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Description

The present invention relates to delayed coking. In particular, this invention relates to a process for minimizing the quantity of coke produced in a delayed coking process.

Delayed coking is a process in which heavy oil is rapidly heated in a coker furnace and then passed to a reaction zone comprising one or more coke drums. There, the heavy oil undergoes cracking and condensation reactions, resulting in coke and a full boiling range of oils and gases which are then subjected to fractionation in a coker fractionator.

The goal in a delayed coking process is to minimize the quantity of low value coke while maximizing the quantity of liquid product output. Traditionally, to minimize the quantity of coke formed, the pressure in the coke drum is set at minimum levels. In today's delayed cokers, the minimum practical pressure level is 6.89×10^4 to 1.03×10^5 Nm⁻² (10 to 15 psig). To achieve lower pressures requires large and expensive equipment with high compression requirements.

As an alternative to lowering the pressure, the same result can be achieved by operating the process at a lowered effective pressure, which is achieved by lowering the partial pressure of the heavy oil in the coke drum.

Most delayed coker processes use water or steam in the coker furnace to increase the velocity of the heavy oil through the furnace and to reduce the formation of coke within the furnace. This water or steam also reduces the oil partial pressure in the coke drum slightly, but to use the steam for this purpose would be impractical because expensive high-valued, high-pressure steam is required to increase the velocity of the oil and to reduce the formation of the coke.

U.S. Patent Specification No. 3,956,101 discloses a process for producing high grade needle-shaped cokes which comprises:

charging a raw material oil into a coking drum,
reforming the charged raw material oil in the coking drum by heating the oil at a temperature of from 300° to 400° C under a pressure of from 2mmHg to 3 atmospheres for from 0.5 to 10 hours,
coking the reformed raw material oil by heating the oil in the coking drum at a temperature of from 400° C to 500° C under a pressure higher than atmospheric pressure while blowing a non-oxidizing gas selected from vaporized hydrocarbon oil, hydrogen, nitrogen and steam heated at a temperature higher than that of the reformed raw material oil by at most 300° C into the bottom of the coking drum through the oil until coking of the reformed raw material oil has been substantially completed, thereby simultaneously heating and agitating the

reformed raw material oil within the coking drum to secure uniform heating of the reformed raw material oil, removal of excess heat generated in the coking drum and promotion of crystal orientation of the coke to be produced, and

decoking the product thus produced.

U.S. Patent Specification No. 4,036,736 discloses a process for producing synthetic coking coal which comprises delayed coking a heavy hydrocarbon oil by:

heating the oil in a furnace to a coking temperature of from about 380 to about 500° C sufficient to initiate cracking,

introducing the heated oil into a coking drum,

maintaining the heavy hydrocarbon oil in the coking drum for a time ranging from 30 minutes to about 36 hours at the coking temperatures to effect coking thereof; introducing a diluent gas into the body of the oil in the cooling drum at a flow rate greater than 51/hr kg of oil to maintain the partial vapor pressure of the cracking product vapor over the oil in the coking drum at about 50 to about 600 mm Hg during coking, and

recovering a synthetic coking coal having a free swelling index greater than 4 and containing 20 to 40% by weight of volatile matter. The diluent gas typically comprises an inert gas such as nitrogen, steam, water or a hydrocarbon gas recovered from the coking process.

In the case of water injection, additional fuel must be fired to provide the heat necessary to produce the steam within the coker furnace. In addition, this steam leaves the coker unit eventually as sour water which, in order to be disposed of, must first be treated.

As a result, the quantity of steam or water injected into the coker furnace has conventionally been limited to only that amount of steam or water required to maintain the velocity of the heavy oil and reduce coking in the furnace tubes. Similarly, certain instruments and valves are purged with steam, but again the rate is set at the minimum required to meet the purging requirements.

The delayed coking process is such that large amounts of waste heat can be recovered in the fractionation portion of the process. Some of this heat is available at high and useful levels. Some of it is at such a temperature as to be useful only for producing low pressure steam. Frequently, this steam is in excess and is of little or no value.

The present invention provides for using this low value heat, or low value heat from another process, to provide an inexpensive source of steam or other heated fluid that can be used to reduce the partial pressure of the heavy oil in the coke drums and thereby the amount of coke formed therein.

According to the present invention there is

provided a method for reducing coke formation in a delayed coking process carried out in a coker unit comprising a coker furnace, a coke drum and a coker fractionator, which method comprises:

heating heavy oil to coking temperature in the coker furnace,

passing the heated oil to the coke drum where coke and overhead vapors are formed, and

passing the overhead vapors to the fractionator, which method further comprises introducing into the coke drum a fluid in an amount sufficient to lower the partial pressure of the heavy oil in the coke drum, characterised in that the fluid is heated with heat recovered from the coking process.

One of the advantages of this invention is that fluids already present in the delayed coking process, such as sour water recovered from the coker fractionator, or other fluids, can be used to reduce the partial pressure of the oil in the coke drum and thereby achieve decreased coke yields. Heat available within the delayed coking process, which is of low value otherwise, is used to preheat the fluids to be used in the coke drum. Consequently, lower than normal coker furnace outlet temperatures may be used by introducing superheated fluid into the coke drum. The superheated fluid is preferably obtained by passing the fluid through the coker furnace.

In one preferred embodiment, the heated fluid is sour water, recovered from the coker fractionator.

In another preferred embodiment, the heated fluid is steam, which can be superheated by passing the fluid through the coker furnace.

The invention will now be described by way of example with reference to the accompanying drawings in which;

Figure 1 is a schematic flowsheet illustrating the basic method of the invention, and

Figures 2 to 5 are schematic flowsheets illustrating preferred embodiments of the basic method of the invention.

Referring to Figure 1, fresh coker feedstock, which can be preheated from a means not shown, is introduced into the bottom of the coker fractionator through line 1.

The invention is particularly useful when oils having an API gravity of about 15 degrees or heavier are coked. Typical feedstocks to which the invention is especially useful include vacuum residues, asphalts and coal tar pitches.

Feed which has been stored in the coker fractionator is withdrawn via line 3 and fed into the coker furnace where the oil is heated to coking temperature.

Generally, the coker furnace will operate at a temperature ranging from 475°C to 525°C and a pressure of 1.03×10^5 to 5.17×10^5 Nm⁻² (15 to

75 psig). Preferably the temperature will range from about 490°C to about 510°C and the pressure will range from 1.38×10^5 to 3.45×10^5 Nm⁻² (20 to 50 psig).

The oil is then transferred via transfer line 5 to one of several coke drums 6 and 7, where the oil is coked.

The coke drums are maintained at a coking temperature generally ranging from 415°C to 470°C and a pressure from 6.89×10^4 to 2.41×10^5 Nm⁻² (10 psig to 35 psig). The temperature and pressure preferably range from 435°C to 455°C and 1.03×10^5 to 1.72×10^5 Nm⁻² (15 psig to 25 psig, respectively).

More than one coke drum is used so that when one of the coke drums is full of solid coke, the feed can be switched to another drum. The full drum is then cooled and emptied by conventional methods.

Vapors leaving the coke drums via line 8 are returned to the fractionator. These vapors are fractionated to produce desired products including heavy coker gas oil, light coker gas oil, overhead naphtha and overhead gases. Overhead gases are recovered through line 10, heat exchanger 12, knock-out drum 14 and line 15. Coker naphtha is recovered through lines 16 and 17. Light coker gas oil is recovered through line 18. Heavy coker gas oil is recovered through line 20 and sour water is recovered through line 11.

According to this invention, as generally shown in Figure 1, low pressure steam or heated fluid is introduced via line 9, into transfer line 5 and/or directly into coke drums 6 and 7 through lines 21 and 22.

The heated fluid introduced into the coke drums to lower the effective pressure of the oil can be generally be any fluid, including water, sour water, steam, gases, naphtha, or other material which can be vaporized by low level heat. Preferably, the fluid is a gas at 15°C (60°F) and atmospheric pressure. Most preferably, the fluid is water, sour water, naphtha or steam.

The fluid is preferably heated according to the invention using low level heat from the coker fractionator. This can be accomplished through conventional heat exchange processes known in the art.

The fluid is generally heated so that it will not adversely lower the temperature of the coke drums. Generally, this temperature ranges from 415°C to 535°C and preferably from 480°C to 510°C. Alternatively, heated fluid product of the fractionator can be used directly. The fluid can also be superheated by being passed through the coker furnace.

Generally, the amount of the fluid introduced into the coke drums depends upon the type of fluid and the processing conditions. Preferably, the amount of fluid introduced into the drum ranges

from 0.57 Kg mols/m³ (0.2 lbmols/bbl) of fresh feed to 14.27 Kg mols/m³ (5.0 lbmols/bbl) of fresh feed.

In a preferred embodiment of the invention, shown in Figure 2, sour water, recovered from the fractionator, through lines 10, 11 and 23, is heated using reflux from line 13 and then introduced through line 9 into transfer line 5 and/or directly into coke drums 6 and 7 through lines 21 and 22.

In another preferred embodiment of the invention, shown in Figure 3, sour water from line 23 is converted to steam using column 24 with heat from reflux line 13, which exchanges with recycle in line 26.

In yet another embodiment, shown in Figure 4, the steam from column 24 can be superheated by passing it through line 25 and the coker furnace. The superheated steam allows for the use of a lower outlet temperature from the coker furnace for the oil transferred via line 5.

Figure 5 demonstrates the use of other fluids, such as naphtha, which is withdrawn from the fractionator through lines 10, 16, 17, 23, and 9.

Other embodiments are included within the scope of this invention and this invention is not intended to be limited by the foregoing description but only by the following claims.

Claims

1. A method for reducing coke formation in a delayed coking process carried out in a coker unit comprising a coker furnace, a coke drum and a coker fractionator, which method comprises:
 - heating heavy oil to coking temperature in the coker furnace,
 - passing the heated oil to the coke drum where coke and overhead vapors are formed, and
 - passing the overhead vapors to the fractionator, which method further comprises introducing into the coke drum a fluid in an amount sufficient to lower the partial pressure of the heavy oil in the coke drum, characterised in that the fluid is heated with heat recovered from the coking process.
2. A method as claimed in Claim 1 in which the fluid is sour water recovered from the fractionator.
3. A method as claimed in Claim 2 in which the sour water is converted to steam in a stripping tower.
4. A method as claimed in Claim 3 in which the steam is superheated by being passed through the coker furnace.

5. A method as claimed in Claim 1 in which the fluid is naphtha recovered from the fractionator.
6. A method as claimed in Claim 1 in which the fluid is steam.
7. A method as claimed in Claim 1 in which the fluid is a gas at 15 °C (60 °F) and atmospheric pressure.
8. A method as claimed in any preceding Claim in which the fluid is introduced in an amount ranging from 0.57 to 14.27 kg mols/m³ (0.2 lbmols/bbl to 5 lbmols/bbl).

Revendications

1. Procédé pour la réduction de la formation de coke dans un procédé de cokéfaction différée effectué dans une unité de cokerie comprenant un four de cokerie, un réservoir à coke et une tour de fractionnement de cokerie, ledit procédé comprenant :
 - le chauffage d'huile lourde à la température de cokéfaction dans le four de cokerie ;
 - le passage de l'huile chauffée dans le réservoir à coke où du coke et des vapeurs de tête sont formés ; et
 - le passage des vapeurs de tête dans la tour de fractionnement,
 ledit procédé comprenant en outre l'introduction, dans le réservoir à coke, d'un fluide dans une quantité suffisante pour abaisser la pression partielle de l'huile lourde dans le réservoir à coke, caractérisé par le fait que le fluide est chauffé par de la chaleur récupérée à partir du procédé de cokéfaction.
2. Procédé selon la revendication 1, dans lequel le fluide est de l'eau acide récupérée à partir de la tour de fractionnement.
3. Procédé selon la revendication 2, dans laquelle l'eau acide est convertie en vapeur d'eau dans une tour de rectification.
4. Procédé selon la revendication 3, dans lequel la vapeur d'eau est surchauffée par passage à travers le four de cokerie.
5. Procédé selon la revendication 1, dans lequel le fluide est du naphta récupéré à partir de la tour de fractionnement.
6. Procédé selon la revendication 1, dans lequel le fluide est de la vapeur d'eau.

7. Procédé selon la revendication 1, dans lequel le fluide est un gaz à 15 °C (60 °F) et à la pression atmosphérique. lbmols/bbl bis 5 lbmols/bbl) reicht, eingeleitet wird.
8. Procédé selon l'une quelconque des revendications précédentes, dans lequel le fluide est introduit dans une quantité se situant dans la plage de 0,57 à 14,27 kg moles/m³ (0,2 livre moles/baril à 5 livres moles/baril).

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Patentansprüche

1. Verfahren zum Reduzieren der Koksbildung in einem Verfahren zum verzögerten Verkoken, das in einer Kokereinheit ausgeführt wird, die einen Kokereiofen, eine Kokstrommel und einen Koker-Fraktionierturm aufweist, welches Verfahren umfaßt:
- Erhitzen von Schweröl auf die Verkokungstemperatur im Kokereiofen, 15
- Leiten des erhitzten Öls zur Kokstrommel, wo Koks und Kopfdämpfe gebildet werden, und 20
- Leiten der Kopfdämpfe in den Fraktionierturm, welches Verfahren ferner die Einleitung eines Fluids in einer ausreichenden Menge zur Absenkung des Partialdrucks vom Schweröl in der Kokstrommel in die Kokstrommel umfaßt, **dadurch gekennzeichnet,** 25
- daß das Fluid mit aus dem Verkokungsprozeß rückgewonnener Wärme erwärmt wird. 30
2. Verfahren nach Anspruch 1, in welchem das Fluid aus dem Fraktionierturm rückgewonnenes saures Wasser ist. 35
3. Verfahren nach Anspruch 2, in welchem das saure Wasser in einer Rektifizierkolonne in Dampf umgesetzt wird. 40
4. Verfahren nach Anspruch 3, in welchem der Dampf überhitzt wird, indem er durch den Kokereiofen geleitet wird.
5. Verfahren nach Anspruch 1, in welchem das Fluid aus dem Fraktionierturm rückgewonnenes Naphtha ist. 45
6. Verfahren nach Anspruch 1, in welchem das Fluid Dampf ist. 50
7. Verfahren nach Anspruch 1, in welchem das Fluid ein Gas auf 15 °C (60 °F) und Atmosphärendruck ist. 55
8. Verfahren nach einem vorhergehenden Anspruch, in welchem das Fluid in einer Menge, die von 0,57 bis 14,27 kg mols/m³ (0,2

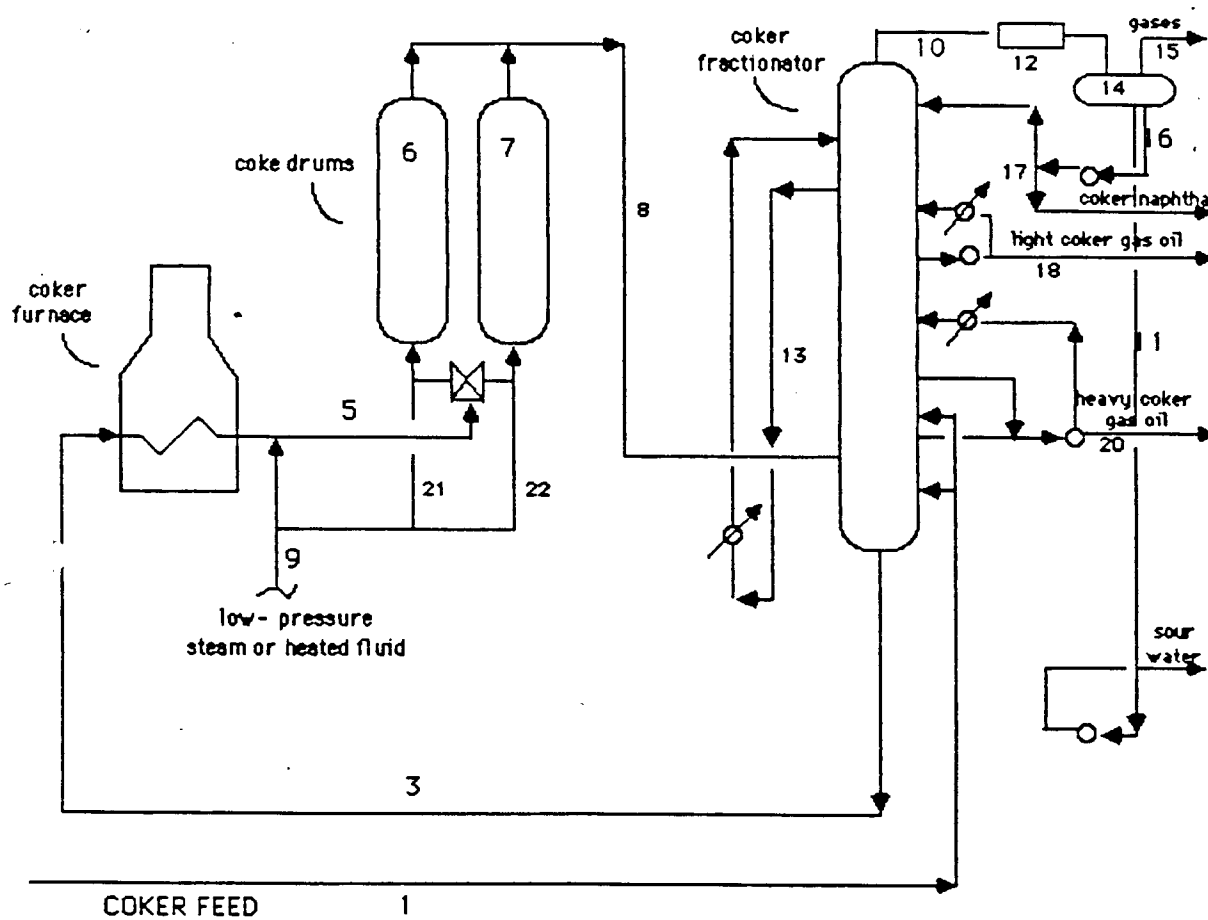


figure 1

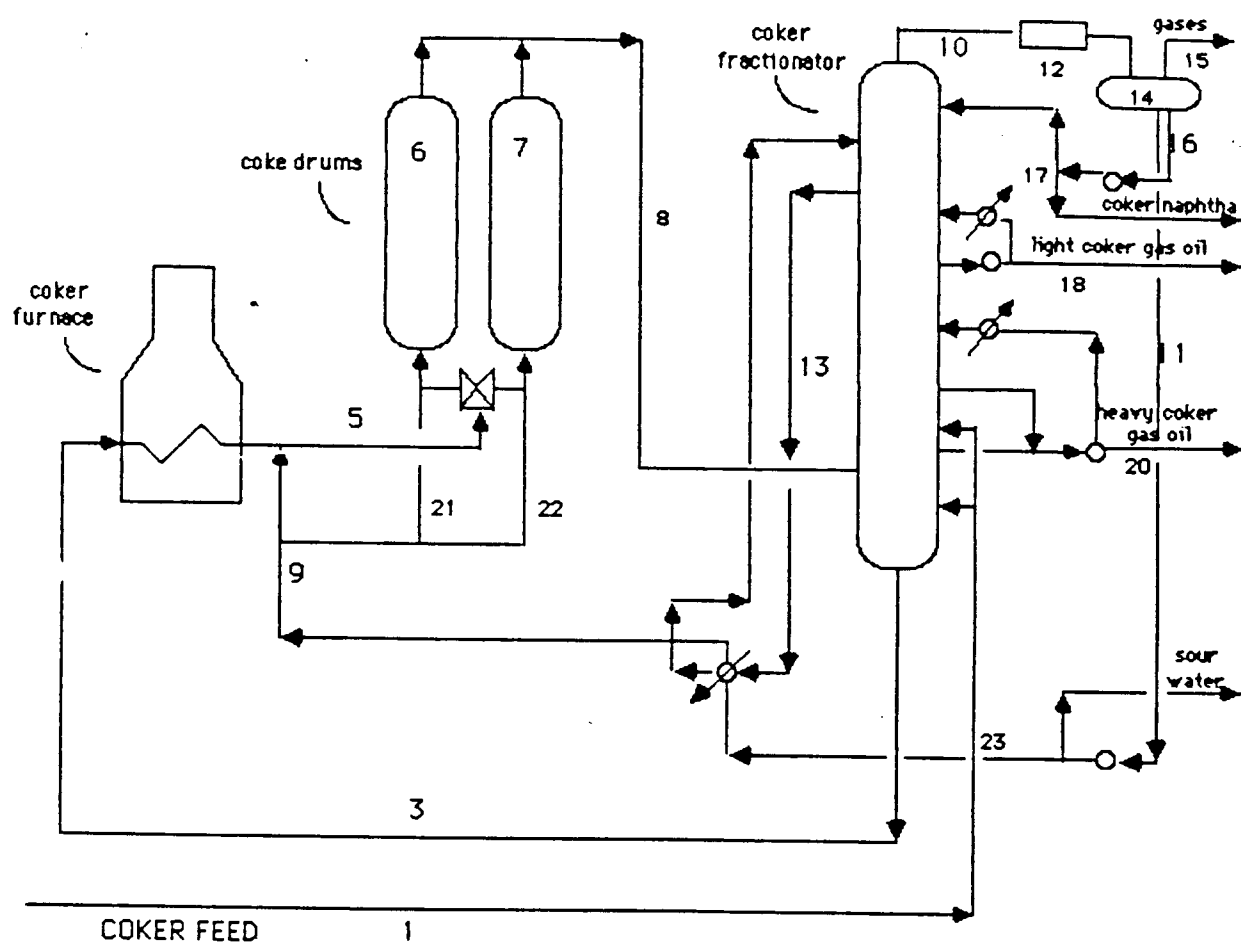


figure 2

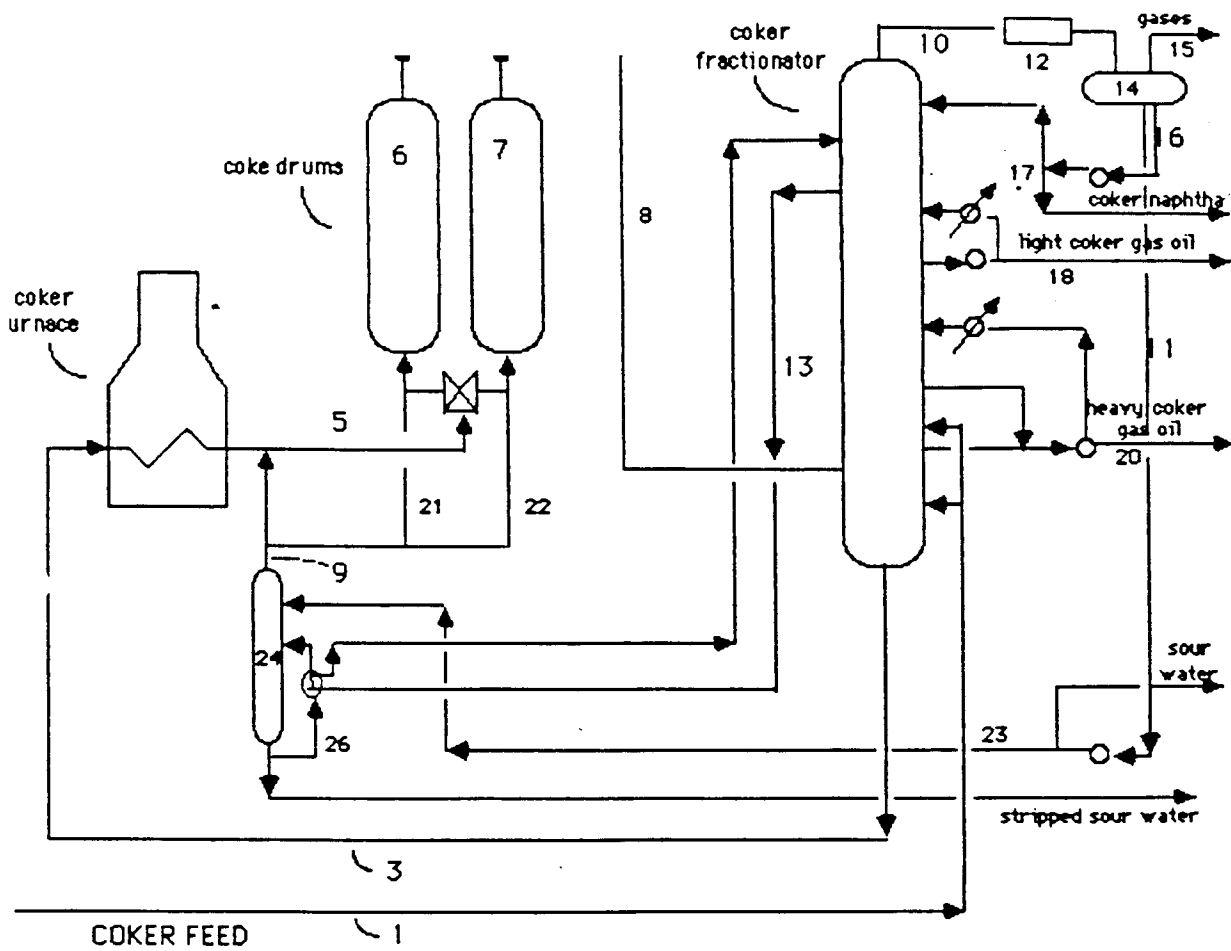


figure 3

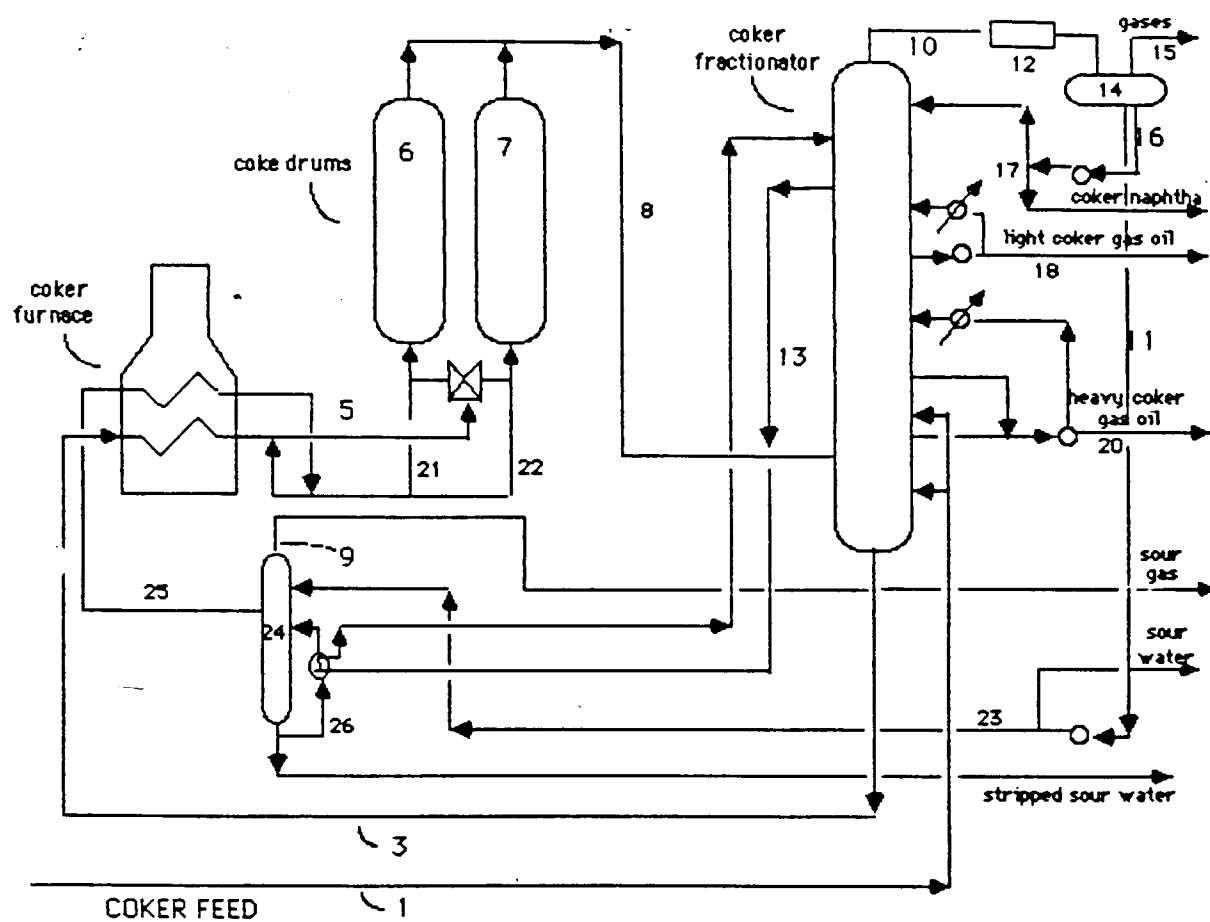


figure 4

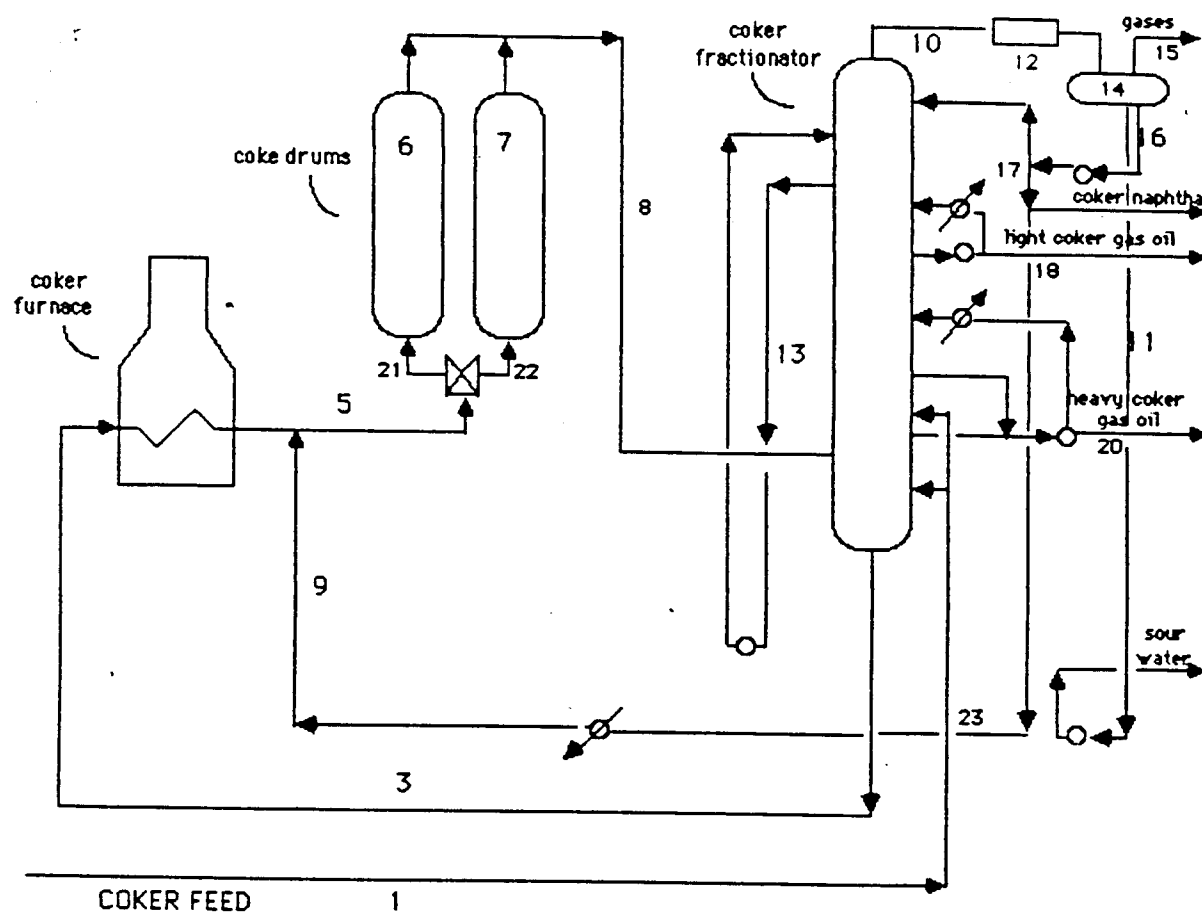


figure 5