react with the desired olefin oxide end-products. Difficulty is therefore encountered in the aforementioned present olefin oxidation processes, when it is desired to effect the conversion of low-olefin containing gases to their corresponding olefin oxides.

It is, therefore, an object of the present invention to provide for an improved process for the production of olefin oxides.

Another object of the invention is to provide for an improved process for the production of olefin oxides from olefinic gases, in which the production of these oxides is unaffected by the concentration of olefins present in these gases.

Still another object of the invention is to provide for an improved process for the production of oxides of ethylene and higher olefins as obtained in gases produced by the thermal or catalytic cracking of petroleum hydrocarbons, in which the production of these oxides is unaffected by the concentration of olefins present in these gases.

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Other objects and advantages inherent in the invention will be apparent to one skilled in the art from the following more detailed disclosure.

In accordance with the broad method of the present invention, an olefinic gas (comprising a gaseous olefin in combination with other non-olefinic gases, such as methane, ethane, propane, hydrogen, nitrogen, or water vapor) is first contacted in an absorption zone at a suitable temperature with a metallic salt which is capable of forming coordination compounds with olefins present. By an "olefin coordination compound" is meant a metal-olefin compound, characterized by the linkage of the double bond to the metal in which the unsaturated molecule occupies only one coordination position in the complex and having the following general composition:

$$C_nH_{2n}X$$

in which X is a metallic salt, as more fully hereinafter described. The resulting olefin coordination compound, which is first separated from any unreacted gases that may be present, is next contacted with gaseous oxygen, either in the pure state or in admixture with inert gases such as nitrogen, or an oxygen-containing gas, such as air, or an oxygen-containing compound, such as hydrogen peroxide, which is capable of liberating oxygen under the operating conditions, as more fully hereinafter described, in order to convert the aforementioned olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of the metallic salt. The olefin oxide thus produced is next separated from the formed oxygen-containing metallic salt as a product of the process, while the salt residue is subjected to suitable treatment, for example, by contact with mineral acids such as hydrochloric acid or sulfuric acid to regenerate the pure metallic salt for reuse in the treatment of further quantities of the olefinic gases.

In carrying out the conversion of olefinic gases to their corresponding pure olefin oxides in accordance with the aforementioned broad method of the invention, the olefin coordination compound formed by contact with the metallic salt is found to be more stable than the pure gaseous olefin itself, by reason of the dissociation pressure of the coordination compound being appreciably lower than the vapor pressure of the pure gaseous olefin. Thus, where an oxygen molecule is brought into contact with a molecule of the coordination compound, only one oxygen atom attaches to the olefin molecule while the other oxygen atom is taken up by the metal in the aforementioned coordination compound. Hence, there is obtained no break-down or loss of the formed olefin oxide into the final products of oxidation, namely, carbon dioxide and water,

as is otherwise obtained by the direct oxidation of olefins. Therefore, in operating by the process of the present invention, greater yields of olefin oxides are obtainable, inasmuch as the process permits the withdrawal of unreacted non-olefinic gases from the absorption zone prior to the subsequent oxidation treatment.

In carrying out the process of the present invention, the gaseous olefin is contacted with the metallic salt, either as a solid or as a solution thereof, in an absorption chamber at a temperature within the range between about 30° F. and about 150° F. and at a pressure between about 50 and about 400 pounds per square inch absolute for a residence time of between about 10 and about 200 seconds, the latter varying with the severity of operating conditions of temperature and pressure, in order to absorb the olefin and form the corresponding olefin coordination compound. The metallic salt thus employed is one which is capable of forming the aforementioned coordination compound. Preferably, such metallic salts may be employed for this purpose as cuprous halides, for example, solid cuprous chloride, solutions of cuprous chloride in hydrochloric acid, ammoniacal cuprous halide solutions, and solutions of cuprous halides in ethanolamine, the latter being especially suitable for the absorption of relatively low boiling olefins such as ethylene, propylene or isobutylene; while solid cuprous bromide is preferred where gaseous ethylene is the only olefin present. Platinum halides may also be employed as the metallic salt, such as platinic chloride, compounds of potassium chloride and platinic halides, solutions of platinic halides in hydrochloric acid, and ammoniacal platinic halide solutions. There may also be successfully employed as the metallic salt, such compounds as palladium chloride, iridium choride, aluminum chloride and aluminum trichloride, zinc chloride, silver chloride and silver nitrate, mercuric and mercurous halides, antimony trichloride, and various other compounds of the above, such as acetates, phenols, anilines, benzenes and thiophenes of the aforementioned metals. In general, approximately one molecule of olefin is absorbed per molecule of metallic salt to form the corresponding coordination compound.

Following the formation of the olefin coordination compound in the absorption chamber, this compound is withdrawn either as a solid or as a solution thereof, or as a slurry of solution and undissolved solid (depending upon the condition of the aforementioned metallic salt previously introduced into the absorption chamber) by suitable means, such as pumping action or gravitational flow. The olefin coordination compound thus withdrawn from the absorption chamber is next passed to a suitable reaction vessel in which it is contacted with oxygen or the oxygen-containing compound, as a source of oxygen, for effecting the conversion of the coordination compound to its corresponding pure olefin oxide, with or without the presence of a suitable oxidation catalyst such as silver, silver activated by introducing therein small proportions of copper or iron, bismuth, antimony, mixtures of silver, bismuth and antimony, or mixtures of silver and bismuth. The aforementioned oxidation is preferably carried out at a temperature within the range between about 400° F. and about 1000° F. and at a pressure between about 500 and about 3000 pounds per square inch absolute. The residence time employed necessarily will vary with the severity of the reaction conditions. For conditions of temperature and pressure in the above-mentioned ranges, it is found that a residence time of between about 10 seconds and about 2 minutes are ordinarily sufficient.

In conducting the absorption of the gaseous olefin with the metallic salt under the aforementioned preferred conditions of temperature, pressure and residence time within the absorption zone, it will be found that the selection of proper operating conditions is not critical. In this respect, it should be noted, however, that if the temperature in the absorption chamber is raised substantially above the upper limit of about 150° F., varying quantities of olefinic gas tend to escape; while, on the other hand, if the temperature is lowered substantially below the lower limit of about 30° F., the absortpion of olefinic gas tends to proceed too slowly. Similarly, where the pressure within the absorption chamber is raised substantially above the upper limit of about 400 pounds per square inch absolute, non-olefinic gases in addition to the olefinic gas tend to be absorbed while a substantial reduction in pressure below the lower limit of about 50 pounds per square inch absolute tends to effect a decrease in the quantity of olefinic gases absorbed.

In conducting the oxidation of the formed olefin coordination compound, withdrawn from the absorption zone, under the aforementioned preferred conditions of temperature, pressure and residence time within the reaction zone, the selection of proper operating conditions is not critical, provided however that the temperature and pressure at the reaction conditions are not substantially raised or lowered so that the formed olefin oxides no longer exist as a vapor and thereby tend to be taken along with the formed oxygen-containing salt, thus complicating subsequent regeneration of the salt to its original condition; or on the other hand, tend to cause all of the liquid present to vaporize before the reaction is complete. It will also be noted that the residence time within the reaction zone, within the aforementioned range, is not critical except that if the residence time is substantially increased, not only are olefins oxidized but any unreacted gases present may be oxidized to carbon dioxide and water; while if the residence time is too short, the reaction is of course not completed, with varying quantities of olefinic material remaining in an unoxidized state.

The resulting olefin oxide from the aforementioned procedure is obtained in the vapor state, while the remaining metallic salt is obtained as an oxygen-containing compound in a solid or liquid state. The metallic salt now contains one oxygen atom per molecule, with the other oxygen atom from each oxygen molecule consumed, being utilized in the conversion of an olefin molecule to its oxide. The thus formed gaseous olefin oxide and oxygen-containing metallic salt, either as a solid or as a solution thereof or slurry, is next withdrawn from the aforementioned oxidation zone and transferred to a suitable stripping vessel from which the volatile gaseous olefin oxide is withdrawn and condensed as a final product of the process; or if so desired, where the final product comprises various olefin oxides, separation of individual substantially pure olefin oxides may be effected by distillation.

The oxygen-containing metallic salt, separated from the volatile olefin oxide, may next be contacted with a suitable reagent such as hydrochloride acid to effect removal of the oxygen

atom added to the salt in the oxidation step, to regenerate the salt to its original condition. The salt thus regenerated is preferably cooled and returned to the initial absorption or reaction chamber for reuse. When the metallic salt is employed in a solid state, the absorption of the gaseous olefin may be carried out in a reactor employing suitable fluidized-powder systems or systems of the moving-bed type, the operation of these systems being known to those skilled in the art.

The invention will be discussed further by reference to the accompanying drawing which comprises views in elevation of suitable apparatus for carrying out the process of the invention. Figure 1 of the drawing is an elevational view diagrammatically illustrating absorption and reaction zones and suitable auxiliary equipment for carrying out an embodiment of the invention, in which the metallic salt is employed as a solution thereof; while Figure 2 is a modification of the apparatus of Figure 1, suitable for carrying out an embodiment of the invention in which the metallic salt is employed in the solid state.

In Figure 1 of the drawing, an olefinic gas, such as is obtained by the thermal cracking of petroleum hydrocarbons, comprising ethylene and higher olefins such as propylene and butylene, and containing the aforementioned non-olefinic gases such as methane and higher hydrocarbons, hydrogen, nitrogen or water vapor, is introduced at a low point through valved-line 10 to a suitable absorption zone, represented by absorption chamber 11. In chamber 11 the olefinic gas is absorbed by contact with a solution of the aforementioned metallic salt (or a slurry of solution and undissolved solid), such as cuprous chloride. The salt solution thus employed is introduced at an upper point in chamber 11 through line 12. In chamber 11 the olefinic gas is contacted with the metallic salt solution at a temperature within the aforementioned range of between about 30° F. and about 150° F., with a range between about 50° F. and about 100° F. being preferred, and at a pressure within the aforementioned range of between about 50 and about 400 pounds per square inch absolute, with a range between about 100 and about 200 pounds per square inch absolute being preferred. The resulting olefin coordination compounds thus formed in chamber 11 are withdrawn through line 13 as a liquid, while the remaining unreacted gases are withdrawn through line 14 for further use or treatment outside the scope of the present process.

The olefin coordination compounds withdrawn through line 13 are next transferred via valved-line 15, with which line 13 connects, by suitable means, for example by pumping action or gravitational flow, to a suitable reaction vessel represented by reactor 16. In reactor 16 the olefin coordination compounds, which in the embodiment illustrated in the drawing have the general composition $C_nH_{2n}CuCl$, are next contacted with oxygen which is introduced into reactor 16 via line 15. In reactor 16, the aforementioned olefin coordination compounds are oxidized with or without the presence of one of the aforementioned suitable oxidation catalysts, such as silver, at a temperature within the aforementioned range of between about 400° F. and about 1000° F., with a range between about 500° F. and about 700° F. being preferred, and at a pressure within the aforementioned range of between about 500 and about 3000 pounds per square inch absolute, with a range between about 1000 and about 2000 pounds per square inch absolute being preferred, for a residence time preferably between about 10 seconds and not more than about 2 minutes. Reactor 16 is preferably cooled, with suitable heat exchange means not shown in the drawing, in order to absorb any heat that may be liberated during the reaction.

The resulting oxidation compounds in reactor 16, comprising oxides of ethylene and higher olefins and an oxygen-containing compound of the metallic salt, which comprises the metallic salt molecule with an additional oxygen atom and which in the present embodiment has the composition CuOCl, are next withdrawn through line 17 and transferred to a suitable stripping vessel 18. Stripper 18 is operated under suitable conditions of temperature and pressure effective to take overhead relatively pure gaseous ethylene and higher olefin oxides which are withdrawn through line 19, cooled in a cooler 20 and transferred from cooler 20 through line 21 to a suitable distillation apparatus represented by distillation tower 22. Tower 22 is operated under suitable conditions of temperature and pressure in order to effect separation of individual olefin oxide components. Hence, ethylene oxide may be withdrawn through line 23 and passed to a condenser 24, from which substantially pure liquid ethylene oxide may be withdrawn as a product of the process through line 25. Propylene and higher olefin oxides may be withdrawn as bottoms from tower 22 through line 26 for further use or treatment if so desired.

The residue from stripper 18, comprising the aforementioned oxygen-containing metallic salt, namely CuOCl, is withdrawn through line 27 and contacted with a suitable reagent such as hydrochloric acid, utilizing suitable mixing and separation apparatus represented by regeneration stage 28, to effect the aforementioned removal of the oxygen atom contained in the salt and thus obtain the metallic salt, namely CuCl, in a substantially oxygen-free condition. The salt, thus regenerated, is next transferred from this regeneration stage via line 29 and preferably cooled in a cooler 30. From cooler 30 the metallic salt is returned via line 12 to the absorption chamber 11 for reuse. Make-up metallic salt is introduced into chamber 11 through valved line 31 via line 12, with which line 31 connects.

In the modification represented by Figure 2 of the drawing, the olefinic gas is introduced through valved-line 32 at a low point in an absorption chamber 33, in which the olefinic gas is absorbed by contact with the metallic salt (namely, cuprous chloride in the solid state, in the embodiment illustrated in the drawing), the latter being introduced at an upper point in chamber 33 through line 34. In chamber 33 the olefinic gas is contacted with the solid metallic salt under substantially similar operating conditions of temperature, pressure and residence time as employed in absorption chamber 11 in Figure 1 of the drawing, in the description hereinbefore given. The resulting olefin coordination compounds thus formed in chamber 33 are next transferred by pressured hoppers, or other suitable means for conveying the solid material, through line 35 which opens into a reaction chamber 36. In reactor 36 the resulting olefin coordination compounds thus introduced through line 35 are contacted with oxygen which is introduced at a low point in reactor 36 via valved-line

37. Substantially similar operating conditions of temperature, pressure and residence time are maintained in reactor 36 as employed in reactor 16 in Figure 1 of the drawing, in the description hereinbefore given.

The resulting oxidation compounds in reactor 36 comprise oxides of ethylene and higher olefins in the vapor state and an oxygen-containing compound of the metallic salt in the solid state (which comprises the metallic salt molecule with an additional oxygen atom having the composition CuOCl, in the present embodiment of the process of the invention). The effluent vapors of ethylene oxide and higher olefin oxides are taken off from reactor 36 through line 38 and transferred to a cooler 39. From cooler 39 the condensed liquid olefine oxides are withdrawn through line 40 and transferred through this line to a suitable distillation vessel, represented by distillation tower 41. Tower 41 is operating under suitable conditions of temperature and pressure in order to effect separation of individual olefin oxide components. Hence, ethylene oxide may be withdrawn through line 42 as a vapor and passed to a condenser 43, from which substantially pure liquid ethylene oxide may be withdrawn as a product of the process through line 44. Propylene and higher olefin oxides may be withdrawn as bottoms from tower 41 through line 45 for further use or treatment if so desired.

The residue from reactor 36, comprising the aforementioned oxygen-containing metallic salt (CuOCl), is withdrawn through line 46 and contacted with a suitable reagent such as hydrochloric acid utilizing suitable mixing and separation apparatus represented by regeneration stage 47, to effect the aforementioned removal of the oxygen atom contained in the salt and thus obtain the metallic salt, namely CuCl, in a substantially oxygen-free condition. The salt thus regenerated is next transferred from this regeneration stage via line 48 and preferably cooled in a cooler 49. From cooler 49 the metallic salt is returned via line 34 to absorption chamber 33 for reuse, employing suitable apparatus, such as a screw-conveyor, for this purpose. Make-up metallic salt is introduced into chamber 33 through valved-line 50 via line 34, with which line 50 connects. Unreacted gases from chamber 33 are withdrawn through line 51.

It will be noted that where the olefin coordination compounds are contacted with air instead of oxygen in reactor 16, in the embodiment illustrated in Figure 1 of the drawing, it is preferred to remove inert gases present in the resulting solution in line 17 prior to separation of the formed olefin oxides therefrom. For this purpose, this solution in line 17 may be first contacted with water under suitable pressure in an absorption chamber (not shown in the drawing) to dissolve the olefin oxides and thus separate them from the inert gases, the latter being drawn off from this additional absorption chamber. The remaining dissolved olefin oxides are next transferred to stripper 18 for further separation as previously described. Similarly, where air is the oxidizing medium instead of oxygen in reactor 36, in the modification illustrated in Figure 2 of the drawing, the effluent in line 38 from reactor 36 is also preferably first contacted with water under suitable pressure in an absorption chamber (not shown in the drawing) to effect separation of inert gases, and the resulting solution is next transferred to a stripper (also not shown in the drawing) to separate the dissolved olefin oxides from the water. The olefin oxides thus separated are next transferred to distillation tower 41, for further separation as previously described.

The following examples will serve to illustrate but are not intended in any way to limit the process of the present invention.

EXAMPLE I

Employing the apparatus illustrated by the embodiment in Figure 1 of the drawing, an olefinic feed gas was introduced into the absorption chamber at a flow rate of 10,000 standard cubic feet per hour. This gas had the following composition by volume:

	Percent
H_2	20.2
N_2	14.0
CO_2	6.5
CH_4	29.8
C_2H_4	7.5
C_2H_6	13.5
C_3H_6	4.0
C_3H_8	3.9
C_4H_{10}	0.6
	100.0

The olefinic gas was contacted in the absorption chamber with a cuprous chloride solution having the following composition by weight:

	Percent
Cuprous chloride	15
Hydrogen chloride	17
Water	68
	100

Operating conditions in the absorption chamber were maintained at a temperature of about 85° F. and at a pressure of about 175 pounds per square inch absolute. The cuprous chloride solution was introduced into the absorption chamber at a flow rate at about 4000 pounds per hour. The resulting solution from the absorption chamber was next contacted with pure oxygen in the reaction chamber in the presence of a silver catalyst, with oxygen being introduced at the rate of about 95 pounds per hour. Operating conditions in the reactor were maintained at a temperature of about 550° F., a pressure of about 1250 pounds per square inch absolute and a reaction time of about 50 seconds. The resulting yield from the foregoing operations was found to comprise ethylene oxide at a flow rate of about 78 pounds per hour and propylene oxide at a flow rate of about 58 pounds per hour.

EXAMPLE II

Employing the apparatus illustrated by the modification in Figure 2 of the drawing, an olefinic feed gas was introduced into the absorption chamber at a flow rate of 100,000 standard cubic feet per hour. This gas had the following composition by volume:

	Percent
H_2	38.7
CH_4	51.2
C_2H_4	4.3
C_3H_6	2.1
C_3H_8	3.5
C_4H_{10}	0.2
	100.0

The olefinic gas was contacted in the absorption chamber with solid cuprous chloride in pel-

8. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with cuprous bromide to form a coordination compound with said olefin at a temperature between about 30° F. and about 150° F. and at a pressure between about 50 and about 400 pounds per square inch absolute, separating said olefin coordination compound from said gas, contacting said olefin coordination compound with an oxygen-containing gas in a second reaction zone at a temperature between about 400° F. and about 1000° F. and at a pressure between about 500 and about 3000 pounds per square inch absolute in the presence of an oxidation catalyst for a residence time between about 10 seconds and about 2 minutes to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of cuprous bromide, and separating the olefin oxide thus produced from said oxygen-containing compound of cuprous bromide.

9. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with a platinum halide to form a coordination compound with said olefin at a temperature between about 30° F. and about 150° F. and at a pressure between about 50 and about 400 pounds per square inch absolute, separating said olefin coordination compound from said gas, contacting said olefin coordination compound with an oxygen-containing gas in a second reaction zone at a temperature between about 400° F. and about 1000° F. and at a pressure between about 500 and about 3000 pounds per square inch absolute in the presence of an oxidation catalyst for a residence time between about 10 seconds and about 2 minutes to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of the platinum halide, and separating the olefin oxide thus produced from said oxygen-containing compound of the platinum halide.

10. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with a reagent comprising a metal halide selected from the group consisting of copper, platinum, palladium, iridium, aluminum, zinc, silver, mercury and antimony to form a coordination compound with said olefin at a temperature between about 30° F. and about 150° F. and at a pressure between about 50 and about 400 pounds per square inch absolute, separating said olefin coordination compound from said gas, contacting said olefin coordination compound with an oxygen-containing gas in a second reaction zone at a temperature between about 400° F. and about 1000° F. and at a pressure between about 500 and about 3000 pounds per square inch absolute in the presence of an oxidation catalyst comprising silver for a residence time between about 10 seconds and about 2 minutes to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of the metal halide, and separating the olefin oxide thus produced from said oxygen-containing compound of the metal halide.

11. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with a reagent comprising a metal halide selected from the group consisting of copper, platinum, palladium, iridium, aluminum, zinc, silver, mercury and antimony to form a coordination compound with said olefin at a temperature between about 50° F. and about 100° F. and at a pressure between about 50 and about 400 pounds per square inch absolute, separating said olefin coordination compound from said gas, contacting said olefin coordination compound with an oxygen-containing gas in a second reaction zone at a temperature between about 400° F. and about 1000° F. and at a pressure between about 500 and about 3000 pounds per square inch absolute in the presence of an oxidation catalyst for a residence time between about 10 seconds and about 2 minutes to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of the metal halide, and separating the olefin oxide thus produced from said oxygen-containing compound of the metal halide.

12. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with a reagent comprising a metal halide selected from the group consisting of copper, platinum, palladium, iridium, aluminum, zinc, silver, mercury and antimony to form a coordination compound with said olefin at a temperature between about 30° F. and about 150° F. and at a pressure between about 50 and about 400 pounds per square inch absolute, separating said olefin coordination compound from said gas, contacting said olefin coordination compound with an oxygen-containing gas in a second reaction zone at a temperature between about 500° F. and about 700° F. and at a pressure between about 500 and about 3000 pounds per square inch absolute in the presence of an oxidation catalyst for a residence time between about 10 seconds and about 2 minutes to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of the metal halide, and separating the olefin oxide thus produced from said oxygen-containing compound of the metal halide.

13. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with a reagent comprising a metal halide selected from the group consisting of copper, platinum, palladium, iridium, aluminum, zinc, silver, mercury and antimony to form a coordination compound with said olefin at a temperature between about 50° F. and about 100° F. and at a pressure between about 50 and about 400 pounds per square inch absolute, separating said olefin coordination compound from said gas, contacting said olefin coordination compound with an oxygen-containing gas in a second reaction zone at a temperature between about 500° F. and about 700° F. and at a pressure between about 500 and about 3000 pounds per square inch absolute in the presence of an oxidation catalyst for a residence time between about 10 seconds and about 2 minutes to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of the metal halide, and separating the olefin oxide thus produced from said oxygen-containing compound of the metal halide.

14 A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with a reagent comprising a metal halide selected from the group consisting of copper, platinum, palladium, iridium, aluminum, zinc, silver, mercury and anti-

letted form, at a flow rate of 7170 pounds per hour. Operating conditions in the absorption chamber were maintained at a temperature of 60° F. and a pressure of about 160 pounds per square inch absolute. The resulting material from the absorption chamber was next contacted with pure oxygen in the reactor chamber, with oxygen being introduced at the rate of about 900 pounds per hour. Operating conditions in the reactor were maintained at a temperature of about 600° F., a pressure of about 1000 pounds per square inch absolute and a reaction time of about 20 seconds. The resulting yield from the foregoing operations was found to comprise ethylene oxide at a rate of 425 pounds per hour and propylene oxide at a rate of 273 pounds per hour.

I claim:

1. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with a reagent comprising a metal halide selected from the group consisting of copper, platinum, palladium, iridium, aluminum, zinc, silver, mercury and antimony at a temperature between about 30° F. and about 150° F. to form an olefin coordination compound, separating said olefin coordination compound from said gas, oxidizing said olefin coordination compound in a second reaction zone at a temperature between about 400° F. and about 1000° F. to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of the metal halide, and separating the olefin oxide thus produced from said oxygen-containing compound of the metal halide.

2. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with a cuprous halide at a temperature between about 30° F. and about 150° F. to form an olefin coordination compound, separating said olefin coordination compound from said gas, oxidizing said olefin coordination compound in a second reaction zone at a temperature between about 400° F. and about 1000° F. to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of the cuprous halide, and separating the olefin oxide thus produced from said oxygen-containing compound of the cuprous halide.

3. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with cuprous chloride at a temperature between about 30° F. and about 150° F. to form an olefin coordination compound, separating said olefin coordination compound from said gas, oxidizing said olefin coordination compound in a second reaction zone at a temperature between about 400° F. and about 1000° F. to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of cuprous chloride, and separating the olefin oxide thus produced from said oxygen-containing compound of cuprous chloride.

4. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with cuprous bromide at a temperature between about 30° F. and about 150° F. to form an olefin coordination compound, separating said olefin coordination compound from said gas, oxidizing said olefin coordination compound in a second reaction zone at a temperature between about 400° F. and about 1000° F. to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of cuprous bromide, and separating the olefin oxide thus produced from said oxygen-containing compound of cuprous bromide.

5. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with a reagent comprising a metal halide selected from the group consisting of copper, platinum, palladium, iridium, aluminum, zinc, silver, mercury and antimony to form a coordination compound with said olefin at a temperature between about 30° F. and about 150° F. and at a pressure between about 50 and about 400 pounds per square inch absolute, separating said olefin coordination compound from said gas, contacting said olefin coordination compound with an oxygen-containing gas in a second reaction zone at a temperature between about 400° F. and about 1000° F. and at a pressure between about 500 and about 3000 pounds per square inch absolute in the presence of an oxidation catalyst for a residence time between about 10 seconds and about 2 minutes to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of the metal halide, and separating the olefin oxide thus produced from said oxygen-containing compound of the metal halide.

6. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with a cuprous halide to form a coordination compound with said olefin at a temperature between about 30° F. and about 150° F. and at a pressure between about 50 and about 400 pounds per square inch absolute, separating said olefin coordination compound from said gas, contacting said olefin coordination compound with an oxygen-containing gas in a second reaction zone at a temperature between about 400° F. and about 1000° F. and at a pressure between about 500 and about 3000 pounds per square inch absolute in the presence of an oxidation catalyst for a residence time between about 10 seconds and about 2 mintues to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of the cuprous halide, and separating the olefin oxide thus produced from said oxygen-containing compound of the cuprous halide.

7. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with cuprous chloride to form a coordination compound with said olefin at a temperature between about 30° F. and about 150° F. and at a pressure between about 50 and about 400 pounds per square inch absolute, separating said olefin coordination compound from said gas, contacting said olefin coordination compound with an oxygen-containing gas in a second reaction zone at a temperature between about 400° F. and about 1000° F. and at a pressure between about 500 and about 3000 pounds per square inch absolute in the presence of an oxidation catalyst for a residence time between about 10 seconds and about 2 minutes to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of cuprous chloride, and separating the olefin oxide thus produced from said oxygen-containing compound of cuprous chloride.

mony to form a coordination compound with said olefin at a temperature between about 50° F. and about 100° F. and at a pressure between about 100 and about 200 pounds per square inch absolute, separating said olefin coordination compound from said gas, contacting said olefin coordination compound with an oxygen-containing gas in a second reaction zone at a temperature between about 500 and about 700° F. and at a pressure between about 1000 and about 2000 pounds per square inch absolute in the presence of an oxidation catalyst for a residence time between about 10 seconds and about 2 minutes to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of the metal halide, and separating the olefin oxide thus produced from said oxygen-containing compound of the metal halide.

15. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with a cuprous halide to form a coordination compound with said olefin at a temperature between about 50° F. and about 100° F. and at a pressure between about 100 and about 200 pounds per square inch absolute, separating said olefin coordination compound from said gas, contacting said olefin coordination compound with an oxygen-containing gas in a second reaction zone at a temperature between about 500 and about 700° F. and at a pressure between about 1000 and about 2000 pounds per square inch absolute in the presence of an oxidation catalyst for a residence time between about 10 seconds and about 2 minutes to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of the cuprous halide, and separating the olefin oxide thus produced from said oxygen-containing compound of the cuprous halide.

16. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with cuprous chloride to form a coordination compound with said olefin at a temperature between about 50° F. and about 100° F. and at a pressure between about 100 and about 200 pounds per square inch absolute, separating said olefin coordination compound from said gas, contacting said olefin coordination compound with an oxygen-containing gas in a second reaction zone at a temperature between about 500° F. and about 700° F. and at a pressure between about 1000 and about 2000 pounds per square inch absolute in the presence of an oxidation catalyst comprising silver for a residence time between about 10 seconds and about 2 minutes to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of cuprous chloride, and separating the olefin oxide thus produced from said oxygen-containing compound of cuprous chloride.

17. A process for the production of ethylene oxide which comprises contacting ethylene in a first reaction zone with cuprous bromide to form a coordination compound with ethylene at a temperature between about 50° F. and about 100° F. and at a pressure between about 100 and about 200 pounds per square inch absolute, contacting said ethylene coordination compound with oxygen in a second reaction zone at a temperature between about 500° F. and about 700° F. and at a pressure between about 1000 and about 2000 pounds per square inch absolute in the presence of an oxidation catalyst comprising silver for a residence time between about 10 seconds and about 2 minutes to convert said ethylene coordination compound to ethylene oxide and to form an oxygen containing compound of the cuprous bromide, and separating ethylene oxide thus produced from said oxygen-containing compound of cuprous bromide.

18. A process for the production of propylene oxide which comprises contacting propylene in a first reaction zone with cuprous chloride to form a coordination compound with propylene at a temperature between about 50° F. and about 100° F. and at a pressure between about 100 and about 200 pounds per square inch absolute, contacting said propylene coordination compound with oxygen in a second reaction zone at a temperature between about 500° F. and about 700° F. and at a pressure between about 1000 and about 2000 pounds per square inch absolute in the presence of an oxidation catalyst comprising silver for a residence time between about 10 seconds and about 2 minutes to convert said propylene coordination compound to propylene oxide and to form an oxygen-containing compound of cuprous chloride, and separating propylene oxide thus produced from said oxygen-containing compound of cuprous chloride.

19. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with a palladium halide at a temperature between about 30° F. and about 150° F. to form an olefin coordination compound, separating said olefin coordination compound from said gas, oxidizing said olefin coordination compound in a second reaction zone at a temperature between about 400° F. and about 1000° F. to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of the palladium halide, and separating the olefin oxide thus produced from said oxygen-containing compound of the palladium halide.

20. A process for the production of olefin oxides which comprises contacting an olefin-containing gas in a first reaction zone with an aluminum halide at a temperature between about 30° F. and about 150° F. to form an olefin coordination compound, separating said olefin coordination compound from said gas, oxidizing said olefin coordination compound in a second reaction zone at a temperature between about 400° F. and about 1000° F. to convert said olefin coordination compound to its corresponding olefin oxide and to form an oxygen-containing compound of the aluminum halide, and separating the olefin oxide thus produced from said oxygen-containing compound of the aluminum halide.

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