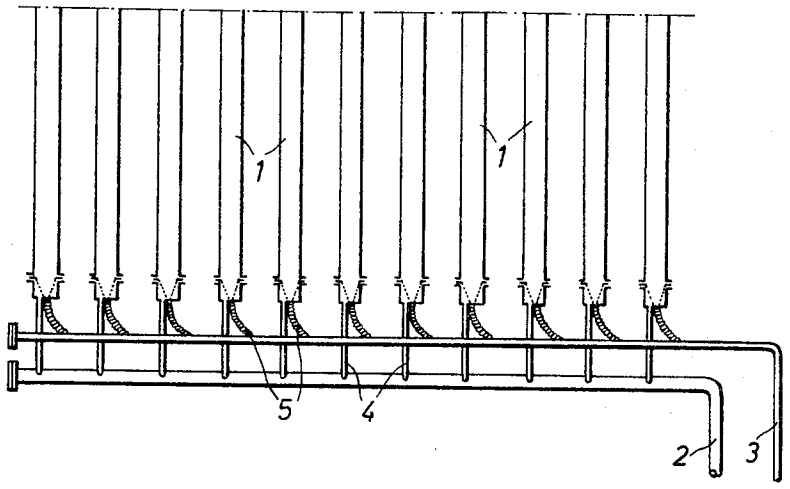
Aug. 23, 1966 J. SELLIN 3,268,435

PROCESS AND APPARATUS FOR ADMISSION TO TUBES IN TUBE HEATERS

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4 Sheets-Sheet 1

Fig.1



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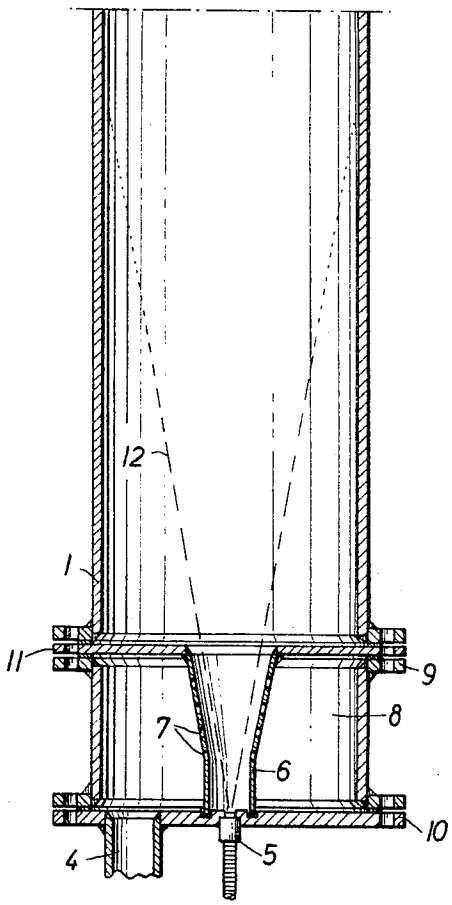


Fig. 2

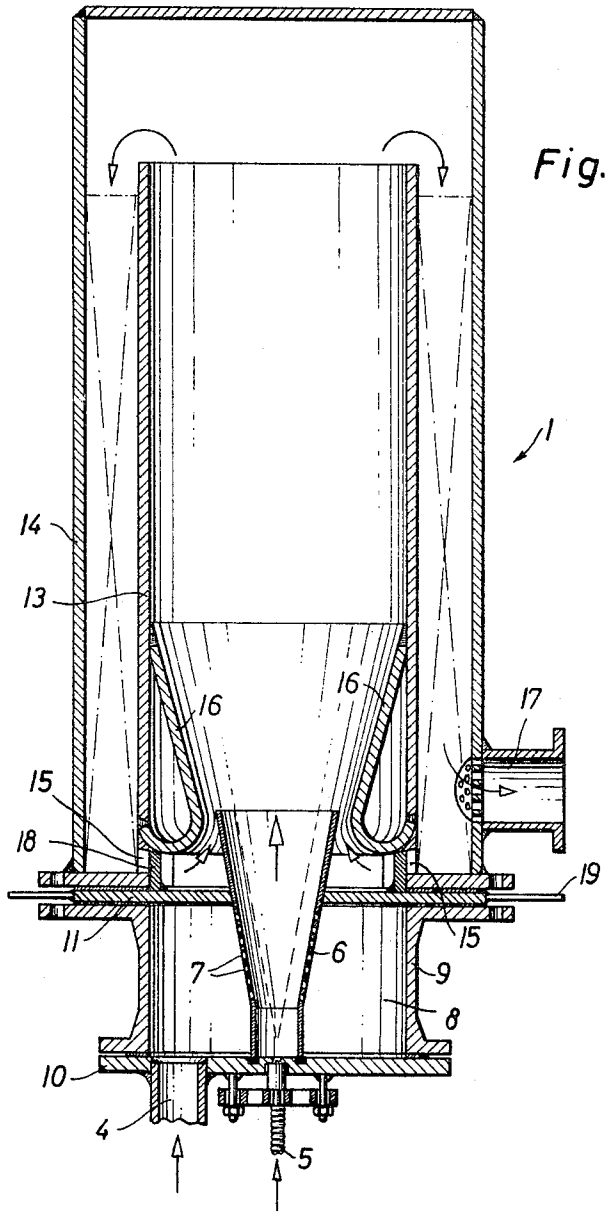
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PROCESS AND APPARATUS FOR ADMISSION TO TUBES IN TUBE HEATERS

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Fig. 3



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PROCESS AND APPARATUS FOR ADMISSION TO TUBES IN TUBE HEATERS

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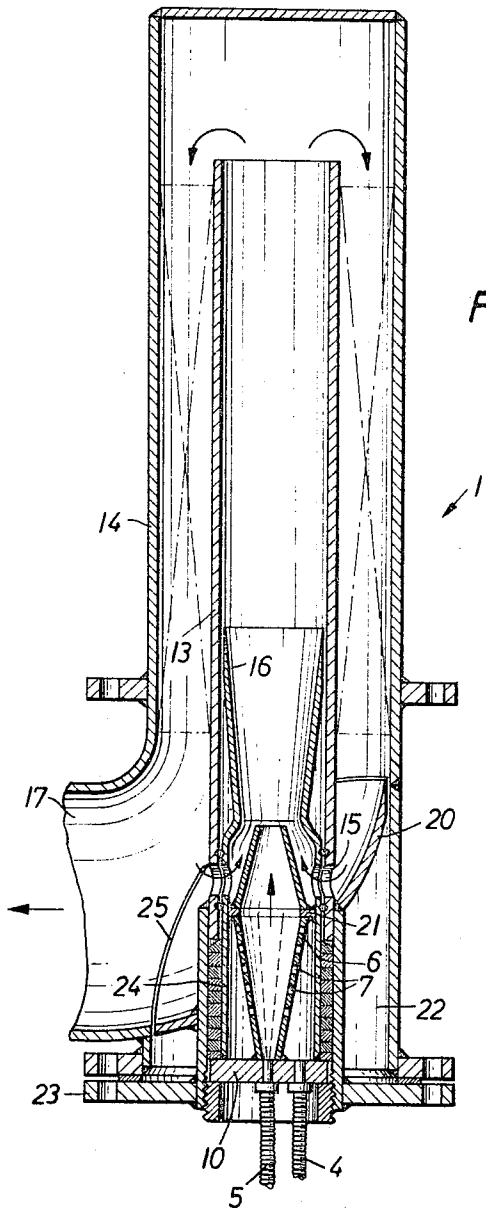


Fig. 4

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PROCESS AND APPARATUS FOR ADMISSION TO TUBES IN TUBE HEATERS

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7 Claims. (Cl. 208—48)

This invention relates to a process for introducing fluid materials into heaters and to suitable apparatus for carrying out process of this character.

In tube heaters equipped with tubes wherein chemical reactions are carried out such as those involved in the cracking of hydrocarbons, it is among other things, of great importance that the admission of the materials to the respective tubes of the tube heater be uniform as far as possible, and independent of changes in the total volume of materials admitted to the heater and of changes in the flow resistance in the heater itself or in the subsequent tube system. This is very important because, for example, through insufficient admission of reactants to a part of the reaction tubes their walls may not be sufficiently cooled, whereby danger arises of unduly overheating the tube and consequently of damaging or even destroying it. There are also certain reactions in which a too great or too slight supply of heat may lead to the depositing of soot and tar or other clogging substances in the tube which may be charged with catalytic material. The effect of this again is conversion losses and interruption of production for more frequently required intervals of regeneration.

To obtain the most uniform admission possible in all tubes of a tube heater, it has previously been proposed, for example in hydrocarbon cracking processes carried out in the presence of steam and air to arrange concentric with the heater axis and immediately above the individual reaction tubes and the heater cover a so-called spin distributor which acts simultaneously as a mixing chamber and distributor. Hereby the various admixed media are each individually adjusted to equal pressure ahead of the mixing chamber and are only then brought together. Next, flexible tubes of equal length and diameter leading from the mixing chamber to each reaction tube are provided so as to achieve equal flow resistances and consequently uniform admission to all tubes.

But since in the case of this known method the pressure difference between the mixing chamber and the interior of the tube is very small even relatively small variables of the individual tubes such for example as differences in density of the catalyst charge or differences in the flow of the discharge will often cause uneven admission to the individual tubes and thereby also the above mentioned disadvantages.

It is furthermore known that the individual reaction tubes may be provided with aperture shutters at their intake end in order to regulate by these means a uniform admission to all tubes, which naturally is very difficult, since without built-in additional control instruments the exactly correct dosage can only be based on results derived from lengthy periods of operation. In addition the relatively insignificant pressure difference between the manifold and the intake ends of the individual tubes offers only a limited throttling range, as both the initial pressure regulation and the mixing of the different reactants in the last described method are understaken outside the heater system, ahead of the manifold. Furthermore in the last described method a new adjustment is necessary each time the total admission to the heater is changed.

In order to avoid the above described shortcomings, it is now according to the present invention proposed that the fluid material or materials to be supplied to the tubes be conveyed to each tube at a considerably higher pressure than the working pressure in the tubes and that the pressure drop of the media to the working pressure in the tubes take place separately for each tube immediately at the intake end of the tube, whereby it has been proven advantageous to have the delivery pressure of the admitted material or materials at least 1.1 times as high as the working pressure in the tubes. According to the invention the pressure difference between the interior of a given reaction tube and the supply pipes discharging directly thereinto is greater than the pressure drop in the reaction tube resulting from variable charging rates or variable inflow or outflow therein. It follows that a much more uniform admission to the individual reaction tubes is achieved, independent of the total admission to the tube heater at the time.

A further serious disadvantage of hitherto known methods of admission to such tube heaters in which several media are supplied to the reaction tubes consists in that undesired reactions would occur even during the mixing of the various media that formerly was effected before the entry of the materials into the reaction tubes, as a result of which, for example, coke formation may occur and thereby the catalyst material that is then usually present at the intake end of the tubes would be clogged, so that the function of certain catalyst layers would be eliminated from the desired reaction at the start.

To counteract this shortcoming, quite frequent regeneration of the catalyst charge was therefore resorted to, by which consequent correspondingly frequent interruptions of operation become necessary. Of course the undesired reactions can be prevented by keeping the preheating of the various reaction media suitably low, for example by heating the steam needed for the cracking of the hydrocarbons to a relatively small degree, whereby however, the total thermal economy of a tube heater so operated in return would entail a serious loss, as then the excess heat produced cannot be completely exploited.

In further use and development of the principles of the present invention these disadvantages can now also be counteracted by delivering each of several media separately into the intake end of the several tubes in such a way that an intensive mixing of the different media takes place at the tube intake end at the same time that the pressure is reduced to the working pressure in the interior of the tubes. In this way it becomes possible without danger of unfavorable side effects, for example in hydrocarbon cracking processes, to supply the necessary steam for the purpose, to the reaction tubes at relatively high temperatures. In addition to the satisfactory exploitation of potentially waste heat associated with heaters operated in this way, there is also especially the advantage of the method according to the present invention, in that a very rapid heating of the reaction mixture to the required maximum reaction temperature occurs, which is of definite advantage and importance for the optimal course of reaction. By addition of the maximally superheated steam, the mixing with the gaseous hydrocarbons is furthermore much facilitated, and as a result of the high heat content, the tendency to water condensation, harmful alike to catalyst and tube walls, that would otherwise occur during the starting period, is avoided. Furthermore since according to the method of the invention a substantially larger portion of the required reaction heat can be delivered by the reaction media themselves, the necessary exchange surfaces of the reaction tubes and consequently of the total heater volume can be considerably reduced.

With delivery of liquid media that are to be vaporized in the tubes, it is advantageous to deliver the media to

the expansion points of the individual tubes at such high pressure that at the prevailing ambient temperature vaporization of the media does not occur ahead of the expansion zones.

Furthermore it is very advantageous if in delivery of a plurality of media the supply of each material to each tube is regulatable, possibly automatically according to a predetermined program, independent of the rate of delivery of the other media.

Hereby, for example, in a hydrocarbon cracking process in which steam and hydrocarbons are delivered separately from individual pipes to catalyst charged tubes, it is possible alternatively to cut off the delivery of hydrocarbons to selected tubes while maintaining normal operation of the remaining tubes, until carbonaceous material deposited on the catalyst charge has been converted to a gaseous state as a result of the continued delivery of steam.

Furthermore, according to the present invention not only is an interruption of operation for needed catalyst regeneration no longer required, but also the carbonaceous material deposited on the catalyst can be made usable again for exploitation in the process by the regasification thereof effected by the highly superheated steam.

Also it can be advantageous to cause the delivery of specific media to all tubes to occur uniformly at specific intervals.

The relocation of the expansion process according to the invention to a point immediately in the region of the intake ends of the individual reaction tubes makes it possible furthermore with very simple means to effect a recycling, that is advantageous in many reactions, of a partial stream of the product of the tubes, solely by means of a suction effect occurring independently in the several tubes due to the expansion of the supplied medium or media at the intake end of each tube.

An arrangement suitable for the carrying out of the process according to the invention is characterized in that an expander device is provided at the intake end of each tube for the conveyance of media to the tube heater in question, the expander device in the case of a plurality of delivered media being constructed to serve at the same time as a mixer.

Hereby, for example, for the expansion and mixing of a liquid material and a gaseous medium, the liquid material may be delivered into a centrally arranged conically widening nozzle the walls whereof may be provided with a plurality of openings and be surrounded by an annular chamber into which the inlet for the gaseous medium empties. It has been demonstrated that with an arrangement of this sort, simultaneously with the expansion of the two separately introduced media an excellent mixing of the said media can be attained immediately at the point of confluence, i.e. within the flaring nozzle.

For achieving the recycling of a partial flow of the product of the respective reaction tubes, there may be provided a very simple and advantageous construction whereby the expander-mixer device of each tube is arranged to deliver the mixture into the intake end of an inner tube of a known counterflow type, and at or adjacent the intake end of the latter, openings in the inner tube are provided, in such relationship to a jet or venturi suction device combined with the expander-mixer that the desired partial flow of the product from the annular chamber between the outer and inner tube is drawn back into the intake end of the inner tube.

In many cases it may be advantageous to make the recycling of the partial flow subject to control for the purpose of adapting to changing conditions. This is possible in a very simple way, by making the size of the recycling openings for the partial flow adjustable.

The invention is explained more fully by examples in the drawings.

FIG. 1 is a diagrammatic view of a tube heater arrangement according to the present invention.

FIG. 2 is a section view of the intake end of one of the reaction tubes according to FIG. 1.

FIG. 3 is a sectional view of a reaction tube constructed as counterflow tube with jet suction device for recycling of a partial flow of the product.

FIG. 4 is a sectional view of a further embodiment of the invention, showing a reaction tube construction as counterflow tube for recycling a partial flow.

The arrangement shown in the drawings is intended for example for the cracking of hydrocarbons, by which process the hydrocarbons in liquid state are supplied to the individual reaction tubes **1** through the common pipe **3** and branch pipes **5** and the steam required for the cracking process is supplied through common pipe **2** and individual branch pipes **4**.

According to the invention, the different media are delivered to the intake end of each tube at a pressure considerably above the working pressure in the tubes and are expanded in each tube separately and at the same time intensively mixed together. Hereby in the arrangement illustarted, supply pipe **5** for the liquid hydrocarbons, advantageously provided with a check valve, empties centrally into a conically widening nozzle **6** whose walls are provided with a plurality of openings **7** and which is surrounded by an annular chamber **8** that is enclosed by tube section **9**, cover plate **10** and an annular plate **11** inserted between tube section **9** and reaction tube **1**, and connected with the end of nozzle **6** extending into tube **1**. Delivery pipe **4** for the steam required for the cracking of the hydrocarbons empties into said annular chamber **8** through cover plate **10**.

It has been found with such an arrangement that simultaneously with the expansion of the different media to the desired working pressure an extremely intensive mixing together of the different media takes place, and that immediately on their confluence inside nozzle **6**, so that the intensively mixed media enter the interior of the tube in a jet.

As fully explained above, on the basis of this arrangement it is furthermore possible to heat the steam delivered through pipe **4** to a very high temperature, without risking undesirable premature reaction, so that considerably less heat will have to be supplied through the walls of the reaction tubes to the reaction media after their entry into the interior of the tube, whereby the number of, or the effective surface area of, such reaction tubes may be considerably reduced. In addition the waste heat from the heaters can be better exploited for the correspondingly high degre of heating of the required steam.

In the counterflow tube unit shown in FIG. 3 and again collectively designated by numeral **1**, the construction of the expanding and mixing arrangement corresponds essentially to the construction shown in FIG. 2. Additional means are provided for delivering a controlled partial flow of the end product of the reaction tube to the intake end of the tube.

The inner tube of the counterflow unit is here provided in the lower part with openings **15** and also nozzle **6** is continued above annular plate **11** so that in connection with narrowing inserts **16** in the interior wall of inner tube **13** by expansion of the supplied media through pipes **4** and **5** an injector effect is achieved in the annular slot between the projecting end of nozzle **6** and inserts **16** by which a partial flow of the end product is sucked back from the annular chamber between inner tube **13** and outer tube **14** of the counterflow unit to the intake end of the inner tube, while the rest of the end product leaves the counterflow unit through outlet pipe connection **17**. In this way the partial flow that is recycled loses practically no heat during the recycling. There is also the additional advantage that the apparatus required for the recycling is reduced to a minimum. To control the recycling partial flow, annular plate **11** is further rigidly connected with a ring **18** which adjoins inner tube **13** on the inside in the area of the recycling openings **15** and is

provided with openings corresponding to said openings **15**. By turning said ring **18** by means of projections **19** on plate **11** the cross section of openings **15** can be optionally reduced and in that way the amount of recycling can be controlled.

The construction shown in FIG. 4 corresponds substantially to the construction shown in FIG. 3, except that the jet suction device is shaped somewhat differently and combined with the device for cotnrol of the recycling partial flow. In addition the arrangement is advantageous in that the entire inner tube can be installed and dismantled without destruction of material such as occurs in parting-off grinding, sawing, etc.

To this end, inner tube **13** is fastened to a detachable flange **23** at the bottom and the lower part of outer tube **14** is constructed as the outlet **17** that extends to one side, by which the wall **20** surrounding inner tube **13** is provided with a parting joint **25**. Space **22** surrounding the parting joint on all sides is sealed in a gastight manner so that a further escape of gases passing through parting joint **25** is impossible. The narrowing insert **16** of the jet suction device is combined with the device for control of recycling openings **15** to form an essentially sleevelike member **24** which has openings corresponding to recycling openings **15** and which is rigidly fastened at the bottom to cover plate **10**. Nozzle **6** is likewise fastened at the bottom to plate **10**, and its upper part is fastened by means of a ring **21** to sleevelike member **24**. By turning cover plate **10** in relation to inner tube **13** the recycling quantity can consequently be controlled on the basis of a changing degree of uncovering of openings **15** by sleevelike member **24**.

A further advantage of the method of the invention also resides in the fact that due to the delivery of the supplied media direction at the reaction tubes at a higher pressure than formerly, the cross sections of the pipes may be considerably reduced, and as a result there is less heat loss from the said pipes.

Of course it is also possible to cause the expansion of the supplied media to occur in the branch pipes to the individual tubes, if the arrangement is so effected that a back pressure and resulting effect on adjacent tubes is avoided. In case of delivery of a plurality of media, the expansion usually accompanied by mixing directly at the intake ends of the tubes will however be preferred.

I claim:

1. Apparatus for carrying out processes of the type involving introduction and admixing of fluid materials into tube heaters comprising: a reaction tube into which fluid materials are fed, said reaction tube having within the intake end thereof a conical shaped nozzle flaring in the direction of the main flowpath, means for introducing one of said materials into the smaller end of said nozzle, a plurality of openings in the walls of said nozzle, an annular chamber surrounding said nozzle, means for delivering fluid material into said annular chamber, an inner counterflow tube in said reaction tube opening in the direction of main intake, the lower end of said counterflow tube extending to some extent around said nozzle, said counterflow tube being provided with openings in the lower portion thereof through which vapors are drawn from said reaction tube into said counterflow tube.

2. Apparatus according to claim **1** wherein means is provided for adjustably regulating the size of said last named openings.

3. Apparatus according to claim **2** wherein said means for adjustably regulating the size of said last named openings is a rotatable annular member.

4. Apparatus according to claim **1** wherein said inner tube is mounted on a detachable flange, the lower portion of said reaction tube being provided with a side opening portion, the wall of said portion being provided with a parting joint.

5. A process for the uniform introduction and intimate mixing of at least two fluids in a pluarity of reaction tube heaters having an inlet and outlet comprising the steps of:

(a) providing two independent sources of fluid at a pressure of at least 1.1 times greater than the normal operating pressure within reaction tube heater;
one of said fluids comprising a superheated steam and the other fluid comprising a volatile material;

(b) connecting said plural tubes independently to said independent sources of fluid whereby the pressure at each tube is substantially the same;

(c) separately introducing said fluids into the inlet of each of said tubes simultaneously, with the superheated steam surrounding said other fluid and mixing axialy therewith and expanding at said inlet to substantially the operating pressure to be maintained in said reaction heater tubes and substantially heating said other fluid prior to volatilization of said other fluid in said reaction heater tubes whereby uniform control of the reaction process is maintained and minimum heating tube sizes can be utilized with a minimum of heat being applied to said reaction heater tubes.

6. The process as claimed in claim **5** including independently adjustably controlling the admission of said intimately mixed fluids into said reaction tube heaters in relation to the operational characteristics of said tubes.

7. The process as claimed in claim **6** including recirculating a portion of the mixed fluids passing through said tubes by introducing the portion of the mixed fluids back into the tube above that portion of the tubes in which the fluids were initially mixed.

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