

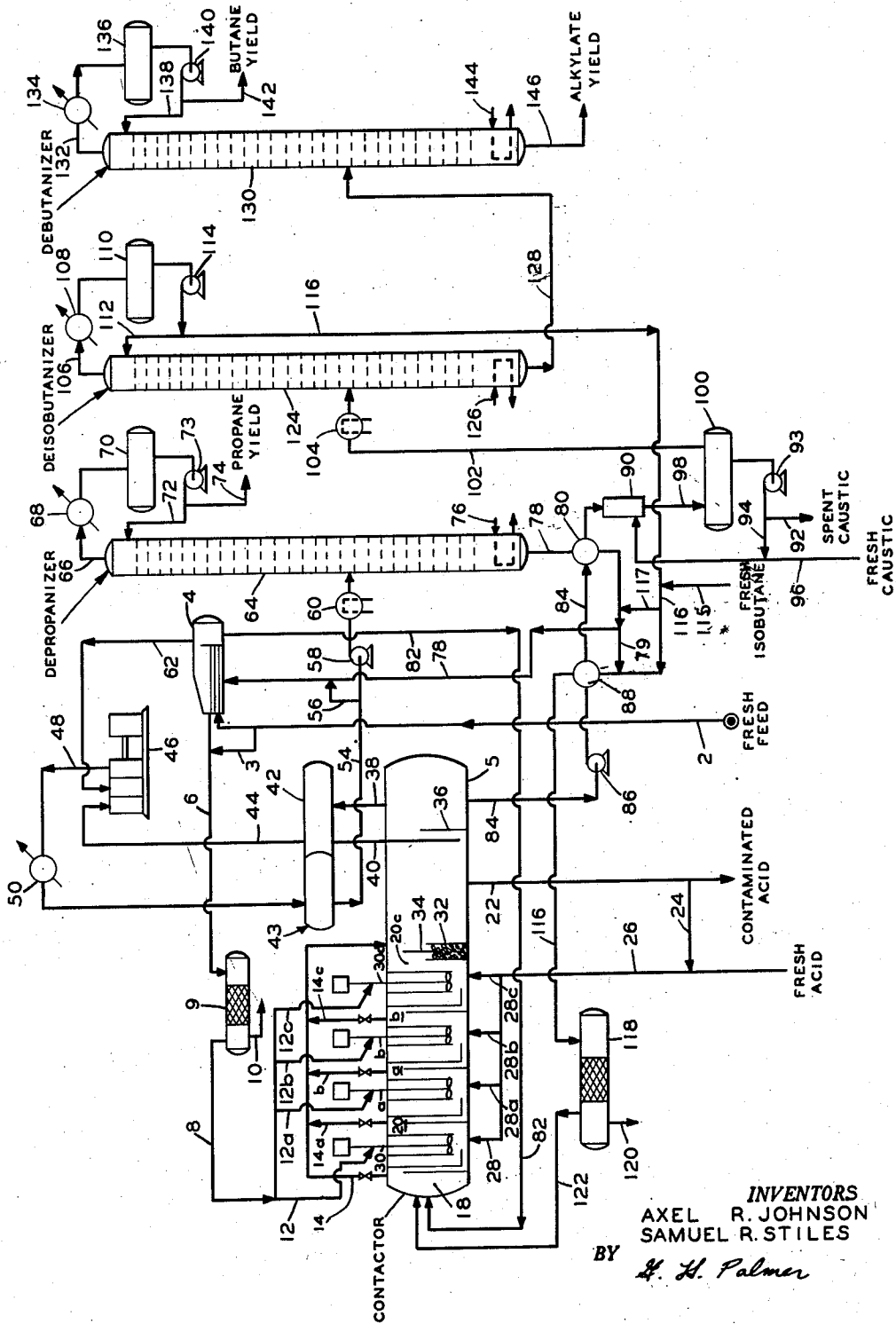
April 1, 1958

S. R. STILES ET AL

2,829,181

HYDROCARBON CONVERSION PROCESS

Filed Sept. 8, 1954



INVENTORS
AXEL R. JOHNSON
SAMUEL R. STILES

BY *H. H. Palmer*

ATTORNEY

1

2,829,181

HYDROCARBON CONVERSION PROCESS

Samuel R. Stiles, Cresskill, N. J., and Axel R. Johnson, Flushing, N. Y., assignors to The M. W. Kellogg Company, Jersey City, N. J., a corporation of New Jersey

Application September 8, 1954, Serial No. 454,759

6 Claims. (Cl. 260—683.4)

This invention relates to an autorefrigeration process and, more particularly, to the use of autorefrigeration in an alkylation process. Still more particularly, it relates to an improved method for cooling process streams in the alkylation of isoparaffins with olefins in the presence of an acid catalyst.

The alkylation of low boiling isoparaffins with olefins to form alkylates of high octane quality is customarily carried out at low temperatures. In the usual process it is preferred to maintain the reaction zone at a temperature substantially less than the average atmospheric temperature, that is, between about 0° F. and about 60° F. To maintain this temperature level it is not only necessary to remove sensible heat from the reactants but also large quantities of heat generated in the alkylation reaction. Autorefrigeration is one simple and efficient method for removing this heat which is frequently used. Cooling the reaction zone by this method is accomplished by lowering the pressure therein whereby a portion of the lighter hydrocarbons present are vaporized, the heat of vaporization being supplied from the unvaporized material. The vapors are removed from the reaction zone by a compressor, are compressed and condensed and the condensate is recycled to the reaction zone. Because of the quantity of heat released in the alkylation reaction large amounts of energy are required to vaporize and compress the autorefrigeration stream. Still more energy is required to remove sensible heat from the materials entering the reaction zone including large quantities of unreactive paraffin hydrocarbons introduced in the alkylation feed. In addition a high isoparaffin-to-olefin ratio is maintained in the reaction zone by recycling a stream rich in isoparaffins separated from the alkylate product. These hydrocarbon materials are also of necessity cooled to the reaction zone temperature, thus providing a large additional compression load.

It is an object of this invention to provide an improved method for cooling hydrocarbon process streams.

It is another object of this invention to increase heat exchange efficiency in the alkylation of isoparaffins with olefins.

It is still another object of this invention to decrease the compression horsepower required for autorefrigeration cooling in the alkylation of isoparaffins with olefins.

Still another object of this invention is to reduce the vaporization of olefins from the reaction zone in the autorefrigeration cooling of an olefin-isoparaffin alkylation reaction and thereby increase the yield of alkylate.

Yet another object of this invention is to reduce the size of the separation zone required to separate low boiling paraffins from the reaction products in the alkylation of isoparaffins with olefins.

These and other objects of the invention will become more apparent from the following detailed discussion and description.

In the method of this invention an autorefrigerant stream obtained in the cooling of a conversion zone, to which there is charged a fresh feed and a recycle stream,

2

is partially flashed at a pressure higher than the conversion zone pressure and a portion of the cooling effect which results is imparted by indirect heat exchange to the fresh feed stream whereby this stream is decreased in temperature. The unvaporized portion of the autorefrigerant stream is returned to the conversion zone and the vaporized material is compressed, condensed and recycled to the heat exchange step.

In another aspect this invention comprises a method of cooling an alkylation feed stream by indirect heat exchange with an autorefrigerant removed from an alkylation zone, the cooling being effected by flashing the autorefrigerant stream to a lower pressure and passing this stream in indirect heat exchange with the alkylation feed stream whereby both streams are lowered in temperature.

In still another aspect of this invention a recycle isoparaffin stream is also cooled by combining it with the autorefrigerant stream prior to flashing.

The method of this invention is applicable in any hydrocarbon process in which quantities of heat are removed by vaporization of low boiling hydrocarbons, for example, in lube oil dewaxing, polymerization of olefins, etc. However, the invention will be described and discussed herein with reference to the alkylation of low boiling isoparaffins and olefins.

In the commercial alkylation of low boiling isoparaffins with olefins it is customary to utilize feed stocks varying widely in composition and containing a large variety of saturated and unsaturated compounds, for example, either cracked or straight run refinery gases which are a prime source of alkylation feed stocks may contain paraffins having from 1 to 6 carbon atoms, isoparaffins including isobutane, isopentane and others of higher molecular weight and numerous low boiling olefins and their isomers. It is within the scope of this invention to use feed stocks containing any of these low boiling compounds or mixtures thereof in widely varying proportions.

The alkylation reaction takes place over a wide range of temperature and pressure varying from about 0° F. to as high as about 400° F. and between about atmospheric pressure and about 1000 p. s. i. g. Numerous catalysts are used to promote alkylation including acids such as sulfuric, hydrofluoric and phosphoric, metal halides, for example, aluminum chloride, zinc chloride, aluminum bromide, etc., phosphorus pentoxide and others. Of particular commercial interest in the alkylation field is the reaction of isobutane with butylene in the presence of sulfuric acid to form valuable gasoline components. For the purpose of clarity and because of its widespread use the subsequent discussion will be directed to this process. This, however, is not to be construed as restricting the scope of the invention.

The sulfuric acid alkylation of isobutane with butylene is preferably conducted in several stages and at a temperature between about 0° F. and about 60° F. The pressure in the reaction zone is maintained at a level sufficient to keep the reactants in a liquid state, usually between about atmospheric and about 100 p. s. i. g. In order to obtain a good quality alkylate it is desirable to maintain a high isobutane to olefin ratio in the reaction zone, preferably between about 100/1 and about 1000/1 mols per mol.

In a typical application of this invention isobutane and sulfuric acid are introduced into an alkylation reaction zone and are violently agitated to form an emulsion, this being the preferred method of assuring intimate contact between the acid catalyst and the hydrocarbon to be alkylated. The major portion of the isobutane present in the reactor is provided by a recycle stream obtained from subsequent distillation steps and from the refrigerant stream. Normally the quantity of isobutane re-

3

quired for reaction with olefins is supplied in the olefin feed, however, in many instances isobutane is supplied from an independent source and included in the recycle stream or the refrigerant stream. The mixing and agitation required in the contact zone may be provided in a number of ways, however, usually a conventional mixer or pump provides a means for creating and moving the emulsion at high velocity and also for circulating the emulsion in the contact zone. The reaction may be carried out in one stage although more usually several stages in series are provided with a portion of the olefin reactant being admitted to each stage and contacting isobutane passing serially through the successive stages. The alkylation feed which contains the olefin reactant also contains isobutane, butane, propane and frequently small quantities of lighter paraffins. The temperature in the reaction zone is maintained at a constant low level by vaporizing therefrom the lighter components in the reaction products; more usually, a mixture of butane, isobutane, propane and any lower boiling compounds. The vapors are compressed and condensed and a portion of the condensate is passed to a distillation zone where a quantity of propane and lower boiling compounds equal to the quantities admitted to the feed thereof are removed. The bottoms liquid from this distillation step is cooled by indirect heat exchange with effluent from the reaction zone, combined with the remainder of the compressor condensate and the combined stream is flashed to a reduced pressure and temperature intermediate between the conversion zone pressure and the compressor discharge pressure and passed into a heat exchanger zone. A vapor-liquid mixture is formed which absorbs heat from fresh feed by indirect heat exchange thereby allowing fresh feed to be introduced to the alkylation zone at a substantially lower temperature. The combined depropanizer bottoms and compressor condensate stream, less the material vaporized prior to and in the heat exchange zone, is removed therefrom and returned to the alkylation zone. The material flashed in the heat exchanger zone is returned to the compressor and after compression rejoins the autorefrigerant stream. Although only one compressor is required for carrying out the process a separate compressor may be used to compress the flashed hydrocarbons if this is found to be desirable.

In order to more clearly illustrate the invention and to provide a better understanding thereof reference is had to the attached drawing which is a diagrammatic illustration of a process equipment arrangement used in the alkylation of isoparaffins with olefins. Referring to the drawing the alkylation reactions are carried out in a cylindrical elongated contacting vessel 5. The interior of approximately $\frac{2}{3}$ of the contactor is divided into a number of separate reaction stages or sections 20, 20a, 20b and 20c, by transverse baffles so arranged that liquid entering the end of the contactor passes from an inlet chamber 18 upward through the first section 20 over a baffle down to the bottom of the second section 20a, then upward through the second section over a second baffle and in a similar manner through the third and fourth sections 20b and 20c. Each section contains a mixer 30, 30a, 30b and 30c respectively, in this specific illustration, enclosed propeller submersible pumps disposed vertically with the drivers located outside and above the contactor and the propellers located in the lower portion of each reaction section. Each pump is so constructed that material entering the suction is forced upward within the pump casing and then downward and out through perforations within the casing into the upper part of the corresponding section. The pump capacities are such that the quantity of materials circulated through each pump is several times greater than the total liquid flow entering the section in which the pump is located.

The alkylation reactants and catalyst enter the con-

4

factor 5 at three different points. The alkylation feed comprising a mixture of propane, butane, isobutane and butylene is split into four streams which enter the mixing pumps 30, 30a, 30b and 30c through conduits 12, 12a, 12b and 12c respectively. This material passes downward within each pump through a hollow sleeve surrounding the pump shaft and is admitted to the liquid stream flowing through the pump downstream of the pump impeller. Mixtures of butane and isobutane made up of a recycle stream from the de-isobutanizer 124 and fresh isobutane from conduit 115 and a mixture of butane and isobutane and propane from the heat exchanger 4 are admitted to the inlet chamber 18 of the contactor through conduits 122 and 82 respectively. The acid catalyst comprising fresh acid or a mixture of fresh acid and contaminated acid is admitted to the bottom of the first reaction section 20 through conduit 28. As illustrated acid may also be introduced into the succeeding sections 20a, 20b and 20c through conduits 28a, 28b and 28c respectively.

Hydrocarbon passes from the inlet chamber 18 into the first reaction section 20, is combined with acid and the mixture enters the suction of the pump 30 where it is picked up, emulsified and directed upward within the pump casing at a high velocity. The alkylation feed from conduit 12 is admitted to the emulsion downstream of the pump impeller and the alkylation reaction proceeds immediately and is substantially completed before the reactants leave the pump casing. As mentioned previously, the capacity of pump 30 is sufficiently great to assure a circulation rate several times as large as the flow of alkylation feed, isobutane and acid into section 20, thus unreacted isobutane is circulated along with the acid catalyst and a portion of the alkylation product through the pump a number of times before it passes into the next section where another portion is reacted with fresh alkylation feed. The same procedure is repeated in sections 20b and 20c.

A mixture of isobutane, alkylate and acid leaves the last reaction section and passes through an emulsion breaking zone 32 formed by parallel transverse baffles and containing a conventional inert packing material. All of the effluent from the last section is forced to flow through this zone by a deflector baffle 34 extending above the alkylate level within the contactor and downward within the emulsion breaking zone. Subsequent to this zone, the acid separates from the hydrocarbon oil and is contained in a settling zone enclosed by baffle 36 over which alkylate and unreacted isobutane flow into the remainder of the contactor. The contaminated acid containing polymers and other impurities passes from the contactor through conduit 22. A portion of this acid is recycled to the contactor through conduit 24 and the remainder of the acid is discarded or is processed and reconcentrated for use again in the alkylation reaction.

The alkylation contactor 5 is maintained at a temperature of about 35° F. and at a pressure of about 3.5 p. s. i. g. Since the catalyst and hydrocarbon streams normally enter the contactor above 35° F. it is necessary to provide a method of cooling the reactor to remove the sensible heat in these streams. In addition the exothermic nature of the alkylation reaction requires further cooling to remove reaction heat and maintain the reaction sections at the required low temperature. In this specific illustration the cooling is accomplished by autorefrigeration of the reactants and reaction products. In carrying out this operation vapors are withdrawn from the contactor through conduit 38 into a dry drum 42. Any materials settling in the dry drum are returned to the contactor settling zone beneath the acid level through conduit 40. The dry gas from drum 42 enters the suction of compressor 46 through conduit 44, is compressed to about 90 p. s. i. g., discharged through conduit 48, condensed in a conventional water cooler 50

and passed to a condensate drum 43. The autorefrigerant condensate comprises a mixture of propane, butane and isobutane. It is withdrawn from the condensate drum and divided into two parts with a portion being sent to the depropanizer 64 through conduit 54 and the remainder being passed to heat exchanger 4 through conduit 56.

A substantial amount of the vaporization which occurs in the contactor takes place in the entrance chamber 18 and the reaction sections 20, 20a, 20b and 20c. The isobutane recycle stream enters the contactor as a liquid and at a higher temperature and pressure than exists within the contactor. As a result a portion of this stream flashes in the entrance chamber 18. To prevent a mixture of vapor and liquid from passing over the baffle into reaction section 20 and into the suction of pump 30 an outlet for this gaseous material is provided through conduit 14. A similar situation prevails in each of the reaction sections, since, in order to remove the reaction heat from each section, it is necessary that a further amount of light material be vaporized therein. This material is supplied to a great extent by the fresh feed from conduits 12, 12a, 12b and 12c, which feed is also introduced at a temperature and pressure higher than that maintained in the contactor. Vapor formed in the reaction sections is removed from the contactor through conduits 14a, 14b and 14c, is combined with the vapor from conduit 14, passes into the upper portion of the contactor downstream of the last reaction section and is withdrawn from the contactor through conduit 38. By this method of operation it is possible to maintain a relatively constant temperature throughout the contactor and control the flow of acid and hydrocarbons properly.

The charge to the depropanizer 64 is picked up by a pump 58 and is passed through a steam preheater 60 prior to entering this tower. Propane is taken overhead from the depropanizer through conduit 66, condensed in condenser 68 and discharged into accumulator 70. A portion of the overhead liquid is transferred by pump 73 through conduit 72 as reflux to the depropanizer and the remainder is removed from the unit as propane yield. Heat is supplied to the depropanizer by a conventional reboiler 76 or other conventional heat source. The tower bottoms, comprising primarily isobutane, pass from the bottom of the depropanizer through conduit 78, give up a portion of their heat in exchanger 80 to cold effluent from the alkylation contactor and pass through conduit 78 to heat exchanger 4. The remainder of the autorefrigerant material (compressor condensate) is combined with the depropanizer bottoms through conduit 56. The combined stream is expanded to a lower pressure either in exchanger 4 or through an expansion valve (not shown) prior to exchanger 4. The vaporization which occurs effectively lowers the temperature both of the vapor and the unvaporized portion of this material. The cooling effect of this expansion is advantageously utilized by passing a fresh feed stream in indirect heat exchange with the cold liquid and vapor in exchanger 4. The cooled fresh feed is then removed from the exchanger through conduit 6, passed through a water coalescer 9, from which water is removed through conduit 10, and then through conduit 8 to the mixing pumps as previously described. The unvaporized portion of the combined autorefrigerant and isoparaffin stream, still at a temperature level less than that which existed prior to the expansion step, is passed from exchanger 4 through conduit 82 into the entrance section 18 of the contactor. The material vaporized in exchanger 4 is passed therefrom through conduit 62 and is returned to the suction of compressor 46.

The temperature of the streams leaving exchanger 4 is controlled by the pressure which prevails after expansion of the combined autorefrigerant and isoparaffin stream. This pressure also establishes the relative amounts of the expanded stream leaving the exchanger as vapor and liquid. The pressure in exchanger 4 may

be set at any level intermediate between the pressure in the contactor 5 and the discharge pressure of compressor 46, however, to obtain substantial savings in compressor horsepower it is preferable that the pressure be maintained substantially above the contactor pressure, between about 20 p. s. i. g. and about 30 p. s. i. g. In this specific illustration the pressure in exchanger 4 is set at 22 p. s. i. g.

The described method of cooling the alkylation process streams produces several important advantages, including lower olefin vaporization in the contactor, decreased autorefrigeration compression energy and reduced load on the depropanizer tower. The mechanism by which a considerable portion of the reaction and sensible heat is removed from the reaction sections by vaporization therein has been previously described. Because of the method of contacting the reactants, the major portion of the reaction heat is released inside the mixing pumps 30, 30a, 30b and 30c. Inasmuch as this is the point of maximum olefin concentration, the material vaporized here is relatively rich in olefins. Loss of this material through vaporization and removal of the vapor from the alkylation contactor decreases the amount of olefins in the liquid and thus decreases the amount of alkylate formed.

Although the higher boiling olefins vaporized in the contactor are returned to the reaction zone in the depropanizer bottoms recycle, these olefins contact the acid catalyst in the contactor before the catalyst enters the pump and at a point where there is little or no acid-hydrocarbon emulsion. As a result the mixing necessary to produce a good quality alkylate is not present and there is a tendency for olefin polymers to be formed. Another disadvantage to olefin vaporization lies in the fact that low boiling olefins present in the autorefrigerant are lost from the system in the paraffins separated in the depropanizer 64. This invention provides a method of decreasing olefin vaporization by lowering the temperature of the fresh feed prior to its admission to the contactor through the mixing pumps and thereby prevents excessive olefin consumption.

Raising hydrocarbon vapors from the low pressure which exists in the reaction zone to the pressure necessary to assure condensation of the compressor effluent at the cooling water temperature available requires a high compression ratio and large amounts of energy. By flashing compressor condensate in exchanger 4 at a pressure intermediate between the contactor and compressor discharge pressures, cooling of this material and the alkylation feed passed in indirect heat exchange therewith is accomplished at a much lower compression ratio. This cooling step combined with the primary cooling in the contactor provides a dual autorefrigeration process which results in the same overall cooling effect as the conventional process but with a substantial decrease in the energy required for compression.

At the pressure existing in exchanger 4 the material vaporized therein comprises a lower boiling hydrocarbon mixture than the material vaporized from the contactor. Since vapor from the exchanger is recycled to the compressor the concentration of light material in the circulating system, which includes exchanger 4, is increased, the degree of increase being directly dependent on the difference in the pressures maintained in the contactor 5 and exchanger 4. Changing the composition of the circulating stream in this manner provides a feed stream to the depropanizer 64 which is substantially richer in propane and lower boiling hydrocarbons. Since the quantity of this stream is limited to provide a propane yield from the depropanizer equal in amount to the propane admitted in the fresh feed and a depropanizer bottoms stream reduced in propane content or essentially free of propane, the depropanizer feed is reduced in quantity thus allowing a reduction in the size of the depropanizer tower.

The specific illustration presented herein incorporates

only one of several embodiments of this invention. Since there are three hydrocarbon process streams which enter the contactor, all of which are advantageously precooled, several variations and combinations of cooling are possible. For example, it is within the scope of the invention to utilize isobutane recycle from the deisobutanizer 124 after drying in place of the depropanizer tower bottoms by use of conduits 79 and 117. In another variation the same isobutane recycle stream is substituted for the olefin feed. Other combinations which are obvious to those skilled in the art as, for example, using mixtures of these streams are also within the scope of the invention.

The alkylation products and unreacted materials after separation from the spent acid in the contactor 5 pass through conduit 84, pump 86 and exchanger 88 in which heat is absorbed by indirect heat exchange with recycle isobutane being returned to the contactor. The warmer contactor effluent then passes through conduit 84 and through exchanger 80 where additional heat is picked up from indirect heat exchange from the depropanizer tower bottoms. The still warmer hydrocarbon stream is then combined with caustic discharged from pump 93 and conduit 96 and the mixture passes through a mixer 90 into a caustic settler 100. Neutralized caustic is removed from the settler by pump 93, a portion being recycled to the mixer 90 through conduit 94 and the remainder being discharged from the unit through conduit 92. Acid free alkylate and reactants are passed through conduit 102 and a conventional steam heater 104 into the deisobutanizer 124.

Passage of the contactor effluent through exchanger 80 in indirect heat exchange with the depropanizer bottoms provides another advantage not present in the conventional alkylation process. Previous operating schemes have utilized the depropanizer bottoms to heat feed to this tower and have added heat to the contactor effluent by indirect heat exchange with either fresh isobutane, recycle isobutane or both. Of these five streams, the depropanizer feed, the depropanizer bottoms, contactor effluent, fresh isobutane and recycle isobutane, the one lowest in temperature is the contactor effluent and the one having the highest temperature is the depropanizer bottoms. In the method of this invention these two materials pass in indirect heat exchange thus providing a feed stream to the deisobutanizer of a considerably higher temperature than is obtained by any other combination of contacting the streams mentioned. The advantage in this is to warm this stream to efficient caustic washing temperature for removal of esters.

Vapor rich in isobutane passes overhead from the deisobutanizer 124 through conduit 106, condenser 108 and into accumulator 110. A portion of the condensed material is returned through pump 114 and conduit 112 to the deisobutanizer as reflux. The remainder is discharged through conduit 116, passes through exchanger 88 as previously mentioned, passes through a water coalescer 118 and then through conduit 122 into the contactor. The water separated from the isobutane recycle is removed from the coalescer through conduit 120. The heat required to vaporize isobutane in tower 124 is supplied by a conventional reboiler 126. The bottoms from the deisobutanizer comprising a mixture of butane and alkylate pass through conduit 128 to a debutanizer tower 130, also heated by a conventional reboiler 144. Butane vapor is removed overhead through conduit 132, is condensed in a conventional water condenser 134, and passes into accumulator 136. Debutanizer reflux is provided from accumulator liquid discharged from pump 140 through conduit 138. The remaining condensed overhead is discharged through conduit 142 as butane product. The debutanizer bottoms comprising alkylate leave the debutanizer through conduit 146 for further processing and treatment (not shown).

Although the method of this invention has been described with reference to a specific type of hydrocarbon

process, that is, alkylation, it is not intended that the invention be restricted thereby but that it include the cooling of hydrocarbon reactions and hydrocarbon process streams in general and that its scope be limited only by the appended claims.

We claim:

1. In a process for cooling a hydrocarbon conversion zone which is maintained at a low temperature and from which heat is removed by autorefrigeration whereby low boiling hydrocarbons are vaporized, the improvement which comprises compressing and condensing the low boiling hydrocarbon vapors thereby providing a liquid autorefrigerant under elevated pressure, expanding said autorefrigerant to a lower pressure whereby vaporization occurs, contacting the expanded autorefrigerant in indirect heat exchange with hydrocarbon reactants whereby said hydrocarbons are cooled prior to their admission to the conversion zone, passing the liquid portion of the expanded autorefrigerant to the conversion zone, compressing and condensing the vaporized portion of the expanded autorefrigerant and combining it with fresh autorefrigerant from the conversion zone.

2. In a process for cooling a hydrocarbon conversion zone which is maintained at a low temperature and pressure and from which heat is removed by autorefrigeration whereby low boiling hydrocarbons are vaporized, the improvement which comprises compressing and condensing the low boiling hydrocarbon vapors thereby providing a liquid autorefrigerant under elevated pressure, expanding the autorefrigerant to a lower pressure above the pressure in the conversion zone whereby vaporization occurs, contacting the expanded autorefrigerant in indirect heat exchange with hydrocarbon feed whereby said hydrocarbons are cooled prior to their admission to the conversion zone, passing the liquid portion of the expanded autorefrigerant also at a lower temperature to the conversion zone, compressing and condensing the vaporized portion of the expanded autorefrigerant and combining it with fresh autorefrigerant from the conversion zone.

3. In an alkylation process in which a mixture of isoparaffins, paraffins and olefins are contacted in a conversion zone in the presence of an acid catalyst at a temperature suitable to effect alkylation of the isoparaffins with the olefins, said temperature being maintained by autorefrigeration by removing from the reactants and reaction products a vapor stream comprising a mixture of isoparaffins and paraffins, the improvement which comprises compressing and condensing the isoparaffin-paraffin vapor stream thereby providing a liquid autorefrigerant under elevated pressure, passing a portion of said autorefrigerant to a separation zone for the removal of a stream richer in isoparaffins, combining the isoparaffin rich stream with the remainder of said autorefrigerant, expanding the combined stream to a lower pressure whereby a vaporous portion and a liquid portion is formed, contacting said expanded combined stream in indirect heat exchange with olefin feed whereby said olefins are cooled prior to their admission to the conversion zone, passing the liquid portion of the expanded combined stream to the reaction zone, compressing and condensing the vaporized portion of the expanded combined stream and combining it with fresh autorefrigerant from the conversion zone.

4. In an alkylation process in which a mixture of isoparaffins, paraffins and olefins are contacted in a conversion zone in the presence of an acid catalyst at a temperature and pressure suitable to effect alkylation of the isoparaffins with the olefins, said temperature and pressure being maintained by autorefrigeration by removing from the reactants and reaction products a vapor stream comprising a mixture of isoparaffins and paraffins, the improvement which comprises compressing and condensing the isoparaffin-paraffin vapor stream thereby providing a liquid autorefrigerant under elevated pressure, passing a portion of said autorefrigerant to a separation zone for the removal of a stream richer in isoparaffins;

9

combining the isoparaffin rich stream with the remainder of said autorefrigerant, expanding the combined stream to a lower pressure above the pressure in the conversion zone whereby a vaporous portion and a liquid portion is formed, contacting the expanded combined stream in indirect heat exchange with olefin feed to said conversion zone whereby said olefins are cooled prior to their admission to the conversion zone, passing the liquid portion of the expanded combined stream to the reaction zone, compressing and condensing the vaporized portion of the expanded combined stream and combining it with fresh autorefrigerant from the conversion zone.

5. An alkylation process which comprises contacting a mixture of low boiling isoparaffins, olefins and paraffins in a conversion zone under conditions suitable to effect alkylation of the isoparaffins with the olefins, maintaining a low temperature in the conversion zone and removing sensible and reaction heat by autorefrigeration whereby a vapor stream comprising a mixture of isoparaffins and paraffins is removed from the conversion zone, compressing and condensing the isoparaffin-paraffin vapor stream thereby providing a liquid autorefrigerant under elevated pressure, passing to a distillation zone a portion of said autorefrigerant and separating therefrom a stream rich in isoparaffins, passing the isoparaffin rich stream in indirect heat exchange with a cold effluent stream from the conversion zone, combining the isoparaffin rich stream with the remainder of said autorefrigerant, expanding the combined stream to a lower pressure whereby a vaporous portion and a liquid portion is formed, contacting the expanded combined stream in indirect heat exchange with olefin feed to said conversion zone whereby said olefins are cooled prior to their admission to the conversion zone, passing the liquid portion of the expanded combined stream to the reaction zone, compressing and condensing the vaporized portion of the expanded combined stream and combining it with fresh autorefrigerant from the conversion zone.

10

6. An alkylation process which comprises contacting a mixture of low boiling isoparaffins, olefins and paraffins in a conversion zone under conditions suitable to effect alkylation of the isoparaffins with olefins, maintaining a low temperature and pressure in the conversion zone and removing sensible and reaction heat by autorefrigeration whereby a vapor stream comprising a mixture of isoparaffins and paraffins is removed from the conversion zone, compressing and condensing the isoparaffin-paraffin vapor stream thereby providing a liquid autorefrigerant under elevated pressure, passing to a distillation zone a portion of said autorefrigerant and separating therefrom a stream rich in isoparaffins, passing the isoparaffin rich stream in indirect heat exchange with a cold effluent stream from the conversion zone, returning the isoparaffin rich stream to the conversion zone, passing the warmer effluent stream to a second distillation zone wherein there is separated a second stream rich in isoparaffins, combining the second isoparaffin rich stream with the remainder of the autorefrigerant, expanding the combined stream to a lower pressure above the pressure in the conversion zone, passing the expanded combined stream in indirect heat exchange with olefins whereby said olefins are cooled prior to their admission to the conversion zone, passing the liquid portion of the expanded combined stream to the reaction zone, compressing and condensing the vaporized portion of the expanded combined stream and combining it with fresh autorefrigerant from the conversion zone.

References Cited in the file of this patent

UNITED STATES PATENTS

2,429,205	Jenny et al. -----	Oct. 21, 1947
2,441,249	Ocon et al. -----	May 11, 1948

OTHER REFERENCES

Weber: Improved Alkylation Process, Oil and Gas Journal, vol. 49, No. 34, page 78 (December 28, 1950).