# United States Patent [19]

**Chapman**

[11] **3,716,343**

[45] **Feb. 13, 1973**


[54] **APPARATUS FOR INCREASING QUALITY AND QUANTITY OF PRODUCT FROM AN EXISTING CHEMICAL APPARATUS OPERATION**


[75] Inventor: **Charles C. Chapman,** Bartlesville, Okla.

[73] Assignee: **Phillips Petroleum Company**



[22] Filed: **Nov. 2, 1970**

[21] Appl. No.: **86,156**

[52] **U.S. Cl.**.....**23/285,** 23/288 E, 260/683.48

[51] **Int. Cl.**.....**B01j 9/08,** C07c 3/12, C07c 3/54

[58] **Field of Search**.....23/288 E, 285, 283, 260, ; 260/683.43, 683.48, 683.45, 683.46



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,937,079 | 5/1960 | Van Pool | 23/285 |
| 3,281,213 | 10/1966 | Waddill | 23/285 |
| 3,006,739 | 10/1961 | Van Pool | 23/285 |
| 3,213,157 | 10/1965 | Hays et al. | 23/285 X |
| 3,426,095 | 2/1969 | Passley | 23/288 E X |



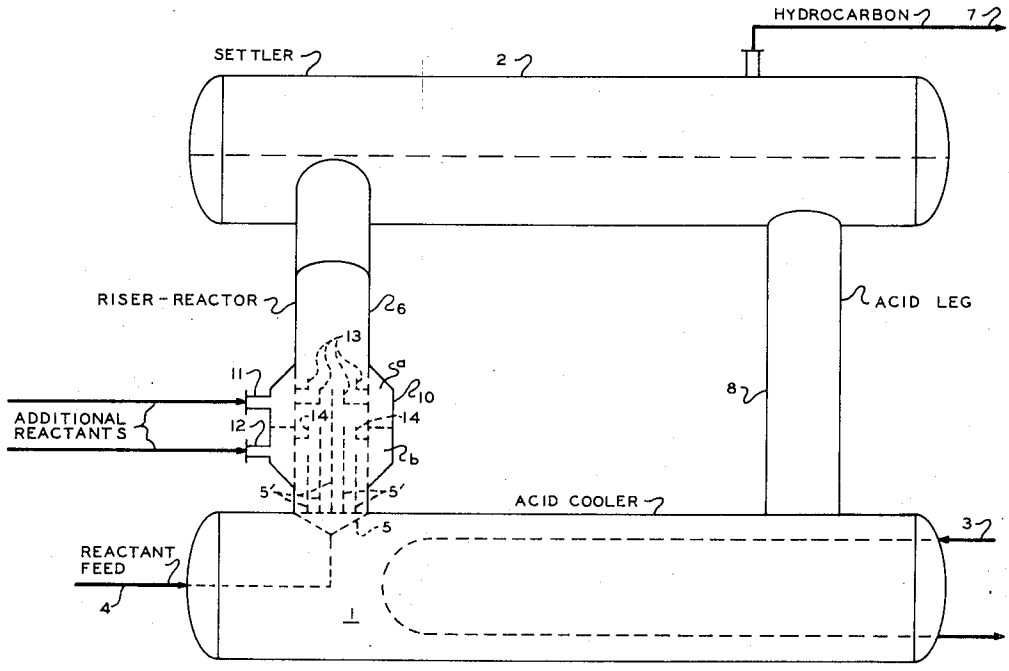
*Primary Examiner*—Joseph Scovronek
*Attorney*—Young and Quigg



[57] **ABSTRACT**

An existing riser-reactor into which reactants are injected for reaction therein through a plurality of nozzles is modified to provide the same with additional nozzles and as desired the nozzles are arranged to inject the same or different reactants to portions of the riser-reactor which are separated each from the other so that optimum reaction can take place in each portion. In one form of the apparatus a chamber is constructed around an existing riser-reactor into which at the place surrounded by the chamber there have been inserted and fixed to its wall a plurality of nozzled pipes whereby to feed reactant from the chamber through the pipes and nozzles into the riser-reactor. As desired, the pipes can extend to provide nozzles for injection into the riser-reactor at various depths or levels therein. Also, by partitioning the chamber different reactants can be injected from the overall chamber to different portions of the riser-reactors. An apparatus as described can be originally constructed in toto rather than by modifying an existing riser-reactor.


**4 Claims, 11 Drawing Figures**



PATENTED FEB 1 3 197

3,716,343

SHEET 1 OF 3

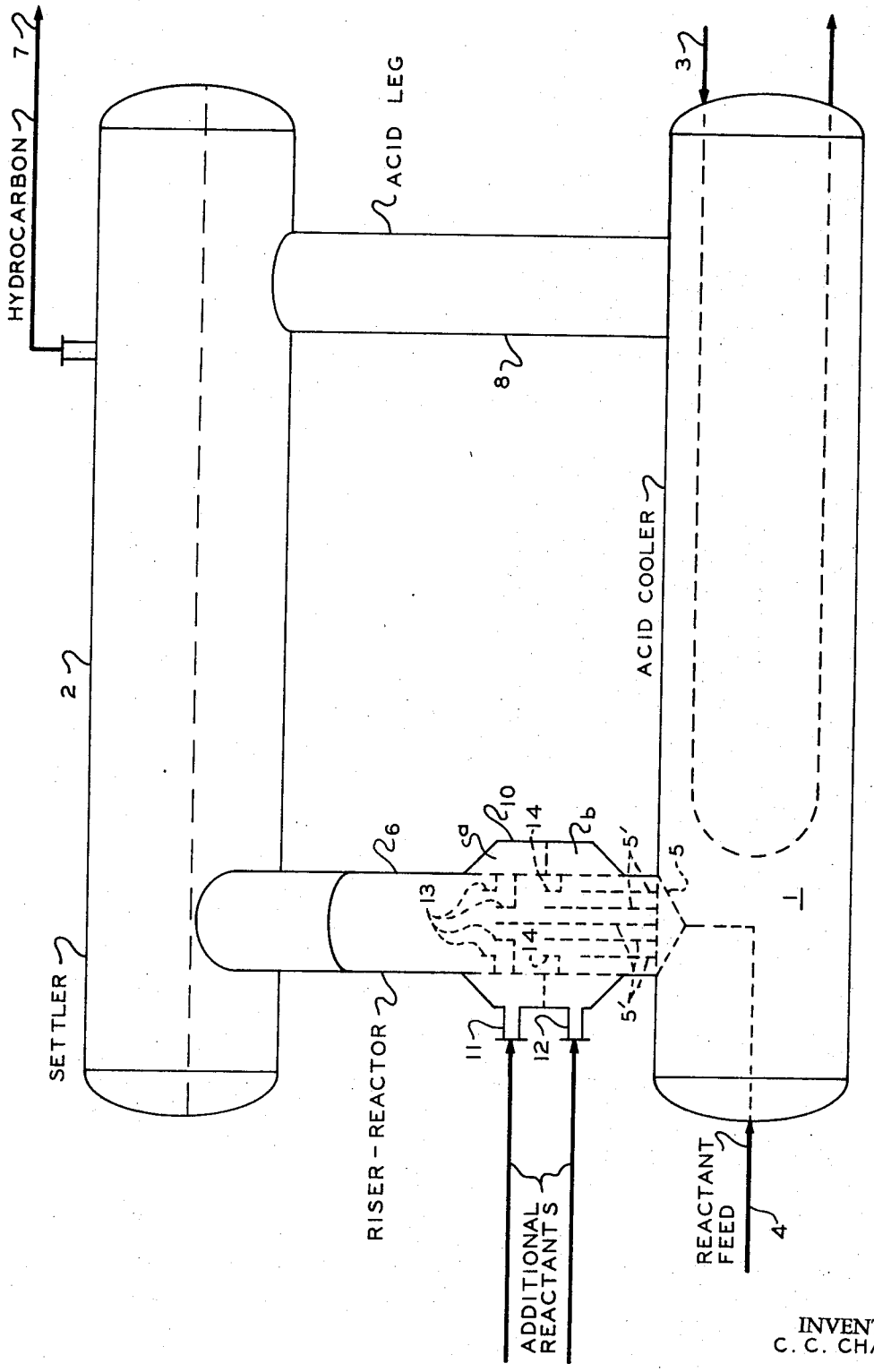



FIG. 1

INVENTOR.
C. C. CHAPMAN

BY

ATTORNEYS

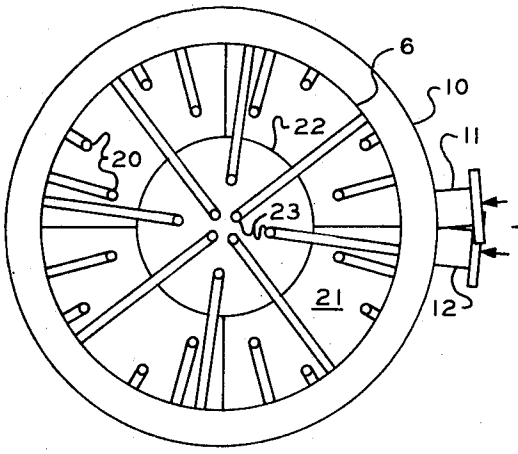



FIG. 2

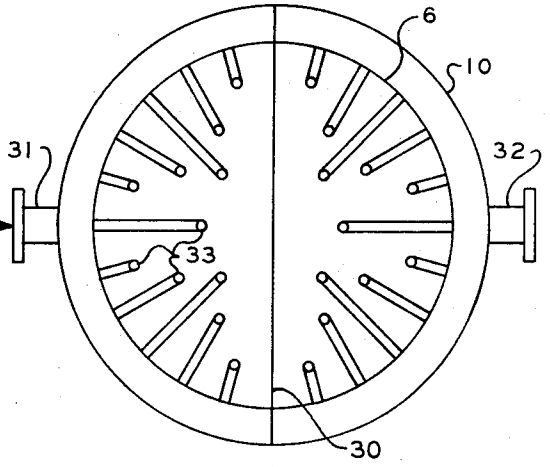



FIG. 5

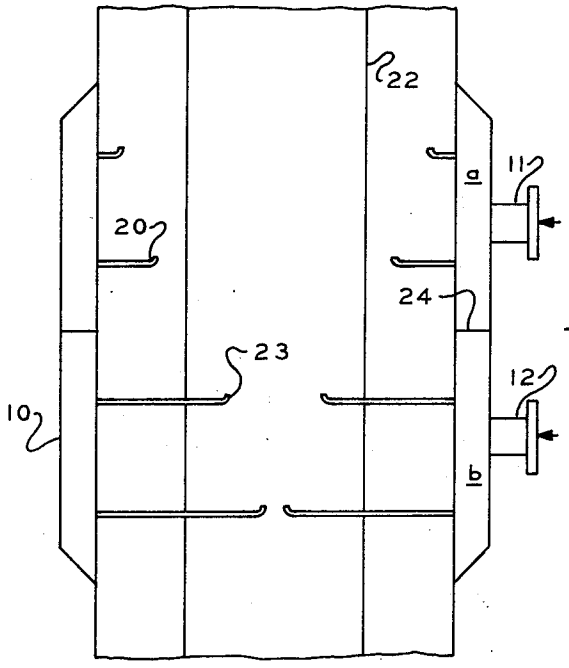



FIG. 3

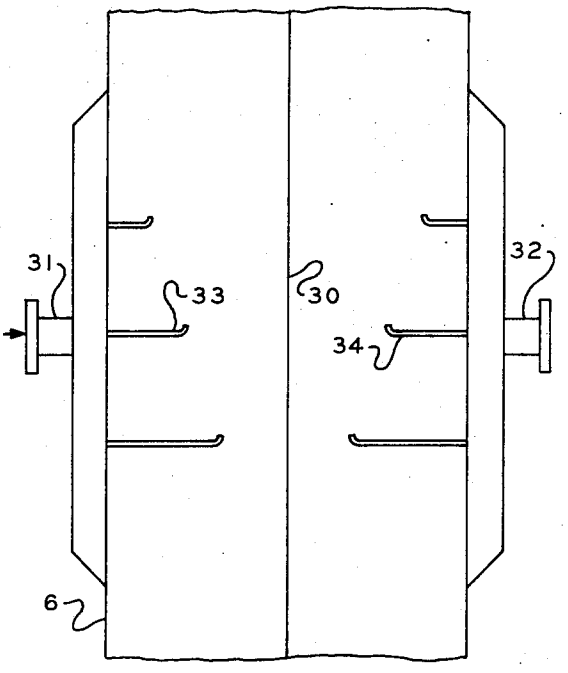



FIG. 4

INVENTOR.
C. C. CHAPMAN

BY

ATTORNEYS

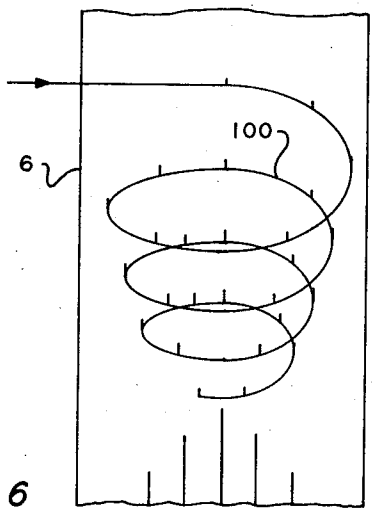



FIG. 6

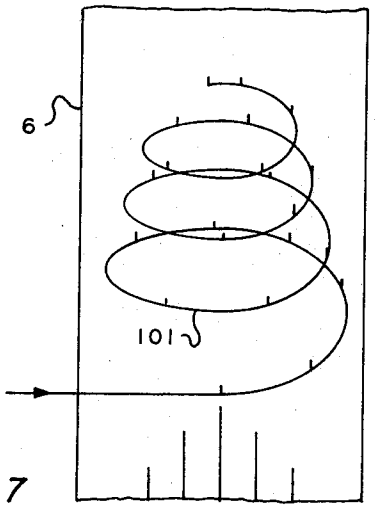



FIG. 7

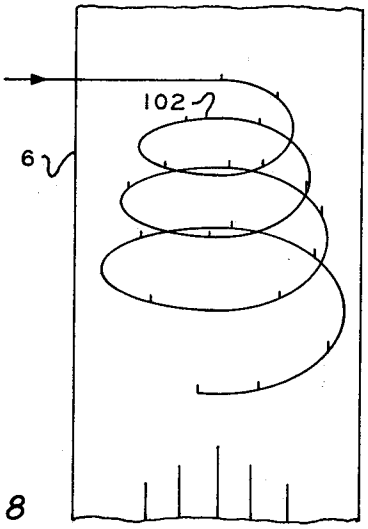



FIG. 8

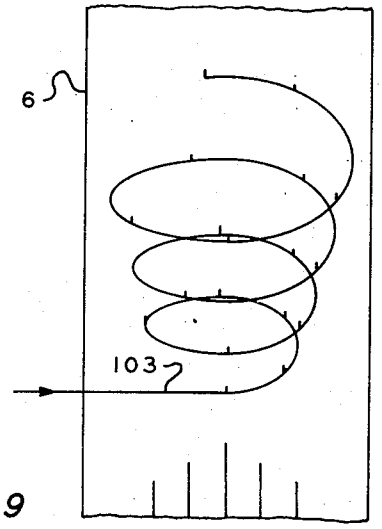



FIG. 9

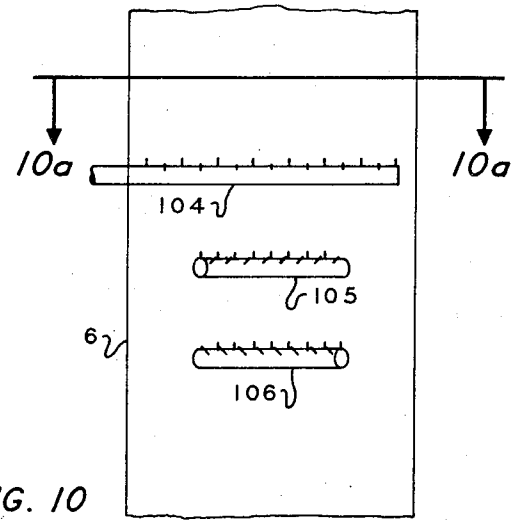



FIG. 10

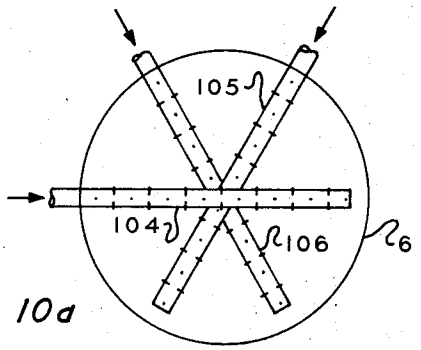



FIG. 10a

INVENTOR.
C. C. CHAPMAN

BY

ATTORNEYS

# APPARATUS FOR INCREASING QUALITY AND QUANTITY OF PRODUCT FROM AN EXISTING CHEMICAL APPARATUS OPERATION

This invention relates to a method for modifying an existing chemical apparatus. It also relates to a modified chemical apparatus. Further, it relates to the construction of a new form of chemical apparatus. The invention is particularly applicable to alkylation of an alkylatable substance with an alkylating agent in the presence of a fluid catalyst; for example, the alkylation of an isoparaffin with an olefin in the presence of a catalyst, such as hydrofluoric acid, sulfuric acid, etc.

In a more specific aspect of the invention, it relates to the construction or modification of an alkylation apparatus in which the riser-reactor is used, for example as described in U. S. Pat No. 3,281,213 issued Oct. 25, 1966, P. M. Waddill, and relates to U. S. Pat. No. 3,435,092 issued Mar. 25, 1969, to T. Hutson, Jr. et al.

In one of the concepts of the invention it provides a riser-reactor with a wrap-around chamber or header and with nozzle feed pipes extending inwardly from the wall of the riser-reactor in communication with the chamber or header in a manner to provide for feeding a reactant into the chamber or header and from there into the riser-reactor through the nozzled pipes. In another of its concepts, the invention provides that the pipes shall be of different length so that the nozzles will inject reactant at different depths or to different levels in the riser-reactor. In a further concept of the invention, the chamber or header can be partitioned to provide in effect for more than one chamber or header and for each chamber or header its nozzled pipe or pipes so that a plurality of reactant streams, the reactants of which can be different, can be simultaneously injected to different depths or to different levels along the riser-reactor. In a further concept still, the invention provides a separator or internally disposed annulus-forming partition into which at least some of the nozzled pipes can extend.

In the patent above identified, the reactant hydrocarbon feed inlet distributor is provided, in an alkylation apparatus, which comprises a plurality of small cross section of tubular members of different lengths extending upwardly into the lower portion of a vertically upwardly extending elongated alkylation reaction zone (riser-reactor) so that reactants can be introduced into the action chamber at a plurality of spaced apart points. The number of tubular members which can be provided as in the patent is limited because the header from which the pipes extend upwardly will accommodate just so many pipes and no more. Nozzles are preferably located at the outlets of the tubular members.

It has now occurred to me that by providing a wrap-around header or chamber as herein further described and feeding additional reactant to said header or chamber, I can by installing additional tubular members or nozzled pipes into the wall of the reactor-riser, which is encompassed within said header or chamber, feed additional reactant into the riser-reactor. Further, it has occurred to me that by providing a suitable partitioning within the header or chamber and/or within the riser-reactor I can place additional reactant or all of the reactants in the process into different portions of the rise. Also, it has occurred to me that a riser-reactor pipe in which a reaction can take place be provided with a pipe communicating from without the apparatus with the inside of said riser-reactor.



An object of the invention is to provide a novel apparatus for bringing together chemical reactants. Another object of the invention is to provide a method for bringing together chemical reactants. A still further object of the invention is to provide for the modification of an existing chemical apparatus so that additional chemical reactants can be injected into the same, or so that the same amount of reactants can be charged when the orifice size of the nozzles is decreased. A further object of the invention is to provide an improved apparatus for the alkylation of an alkylatable substance with an alkylating agent. Further still, an object of the invention is to provide for an improved apparatus for the alkylation of an isoparaffin with an olefin in the presence of a catalyst; for example hydrofluoric or sulfuric acid. A still further object of the invention is to provide for increasing the amount of reactant injected into a riser-reactor in an existing alkylation apparatus.

Other aspects, concepts, objects and the several advantages of the invention are apparent from a study of this disclosure, the drawing and the appended claims.

According to the invention, there is provided, in one form thereof, a wrap-around header or chamber on a riser-reactor. Further, according to the invention, there is provided in the wall of the riser-reactor, which is surrounded by said header or chamber, pipes for any communication between said header or chamber and the inside of said riser-reactor. Further still, according to the invention, the header or chamber is partitioned so that the plurality of different reactants can be fed thereto and therefrom to a plurality of points of within said riser-reactor. Further still, according to the invention, within said riser-reactor there is provided at least one partitioning or separator means so that different portions of said riser-reactor can be established therein for independent reaction, at least for a time, of the reactants introduced into the said portions.

Referring now to the drawings,

FIG. 1 shows generally the positioning of a header or chamber according to the invention onto a riser-reactor of an existing apparatus.

FIGS. 2 and 3 show respectively the horizontal and vertical cross section and apparatus modified or constructed according to the invention. The apparatus broadly consists of a chamber formed around a riser-reactor which can be a pre-existing riser-reactor.

FIGS. 2 and 3 show the general arrangement of nozzle feeds to the respective parts of the apparatus.

FIG. 4 shows a vertical cross section of an arrangement in which different feeds can be injected into a compartmented or separated riser-reactor.

FIG. 5 is a horizontal cross section of another form of the separated riser-reactor.

FIGS. 6, 7, 8 and 9 show general arrangements of nozzled feed inlet and to respective parts of the apparatus.

FIG. 10 shows another arrangement of nozzled inlets.

FIG. 10*a* is a horizontal cross section of FIG. 10, taken along *a–a* of FIG. 10.

Referring now to the drawings, the invention will be described in connection with an existing alkylation apparatus and operation conducted therein. Thus, in FIG. 1 there are shown an acid cooler 1 and a settler 2. A heat exchange medium 3 is circulated through acid cooler 1. Reactant feed enters at 4 and is distributed at header 5 into a plurality of tubular conduits of different lengths positioned immediately above header 5 in riser-reactor 6. The upward momentum of the reactant feed as it enters from the tubular members into riser-reactor 6 moves acid upwardly together with the reactant into settler tube wherein reactant products are taken off as an upper phase through 7 and from which separated acid is returned by 8 to acid cooler 1.

Thus, in the alkylation of an isoparaffin with an olefin, for example, isobutane with a propylene-butylene mixture in the presence of hydrofluoric acid, the said mixture of isoparaffin and olefin is introduced at 4 and at the ends of the tubular members is intimately intermingled with the hydrofluoric acid for immediate reaction to produce alkylate. The alkylate is taken off at 7 and the acid returned through 8 to the acid cooler 1.

The conditions, ratios, etc. for causing the alkylation of an isoparaffin with an olefin or for effecting other chemical reactions which can be effected within the apparatus of the invention according to the method of the invention are well known in the art and form no part of the present invention. The patent to which reference has been made describes that the alkylation reaction is carried out with hydrocarbon reactants in the liquid phase but that the reactants need not be normally liquid hydrocarbons. Thus, the reaction conditions include temperatures from subzero temperatures to temperatures as high as several hundred degrees Fahrenheit and the reaction can be carried out at pressures varying from atmospheric to as high as a thousand pounds per square inch and higher and space velocities from about 0.1 to about 20.

The patent describes the alkylation of low boiling olefins like propylene, butenes, isobutylene, pentenes, etc. with saturated branch chain paraffins, such as isobutane in the presence of hydrofluoric acid. The disclosure of the patent is incorporated herein by reference.

Referring again to FIG. 1 there is shown on riser-reactor 6 a compartmented header or chamber 10 having additional reactant feed inlets 11 and 12. Additional reactant 11 enters into section a of header 10 and passes from there by way of nozzles 13 into riser-reactor 6. Similarly, additional reactant enters through 12 into section b of header 10 and then into riser-reactor 6 by way of nozzles 14.

It will be seen, without more, that additional reactants are injectable into riser-reactor 6 by virtue of the modification thereof according to the invention. Further, it will be seen that the additional reactants can be different and can be injected to different levels of riser-reactor 6, or when smaller nozzles are used on the vertical tubes, at least the same amount of reactants can be charged as were charged with larger nozzles on the vertical tubes.

Referring now to FIG. 2 and to FIG. 3, riser-reactor 6 is surrounded by header 10 provided with inlet 11. Riser-reactor 6 is also provided with nozzled pipes 20 extending into annulus 21 formed within riser 6 by separator pipe 22. Further, additional nozzle pipes 23 are provided within wall 6 and extend from the chamber into within pipe 22. By this arrangement the contents of pipe 22 are kept separate from the contents of annulus 21, and if desired, different reactants can be separately charged and reacted.

According to FIG. 3, it will be seen that pipes 20 are at a different level from those of pipes 23. Further, it will be seen that pipes 23 extend to a greater depth into the riser-reactor and indeed into pipe 22. It will be noted also that in chamber 10, partition 24 divides chamber 10 into headers or portions A and B so that different reactants can be fed thereinto, as earlier explained in connection with FIG. 1, through pipes 11 and 12.

Referring now to FIG. 4, there is shown a different form of the invention in which a separator or partition wall 30 separates riser-reactor 6 into two portions. Different reactants can be introduced through pipes 31 and 32 into nozzles 33 and 34 respectively.

Referring now to FIG. 5, there can be seen the arrangement of nozzles 33 and 34 about the wall of the riser-reactor 6.

FIGS. 6, 7, 8 and 9 shown nozzle arrangements for hydrocarbon reactant introduction above distributor header 5 and its nozzled outlets 5'. Numerals 100, 101, 102, 103, respectively for FIGS. 6, 7, 8 and 9 represent spiral nozzled inlets for reactant. Inlet 100 of FIG. 6, spirals inwardly toward the vertical axis of the reactor 6 in a downward direction. Inlet 101 of FIG. 7 spirals inwardly toward the vertical axis of the reactor 6 in an upward direction. Inlet 102 of FIG. 8 spirals outwardly from the vertical axis of the reactor 6 in a downward direction. Inlet 103 of FIG. 9 spirals outwardly from the vertical axis of the reactor 6 in an upward direction. FIG. 10 shows nozzled inlet pipes 104, 105, and 106 which can enter the reactor at an angle from the horizontal but are shown as entering horizontally from different loci around the riser-reactor 6. FIG. 10*a* is a horizontal cross section taken at *a–a* of FIG. 10 showing inlets 104, 105, 106 and their nozzles.

The following gives a comparison between an existing reactor and that reactor modified according to the invention.

Originally in the reactor of FIG. 1, without the added reactant inlets of my invention, the maximum reactants charged through the 240 tubular members mounted on header 5, using the maximum number physically mountable tubes, was 700 barrels per hour of hydrocarbons (fresh plus recycle isobutane to olefins mol ratio of 12:1). With the added inlets of my invention, using 60 additional inlets of the same diameter, the volume of these reactants is increased to produce 875 barrels per hour of additional alkylate of the same quality as originally produced without my additional reactant inlets.

Using smaller nozzles on the original tubes, which allow less reactant flow, the adding of the additional reactant outlets of my invention, using also these smaller nozzles, allows production of the same quantity of alkylate as conventionally made with the larger nozzles, but of higher quality or octane number than originally made.

It will be seen by one skilled in the art in possession of this disclosure that the amount of reactants which can be introduced into the existing riser-reactor has been substantially increased. Further, this increase is accomplished advantageously without undue rise in temperature of the reacting substances because the additional nozzles are at points different from the points at which the tubular members of FIG. 1 terminate.

Reasonable variation and modification are possible within the scope of the foregoing disclosure, the drawing and the appended claims to the invention the essence of which is that there has been provided a method for modifying an existing riser-reactor by placing therearound a chamber and positioning within the wall of the riser-reactor, thus surrounded inlet pipes, tubes or nozzles so that fluid fed to said chamber can be fed therefrom through said tubes, pipes or nozzles into the riser-reactor and that with suitable partitioning different length pipes, tubes and nozzles extended into different portions of the riser-reactor at different levels, as desired, can be effectively employed to carry out a chemical reaction; for example, an alkylation reaction.

I claim:

1. In an alkylation apparatus comprising an acid cooler and a settler, a riser-reactor extending therebetween through which fluid moves from said cooler to said settler and means for conveying fluid from said settler to said cooler, said riser-reactor being suitable for the alkylation of an isoparaffin with an olefin in the presence of an acid moving from said acid cooler through said riser-reactor, reactant injector pipes within said riser-reactor, said pipes communicating with a reactant supply at the base of said riser-reactor, the improvement comprising a chamber surrounding said riser-reactor forming an enclosed space thereabout, a pipe communicating from without the apparatus with the inside of said chamber and at least one opening from said chamber into said riser-reactor for supplying additional fluid from outside the apparatus through said chamber directly into said riser-reactor.

2. The riser-reactor according to claim 1 wherein a plurality of pipes extend inwardly from the riser-reactor wall into the riser-reactor and are in communication with said chamber.

3. An apparatus according to claim 2 wherein there is a separator within said riser-reactor to separate the same into a plurality of sections and there extends respectively into each of said sections a pipe from said chamber.

4. An apparatus according to claim 3 wherein there are at least two pipes communicating from without the apparatus with said chamber, said chamber is partitioned to form two sections, tubular inlet pipes communicate from each of said sections of said chamber with each of the sections formed within said riser-reactor.

* * * * *