

[54] **METHOD AND APPARATUS FOR
WITHDRAWING FLUID SAMPLES FROM A
PROCESS STREAM**

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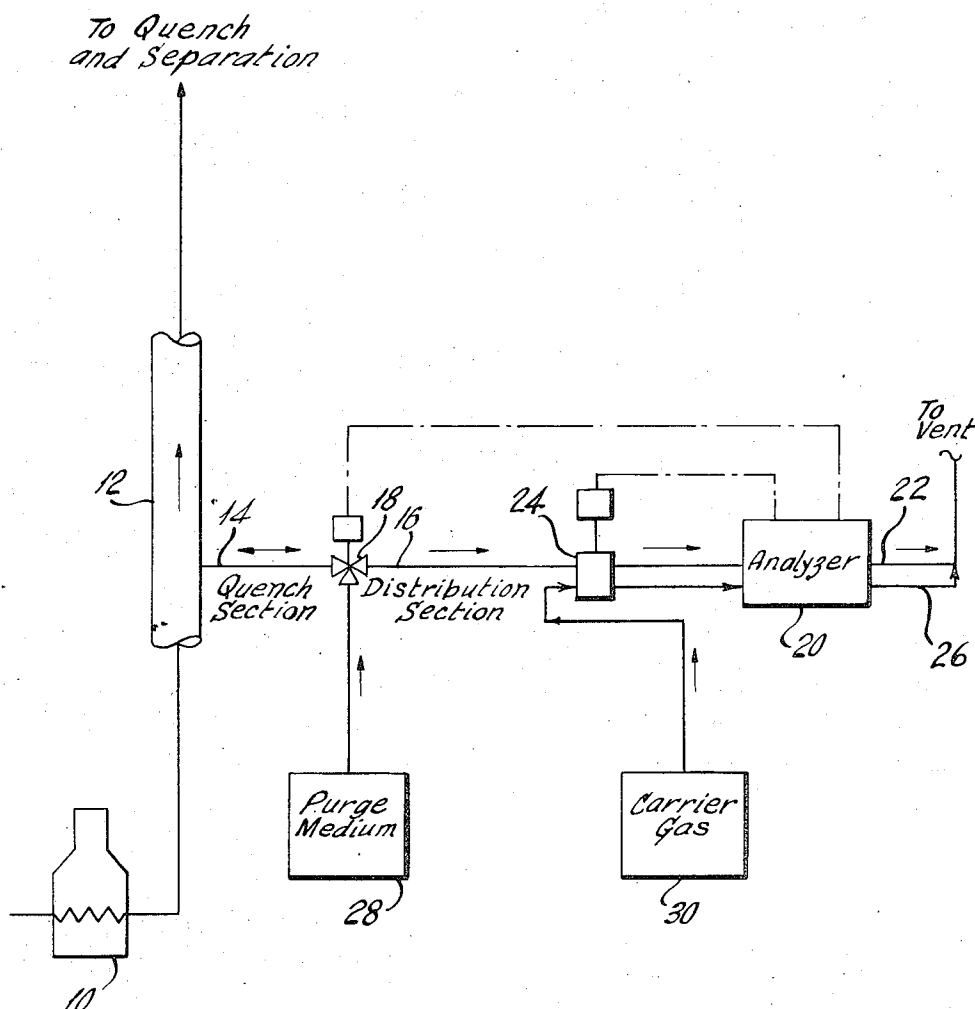
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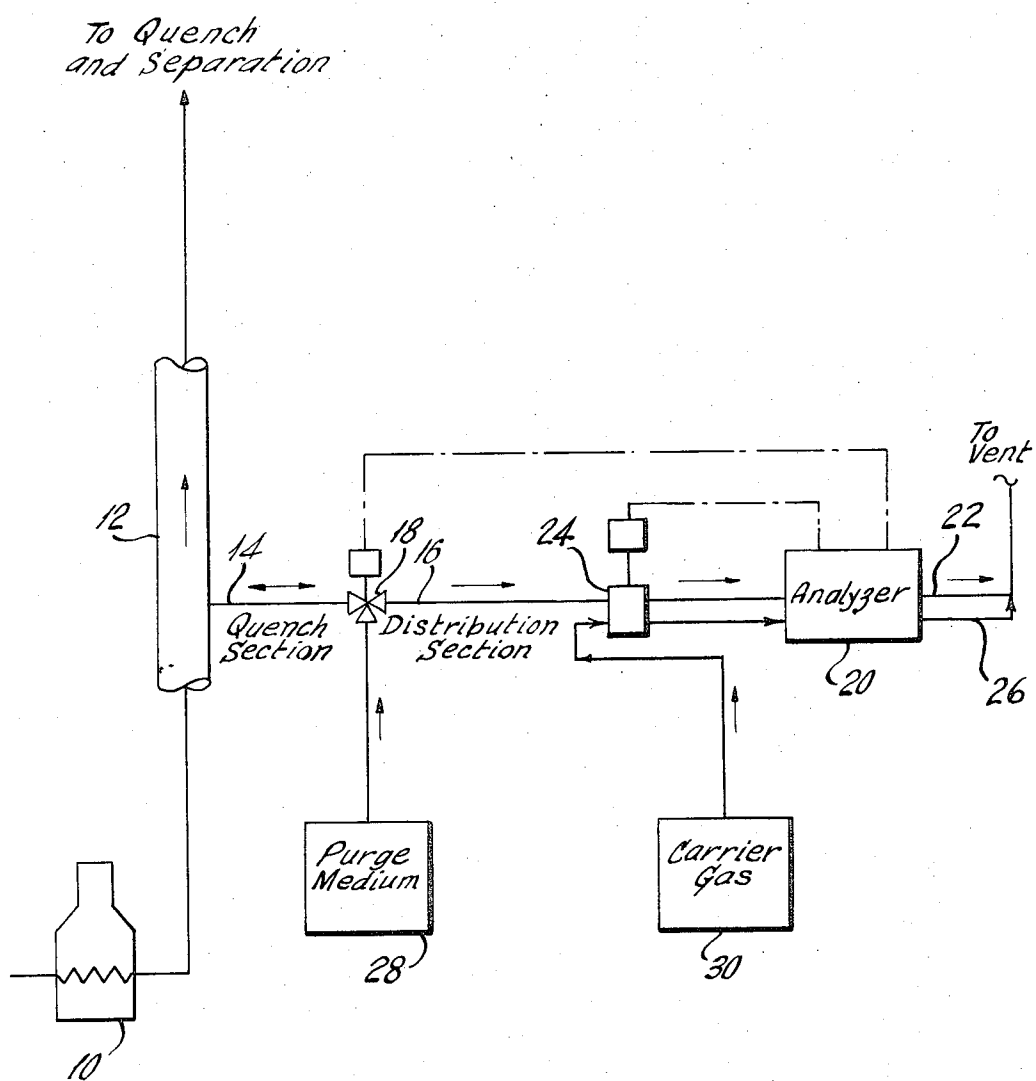
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[57] **ABSTRACT**

A system for sampling a steam cracking furnace effluent by cyclically withdrawing a high temperature sample through small bore tubing, thereby providing a rapid quench without need for an indirect cooling device or a direct contact quench by an extraneous stream. After a sample has been taken, the sample tubing is blown back to remove deposits prior to withdrawal of the subsequent sample.

3 Claims, 1 Drawing Figure





METHOD AND APPARATUS FOR WITHDRAWING FLUID SAMPLES FROM A PROCESS STREAM

BACKGROUND OF THE INVENTION

While the sampling system disclosed herein has been successfully developed for steam cracking processes, it is broadly applicable to many industrial processes. There exists considerable incentive to analyze the effluent of steam cracking furnaces. However, the steam cracking process has presented a difficult sampling problem which has not been satisfactorily resolved by prior art devices. In a typical steam cracking plant multiple furnaces are used in parallel operation to crack hydrocarbons at very high temperatures in the presence of steam to form olefinic products, principally ethylene, propylene, and their homologues. Each furnace has many passes operating in parallel so the degree of cracking may vary among the passes as well as among the multiple furnaces. In order to optimize the steam cracking process, it would be desirable to know the composition of the effluent from each tube of each furnace. Furnace firing and other process conditions could be adjusted in order to yield the most desirable products with the most economically efficient operation. That such samples are not taken in commercial units is only in part due to the cost of making the analysis. The principal reason is that heretofore it has been extremely difficult and expensive to obtain a satisfactory sample for even a single analysis, thus making it impractical to make the multiple analyses which are most desirable.

Since the cracking reaction is very rapid and continues even after leaving the furnace, it is essential that the effluent from the furnace be quenched immediately. This is commonly done prior to the separation of the products. The yield of olefins may be determined indirectly by making elaborate material balances over the entire plant in order to determine what the average composition of the furnace effluents may have been at some previous time. However, a direct analysis of the furnace effluent would obviously be preferred since it could be used for "fine tuning" the furnace operations. To take a sample of the furnace effluent, it is essential to quench the effluent sample immediately in order to duplicate the conditions which are occurring in the plant itself. Materials which would be detrimental to the performance of the analyzer, typically a gas chromatograph, must be removed before analysis. Condensed water and heavy hydrocarbons and carbon formed by coking of hydrocarbons must be removed. In order to do this prior art devices have used complex systems for conditioning samples. Prior art methods have relied on direct water quenching or indirect cooling in order to remove the unwanted components. Such sampling systems are subject to plugging and the maintenance of such sample systems is difficult. What has been desired, but not achieved, is a simple device for obtaining a sample which can avoid the plugging which has been heretofore an exceedingly difficult problem. The sampling system must, however, at the same time satisfy the requirement of quenching the furnace effluent and supplying the analyzer with a properly conditioned sample.

The sampling system disclosed herein has been found to satisfy the requirements which are set forth above and at the same time reduce the cost of the sampling

system, thus making it possible to use it for each steam cracking unit. The approach taken in the design of the sampling system which is the subject of the present invention is contrary to conventional learning in the analyzer field and represents a novel yet simple advance in the state of the art.

SUMMARY OF THE INVENTION

A sampling system which is suitable for extracting samples at high temperatures and under severe conditions from the effluent of steam cracking furnaces cyclically withdraws such a sample through very small bore tubing, thereby providing a quench of said sample without the use of any secondary cooling. The sample is passed through a vent at the analyzer for only a long enough period to purge the line, after which the analyzer admits a small sample for analysis. Subsequent to the withdrawal of the sample by the analyzer, the small bore tubing is blown back by an independent purge medium to remove heavy materials and water condensed from the sample taken and to remove coke which has been laid down by the sample in the tubing adjacent to the process line. The blow back occurs for a long period relative to the time when samples are admitted to the analyzer, thereby maintaining the sample line free to admit a sample when required. The sample tubing will typically have an internal diameter of approximately 1/16 inch, making high velocities possible with only a very small purge rate. The amount of metal in the tubing itself is quite large in relation to the sample passing therethrough and the tubing is thus an excellent heat sink. A rapid quench of the hot sample is obtained.

The use of such small tubing in fouling and coking service is contrary to conventional learning since it would be expected to be quickly plugged and completely inoperative thereafter. It has been found, however, that the use of very small tubing is in fact the key to obtaining a satisfactory sample and enables a very simple but effective system to be applied to this difficult sampling problem.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE illustrates schematically a sampling system according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the single FIGURE, the sampling system of the present invention is illustrated in its preferred embodiment at the outlet of a steam cracking furnace 10. Typical conditions at such an outlet are 1,400°F. and 20 psig. Effluent from the furnace 10 passes through line 12 to the quench and separation facilities (not shown). Line 12 is shown enlarged where the sampling system is connected. The connection may be made in any number of ways, preferably by taking a sample from a probe facing downstream in order to avoid impingement of solid coke particles which may travel through the furnace effluent line. The typical tubing connection 14 will be 3/8 inch OD stainless steel with a heavy wall and an ID of approximately 1/16 inch.

The first function of the sample line is to quench the high temperature furnace effluent in order to stop the reaction so that the analysis obtained is truly representative of the production from the furnace. If no such quenching is done, the cracking reaction continues and

the analysis would be erroneous. In order to provide the quenching, only a relatively short section of tubing is required due to the excellent heat transfer characteristics of such a system. It is typically found that after approximately 6 feet of such tubing, the quenched gas is well below the point at which all reaction has ceased. The quench section 14 extends to a three-way valve 18. It is in the quench section 14 that water and any heavy hydrocarbons will be condensed. They may, in an alternative embodiment, be collected for material balance analysis. However, it has been found that for routine monitoring of the steam cracking furnaces, that a material balance may be ignored. The condensates constitute a relatively small portion of the steam and the remaining gaseous portion is the more essential for analysis and control of the furnace operation. It is felt that the prior art sampling systems, being concerned with complete material balance, accepted as necessary a continuous sampling which led to adoption of elaborate means for minimizing plugging.

Subsequent to the quench section, the gas enters the distribution section of the tubing 16 from which it is admitted to the analyzer for measurement.

Three-way valve 18 is operated by the cycle timer of the analyzer 20 and will open to admit the sample to the distribution section. At first, in order to purge the distribution section of any purge medium which is residual therein, the sample will be passed to the vent 22. Typically this will require about 30 seconds, equivalent to approximately four volume purges of the sampling line. After this time the line will be free of any purge medium and the sample will be suitable for the analyzer.

Sample injection valve 24 will be opened by the cycle timer of the analyzer to admit a small fixed amount of the sample stream to the analyzer for measurement. The gas will enter the analyzer mingled with the usual carrier gas from 30, which is fed on a continuous basis through the analyzer 20 and out to vent 26. Once the sample has been injected into the carrier gas valve 24 will return to its normal mode, i.e., venting the sample gas and valve 18 will close with respect to the distribution section, admitting purge medium from an independent source 28 in order to blow-back the quench section 14 into the steam cracking effluent line 12. This blow-back will clear the quench section 14 of any coke which deposited during the brief sample admission period as well as blow out any condensation of water and heavier hydrocarbons which will normally have occurred. When water reaches the portion of the line which retains heat it will vaporize providing additional velocity, and directionally, some chemical decoking. This purge period continues for a relatively lengthy period until the analyzer has performed its analysis, at which time the three-way valve 18 opens to begin the cycle again by admitting a fresh sample from the furnace effluent line 12 into the quench section 14, distribution section 16, and ultimately to the analyzer 20. While such a sampling system is exceptionally simple, it has been found to perform where prior art devices have failed and to obtain samples for long periods without plugging or fouling of the sample lines. The sample system thus makes possible an analysis of steam cracker effluents without the expense and complexity of sample conditioning systems.

The sampling system which has been disclosed herein has been shown in a simple and schematic form. It may be applied to many other applications other than the

difficult one which has been disclosed herein.

The scope of the invention is more fully disclosed by the claims which follow.

I claim:

1. A system for supplying a sample from a stream flowing in a conduit to an analytical instrument comprising:

a. a sample quenching conduit operatively connected to said flowing stream conduit for providing a passageway between said stream conduit and said analytical instrument, said quenching being of metal and conduit being of metal and having a small internal diameter relative to its outside diameter and a thick wall thereby to admit to said quenching conduit a small sample flow relative to the mass of said conduit and to rapidly quench said small sample flow by heat transfer to said quenching conduit without the use of extraneous coolants;

b. vent means connected to said quenching conduit for discharging said sample stream from said quenching conduit to the atmosphere near said instrument and thereby purging said quenching conduit;

c. sample injection means connected to said quenching conduit at a point near said instrument and before said vent means for admitting a predetermined amount of sample from said quenching conduit into said instrument for analysis;

d. blow-back means comprising a source of purge medium in communication with said quenching conduit and means for admitting said purge medium into said conduit for purging said quenching conduit in a reverse direction relative to the flow of said sample stream and into said flowing stream conduit;

e. cycle timer means operatively connected to said blow-back means, said vent means, and said sample injection means for cyclically providing a sample to said instrument and thereafter reverse purging said conduit into said flowing stream conduit.

2. A method of withdrawing a fluid sample intermittently from a flowing sample stream for subsequent analysis by an analyzer comprising the steps of:

a. admitting a sample stream into a quenching conduit sized to rapidly quench said sample stream by heat transfer to said conduit without the use of extraneous coolants;

b. flowing said sample stream after the quenching of (a) through a distribution conduit communicating between said quenching conduit and said analyzer;

c. venting said sample stream at said analyzer until said quenching and distribution conduits have been purged;

d. admitting a predetermined amount of said sample stream to said analyzer;

e. reverse purging said quenching conduit with a purge medium until step (a) is repeated;

f. cyclically repeating the steps (a) through (e) and thereby periodically providing a supply of quenched samples to said analyzer.

3. The method of claim 2 wherein said sample stream is vented until an amount of sample equal to four times the volume of said quenching and distribution conduits has been vented.