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COKE PREVENTION IN STEAM CRACKING

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FIGURE 1

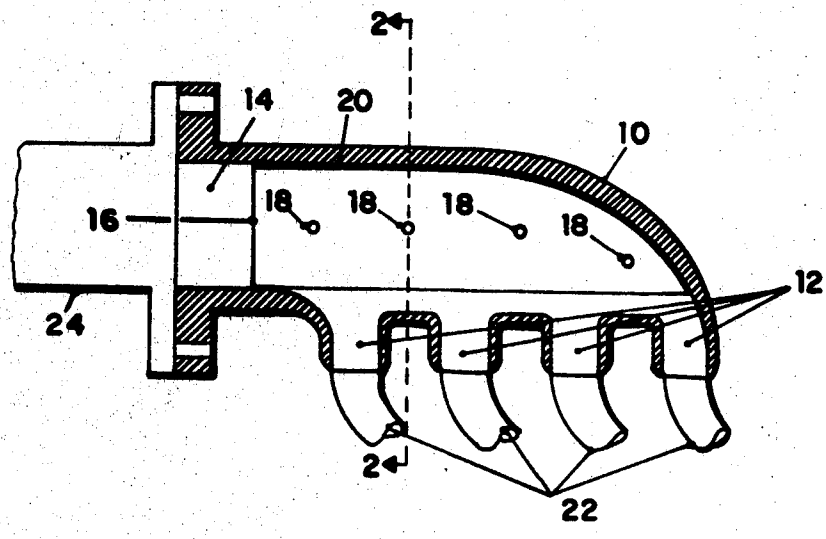
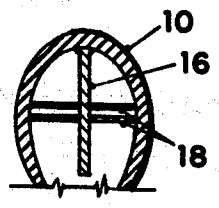


FIGURE 2



Sect. 2-2

N. C. PAMPHILIS
J. A. KIVLEN Inventors

By R. D. Mercadier
Patent Attorney

United States Patent Office

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COKE PREVENTION IN STEAM CRACKING

Nicholas C. Pamphilis, Mendham, and John A. Kivlen, Sparta, N.J., assignors to Esso Research and Engineering Company, a corporation of Delaware

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ABSTRACT OF THE DISCLOSURE

A technique and apparatus is described for lessening the tendency of steam cracker effluents to coke in the process equipment downstream from the steam cracker furnace. A special baffled collection manifold is used on the furnace outlet tubes.

BACKGROUND OF THE INVENTION

This invention relates to steam cracking of hydrocarbons. More particularly, it relates to apparatus for minimizing coking in steam cracking processes. This invention relates especially to collection manifolds used with steam cracking furnaces which greatly lower the extent of coking in process equipment downstream from the furnace.

It is known to react hydrocarbons and steam in a steam cracking furnace. One such process is described, e.g., in U.S. Pat. 2,893,941, issued July 7, 1959, to Kohfeldt et al. In a typical such steam cracking reaction a hydrocarbon is fed with water or steam at considerable velocities through a high temperature reaction zone. A mixed stream of hydrocarbon and steam is preheated and passed through banks or groups of tubes in a high temperature furnace wherein the mixture is elevated to temperatures ranging on the order of from about 1300° F. to about 1800° F., depending upon the specific feeds used and products desired. After the reaction has progressed to the desired degree, the gaseous reaction products are withdrawn from the furnace and rapidly quenched to avoid any further reaction, polymerization, or degradation of the desired products. The time in which the gases remain at cracking temperatures between the furnace and the quenching zone is of critical importance, and, accordingly, the geometry and configuration of the conduit between these two points is extremely important.

To insure that the gases from the various banks or groups of tubes in the furnace are conveyed to the quenching zone in essentially the same time, it is desirable to provide a collection manifold immediately at the outlet of the furnace to combine all of the gaseous streams from the furnace tubes into a single stream and then to convey the single stream to the quenching zone by means of a transfer line.

In a particularly preferred type of collection manifold, the cross-sectional area of the manifold progressively increases in the direction of gas flow so that as the manifold picks up gases from successive banks of furnace heating tubes, the gas velocity through the manifold remains essentially constant. This prevents the formation of stagnant gas areas in the manifold which would permit undesirable reactions and coking in the manifold. Experience has shown, however, that even in the optimum designs of apparatus severe coking is encountered in the downstream lines, e.g., the transfer line from the collection manifold to downstream process equipment. Numerous attempts have been made to prevent coking or to alleviate the degree of coking, e.g., by adding various chemicals or other decoking agents to the process. The addition of such agents is not entirely effective, and also it is sometimes undesirable to have the anti-coking agents present in the products as contaminants.

SUMMARY OF THE INVENTION

It has now been found that by providing a baffle in the collection manifold in accordance with the present invention the coking in the downstream transfer line can be greatly reduced. This invention contemplates the use of a collection manifold for a steam cracking furnace having a baffle positioned to divide the streams of incoming gases from the various tubes of the steam cracking furnace into approximately equal parallel fractions and maintaining these fractions in separate chambers in the collection manifold. The fractions of gases are subsequently recombined at the outlet of the collection manifold as they pass into the transfer line for conveyance to downstream quenching facilities or other process equipment.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be better understood by reference to the accompanying drawings of which:

FIG. 1 is a plan view of the collection manifold of this invention shown in cross-section with the baffle in place and;

FIG. 2 shows a view taken at cross section 2—2 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the figures in detail, therein is shown a manifold body **10** having a number of inlet openings **12** to receive gaseous effluent from the tubes of a steam cracking furnace. A baffle plate **16** is held rigidly in place by a continuous weld **20** along the edge opposite the manifold inlet openings **12**, and spacer rods **18** are attached at points along the baffle to hold it in rigid position within the manifold body. FIG. 1 also shows tubes **22** which connect the manifold inlet openings **12** to the outlet tubes from the steam cracking furnace (not shown). Transfer line **24** is shown in position at the outlet end of the manifold in position to convey gaseous effluent from the manifold to downstream quenching facilities or other process equipment (not shown).

FIG. 2 shows clearly the relationship of baffle **16** with manifold body **10**, dividing the latter into approximately equal sized chambers. Spacer rods **18** are also shown holding the baffle **16** in a stable position to avoid undue wear, vibration, or damage to the baffle.

In the embodiment shown in the figures, the front edge of the baffle **16** is positioned just behind the inlet openings **12** and is aligned so as to divide the openings approximately in half across their horizontal plane. While the baffle should be approximately perpendicular to the inlet openings, variations of 10° either way from the perpendicular have been found acceptable. In general, best results are achieved in reducing coking of downstream equipment if the baffle is positioned to divide the incoming gases from the steam cracking furnace into approximately equal fractions. Preferably, neither fraction should contain more than about 60% of the total gas flow, nor less than about 40%.

The following comparative tests and example illustrate the effectiveness of this invention in reducing the extent of coking in the transfer line downstream from the collection manifold of a vertical steam cracking furnace.

A conventional gas oil feed is preheated and mixed with about ½ lb. steam per lb. of oil and passed through the coils of a conventional vertical steam cracking furnace. The coil outlet temperature of the gaseous product from the furnace is about 1600° F. The hot gaseous effluent passes from the various banks of tubes through connecting tubes into a steel collection manifold identical to that illustrated in FIG. 1, except that it contains no baffle. The gases pass through the manifold and into a transfer line

wherein they are quenched downstream by injection of a stream of cold quench oil in an amount sufficient to reduce the overall product temperature to about 500° F. The quenched product is then conveyed to a distillation tower for separation of the component into various desired products, including, e.g., ethylene, propylene, butadiene, and other olefins and diolefins.

Coking in the transfer line is soon evidenced by the pressure drop of the materials flowing through the line. The coke continues to build up until finally termination of the operation is required. The transfer line is then opened and examination shows extensive coking and plugging of the line both upstream and downstream from the quenching zone.

The collection manifiold is then opened and fitted with a steel baffle, welded into position as illustrated in the figures, dividing the manifold body into essentially equal sized chambers. The manifold is then reinstalled, and steam cracking operations are again commenced in precisely the same manner as previously described. Coking again is evidenced by a gradual build up in pressure drop; however, the rate at which the coke is deposited is much slower than in the previous run made without a baffle in the collection manifold. In fact, the run is continued for a period 80% longer than was previously possible with the unbaffled manifold.

Replicate runs are made, and the total operating time in each case is 50% to 100% longer when the collection manifold is adapted with a baffle compared to the base run made without a baffle.

It has been fairly conclusively established that the astonishing effectiveness of applicant's baffled manifold in lessening the extent of coking in the transfer line results from its virtual elimination of spiral flow of the effluent gases. For example, it is noted that when a baffle is not used, coke is laid down on the walls of the transfer line in a spiral pattern, whereas with the baffle in place, the coke laydown is generally uniform. Furthermore, mock-up tests in transparent scale models indicate, by visual examination, that the gases in the transfer line follow a spiral pattern without the baffle, whereas no spiral pattern is formed when the baffle is used.

It is not entirely certain how the baffled collection manifold of this invention prevents spiral flow; however, it is believed that by dividing the gas stream, dual spirals, which have opposite directions, are formed, and upon recombination, they eliminate each other. Surprisingly, a number of other mechanical devices have been found to be of little or no effect in preventing spiral flow. For example, orifice plates with single or multiple holes have been positioned at the manifold outlets and have been found completely ineffective in preventing spiral flow. Various configurations of straightening vanes have also been used without success.

Spiral flow is a particularly acute problem in the most preferred configurations of collection manifolds, i.e., those having nonuniform, progressively increasing crosssections. Problems are, however, also encountered in cylindrical manifolds of uniform cross-section, and it is contemplated that the unique baffle arrangement of applicants' invention can be used in any conventional manifold configurations.

The reason for the problems encountered in coking when the gaseous streams take on a spiral flow in the transfer line are not entirely clear. However, it is believed that the spiral flow causes heavier components, especially from quench oil, which are more susceptible to coking, to be thrown centrifugally to the walls of the transfer line to form slower moving, or stagnant, zones which are highly susceptible to additional reaction, polymerization, or cracking. Whatever the cause, it is clear that coking is definitely more severe when the effluent gases from the collection manifold take on a spiral flow pattern in the transfer line to the downstream process equipment.

What is claimed is:

1. A method for lessening coking of effluent gases in the transfer line downstream from a collection manifold of a steam cracking furnace which comprises collecting the effluent gases from said furnace at a temperature ranging from about 1300° F. to about 1800° F., dividing the flow of said gases in said manifold into approximately equal parallel fractions, and recombining said fractions prior to quenching of the gaseous effluent, whereby spiral flow of the recombined fractions of gases is avoided.

2. Apparatus for the collection and distribution of gaseous effluent from steam cracking furnaces to downstream processing equipment which lessens coking of said effluent and which comprises:

a manifold body having a plurality of inlets for the entry of said effluent and at least one outlet for the passage of said effluent downstream;

a baffle dividing said manifold body into approximately equal sized chambers, said baffle positioned substantially perpendicular to said inlets whereby said inlets and outlet are in direct and open uommunication with both of said chambers simultaneously;

conduit means for effluent flow from said steam cracking furnace to said inlets; and

transfer line means for connecting said outlet to said downstream process equipment; whereby a fraction of said gaseous effluent from the steam cracking furnace enters each of said chambers through said inlets and then leaves said chambers through said outlet and passes to said downstream process equipment through said transfer line means.

3. The apparatus of claim 2 wherein said baffle is a metallic baffle attached to said manifold body by means of a continuous weld along the edge of the baffle opposite said inlets.

4. The apparatus of claim 3 including spacer rods for maintaining said baffle in rigid alignment with said inlets and outlet.

5. The apparatus of claim 2 wherein said manifold continuously increases in cross-sectional area in the downstream direction.

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DELBERT E. GANTZ, Primary Examiner

C. E. SPRESSER, JR., Assistant Examiner

U.S. Cl. X.R.

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