

METHOD FOR REDUCING FOAM IN A PRIMARY FRACTIONATOR

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to a method of operating a primary fractionator, also termed a quench tower, in an ethylene plant with anti-foulants, particularly defoamers.

In the manufacture of lighter hydrocarbon products such as ethylene, heavier hydrocarbons such as naphtha or diesel oil are cracked in pyrolysis heaters at temperatures of approximately 850°C to form mixtures of smaller molecules including, but not limited to, ethylene, propylene, and butadiene. Such mixtures, commonly termed cracked gases, are cooled in various stages of an ethylene plant until they are separated in the fractionation section of the ethylene plant

During primary heat recovery, the cracked gases pass through and are cooled by a series of heat exchangers, also termed transfer line exchangers, before being quenched with a heavy oil. This heavy oil, which is known as quench oil or bottoms quench oil, accumulates in the bottom of the primary fractionator. The primary fractionator contains varying components of fuel oil species ranging from the bottoms of the column to the beginning of what is called the rectification section of the column. The rectification section of the column is prone to severe fouling problems related to species such as styrene, indene, di-vinyl benzene, alpha-methyl styrene, indene derivatives, naphthalene and other higher ring compound derivatives.

The polymerization products of these species deposit at a very rapid rate not only on upper tray surfaces, but also beneath tray surfaces. Due to this fouling problem, an increase in

column pressure drop along with reduction in fractionation efficiencies are experienced. Consequently, the quality of gasoline condensing in the quench water tower and also the quality of fuel oil made from the system are negatively effected. Typically, the problem of fouling in the rectification section is also accompanied by poor viscosity control in the bottom of the quench oil tower due to improper operations of the primary fractionator. The deposition of the fouling species, commonly as polymers, obstructs the vapor and liquid flow inside the fractionator and due to the reduced surface area available, the environment is conducive to increased froth/foam generation in the column. The presence of foam further increases the pressure drop and results in entrainment of higher boiling point products into the lighter products and vice versa. Due to excessive foaming, the column pressure drop increases very rapidly and is a major reason for reduced unit efficiencies.

U.S. Pat. No. 5,800,738 describes a method of inhibiting foam in crude oils remaining after normal refinery processing steps by adding polyisobutylene to a location that is experiencing foaming. U.S. Pat. No. 5,985,940 describes a method of inhibiting fouling in primary fractionators by adding phenol-formaldehyde resin to a hydrocarbon stream.

As fouling continues to occur, the rate of foaming also increases in the column resulting in plant operators having to reduce unit feed rates significantly and, ultimately, shut down the plant for cleaning the primary fractionator.

Disclosed is a method to operate primary fractionators which are fouled due to polymer deposition by providing an appropriate chemical agent to extend run-length of the primary fractionator.

In accordance with a first aspect of the present invention, there is provided a method for operating a fouled quench tower used for primary heat recovery in an ethylene producing plant, comprising the steps of: (a) directing a cracked gas into the quench tower for removal of heat from the cracked gas wherein the cracked gas exits through an overhead of the quench tower; and (b) adding an additive selected from the groups consisting of a polysiloxane, an ethylene oxide-propylene oxide copolymer, a fatty acid ethoxylate, a poly-iso-butylene and a fatty acid ester to the quench tower whereby pressure drop is reduced in the operating quench tower.

In accordance with a second aspect of the present invention, there is provided a method for normalizing a temperature profile in an operating fouled quench tower used for primary heat recovery in an ethylene producing plant, comprising the steps of: (a) directing a

cracked gas into the quench tower for removal of heat from the cracked gas wherein the cracked exits through an overhead of the quench tower; and b) adding an additive selected from the group consisting of polysiloxane, an ethylene oxide-propylene oxide copolymer, a fatty acid ethoxylate, a poly-iso-butylene and a fatty acid ester to the quench tower whereby the temperature profile in the operating quench tower is normalized.

In accordance with a third aspect of the present invention, there is provided the method according to the second aspect further comprised by the step of: c) measuring an operation efficiency of the quench tower based on at least one of liquid-gas contact ratio, feed rate, reflux rate, product top temperature, gasoline end point or pressure differential.

In accordance with a fourth aspect of the present invention, there is provided a method for improving heat recovery in a cracked gas producing plant, comprising the steps of: a) directing a cracked gas into a quench tower for removal of heat from the cracked gas wherein the cracked gas exits through an overhead of the quench tower; and b) adding an additive selected from the group consisting of polysiloxane, an ethylene oxide-propylene oxide copolymer, a fatty acid ethoxylate, a poly-iso-butylene and a fatty acid ester to the quench tower whereby primary heat recovery is improved during subsequent operation of the operating quench tower.

In accordance with a fifth aspect of the present invention, there is provided the method according to the fourth aspect further comprised by the step of: c) measuring an operation efficiency of the quench tower based on at least one of liquid-gas contact ratio, feed rate, reflux rate, product top temperature, gasoline end point or pressure differential.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 illustrates data for Example 1 in which the feed rate, reflux rate, and column pressure of a primary fractionation column are plotted against time.

Fig. 2 illustrates data for Example 2 collected at in which column pressure for a quench tower is plotted against time.

DETAILED DESCRIPTION OF THE INVENTION

The present invention includes methods for reducing foam in primary fractionators which are experiencing diminished operation efficiencies due to deposits of polymerized hydrocarbon species. The invention comprises the step of adding a foam reducing amount of a foam reducing composition at the primary fractionator. A reduction in foaming is achieved whereby the operational efficiency of the process is improved based upon operation parameters including, but not limited to, liquid-gas contact ratio, product top temperature, pressure differentials, gasoline end point or combinations thereof.

The preferred foam reducing composition is a polysiloxane. A representative polysiloxane useful in the present invention is dimethyl polysiloxane. This is a commercially available chemical which can be purchased, for example, from Dorf Ketal Chemicals India Pvt. Ltd. Other suitable foam reducing compositions include, but are not limited to, ethylene oxide—propylene oxide copolymers, fatty acid ethoxylates, poly-iso-butylenes and fatty acid esters. Suitable examples of these compounds are also available from Dorf Ketal Chemicals India Pvt. Ltd.

The foam reducing composition may be added to the process in neat form, or in any suitable solvent. Representative solvents may be aromatic in character and include, but are not limited to, toluene, xylene, naphtha. It is preferred that the foam reducing composition be

applied either upstream of the particular site experiencing foaming problems or directly to the site of the foaming problem. Specifically, the deposit reducing composition may be added continuously or periodically to the primary fractionator reflux. Primary fractionators may themselves include internal components including ripple trays, sieve trays, bubble cap trays, valve trays

The preferred polysiloxane described above may be applied to the process at end use concentrations ranging from 0.0001% to 0.1% with 0.0005% to 0.0025% being the preferred range (all percentages herein are expressed on a weight/weight basis). These percentages convert into working dosage rates of 1 part per million to about 1000 parts per million hydrocarbon. Specific dosages may be determined by the conditions existing in the particular process. Although the most preferred range for a polysiloxane is provided, it is understood that the present invention is not to be limited by the specific compound or concentration set forth herein. It is further envisioned that the present invention may be applied to the process along with other hydrocarbon treatment agents such as corrosion inhibiting compositions.

The following examples are provided in order to more clearly illustrate the present invention, and while being illustrative, are in no way meant to be construed as limiting the scope of the present invention.

Example 1

An ethylene production plant utilizing naphtha in the production of light hydrocarbons including ethylene, propylene, and butadiene experienced fouling of the primary fractionator

resulting in reduction of column efficiencies even when operated at lower than normal feed rates. Considering the loss of column efficiencies indicated by higher column pressure drop and increased gasoline end point even at 20% reduced plant feed rates, the plant operators contemplated shutting the unit down to clean the column.

However, the present invention was practiced on the respective process in order to achieve acceptable operational parameters and the utility of the present invention was thusly demonstrated. An anti-foaming agent comprising a polysiloxane was injected along with the reflux to the column. The particular agent was dimethyl polysiloxane available from Dorf Ketal Chemicals India Pvt. Ltd. and was fed into the column so as to achieve a working concentration of approximately 100 parts per million.

Within a few hours of using the anti-foaming agent, column pressure drop was reduced as shown in Fig. 1. It was observed that during the fouled condition, the gasoline end point had increased by 20°C, which was also reflected in the color of the respective gasoline. The fouled condition resulted in a brownish colored gasoline in contrast to gasoline normally having a yellowish green coloration. After the polysiloxane compound was injected into the reflux, the plant operators subsequently observed that the color of the gasoline was restored to its normal yellowish green color, along with reduction in gasoline end point indicating improvement of the column operations.

Fig. 1 illustrates the data associated with this experiment wherein time is provided on the X axis and the kilograms per hour of feed rate and reflux mass are provided on the left hand Y axis. In addition, pressure drop in kilograms per centimeter² is provided on the right hand

Y axis. Arrow A indicates the initial injection of the polysiloxane compound into the reflux. Column pressure was measured, as indicated on the X axis. A dramatic reduction in column pressure is evident from the data presented in graphic form.

Example 2

A plant experienced fouling problems due to increased column pressure drop. The pressure drop in this plant operated at normal values of 0.07 to 0.08 kilograms per centimeter². However, the fouling problems resulted in much elevated values ranging from 0.135 to 0.15 kilograms per centimeter². With the fouling problem, reduced feed rates and reflux rates were observed although the pressure drop in the column remained high.

In order to avoid a costly shut down of the manufacturing facility, the plant operators utilized the present invention wherein polysiloxane was injected into the quench oil tower at an injection rate of 10 to 20 parts per million based on column reflux rates. The specific polysiloxane utilized was identical to that of Example 1.

Within hours after the initial injection of the anti-foam, operators observed column pressure reduced to a value of approximately 0.109 kilograms per centimeter² while the column feed rates improved from 175 tons per hour of naphtha to 184 tons per hour of naphtha. During the same time period, reflux rates increased from 20 tons per hour to 30 tons per hour. The improvement in column operations are shown in Fig. 2 in which sampling times are indicated along the X axis and column pressures are indicated in kilograms per centimeter² on the Y axis.

While the invention has been described with reference to preferred embodiments, those skilled in the art will appreciate that certain substitutions, alterations and omissions may be made without departing from the spirit of the invention. Accordingly, the foregoing description is meant to be exemplary only and should not limit the scope of the invention set forth in the following claims.

CLAIMS

What is claimed is:

1. A method for operating a fouled quench tower used for primary heat recovery in an ethylene producing plant, comprising the steps of:
 - a) directing a cracked gas into the quench tower for removal of heat from the cracked gas wherein the cracked gas exits through an overhead of the quench tower; and
 - b) adding an additive selected from the groups consisting of a polysiloxane, an ethylene oxide-propylene oxide copolymer, a fatty acid ethoxylate, a poly-iso-butylene and a fatty acid ester to the quench tower whereby pressure drop is reduced in the operating quench tower.
2. The method according to claim 1 wherein the additive is introduced into the quench tower to achieve a dosage in the range of about 0.01 parts per million to about 5000 parts per million.
3. The method according to claim 1 wherein the additive is introduced into the quench tower in a reflux flow.
4. The method according to claim 1 wherein the additive is continuously introduced into the quench tower in a reflux flow.
5. The method according to claim 1 wherein the additive is periodically introduced into the quench tower in a reflux flow.

6. The method according to claim 1 wherein the additive further includes a solvent selected from the group consisting of toluene, xylene and naphtha.
7. The method according to claim 1 wherein the polysiloxane is dimethyl polysiloxane.
8. The method according to claim 1 further comprised by the step of:
 - c) measuring an operation efficiency of the quench tower based on at least one of liquid-gas contact ratio, feed rate, reflux rate, product top temperature, gasoline end point or pressure differential.
9. A method for normalizing a temperature profile in an operating fouled quench tower used for primary heat recovery in an ethylene producing plant, comprising the steps of:
 - a) directing a cracked gas into the quench tower for removal of heat from the cracked gas wherein the cracked gas exits through an overhead of the quench tower; and
 - b) adding an additive selected from the group consisting of polysiloxane, an ethylene oxide-propylene oxide copolymer, a fatty acid ethoxylate, a poly-iso-butylene and a fatty acid ester to the quench tower whereby the temperature profile in the operating quench tower is normalized.
10. The method according to claim 9 wherein the additive is introduced into the quench tower to achieve a dosage in the range of 0.01 parts per million to 5000 parts per million.
11. The method according to claim 9 wherein the additive is introduced into the quench tower in a reflux flow.

12. The method according to claim 9 wherein the additive is continuously introduced into the quench tower in a reflux flow.

13. The method according to claim 9 wherein the additive is periodically introduced into the quench tower in a reflux flow.

14. The method according to claim 9 wherein the additive further includes a solvent selected from the group consisting of toluene, xylene and naphtha.

15. The method according to claim 9 wherein the polysiloxane is dimethyl polysiloxane.

16. The method according to claim 9 further comprised by the step of:

c) measuring an operation efficiency of the quench tower based on at least one of liquid-gas contact ratio, feed rate, reflux rate, product top temperature, gasoline end point or pressure differential.

17. A method for improving heat recovery in a cracked gas producing plant, comprising the steps of:

a) directing a cracked gas into a quench tower for removal of heat from the cracked gas

wherein the cracked gas exits through an overhead of the quench tower; and

b) adding an additive selected from the group consisting of polysiloxane, an ethylene oxide-propylene oxide copolymer, a fatty acid ethoxylate, a poly-iso-butylene and a fatty acid ester to the quench tower whereby primary heat recovery is improved during subsequent operation of the operating quench tower.

18. The method of claim 17 wherein the additive is introduced into the quench tower to achieve a dosage in the range of 0.01 parts per million to 5000 parts per million.

19. The method according to claim 17 wherein the additive is introduced into the quench tower in a reflux flow.

20. The method according to claim 17 wherein the additive is continuously introduced into the quench tower in a reflux flow.

21. The method according to claim 17 wherein the additive is periodically introduced into the quench tower in a reflux flow.

22. The method according to claim 17 wherein the additive further includes a solvent
10 selected from the group consisting of toluene, xylene and naphtha.

23. The method according to claim 17 wherein the polysiloxane is dimethyl polysiloxane.

24. The method according to claim 17 further comprised by the steps of:

c) measuring an operation efficiency of the quench tower based on at least one of liquid-
gas contact ratio, feed rate, reflux rate, product top temperature, gasoline end point or
15 pressure differential.