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Walker

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[54] **PROCESS FOR ON-STREAM DECOKING OF VAPOR LINES**

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[51] **Int. Cl.**[2]... **C10G 9/16**

[58] **Field of Search**........................ 208/48, 127, 53; 260/683 R

[56] **References Cited**

UNITED STATES PATENTS

2,326,525	8/1943	Diwoky	208/48 R
2,934,489	4/1960	Canevari	208/48 R
3,592,762	7/1971	Blaser et al.	208/127
3,732,123	5/1973	Stolfa et al.	134/19

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[57] **ABSTRACT**

Coke deposited in hydrocarbon vapor conduits as the result of hydrocarbon cracking operations is removed from the conduits without interrupting the cracking operation by periodically contacting the coke deposit with a jet of relatively cold high pressure water. The water is jetted against the coke deposit and in an amount sufficient to thermally shock and break up the coke deposit at a pressure in excess of about 5,000 psig.

9 Claims, No Drawings

PROCESS FOR ON-STREAM DECOKING OF VAPOR LINES

BACKGROUND OF THE INVENTION

In the process of carrying out hydrocarbon cracking operations such as those involved in fluid coking operations, coke or carbon is gradually deposited in the vapor conduit leading from the reaction equipment. Eventually, these coke deposits seriously restrict the flow of hydrocarbon vapors from the reaction zone causing the pressure in the reaction zone to increase to dangerous levels. Consequently, when a dangerous pressure level is reached, the reactor must be shut down and the coke deposit cleared from the conduit.

Coke deposition on the inner surfaces of product vapor cyclone outlet lines of fluid coker reactors has been a problem for some time. In a hydrocarbon cracking operation, such as fluid coking or pyrolysis, the product vapors are usually removed overhead through a cyclone located in the upper portion of the reactor. Since these vapors leaving the reaction zone are at or near their dew or condensation point, they will condense on any cooler surface. Such surfaces are usually those of vapor lines or conduits which conduct the vapors from the reaction zone to accessory equipment, such as a fractionator. This condensation and subsequent coke deposition is particularly serious on surfaces having temperatures of about 700°F. to 1,000°F. The continual buildup of coke in these product transfer lines causes the pressure drop to increase to intolerable levels which require shutdown and cleaning as noted above.

In fluid coking units, one proposed solution has been to inject finely divided hot coke particles into the dispersed phase to prevent coke deposition and condensation by heating the vapors and scouring deposited coke from the cyclone. This method has been used extensively. However, it has proved to be difficult to operate and has not been entirely successful in eliminating coke deposition in the cyclone outlet nozzle. Other on-stream methods have been suggested for overcoming coke deposition in the discharge nozzle and vapor transfer lines. U.S. Pat. No. 2,934,489 suggests injecting a controlled small amount of oxygen-containing gas into the cyclone to combust a portion of the product vapors for the purpose of raising the temperature of the inner surfaces of the discharge lines so that coke deposition is prevented. This procedure is not desirable since products of combustion enter the hydrocarbon vapor stream. U.S. Pat. No. 2,326,525 suggests positively preventing the building up of coke deposits in vapor lines by periodically forcing a plunger equipped with rotating spray nozzles through the buildup of material in the vapor line while spraying oil under pressures in the order of 1,500 to 2,000 pounds at a rate of about 75 to 150 gallons per minute through each of four nozzles. The plunger or "knocker" is used to push through tarry materials or break off hardened coke. By supplying the oil under such pressures and at such rates, it is possible to wash the tarry or soft formations from the vapor riser and to scour the walls of coke deposits which may have become baked thereof. The operation is conducted on a once or twice a day basis for two to three minutes. This method would not be satisfactory for large-scale commercial fluid coking or pyrolysis operations because such quantities of spray oil when injected into the cyclone discharge nozzle would

seriously disrupt the coking or pyrolysis operations by flashing off large amounts of vapors in the vapor line. This in turn would seriously disrupt the coking operation by causing a substantial increase in pressure in the reactor and the fractionation equipment. Such a pressure increase could cause shutdown of the reactor and damage to the fractionation equipment. To avoid this situation the feed rate to the reactor would have to be substantially reduced to compensate for added vapor volume to fractionator. Conducting such a cyclic operation at a frequency of once or twice every 24 hours would be highly undesirable from an operational standpoint. Such severe fluctations would not only adversely effect the reactor, but also all downstream refining equipment.

SUMMARY OF THE INVENTION

It is, therefore, a primary object of the present invention to provide a process for on-stream removal of coke deposits from vapor cyclone discharge nozzles and hydrocarbon vapor lines.

A further object of the present invention is to provide a process for removing solid coke deposits while on-stream without adversely effecting the coking or pyrolysis reaction, the reactor and accessor and downstream refining equipment.

These and other objectives are accomplished according to the present invention by periodically contacting the carbon deposit with a jet of high pressure, relatively cold water. It has been found that for a 7,000 BPD fluid coking unit a relatively small quantity of cold water, preferably between 30 and 40 gallons per minute, delivered at a pressure in excess of about 5,000 psi will thermally shock the coke deposit, break the deposit into pieces and blow the pieces from the nozzle without adversely effecting the coking or pyrolysis operation. The quantity of water will vary somewhat depending on the size of the fluid coking unit, however, the quantity of water must be sufficient to effect a sudden rapid change in the coke temperature. It is desirable to reduce the amount of feed to the fluid coking unit during the jetting period by an amount approximately equal to the volume of water which would be vaporized during the jetting operation. The foregoing procedure has been successfully accomplished on a large-scale, 7,000 barrel per day fluid coking unit which has heretofore had to be shut down to manually remove coke deposits from the cyclone discharge nozzle. In tests conducted on this unit, the on-stream decoking operation is accomplished in about 30 to 60 minutes at about four to six-month intervals.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The process hereinafter described is described in conjunction with a conventional 7,000 BPD fluid coking unit. Such a coking unit includes a reactor having a cyclone separator through which the cracked hydrocarbon vapors are passed to remove fluid coke particles prior to the vapors entering a fractionator. Fluid coking reactors generally operate at pressures of less than 50 psi. This particular reactor is normally operated at a pressure of less than 20 psi with the maximum reactor pressure being about 25 psi. The pressure drop through a clean cyclone is normally about 1 to 4 psi. As coke deposition occurs in the cyclone discharge nozzle, this pressure drop is allowed to increase to about 10 to 12 psi at which time the coke deposit must be removed in order to avoid over pressuring the reactor. Thus, when the pressure drop increases to about 10 to 12 psi, a lance is inserted through a nozzle in the side of the reactor wall and into the vapor cyclone discharge nozzle. The lance contained two small oppositely-opposed holes through which the water jet is caused to be directed at the coke deposit on the inner surfaces of the discharge nozzle. These holes are preferably sloped to the rear of the lance at an angle of about 5° so as to cause the coke pieces to blow out of the nozzle in the direction of normal hydrocarbon vapor flow. Prior to injecting water, the pitch feed rate to the reactor is decreased by approximately 1,000 barrels and the steam rates are reduced somewhat to compensate for the volume of vaporized water which is to be carried overhead to the fractionator. Water at a temperature of about 50°F. to 70°F. is fed to the lance under pressure. The water rate and pressure are increased until a water rate of 30 to 40 gallons per minute and a pressure of from about 6,000 to about 7,000 psi are attained, at which time the coke deposit will break up and be blown from the nozzle. As soon as the coke deposit is removed, a rapid decrease in the cyclone pressure drop will be experienced and the pressure drop will return to its normal operating range in the order of 1 to 4 psi. The lance is then withdrawn and the coking operation returned to normal. The following examples better serve to illustrate the decoking operation in a 7,000 barrel per day fluid coking unit.

EXAMPLE 1

The fluid coking unit was operating at a rate of about 6,324 barrels per day with a cyclone pressure drop of 9.4 psi. The following tabulated sequence of steps were used to successfully reduce the pressure drop to 3.9 psi:

TABLE 1

Time	Unit Conditions and Procedures		
9:00 a.m.	Unit Conditions:		
	Pitch Rate	4,349	bbl/day
	Lower Attrition Steam	2,634	lb/hr
	Stripping Steam	2,247	lb/hr
	Hot Coke Riser Steam	2,085	lb/hr
	Cyclone Δ P	6.15	psi
	Reactor Pressure	12.0	psi
9:13 a.m.	Inserting lance at 6 gal/min water flow rate		
9:15 a.m.	2″–3″ in cyclone outlet nozzle, 30 gal/min at 4,500 psi, 15.0 psi reactor, 6.5 cyclone Δ P		
9:20 a.m.	4″ in nozzle, rotating lance, 35 gal/min at 6,500 psi		
9:53 a.m.	3″ in nozzle, rotating, 35 gal/min at 6,500 psi		
10:06 a.m.	9″ in and out, rotating lance, 35 gal/min at 6,500 psi		
10:14 a.m.	7″ in nozzle, 35 gal/min at 6,500 psi		
10:56 a.m.	9″ in nozzle, 35 gal/min at 6,500 psi		
10:59 a.m.	11″ in nozzle, rotating lance		
11:06 a.m.	Felt obstruction disappear		
11:09 a.m.	13″ something gave way, rotating lance felt obstruction at 14″ in nozzle		
11:12 a.m.	16″ in nozzle something gave way		
11:16 a.m.	14″ in nozzle, lots of chunks hitting lance		
11:20 a.m.	2.5 psi on cyclone Δ P, now Δ P loss. 3.0 psi big chunks hitting quench tower wall on south-east side		
11:35 a.m.	Moving 11″ to 17″ rotating with lance in down-ward position		
11:40 a.m.	20″ in		
11:49 a.m.	Out idled		
12:02 p.m.	35 gal/min at 6,500 psi 14″–16″, rotating and probing with lance		
12:17 p.m.	Backing out, rotating lance		
12:18 p.m.	Out and idled		
6:00 a.m.	Pitch Rate: 6,270 bbl/day, cyclone Δ P: 3.9 psi		

From the above data, it is evident that the coke could not be successfully removed until the water flow rate reached about 35 gallons per minute at 6,500 psi.

EXAMPLE 2

This example presents a log of a second decoking operation conducted approximately four months after the previous decoking operation.

TABLE 2

Time	Unit Condition and Procedure		
10:00 a.m.	Unit running at full rate with the following Readings:		
	Pitch	6,603	bbl/day
	Attrition Steam	3,879	lb/hr
	Stripping Steam	2,770	lb/hr
	Hot Coke Riser Steam	3,948	lb/hr
	Cyclone ΔP	8.5	psi
	Reactor Pressure	20.0	psig
10:02 a.m.	Started reducing pitch and steam rates to obtain 17 psig reactor pressure		
11:45 a.m.	Unit lined out at 17 psig reactor pressure Readings:		
	Pitch	5,751	bbl/day
	Attrition Steam	3,449	lb/hr
	Stripping Steam	2,329	lb/hr
	Hot Coke Riser Steam	3,384	lb/hr
	Chunk Line Steam Reduced	800	lb/hr to 0
	Cyclone Δ P	7.4	psi
1:20 p.m.	Began removing plug for installation of lance		
1:48 p.m.	Lance in place ready to open hot tap valve		
1:53 p.m.	Lance inside valve, started water at five gallons per minute. Cyclone Δ P decreased one psi briefly and returned to 7.4 psi		
1:55 p.m.	Twelve gallons per minute, 500 psi. Now at tip of nozzle		
1:56 p.m.	Now about two inches inside nozzle. Cyclone Δ P increases to 7.9 psi		
1:57 p.m.	Increased water to 15 gallons per minute and 1,000 psig. Reactor pressure now 20 psig. Rotating lance at 2″ into nozzle		
2:00 p.m.	Increase water to 24 gallons per minute and 2,500 psig at about 2″ into nozzle. Sudden drop in cyclone Δ P to 5.2 psi. Reactor pressure now down to 18 psig. Operators next to tower report no sounds heard		
2:02 p.m.	Increase water to 31 gallons per minute and 3,500 psig. Rotating at inlet		
2:03 p.m.	33 gallons per minute and 4,500 psig		
2:06 p.m.	35 gallons per minute and 5,500 psig still at inlet		
2:07 p.m.	Moving in 4″. Surge drum level very high. Reducing pitch rate to 5,110 barrels per day to correct level		
2:08 p.m.	Operators report hearing chunks hit wall but no change in Δ P		
2:09 p.m.	Moving into nozzle a total of 6″. Hear another chunk hit the wall. Sudden drop in Δ P to 2.9 psi. Reactor pressure now 15 psig. Operators make corrections to increase reactor pressure		
2:11 p.m.	36 gallons per minute and 6,000 psig water. Move in total of 7.5 inches. 9″ to go to back wall		
2:15 p.m.	Encountered coke 2″ from metal. Heard more chunks and got a further reduction in Δ P of 0.2 psi. Adjusting steam rates back to normal		
2:17 p.m.	Still at 36 gallons per minute and 6,000 psig water. Moving lance out of nozzle. Rotating lance		
2:24 p.m.	At valve, 12 gallons per minute		
2:26 p.m.	Water turned off		
2:46 p.m.	2.5 psi Δ P, the measuring is satisfactory		
3:10 p.m.	Increasing feed rate to normal		
4:15 p.m.	Unit returned to rates running at 10:00 a.m., Cyclone Δ P = 2.4 psi		

From the above log, it is evident that some minor decoking occurred at about 2,500 psi, however, the coke removal did not successfully begin until a water flow rate of 35 gallons per minute at a pressure of about 5,500 psi had been attained.

It will be appreciated that various modifications and changes may be made in the process of the invention by those skilled in the art without departing from the essence thereof. Therefore, the invention is to be limited only within the scope of the appended claims.

What is claimed is:

1. A process of removing coke deposits from hydrocarbon vapor conduits while continuously passing hydrocarbon vapors through the conduit which comprises contacting the coke deposit with a jet of relatively high pressure water, said water being jetted at a pressure in excess of about 5,000 psi, and at a rate sufficient to thermally shock the contacted coke deposit, whereby the contacted coke is broken into pieces and blown from the conduit.

2. The process as defined by claim **1** wherein the water is jetted at a pressure of from about 6,000 to about 7,000 psi.

3. The process as defined by claim **1** wherein the water is jetted at a temperature of from about 50°F. to about 70°F.

4. The process as defined by claim **1** wherein the water is jetted at a rate of from about 30 to about 40 gallons per minute.

5. The process as defined by claim **1** wherein the water is jetted at a pressure of from about 6,000 to about 7,000 psi, at a temperature of from about 50°F. to about 70°F. and at a rate of from about 30 to about 40 gallons per minute.

6. The process as defined by claim **1** wherein the water is jetted at a pressure of about 6,500 psi and at a rate of about 35 gallons per minute.

7. The process as defined by claim **1** wherein the water is jetted at a pressure of at least about 5,500 psi and at a rate of about 35 gallons per minute.

8. The process as defined by claim **1** wherein the hydrocarbon vapor conduit is the cyclone discharge nozzle of a fluid coker.

9. The process as defined by claim **1** wherein the water is jetted into the cyclone discharge nozzle of a fluid coker at a pressure of from about 6,000 to about 7,000 psi, at a temperature of from about 50°F. to about 70°F. and at a rate of from about 30 to about 40 gallons per minute.

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