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Analysis of gas condensate and its different fractions of Bibiyana gas field to produce valuable products

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Abstract

Physicochemical characteristics of raw gas condensate from Bibiyana gas field, commercial motor spirit, kerosene and diesel fuel as well as products obtained from gas condensate were determined. Experiments were carried out to take apart motor spirit, kerosene and diesel from gas condensate based on boiling ranges. The analysis revealed that collected gas condensate contains more than 50% is motor spirit (regular octane/petrol) in the boiling range of 21-145^{0}C, 23% is kerosene in the boiling range of 140-221^{0}C and 24-25% is diesel in the boiling range of 178-335^{0}C. Remaining 2-3% is found as residue and system loss. The characteristics of different fractions (Motor spirit, Kerosene & Diesel) obtained from condensate are very comparable to commercial products (collected from nearby fuel pump station supplied by Meghna petroleum) and BSTI standard except two properties of petrol (octane number and sulfur content). The octane number of motor spirit is increased by adding 5% of supper octane or ethanol or MTBE.

Key words: Bibiyana gas field; Gas condensate; Boiling range; BSTI; Motor spirit (Petrol); Kerosene; Diesel; MTBE & Super octane

Introduction

Condensate is a low density, high API gravity colorless or light yellow liquid hydrocarbons which is generally found with natural gas. Internal temperature and pressure of the reservoir allows it to be in liquid form. The natural gas condensate is also referred to as simply condensate or gas condensate or sometimes natural gasoline, because it contains hydrocarbons within the gasoline boiling range.

There are hundreds of wet gas field worldwide and each has its own unique gas condensate composition. Natural gas condensate is typically composed of hydrocarbons ranging from C_4 to C_{15} in which mainly contain 25-95 % by wt of C_6, C_7 and C_8 organic compounds. In natural gas condensate comprises hexane, cyclohexane and benzene as C_6 hydrocarbon; heptane and toluene as C_7 hydrocarbon where as octane, ethyl benzene and xylenes consider as C_8 hydrocarbon. Natural gas condensate also has minor amount of C_5 (5-7% by wt) as pentane and other hydrocarbons up to C_{15}. Beside these gas condensate has trace amount of hydrogen sulfide (H_2S), carbon dioxide (CO_2), mercaptanes (RSH, R= -CH_3, -C_2H_5) and aromatics. (http://en.wikipedia.org/wiki/Natural_gas_condensate).

In recent year researchers are trying to findout the way to utilize all raw materials from which energy can be obtained. The present situation of gas condensate in Bangladesh is about 99,000 to 1,00,000 tons and the total production of gas condensate in different gas fields is up to 6605.2 BBLD in Bangladesh (Date: 23-24/10/2013) (http://www.petrobangla. org.bd). This condensate can be used to produce varieties of useful products by refining. New refining plants are being established in recent year. So the demand of condensate refining is increasing gradually (Begum *et al.* 2010).

Now a days, condensate which is obtained from Sangu and Kailastila Gas fields, is mainly processed by Eastern Refinery Limited (ERL). The authority of Eastern Refinery Limited (ERL) mixed the condensate with crude oil and processed it. About 97.5 - 98 % petrol / naptha is obtained from the condensate and 2 - 2.5% is found as operation loss. Bibiyana gas field located at Nabigonj of Hobigonj district was discovered in July, 1998. This is the second largest gas field so far discovered in Bangladesh, both in terms of quality and size of the reserve (Saha 2012). The total reserve of gas has been estimated about

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5.5 TCF (Trillion cubic feet) and 30.7 million barrels of condensate. At present it produces more than 750 MMSCFD of natural gas and approximately 3,500 BPD of condensate which is reserved into 6 condensate storage tanks of Bibiyana gas field (Saha 2012). With a view to produce valuable products such as about 50% motor spirit (Regular octane), 25% kerosene and 25 % diesel from the condensate of Bibiyana gas field was collected and conducted details experiments. Characterization and up-gradation of the products were done to satisfy the level of BSTI standard (Anonimous, 2009).

Materials and methods

Materials

Gas condensates were collected from Bibiyana gas field, Hobigonj. Commercial petrol, kerosene, diesel, motor spirit (100% octane) and MTBE were collected from local market. The chemicals used in this research work were reagent grade.

Method

Properties of gas condensate, commercial motor spirit, kerosene and diesel fuel and products obtained from gas condensate were determined by standard methods.

The octane number of the motor spirit fraction and commercial petrol has been determined through gasoline analyzer (D 2700). Cetane number of the diesel fraction and commercial diesel has been determined through diesel fuel analyzer (D 613-86).

Sulphur content of condensate, motor spirit, kerosene, diesel fraction and commercial motor spirit, diesel and kerosene was determined by standard method D 129-64.

Other properties such as density (D 1298), viscosity (D 445-65), flash point (D 93-62), smoke point (D 1322-64), aniline Point (D 611-64), carbon residue (D 189-65), color (D 1500-64), corrosion (D 130-65), residue on evaporation (IP-131/58), API gravity (D 287-64), acid value (IP-1/58), ash content (D 482-63), water content (IP-74/57), pour point (D 97-57) etc have been determined by standard methods.

The metallic substances present in the gas condensate such as lead, arsenic, zinc, cadmium have been determined by Atomic absorption spectrophotometer (D 1269-61 & D 1549-64).

Fractionation of gas condensed

Gas condensate has been distilled and fractionated into motor spirit, diesel and kerosene fractions using atmospheric vacuum distillation apparatus (ASTM-1160).

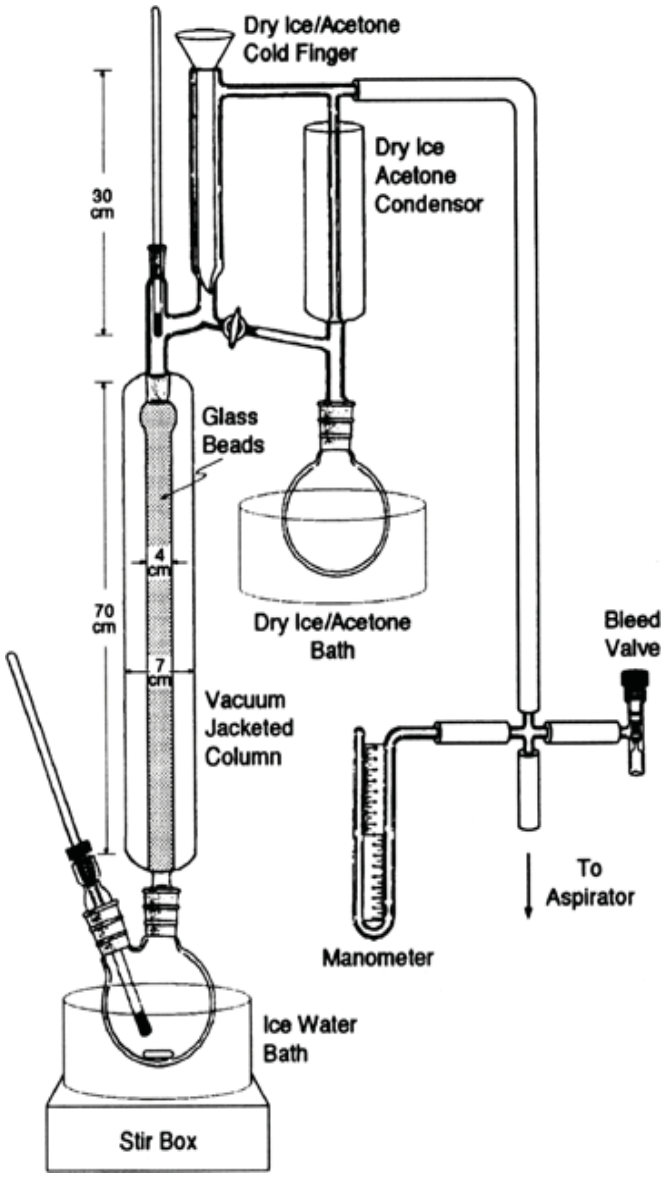

Fig. 1. Flow diagram of fractionation unit.

Results and discussion

Properties of gas condensate which is collected from Bibiyana gas field are shown in the Table I. The fractionation of gas condensate based on boiling range shown in the Table II.

Table I. Properties of gas condensate collected from Bibiyana gas field

Name of the analysis	Method	Results
Range of boiling point, ^{0}C	D 1160	21-345
Motor Spirit		50
Kerosene		23
Diesel		24
Density at 15^{0}C , Kg/L	D 1298	0.8184
API gravity, 60 / 60^0 F	D 287-64	43
Kinematic Viscosity, *c*St 122 ^{0}F	D 445-65	0.999
Kinematic Viscosity, *c*St 70 ^{0}F	D 445-65	1.43
Pour Point, ^{0}C	D 97-57	Below -20
Aniline Point, ^{0}C	D 611-64	43
Acid Value, mg KOH/g	IP-1/58	0.077
Flash Point, ^{0}C	D 93-62	22
Sulfur content, mass %	D 129-64	0.245
Water content, %	IP-74/57	Zero
Light hydrocarbon (Below 50^{0}C), %	D 1160	4.0
Carbon residue, %	D 189-65	1.50
Ash content, %	D 482-63	0.0075
Residue on evaporation, %	IP-131/58	0.387
Lead	D 1269-61	0.07845
Arsenic	-	0.00625
Zinc	D 1549-64	0.78812
Cadmium	-	0.00013

Table II. Distillation products by atmospheric vacuum distillation unit (method D1160) of gas condensate collected from Bibiyana gas field based on temperature ranges

Amount(vol %)	Temperature(^{0}C)
Initial boiling point	21
10%	85
20%	96
30%	104
40%	118
50%	142
60%	162
70%	190
80%	222
90%	286
95%	342
Besides this Residue%	2
Loss %	3

Condensate of Bibiyana gas field was fractionated into 3 major parts based on boiling range by using atmospheric vacuum distillation apparatus. First part motor spirit/Petrol (PFC) was collected in the boiling range 21^{0}C -145^{0}C and it is known as regular motor spirit /petrol. It was found that major properties of PFC such as density, viscosity and flash point were almost identical with commercial petrol which was analyzed in hydrocarbon section in IFRD (collected from nearby fuel pump station supplied by Meghna petroleum) and BSTI standard except octane rating which is shown in Table III.

Octane number can be increased by adding antiknock additives and octane- increasing compounds to the motor spirit/petrol fraction of condensate to increase the octane number which is the simplest and most reasonable from in the technological point of view (Stepanov 2005). For improving the octane number of motor spirit (regular octane) fraction, 5% of different improvers or additives are blended with motor spirit as

shown in Table IV. Among the five different improvers super octane and ethanol showed the most promising result.

Second fractionated product which is known as kerosene fraction (KFC) in boiling ranges 221^{0}C. The properties of KFC were compared with commercial kerosene which was analyzed in hydrocarbon section in IFRD (collected from nearby fuel pump station supplied by Meghna petroleum) and BSTI standard. It was found that major properties of KFC such as density, viscosity and flash point were almost identical with commercial kerosene which is shown in Table V. The major advantage of KFC in respect to environment was low sulfur content in compare with commercial kerosene.

Third fractionated product known as diesel fraction (DFC) was collected in the boiling range 178^{0}C-335^{0}C.

Table III. Comparison of different properties of motor spirit (Petrol) with commercial Petrol and BSTI Standard (June 2009)

Name of the analysis	Method	Petrol fraction from condensate	Commercial Petrol	BSTI Standard (June 2009): BDS 347:1999
Range of boiling, ^{0}C	D 1160	21-145	19.8-196	-
Mass %	,,	49	-	-
Volume %	,,	50	-	-
Density at 15^0 C, Kg/L	IP-160/57	0.7516	0.7423	-
API gravity, 60/60^0 F	D 287-64	50	-	-
Distillation Range IBP	D 1160	21.5	19.8	Not limited
10%	,,	65	53	75
50%	,,	110	74	80-125
90%	,,	139	160	180
FBP	,,	145	196	210
Acid value, mg KOH/g	IP-1/58	0.0798	0.09	-
Water content, %	IP-74/57	Zero	Zero	-
Color (ASTM)	D 1500-64	Zero	0.5	Visual
Flash point, ^{0}C	D 93-62	17	13.33	-
Kinematic Viscosity, 70^{0}F *cSt*	D 445-65	0.615	0.5253	Not limited
Grade of corrosion	D 130-65	Zero	Zero	No worse than no.1
Sulfur content, mass %	D 129 - 64	0.1553	0.455	0.05
Naphthene	-	10.7	4.5	-
Aromatics	D 1320	43.8	31.9	-
Motor test	D 2700	73	77	-
Research method	D 2699	78	83	80
Residue on evaporation, wt %	IP-131/58	0.0084	0.023	4 mg/100ml
Reid steam pressure at 38^{0}C, psi		8.5	-	10
Doctor test		Negative	-	Negative
Lead content, mg/kg		0.041	-	0.013g/L

Table IV. Improvement of octane number by using different types of improver

Name of the improving additives	Increased octane number (Research method D 2699)
Methyl *tert.* Butyl Ether (MTBE)	80
Hydrogen Peroxide	79
Ethanol	81
Normal Octane	80
Super Octane (100 Octane)	81

The properties of DFC were compared with commercial diesel which was analyzed in hydrocarbon section in IFRD (collected from nearby fuel pump station supplied by Meghna petroleum) and BSTI standard. It was found that flash point and cetane number of DFC are higher in compare with commercial diesel which is shown in Table VI.

Table V. Comparison of different properties of KFC with commercial kerosene and BSTI Standard (June 2009).

Name of the test	Method	Kerosene fraction from condensate	Commercial Kerosene	BSTI Standard (June 2009): BDS 830:1991	
				Grade 1	Grade 2
Range of boiling, ^{0}C	D 1160	140 - 221	43.5 - 228	-	-
Mass %	,,	23	-	-	-
Volume %	,,	23	-	-	-
Density at 15 ^{0}C, Kg/L	IP-160/57	0.7882	0.7956	Not limited	Not limited
API gravity, 60/60 ^{0} F	D 287-64	38	-	-	-
Distillation Range IBP	D 1160	51	43.5	-	-
Distillation Range 10%	,,	165	148	-	-
Distillation Range 50%	,,	207	174	-	-
Distillation Range 90%	,,	215	219	-	-
Distillation Range FBP	,,	221	228	-	-
Kinematic Viscosity at 70^{0}F, *cSt*	D 445-65	1.758	1.728	-	-
Pour Point, ^{0}C	D 97-57	Below –20	Below -20	-	-
Acid value, mg KOH/g	IP-1/58	0.126	0.078	-	-
Flash point , ^{0}C	D 93-62	45	47	35	43
Grade of corrosion	D 130-65	Slight	Zero	Not worse than no 1	Not worse than no 2
Sulfur content, mass %	D 129-64	0.2253	0.597	0.40	1.0
Aromatics content,%	D 1320	47.5	45	-	-
Smoke point, mm	D 1322-64	16	14	20	10
Color, (ASTM)	D1500-64	Zero	Blue visual	10	-
Residue on evaporation, wt %	IP-131/58	0.243	0.723	-	-
Ash content, %	D 482-63	0.015	-	-	-
Doctor test	IP-30/56	Negative	-	-	Negative

Table VI. Comparison of different properties of fractionated diesel from Bibiyana gas field condensate and commercial diesel with BSTI Standard (June 2009).

Name of the analysis	Method	Diesel fraction from condensate	Commercial Diesel	BSTI Standard (June 2009): BDS 347:1999
Range of boiling, ^{0}C	D 1160	178 -335	58 -346	-
Mass %	,,	23	-	-
Volume %	,,	24	-	-
Density at 15 ^{0}C	IP -160/57	0.8554	0.8445	0.82 - 0.87
API gravity, 60/60 ^{0}F	D 287 -64	35	-	-
Distillation Range IBP	D 1160	178	58	-
Distillation Range 10%	,,	195	192	-
Distillation Range 50%	,,	238	252	-
Distillation Range 90%	,,	286	340	-
Distillation Range FBP	,,	33 5	34 6	-
Kinematic Viscosity, 70^{0}F *cSt*	D 445 -65	6.32	6.06	9.0 (at 38 ^{0}C)
Pour Point, ^{0}C	D 97 -57	-8	-2	9 for winter 15 for summer
Aniline Point, ^{0}C	D 611 -64	69	-	-
Acid value, mg KOH/g	IP -1/58	0.28	0.34	-
Flash point, ^{0}C	D 93 -62	115	70	32
Grade of corrosion	D 130 -65	Zero	Slight tarnish	No worse than no. 1
Sulfur content, mass %	D 129 - 64	0.1953	0.905	1.0
Cetane no.	D 613 - 86	54	51	45
Diesel index	D 4737 -904	48	52	45
Color (ASTM)	D 1500 -64	1.0	2.0	3.0
Residue on evaporation, wt %	IP -131/58	0.619	0.43	-
Water content, %	IP -74/57	Zero	Zero	0.10
Carbon residue, %	D 189 -65	2.65	-	-
Ash content, %	D 482 -63	0.025	-	-

Conclusion

Natural gas condensate is composed of different types of hydrocarbons. The experiments exposed that 50% motor spirit (regular octane/petrol) was produced in the boiling range of 21-145^{0}C, 23% kerosene of 140-221^{0}C and 24-25% diesel of 178-335^{0}C from Bibiyana gas condensate. The characteristics of produced motor spirit fraction are close to commercial motor spirit (available in the market) as well as BSTI standard except octane number (78) and sulfur content (0.1553%). The sulphur contents in kerosene (0.2253%) and diesel fractions (0.1953%) are found to be much lower than the commercial kerosene and diesel and even than BSTI standard up to June 2009. The properties of diesel fractions obtained from condensate are very comparable to commercial diesel (available in the market) and BSTI standard. Improvement of octane number (81) of motor spirit fraction has been done by adding five different improvers. It was found that 5% of supper octane or ethanol showed the best result.

Nomenclature

BBLD Barrels per Day
BSTI Bangladesh Standard Testing Institute
BTU British Thermal Unit
MSCFD Thousand Standard Cubic Feet per Day
MMSCFD Million Standard Cubic Feet per Day
MTBE Methyl *tert.* Butyl Ether

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