Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2014, 6(11): 923-936

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Simulation of three-phase separator in petroleum industry

Mohammad Rashid Jahangiri and Mohammad Nouri

Azad University, Arak Branch, Department of Production Engineering and Gas Transmission, Arak, Iran

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ABSTRACT

Crude oil is produced from oil reservoirs contain water, gas, salt, sediment and small amounts of metals are, for the preparation of this fluid for export refineries that produce food products can be separated gross be water to Isolation crude oil and gas in the Vessel called separator is used most commonly used three-phase separators are horizontal, multi-stage operation is performed during the first stage of separation near the oil tanks do be called the wellhead separators are known. Software has been studied to implement content Aspen Hysys 2006 software is used, it is considered a horizontal three-phase separator , the results indicate that differences in the number of parameters low Mddvdy and in most cases is negligible for low margin is proposed .

Keywords: Simulated three-phase separator, oil separation operation, constant pressure

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INTRODUCTION

A three-phase separator gas - liquid separation device for gaseous, liquid and low-density (eg crude oil), high-density liquid (eg water) and sometimes solid particles (eg, sand along with the output shaft) , is used as defined. This equipment is widely used in many chemical processes, such as offshore oil and gas and petrochemical projects are.

The crude oil is taken out from, below the surface of soil by digging and pumping through machine. Then the crude oil taken is processed to remove the impurities like salts, sulphur and water.

The main task of the three-phase separator , providing conditions in which the different phases present in a stream based on the difference in density, are separated . In other words , the heavier aqueous phase dispersed in a hydrocarbon phase due to buoyancy force upward move is separated from the aqueous phase . Also , due to the higher density of the aqueous phase to the organic phase to the organic phase is separated downward . Organic phase droplets suspended in the gas phase , due to the downward force of gravity to be separated from the gas phase to the organic phase join. The mechanism of phase separation due to the Drjdaknndh , except household type separator is a gravity separation . The mechanism of separation in dividing two-phase gas - liquid separator , liquid - liquid , based on the same principle.

A three-phase gravity separators, Horizontal and Vertical Tanks are designed to be, it depends on the conditions and such limits of design variables space to install a separator (this is important on offshore platforms) is. In this paper, three-phase separation due to the very wide applications (especially in the cross-shore) have been considered.

Despite the separation mechanism in this type of separation, the separation mechanism is much simpler than the separators such as cyclones (separation in cyclone with centrifugal force is used) or CFD analysis of slot jet impingement cooling on the curved surface, the design of this type of separator always easy is not associated with and requires experience, a designer and having similar data.

The complexity of this type of spacers because the number of variables involved in determining the appropriate size of the separator is high, such as the separator, the separator diameter, Bfl success, Bfl height, the fluid residence time, light and heavy fluid residence time many variables other. Similar Heat Transfer Between Impinging Circular Air Jet and Finned Flat Plate Also, no clear and explicit relationship between variables have been told not to communicate, which adds to the difficulty. This causes never designed a unique solution does not exist.

EXPERIMENTAL SECTION

The model explains

Crude oil will have the following characteristics related to the oil separator to make it a three-phase gas, oil and water separation can be simulated, The results of the simulations to compare with experimental data.

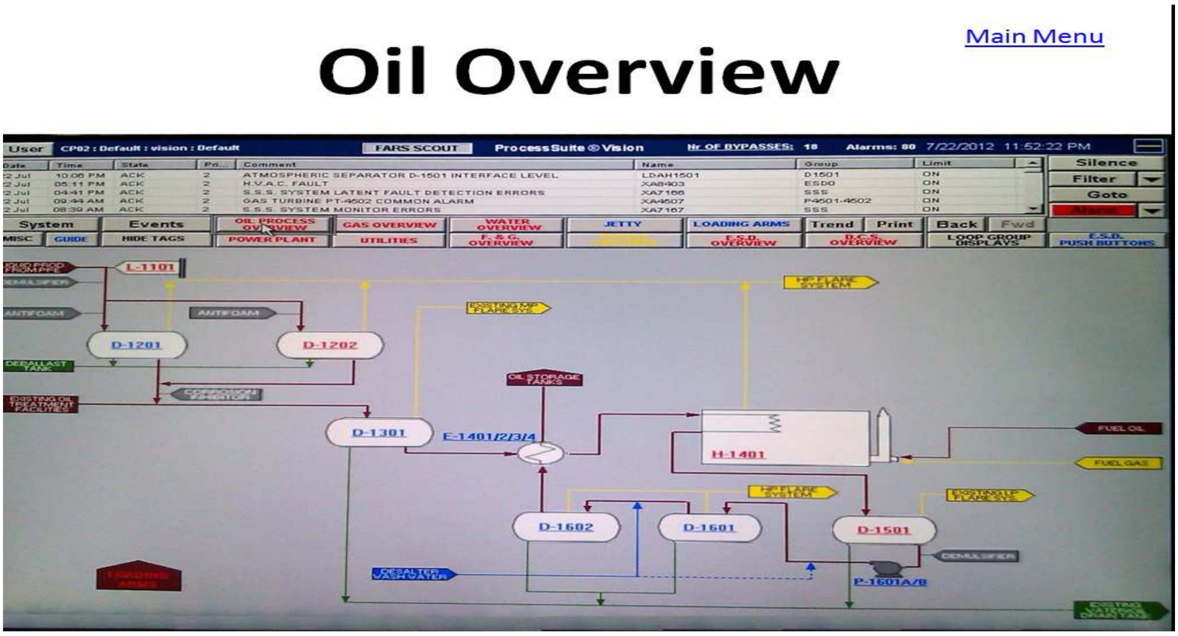
stream	Oli Sea Line
Discription	
Vapour frac.	0.0868
Temperature (0 C)	26.32
Pressure (barg)	12
Molar Flow (kg mole / hr)	2510.9927
Mass Flow (kg/hr)	321414.531
Liq .Vol Flow (barrel / day)	388.1384
Enthalpy (kw)	-7.17E+06
Density (kg/m3)	403.4808
Mole wt.	128
Spec.Heat (KJ/kg-c)	1.9971
Therm Cond (w/m-k)	
Viscosity (cp)	
Z Factor	
Sur Tension (dyne/cm)	
Std. Density (kg/m3)	
Nitrogen (mole frac.)	0.0003
H2S (mole frac.)	0
CO2 (mole frac.)	0.0068
H2O (mole frac.)	0.3018
Methane (mole frac.)	0.0875
Ethane (mole frac.)	0.0376
Propane (mole frac.)	0.0398
i-Butane (mole frac.)	0.0126
n-Butane (mole frac.)	0.0265
i-Pentane (mole frac.)	0.0163
n-Pentane (molr frac.)	0.0218
KC6 (mole frac.)	0.0429
KC7 (mole frac.)	0.0579
KC8 (mole frac.)	0.0399
KC9 (mole frac.)	0.0367
KC10 (mole frac.)	0.0342
KC11 (mole frac.)	0.0245
C12+ (mole frac.)	0.213

component name	T_C (0C)	P_C(barg)	V_C (m3/kg mole)	W	Liq.Dens (kg/m3)	Mol.wt	Boil.pt (0C)
KC6	234.65	32.82	0.35	0.271	689.9997	84	63.9
KC7	269.05	31.51	0.387	0.31	727	96	91.9
KC8	297.45	29.51	0.431	0.349	749	107	116.7
KC9	325.15	27.37	0.481	0.392	768	121	142.2
KC10	349.05	25.3	0.537	0.437	782	134	165.8
KC11	370.15	23.51	0.587	0.479	793	147	187.2
C12+	627.31	9.95	1.6455	0.9071	921	408	463.15

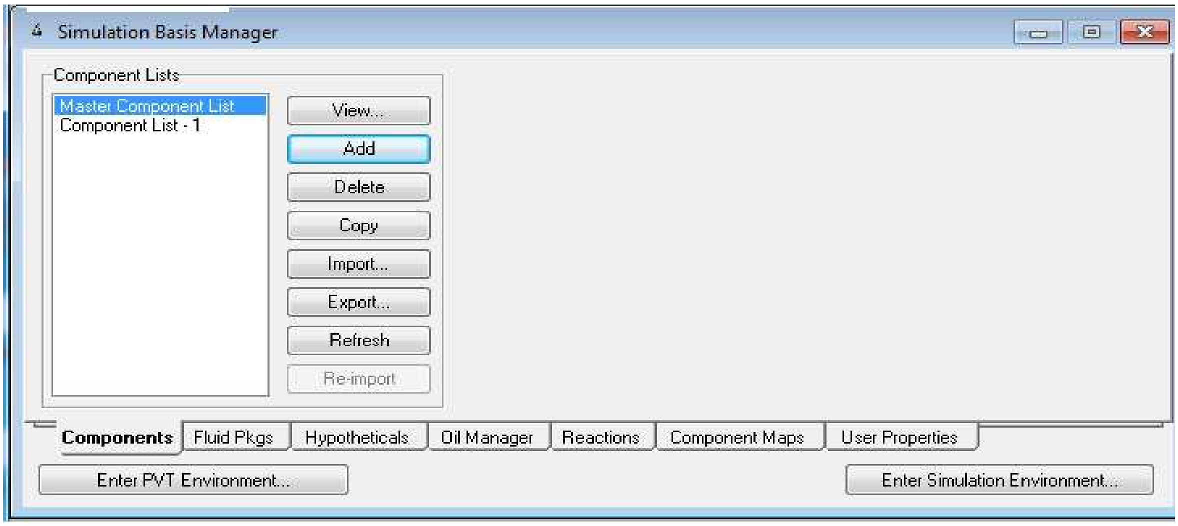
Before it is better to have a precise definition of the term simulation, In order to obtain the simulation output data based on the input data and profile information processing devices (some of which are given to the software by the user) is.

The simulation software used in Aspen Hysys 2006 is a powerful software to simulate the processes of oil, gas and petrochemical, Simulation and Design Rating is done in two ways, in case Vessel Rating outputs object the design information is available regarding the changes in geometry and geometric characteristics of the input stream and change profile, but we checked Vessel design mode with input - output data is computed Vessel design, simulation or Rating is done.

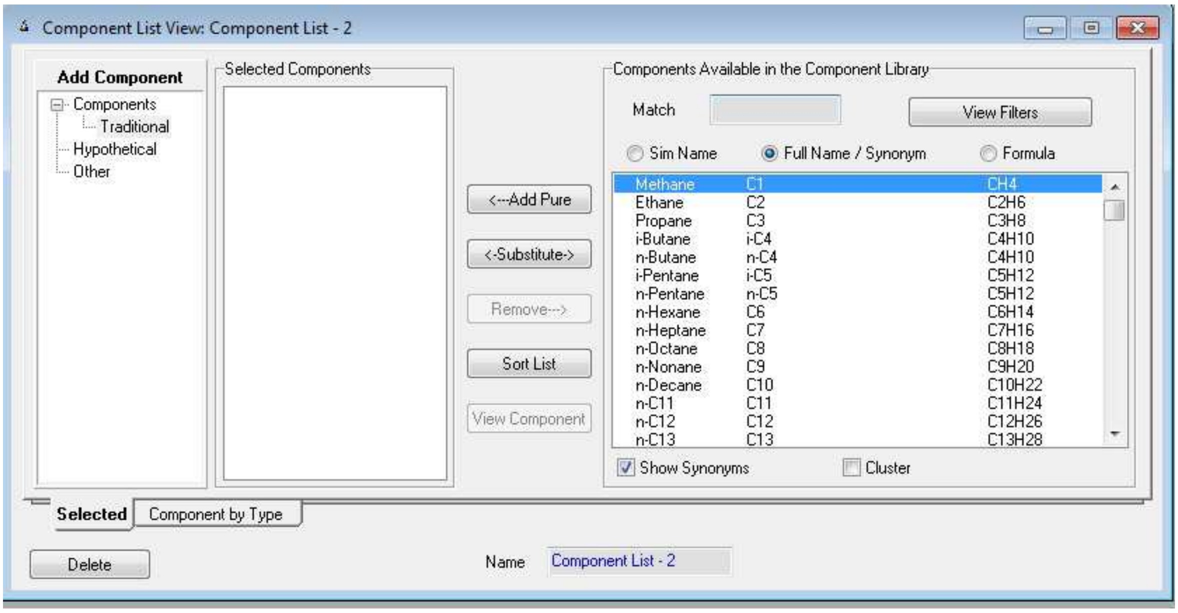
The overview of the petroleum refining process and then we'll start working simulations.



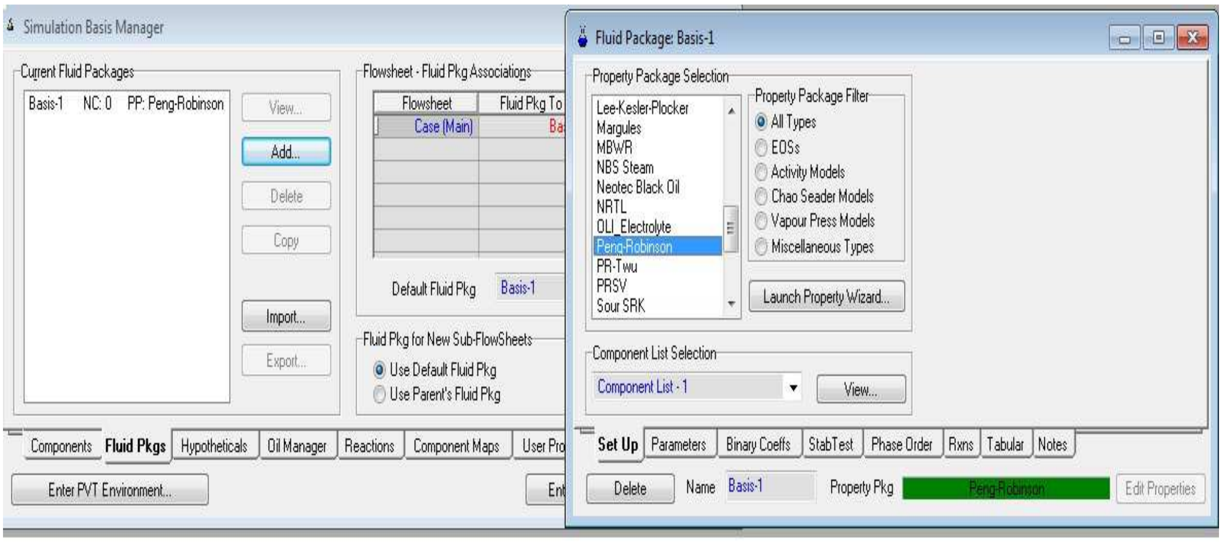
At the beginning of each simulation process, we start with the Basis, the equation of state of the material used and the type of chemical reaction process is characterized



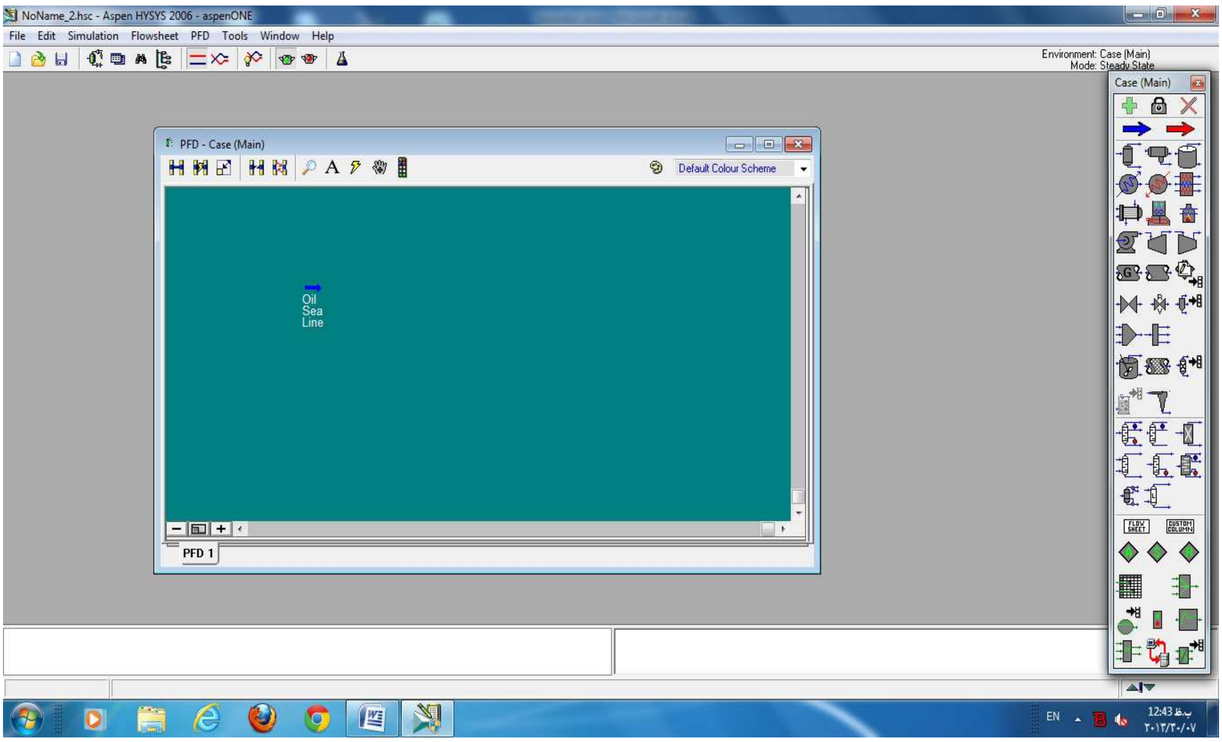
After entering the Main Component of the software to choose the inlet feed



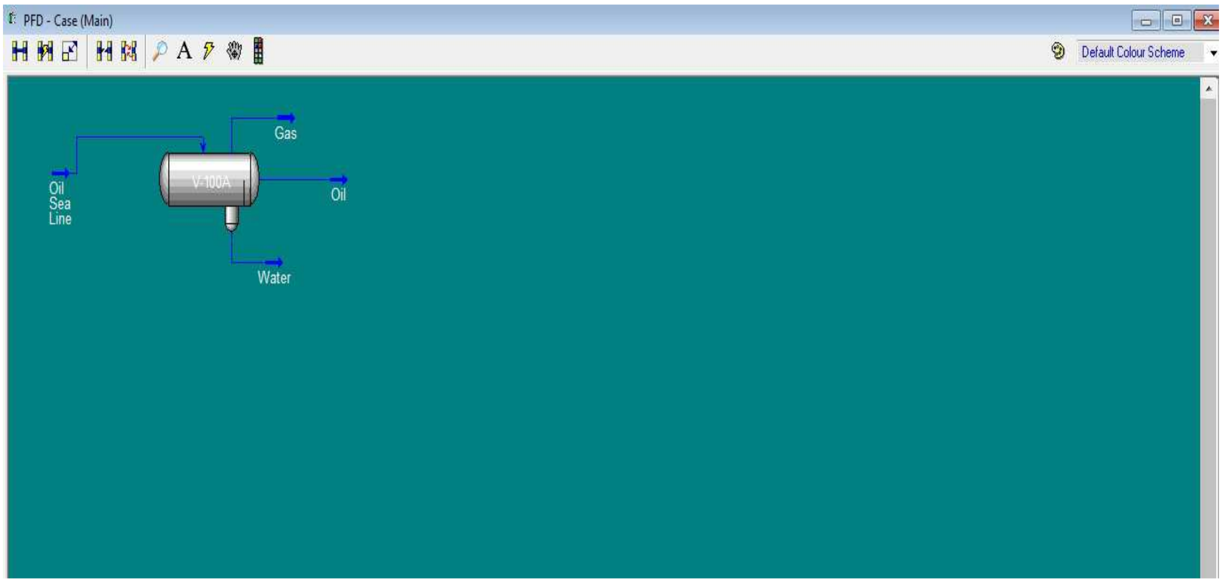
The choice of materials should be used to fit the equation of state is the best equation for edible ingredients are hydrocarbons Peng-Robinson equation is



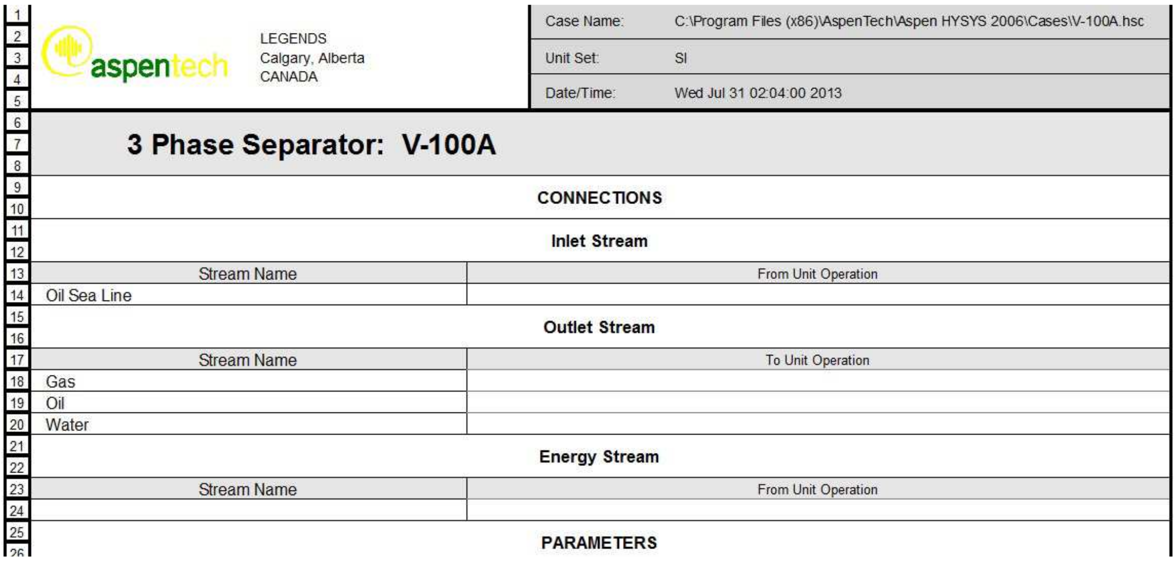
We can choose to enter a simulated environment with a current flow of information to enter, this information includes name, current, temperature, pressure, flow and composition of the feed ingredients are



Simulation by selecting a three-phase separator continue, enter the parameters associated with the separation of three current outputs are Run



However, we report our simulation results and comparison with experimental data, we can do it with Ctrl + R to bring up all the results of the Vessel



aspentech

LEGENDS
Calgary, Alberta
CANADA

Case Name:	C:\Program Files (x86)\AspenTech\Aspen HYSYS 2006\Cases\V-100A.hsc
Unit Set:	SI
Date/Time:	Wed Jul 31 02:04:00 2013

3 Phase Separator: V-100A

CONNECTIONS

Inlet Stream

Stream Name	From Unit Operation
Oil Sea Line	

Outlet Stream

Stream Name	To Unit Operation
Gas	
Oil	
Water	

Energy Stream

Stream Name	From Unit Operation

PARAMETERS

PARAMETERS

Vessel Volume:	80.07 m3	Level SP:	50.00 %	Liquid Volume:	40.03 m3		
Vessel Pressure:	1100 kPa	Pressure Drop:	100.0 kPa *	Duty:	0.0000 kJ/h	Heat Transfer Mode:	Heating

User Variables

RATING

Sizing

Cylinder		Horizontal		Separator has a Boot: Yes	
Boot Diameter:		1.067 m	Boot Height:		3.200 m
Volume:	80.07 m3	Diameter:	3.200 m *	Length:	9.600 m *

Level Taps: Level Tap Specification

Level Tap	PV High	PV Low	OP High	OP Low

Level Taps: Calculated Level Tap Values

Level Tap	Liquid Level	Aqueous Level

Options

PV Work Term Contribution	(%)	100.00 *		

CONDITIONS

Name		Oil Sea Line	Oil	Gas	Water
Vapour		0.0873	0.0000	1.0000	0.0000
Temperature	(C)	26.3200 *	26.1941	26.1941	26.1941
Pressure	(kPa)	1200.0000 *	1100.0000	1100.0000	1100.0000
Molar Flow	(kgmole/h)	2510.9888	1522.4021	232.2241	756.3626
Mass Flow	(kg/h)	321414.5313 *	302474.8495	5310.3126	13629.3692
Std Ideal Liq Vol Flow	(m3/h)	388.1381	360.0101	14.4700	13.6581
Molar Enthalpy	(kJ/kgmole)	-3.553e+005	-4.297e+005	-9.268e+004	-2.861e+005
Molar Entropy	(kJ/kgmole-C)	279.2	407.9	170.6	54.02
Heat Flow	(kJ/h)	-8.9204e+08	-6.5410e+08	-2.1523e+07	-2.1642e+08

PROPERTIES

Name	Oil Sea Line	Oil	Gas	Water	
Molecular Weight	128.0	198.7	22.87	18.02	

Hyprotech Ltd. Aspen HYSYS Version 2006 (20.0.0.6728) Page 1 of 2

Licensed to: LEGENDS * Specified by user.

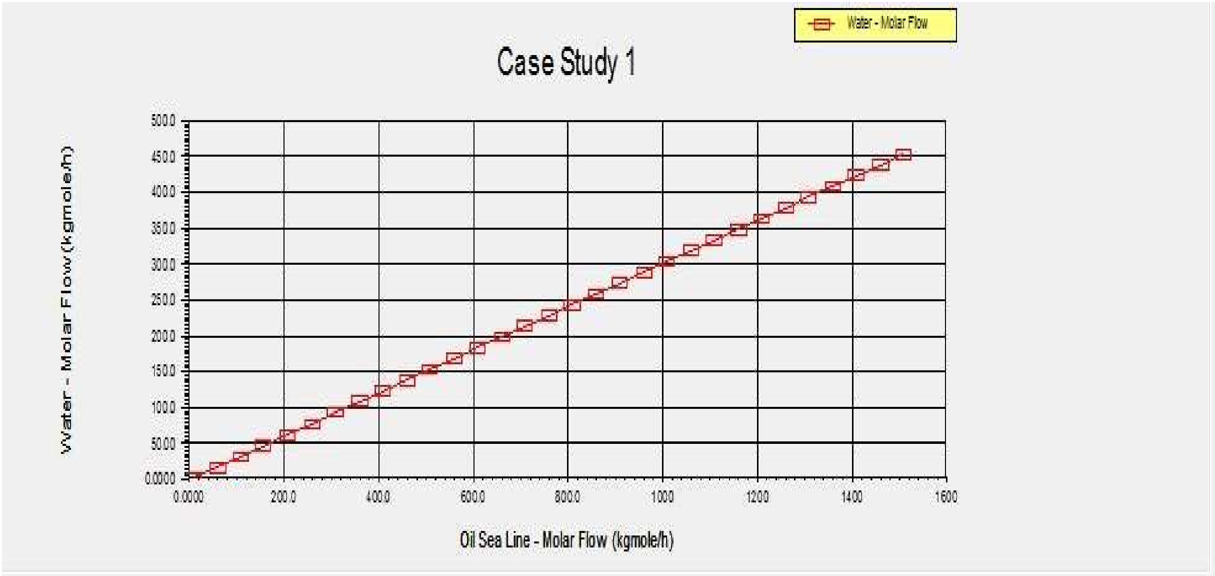
aspentech LEGENDS Calgary, Alberta CANADA	Case Name:	C:\Program Files (x86)\AspenTech\Aspen HYSYS 2006\Cases\V-100A.hsc
	Unit Set:	SI
	Date/Time:	Fri Aug 02 12:18:07 2013

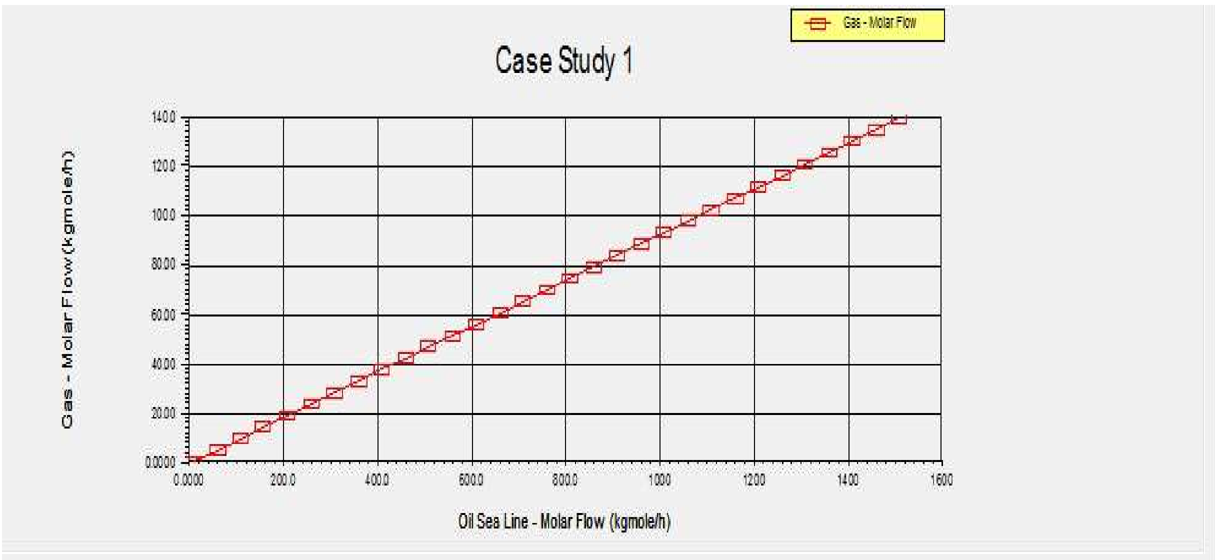
3 Phase Separator: V-100A (continued)

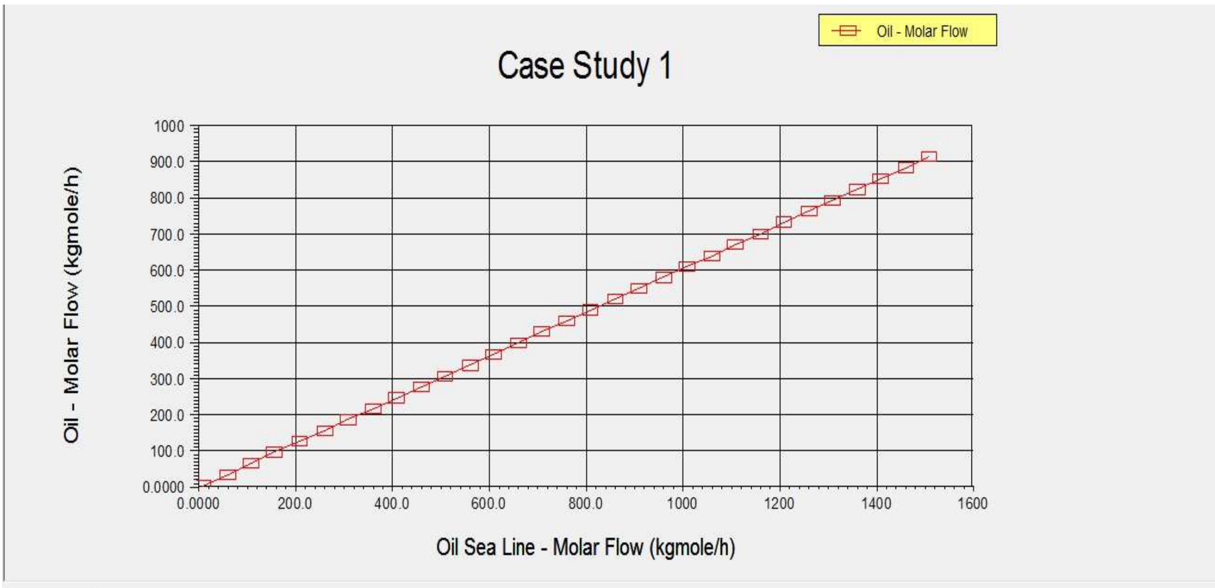
PROPERTIES

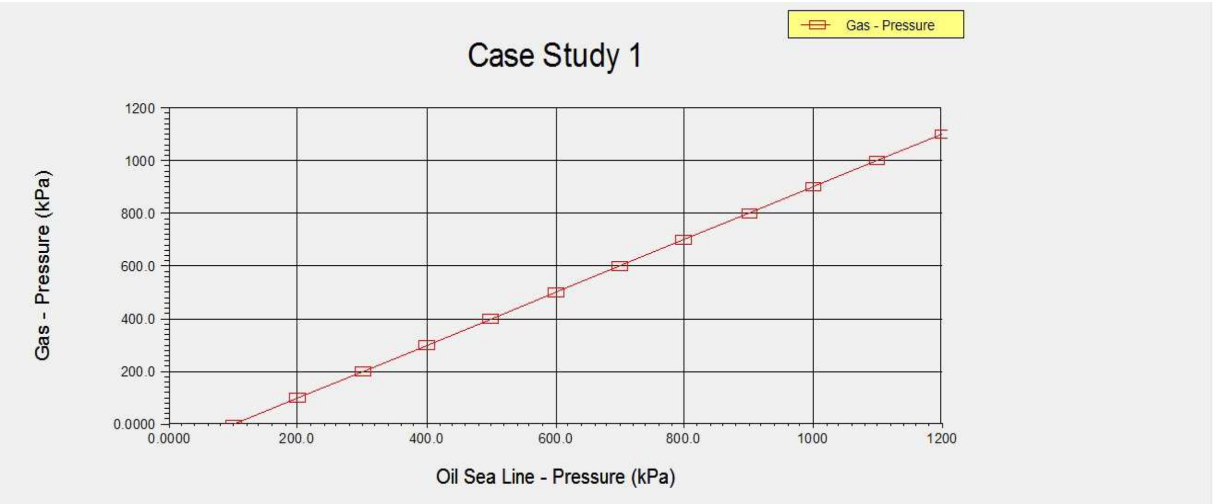
Name		Oil Sea Line	Oil	Gas	Water
Molar Density	(kgmole/m3)	3.134	4.299	0.4631	55.87
Mass Density	(kg/m3)	401.2	854.2	10.59	1007
Act. Volume Flow	(m3/h)	801.1	354.1	501.4	13.54
Mass Enthalpy	(kJ/kg)	-2775	-2162	-4053	-1.588e+004
Mass Entropy	(kJ/kg-C)	2.181	2.053	7.459	2.998
Heat Capacity	(kJ/kgmole-C)	254.4	373.7	45.81	77.69
Mass Heat Capacity	(kJ/kg-C)	1.987	1.881	2.003	4.311
Lower Heating Value	(kJ/kgmole)	---	---	---	3.501e-002
Mass Lower Heating Value	(kJ/kg)	---	---	---	1.943e-003
Phase Fraction [Vol. Basis]		3.496e-002	---	---	---
Phase Fraction [Mass Basis]		1.538e-002	2.122e-314	2.122e-314	2.122e-314
Partial Pressure of CO2	(kPa)	42.24	0.0000	39.48	0.0000
Cost Based on Flow	(Cost/s)	0.0000	0.0000	0.0000	0.0000
Act. Gas Flow	(ACT_m3/h)	---	---	501.4	---
Avg. Liq. Density	(kgmole/m3)	6.469	4.229	16.05	55.38
Specific Heat	(kJ/kgmole-C)	254.4	373.7	45.81	77.69
Std. Gas Flow	(STD_m3/h)	5.937e+004	3.600e+004	5491	1.788e+004
Std. Ideal Liq. Mass Density	(kg/m3)	828.1	840.2	367.0	997.9
Act. Liq. Flow	(m3/s)	0.1023	9.836e-002	0.0000	3.760e-003
Z Factor		---	---	---	---
Watson K		11.63	11.63	17.32	8.522
User Property		---	---	---	---
Partial Pressure of H2S	(kPa)	0.0000	0.0000	0.0000	0.0000
Cp/(Cp - R)		1.034	1.023	1.222	1.120
Cp/Cv		1.005	1.023	1.280	1.148
Heat of Vap.	(kJ/kgmole)	2.104e+005	2.940e+005	1.578e+004	3.693e+004
Kinematic Viscosity	(cSt)	---	7.448	1.065	0.8608
Liq. Mass Density (Std. Cond)	(kg/m3)	867.5	863.2	---	1015
Liq. Vol. Flow (Std. Cond)	(m3/h)	370.5	350.4	---	13.43
Liquid Fraction		0.9127	1.000	0.0000	1.000
Molar Volume	(m3/kgmole)	0.3191	0.2326	2.159	1.790e-002
Mass Heat of Vap.	(kJ/kg)	1643	1480	689.9	2049
Phase Fraction [Molar Basis]		0.0873	0.0000	1.0000	0.0000
Surface Tension	(dyne/cm)	---	20.70	---	71.88
Thermal Conductivity	(W/m-K)	---	0.1282	2.947e-002	0.6128
Viscosity	(cP)	---	6.363	1.128e-002	0.8667
Cv (Semi-Ideal)	(kJ/kgmole-C)	246.1	365.4	37.49	69.37

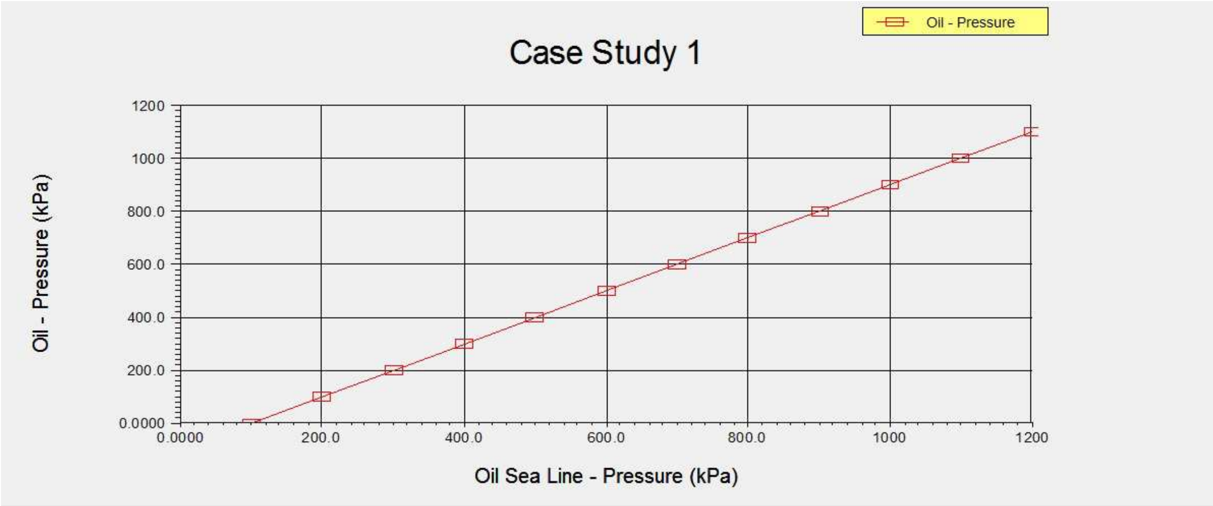
You can also draw graphs for various parameters which we will draw some of these parameters.

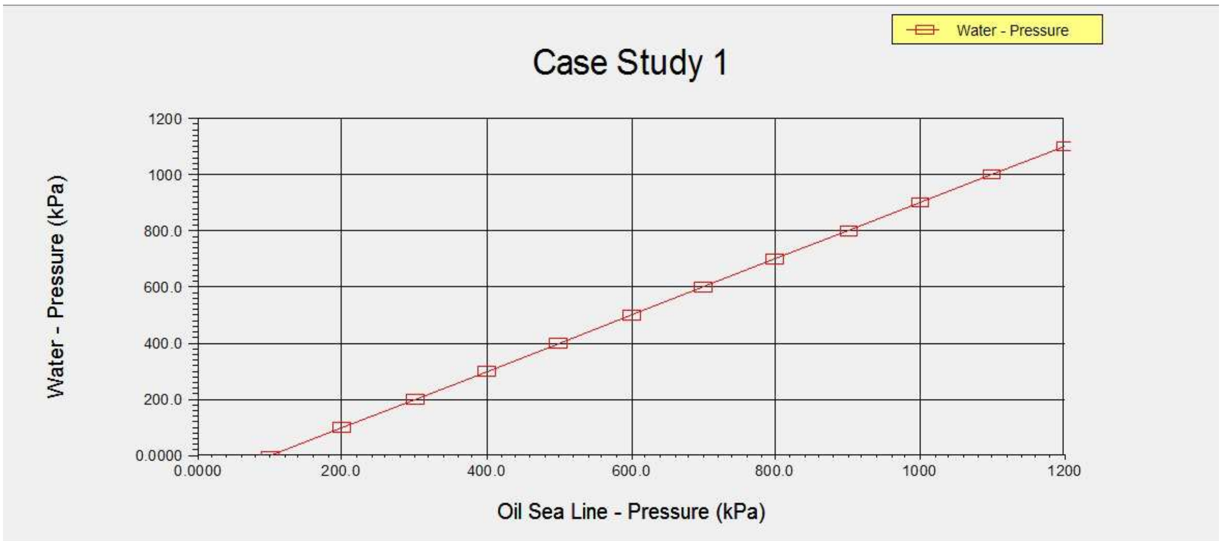

Water - Molar Flow
Case Study 1
Water - Molar Flow (kgmole/h)
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.00
0.0000
0.0000
200.0
400.0
600.0
800.0
1000
1200
1400
1600
Oil Sea Line - Molar Flow (kgmole/h)

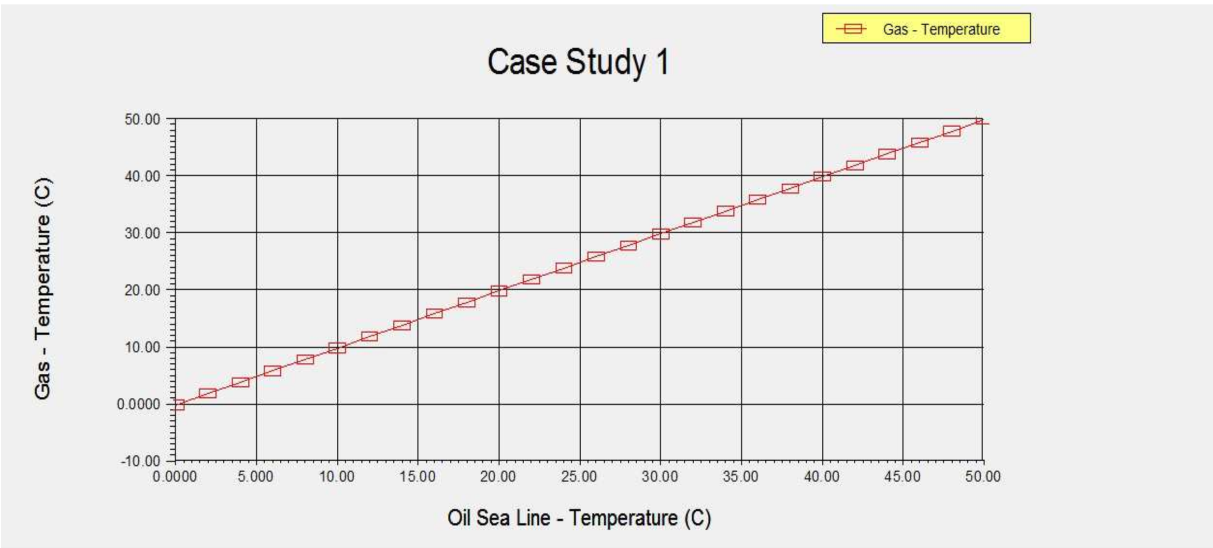

Gas - Molar Flow
Case Study 1
Gas - Molar Flow (kgmole/h)
140.0
120.0
100.0
80.00
60.00
40.00
20.00
0.0000
0.0000
200.0
400.0
600.0
800.0
1000
1200
1400
1600
Oil Sea Line - Molar Flow (kgmole/h)

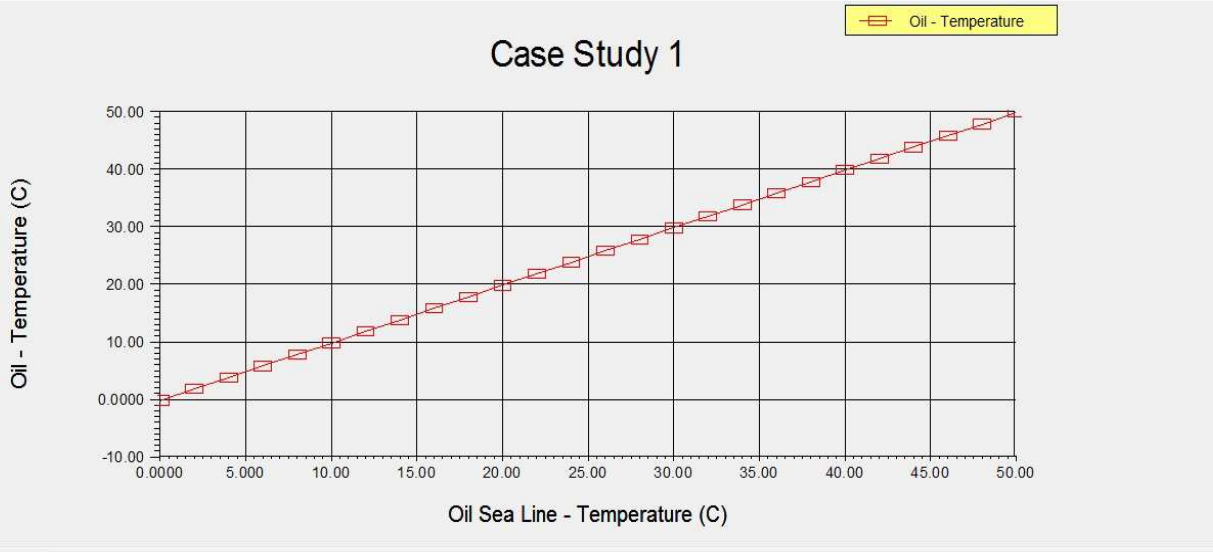

Oil - Molar Flow
Case Study 1
1000
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0000
0.0000
200.0
400.0
600.0
800.0
1000
1200
1400
1600
Oil - Molar Flow (kgmole/h)
Oil Sea Line - Molar Flow (kgmole/h)

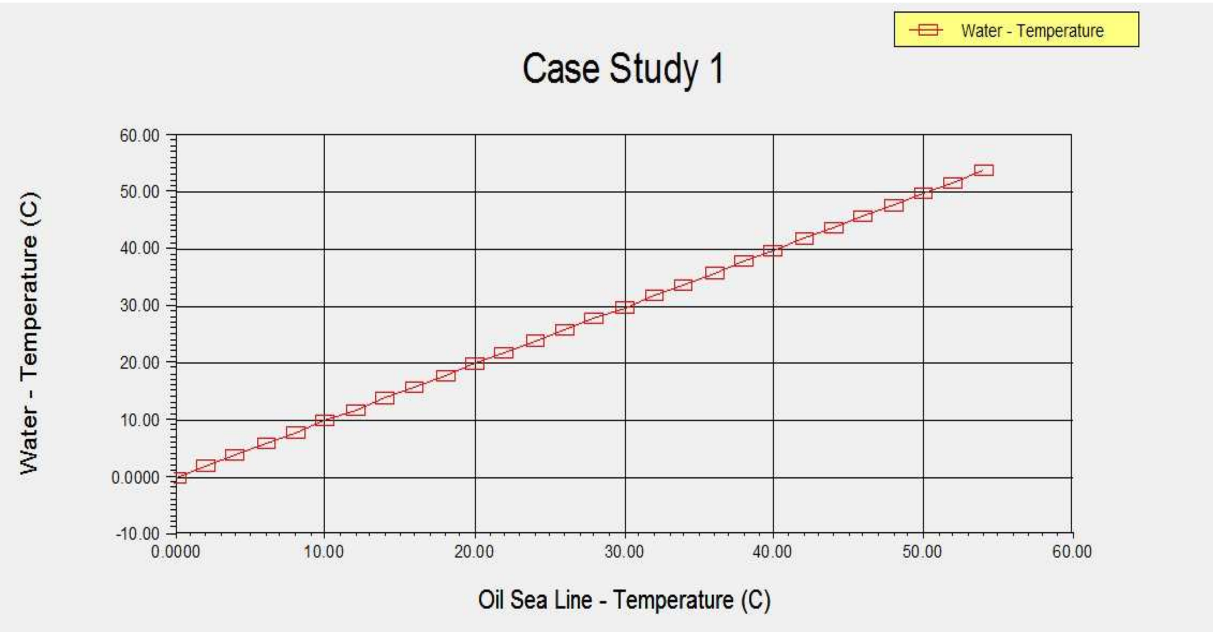

Gas - Pressure
Case Study 1
1200
1000
800.0
600.0
400.0
200.0
0.0000
0.0000
200.0
400.0
600.0
800.0
1000
1200
Gas - Pressure (kPa)
Oil Sea Line - Pressure (kPa)


Oil - Pressure
Case Study 1
Oil - Pressure (kPa)
Oil Sea Line - Pressure (kPa)
1200
1000
800.0
600.0
400.0
200.0
0.0000


Water - Pressure
Case Study 1
Water - Pressure (kPa)
Oil Sea Line - Pressure (kPa)
1200
1000
800.0
600.0
400.0
200.0
0.0000


Gas - Temperature
Case Study 1
Gas - Temperature (C)
Oil Sea Line - Temperature (C)
50.00
40.00
30.00
20.00
10.00
0.0000
-10.00
5.000
15.00
25.00
35.00
45.00





RESULTS AND DISCUSSION

By comparing the data in the table below some information from the laboratory of the Institute of Oil and some have taken control of 24-hour average computer simulation results to verify the correct functioning of the separator will see. The following table shows the main parameters include temperature, pressure Vflv computer control, density and viscosity of the Petroleum Industry Research Laboratories and other parameters are measured.

Separator Experimental Data

stream	Oli Sea Line	Gas out let	Oil out let	Water out let
Discription				
Vapour frac.	0.0868	1	0	0
Temperature (0 C)	26.32	26	26	26
Pressure (barg)	12	11	11	11
Molar Flow (kg mole / hr))	2510.9927	217.8823	1536.6072	756.5032
Mass Flow (kg/hr)	321414.531	4911.4927	302870.8438	13632.1816
Liq .Vol Flow (m3 / hr)	388.1384	13.4859	360.9915	13.661
Enthalpy (kw)	-7.17E+06	555165	-1.49E+06	-6.23E+06
Density (kg/m3)	403.4808	11.4825	853	1007.6971
Mole wt.	128	22.542	197.1036	18.02
Spec.Heat (KJ/kg-c)	1.9971	2.0174	1.8926	4.3111
Therm Cond (w/m-k)		0.0297	0.1303	0.6112
Viscosity (cp)		0.0113	6.7568	0.8884
Z Factor		0.9511	0.112	0.0087
Sur Tension (dyne/cm)			20.8835	72.0689
Std. Density (kg/m3)			860.3945	1014.916
Nitrogen (mole frac.)	0.0003	0.003	0.0001	0
H2S (mole frac.)	0	0	0	0
CO2 (mole frac.)	0.0068	0.0349	0.0061	0.0002
H2O (mole frac.)	0.3018	0.0028	0.0005	0.9998
Methane (mole frac.)	0.0875	0.716	0.0414	0
Ethane (mole frac.)	0.0376	0.1477	0.0405	0
Propane (mole frac.)	0.0398	0.0619	0.0563	0
i-Butane (mole frac.)	0.0126	0.0086	0.0194	0
n-Butane (mole frac.)	0.0265	0.0136	0.0414	0
i-Pentane (mole frac.)	0.0163	0.0035	0.0261	0
n-Pentane (molr frac.)	0.0218	0.0036	0.0351	0
KC6 (mole frac.)	0.0429	0.0028	0.0697	0
KC7 (mole frac.)	0.0579	0.0014	0.0944	0
KC8 (mole frac.)	0.0399	0.0004	0.0651	0
KC9 (mole frac.)	0.0367	0.0001	0.0599	0
KC10 (mole frac.)	0.0342	0	0.0559	0
KC11 (mole frac.)	0.0245	0	0.04	0
C12+ (mole frac.)	0.213	0	0.348	0

Data are obtained from the above data together into Hysys and compare

	Experimental	Hysys	Experimental	Hysas	Experimental	Hysys	Experimental	Hysys
stream	Oli Sea Line		Gas out let		Oil out let		Water out let	
Discription								
Vapour frac.	0.0868	0.0873	1	1	0		0	
Temperature (0 C)	26.32	26.32	26	26.19	26	26.19	26	26.19
Pressure (barg)	12	12	11	11	11	11	11	11
Molar Flow (kg mole / hr)	2510.9927	2511	217.8823	232.2	1536.6072	1522	756.5032	756.4
Mass Flow (kg/hr)	321414.5313	321415	4911.4927	5310	302870.8438	302501	13632.1816	13630
Liq .Vol Flow (m3 / hr)	388.1384	388.1	13.4859	14.47	360.9915	350	13.661	13.43
Enthalpy (kw)	-7.17E+06		555165.004		-1.49E+06		-6.23E+06	
Density (kg/m3)	403.4808	401	11.4825	10.59	853	863.2	1007.6971	1007
Mole wt.	128	128	22.542	22.87	197.1036	198.7	18.02	18.02
Spec.Heat (KJ/kg-c)	1.9971		2.0174		1.8926		4.3111	
Therm Cond (w/m-k)			0.0297	0.02947	0.1303	0.1282	0.6112	0.6128
Viscosity (cp)			0.0113	0.0128	6.7568	6.363	0.8884	0.8667
Z Factor			0.9511		0.112		0.0087	
Sur Tension (dyne/cm)					20.8835		72.0689	
Std. Density (kg/m3)					860.3945		1014.916	997.9
Nitrogen (mole frac.)	0.0003	0.0003	0.003	0.002847	0.0001	0.00006	0	0
H2S (mole frac.)	0	0	0	0	0	0	0	0
CO2 (mole frac.)	0.0068	0.0068	0.0349	0.035895	0.0061	0.00565	0.0002	0.000174
H2O (mole frac.)	0.3018	0.3018	0.0028	0.003192	0.0005	0.00051	0.9998	0.999826
Methane (mole frac.)	0.0875	0.0875	0.716	0.702474	0.0414	0.03715	0	0
Ethane (mole frac.)	0.0376	0.0376	0.1477	0.153261	0.0405	0.03836	0	0
Propane (mole frac.)	0.0398	0.0398	0.0619	0.066243	0.0563	0.05553	0	0

i-Butane (mole frac.)	0.0126	0.0126	0.0086	0.009287	0.0194	0.01936	0	0
n-Butane (mole frac.)	0.0265	0.0265	0.0136	0.014693	0.0414	0.04146	0	0
i-Pentane (mole frac.)	0.0163	0.0163	0.0035	0.003755	0.0261	0.02631	0	0
n-Pentane (molr frac.)	0.0218	0.0218	0.0036	0.003871	0.0351	0.03536	0	0
KC6 (mole frac.)	0.0429	0.0429	0.0028	0.002676	0.0697	0.07034	0	0
KC7 (mole frac.)	0.0579	0.0579	0.0014	0.00129	0.0944	0.09529	0	0
KC8 (mole frac.)	0.0399	0.0399	0.0004	0.000362	0.0651	0.06575	0	0
KC9 (mole frac.)	0.0367	0.0367	0.0001	0.000108	0.0599	0.06051	0	0
KC10 (mole frac.)	0.0342	0.0342	0	0.000036	0.0559	0.0564	0	0
KC11 (mole frac.)	0.0245	0.0245	0	0.000011	0.04	0.0404	0	0
C12+ (mole frac.)	0.213	0.213	0	0	0.348	0.35128	0	0

CONCLUSION

According to the table above, all the parameters are so close together that differ only slightly reduce the flow of oil and gas output difference the following suggestions are presented:

1- Oil and gas output flow transmitters are calibrated, then the comparison is done.

2- Not resolve the problem, open the gas orifice orifice plate flow transmitter it is possible to visit the larger pores of corrosion that have openings with welding and grinding and turning back to normal, if the problem did not solve the orifice plate the transmitter will be replaced.

3- Transmitter Vortex flow of oil from the tank to clean it out and sticking Scale, Scale possibility of sticking to the weight of the Vortex changed and the measurement error is.

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