DESIGN SIMULATION STUDY AND THE DEVELOPMENT OF NATURAL GAS LIQUID FROM RAW NATURAL GAS MECHANISMS

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ABSTRACT

There are a variety of ways to extract natural gas liquids (NGL) from natural gas, since demand for NGL has increased in recent years. A simulation and development research of NGL recovery for two separate methods is shown here. Nigerian National Petroleum Company (NNPC) uses the simulation to evaluate and compare an existing NGL recovery system at Port NLNG Bonny (Nigeria), which is based on the company's Improved Overhead Recycle Mechanisms (IOR) (SCORE). Simulations reveal that IOR mechanisms are more adaptable than SCORE systems when the natural gas feed composition changes from rich to extremely lean. To handle feed gas composition ranging from lean (0.91806-0.9620) to rich (0.91800-0.85511) depending on methane mole fraction, IOR techniques have been developed. SCORE mechanisms' fixed capital investment and operational costs are cheaper than those of IOR mechanisms under typical operating conditions by $ 25.67E+06 / year. SCORE's overall production profit is also $ 10.787E+06 more each year than IOR mechanisms' total production profit. As a result, SCORE mechanisms are the preferred technology for facilities that need high propane recovery and optimum efficiency.

Keywords: *Natural Gas Mechanismsing, NGL, Recovery Mechanisms, Propane, Recovery Mechanisms, SCORE Mechanisms, IOR Mechanisms, Energy* [b]

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1. INTRODUCTION

Increasing operational flexibility, plant automation, shorter project cycles, and other improvements are in demand in the oil and gas business these days. Both as a source of clean energy and as a chemical feedstock, natural gas is an important commodity. Several mechanismsing procedures must be completed before it reaches the client. In order to transport the gas across large distances, and to collect important components from the gas, these processes are required in some way. (1,2). As market circumstances change, gas mechanismsors who can adapt their NGL/LPG recovery plant's performance to optimize product profits while keeping efficient operation will be the most successful in today's economic environment. To reduce capital and operational costs while preserving maximum flexibility, efficiency and product recovery in gas plant in bottle NGL/LPG recovery systems presented are the next generation of mechanisms (3). Technology-enabled solutions to these difficulties include Mechanisms Simulation utilizing HYSYS Software in addition to other ways. (4). Liquefied natural gas (LNG) plant engineering studies using simulation are becoming more important (6). Using simulations, engineers may discover design improvements that have a major impact on both plant efficiency and operational safety and dependability. Furthermore, early detection of such design modifications may result in low-cost implementation and substantial cost savings over the course of a plant's life (7, 8).

2. OBJECTIVE OF THE STUDY

The purpose of this research is to evaluate and explore both the present NGL recovery unit's IOR and SCORE and the followings is to make a comparison between them:

- ✓ Each mechanism's ability to handle a wide range of natural gas mixtures.
- ✓ For each example under study, distinguish between the combined power usage of the two devices.
- ✓ Both processes suppressed by fixed and operational expenses must be evaluated.
- ✓ Assess the SCORE unit's economic advantages over the current IOR unit.

3. ANALYSES OF PLAN MODELING AND DEVELOPMENT FOR IOR AND SCORE

The case study would involve the Nigerian National Petroleum Company's (NNPC) NGL recovery facility, which was operated as an Improved Overhead Recycle mechanism (IOR).

The Nigerian National Petroleum Company (NNPC) was founded to collect gas generated from the Bonny NLNG port, concessions, and gas treatment facilities in order to extract NGL and produce propane, LPG, and condensates in accordance with the overall mechanisms flow scheme, figure.

Initially, The liquid propane is kept in a refrigerated tank in Bonny before being transferred through maritime vessels to the worldwide market. While the LPG and condensate are pumped to the Nigerian National Petroleum Company's (NNPC) appropriate pipeline network for local use.

Currently, liquid propane is sold to the Nigerian Propylene & Polypropylene Company (NPPC) for use in the petrochemical sector in order to optimize foreign currency returns and added value. NPP produces Propylene, while the NNPC's existing Damietta facilities are being renovated to accommodate Propane imports. "The project is currently under construction," in addition to exporting surplus commercial propane to the worldwide market.

The NNPC plant's NGL recovery unit (Ortloff's IOR mechanisms) has a two-column configuration that incorporates an Absorber (C-02) and a Demethanizer (C-01). The cooled and partly condensed vapor from the Demethanizer is used to provide reflux for both columns. Absorber overhead vapours provide the cooling required to partly condense the Demethanizer overhead vapour. Typically, the two columns run at about the same pressure, with pumps supplying the energy necessary to move liquids between the columns, as seen in

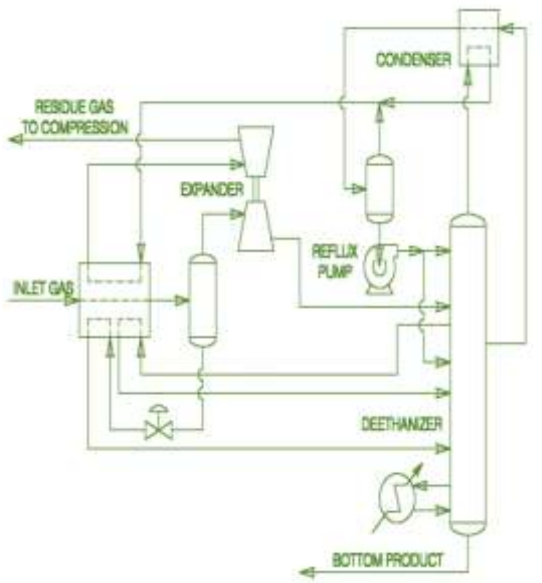


Figure 2.

Figure 1 Single Colum Overhead Recycle Mechanisms (SCORE)

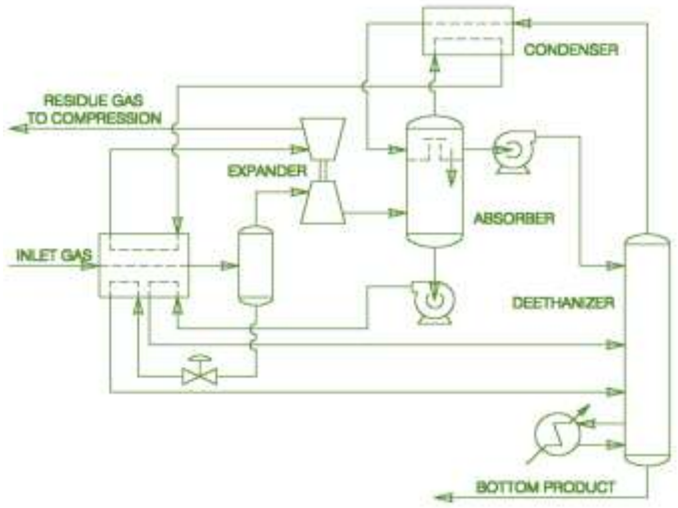


Figure 2 Improved Overhead Recycle mechanisms (IOR)

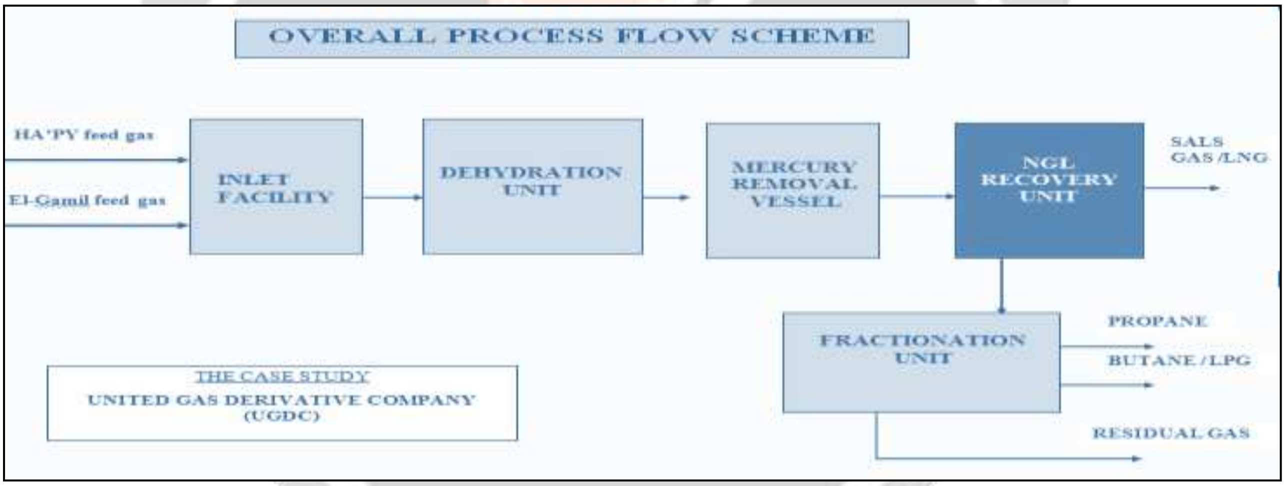


Figure 1 UGDC Overall Mechanisms Flow Scheme.

The purpose of this research was to modify the NNPC unit, which utilizes IOR technology, in order to design it according to the new technology of Single Colum Overhead Recycle Mechanisms (SCORE).

Ortloff invented the Single Column Overhead Recycle (SCORE) mechanism in the late 1990's and it was first used in 2000. Numerous plants are currently operational, and further ones are being built and constructed across the globe. SCORE is a cryogenic gas mechanismsing technique that is well suited for recovering propane and other heavy hydrocarbons from natural gas streams (9, 10).

Although IOR devices have historically been used in two-column configurations, the two columns in any configuration may be conceptualized as a single composite column with an intermediate vapor side draw. As seen in Figure 3, this composite column idea resulted in the creation of the Single Colum Overhead Recycle Mechanisms (SCORE).

SCORE systems use a single, bigger column and a tiny reflux drum rather than the two columns utilized in IOR mechanisms. The column's flux is produced by condensing the vapor side draw stream. To maximize heat integration, a liquid side draw is used to cool the mechanisms.

In order to compare Improved Overhead Recycle Mechanisms (IOR) with Single Colum Overhead Recycle Mechanisms (SCORE) in:

1) The IOR and SCORE mechanisms are adaptable. (The mix of natural gas feedstock varies from lean to rich).

2) Mechanisms for IOR and SCORE development. (Includes fixed and operational costs in addition to the product's overall profit). The facility was modelled using the widely available program HYSYS. When modeling complicated processes using HYSYS, the first step is to define significant species that arise in actual mechanisms and should therefore be incorporated in the simulation and research. (11)

Figure 4 and Figure 5 demonstrate the flow diagrams of the IOR Mechanisms (existing unit) and SCORE Mechanisms (changed unit). Natural gas input composition and operating conditions as per Table 1 of the NNPC.

3.1 IOR and SCORE Mechanisms' Flexibility

3.1.1 Changing the composition of the natural gas feed stream

The natural gas that feeds the NGL/LPG recovery systems may come from a variety of wells. The composition of the feed gas fluctuates constantly owing to variations in the content of the well gas. The NGL / LPG recovery mechanisms must be able to adapt to the changing composition of its supply stream.

Natural gas input stream composition has been altered in order to evaluate the flexibility of the two systems IOR and SCORE, and to determine the best operating circumstances.

Table 2 classifies natural gas into lean and rich gas based on the amount of recoverable liquids in the gas. Per 1000 standard cubic feet of gas, the quantity of potentially recoverable liquid is represented as gallons of liquid at 60 degrees Fahrenheit, if completely condensed (so called GPM, not to confuse with gallon per minute).

Based on ethane and heavier hydrocarbons (C2+) as shown in table 2, a "lean and rich" gas:

Table 2 Types of natural gas

Types of Natural Gas	Heavier hydrocarbons(C2+)
Lean gas	< 2.5 GPM
Moderately –Rich	2.5-5 GPM
Very Rich	> 5GOM

Ten distinct natural gas input compositions will be used to test the IOR and SCORE systems' ability to be flexibly configured.

The content of heavier hydrocarbons (C2+) will fluctuate as a result of a change in the concentration of methane (C1).

NNPC Natural Gas Feed Composition Table 3 shows that methane content is 0.91806 (mole percentage).

In natural gas feed composition, methane content may be raised or lowered (Lean gas) (Rich gas).

There will be a 0.91806 to a 0.9494 concentration shift in Lean gas, which is the maximum separation that the two IOR towers can manage within the product specification, and there will be 10 distinct compositions of feed for this adjustment.

In the case of Rich gas, the methane concentration will be lowered from 0.91806 to 0.8159, a level at which the two IOR towers can no longer manage the separation required to meet the product's specifications. There will be 11 distinct feed compositions as a result of this adjustment.

Table 3 NNPC Natural Gas Feed Composition (Original Composition)

NNPC Natural Gas Feed Composition	
Nitrogen	1.06E-03
CO2	7.24E-03
Methane	**0.91806**
Ethane	4.53E-02
Propane	1.75E-02
i-Butane	3.91E-03
n-Butane	3.59E-03
i-Pentane	1.36E-03
n-Pentane	7.50E-04

Table 1 NNPC Normal Operating Conditions.

4. RESULT AND DISCUSSION

It was earlier stated that HYSYS simulation software version 8.4 and the Peng-Robinson equation of state were used to simulate the current plant for NGL recovery at Port Bonny (IOR) and (SCORE).

The following are the outcomes in each scenario;

4.1 Flexibility of IOR and SCORE Mechanisms

IOR and SCORE systems may be tested to see how flexible they are by varying the composition of the gas they feed with, going from lean gas (higher C1 concentration) to rich gas (lower C1 concentration). IOR mechanisms with two columns that allow for more adaptability. To measure a system's adaptability, we look at how well the two columns can manage varying feed compositions while still maintaining the desired separation and product quality.

Like SCORE, how well can single columns separate products of varying grade when the mix of the feed changes?

4.1.1 Changing lean feed composition for the IOR and SCORE mechanisms

Table 4 A/B shows that the methane mole percentage in the natural gas supply to both IOR and SCORE has been altered from 0.9186 mole to 0.9620 mole.

While the greatest mole fraction of methane that can be accommodated by IOR processes is 0.9620, the maximum mole fraction that can be accommodated by SCORE mechanisms and lean gas streams is 0.9356.

4.1.2 Changing rich feed composition for the IOR and SCORE mechanisms

The natural gas supply stream has been altered for both processes IOR and SCORE from 0.91806 mole to 0.7840 mole proportion of methane displayed in table 5 A/B.

Methane concentrations for IOR mechanisms may be as low as 0.784 however for single column can (SCORE) processes they can be as low as 0.8511 methane mole fraction, according to feed composition analysis. Single column can (SCORE) methods have a concentration of 0.784 whoever for methane mole percentage of 0.8511.

Natural Gas Feed			
Stream Specification		Stream Composition	
Phase Fraction	Vapor	Nitrogen	1.06E-03
Temperature [C]	38	CO2	7.24E-03
Pressure [bar_g]	68.5	Methane	0.918061313
Molar Flow [MMSCFD]	210	Ethane	4.53E-02
Mass Flow [tone/d]	4314.197915	Propane	1.75E-02
Std Ideal LiqVol. Flow [barrel/day]	87342.10094	i-Butane	3.91E-03
Molar Enthalpy [kcal/kgmole]	-18490.38306	n-Butane	3.59E-03
Molar Entropy [kcal/kgmol-K]	35.67336397	i-Pentane	1.36E-03
Heat Flow [kW]	-224773.4438	n-Pentane	7.50E-04
Molar Density [kgmole/m3]	3.090132	C6+*	1.18E-03

4.1.3 Power cost estimation for feed streams to IOR and SCORE mechanisms

Due to the fact that the power cost accounts for around 80% of the mechanisms cost As a result, it is predicted that the power of the sales gas compressors for both procedures depends on the feed composition. Compressors used to boost the pressure of sales gas so that it may be transported to customers' homes or industrial facilities through gas pipes are known as sales gas compressors.

Figure 6 shows that when the methane mole percentage increases, compressor power increases linearly for both the IOR and SCORE methods.

The same results were seen when the gas feed composition changed from lean to rich as indicated in figure 7.

Improved overhead recycling (IOR) consumes more power than a single overhead cycle does (SCORE). Figures 8 and 9 illustrate that lean feed streams use more power than rich feed streams for both processes.

4.1.4 **Products production for IOR and SCORE mechanisms**

As employed in both processes, the NNPC feed composition simulation is shown in Table 1 under typical operating circumstances. The fixed and running expenses, as well as the production of sales gas, propane, liquefied petroleum gas (LPG), and natural gasoline or condensate, will be the subject of the comparison of IOR and SCORE systems for cost assessment. Table (6) shows the outcomes of both techniques (7). According to the simulation, SCORE's propane consumption will rise by 256.2 tons per day compared to IOR's. When LPG for IOR rises to an average of 236.2 tons a day.

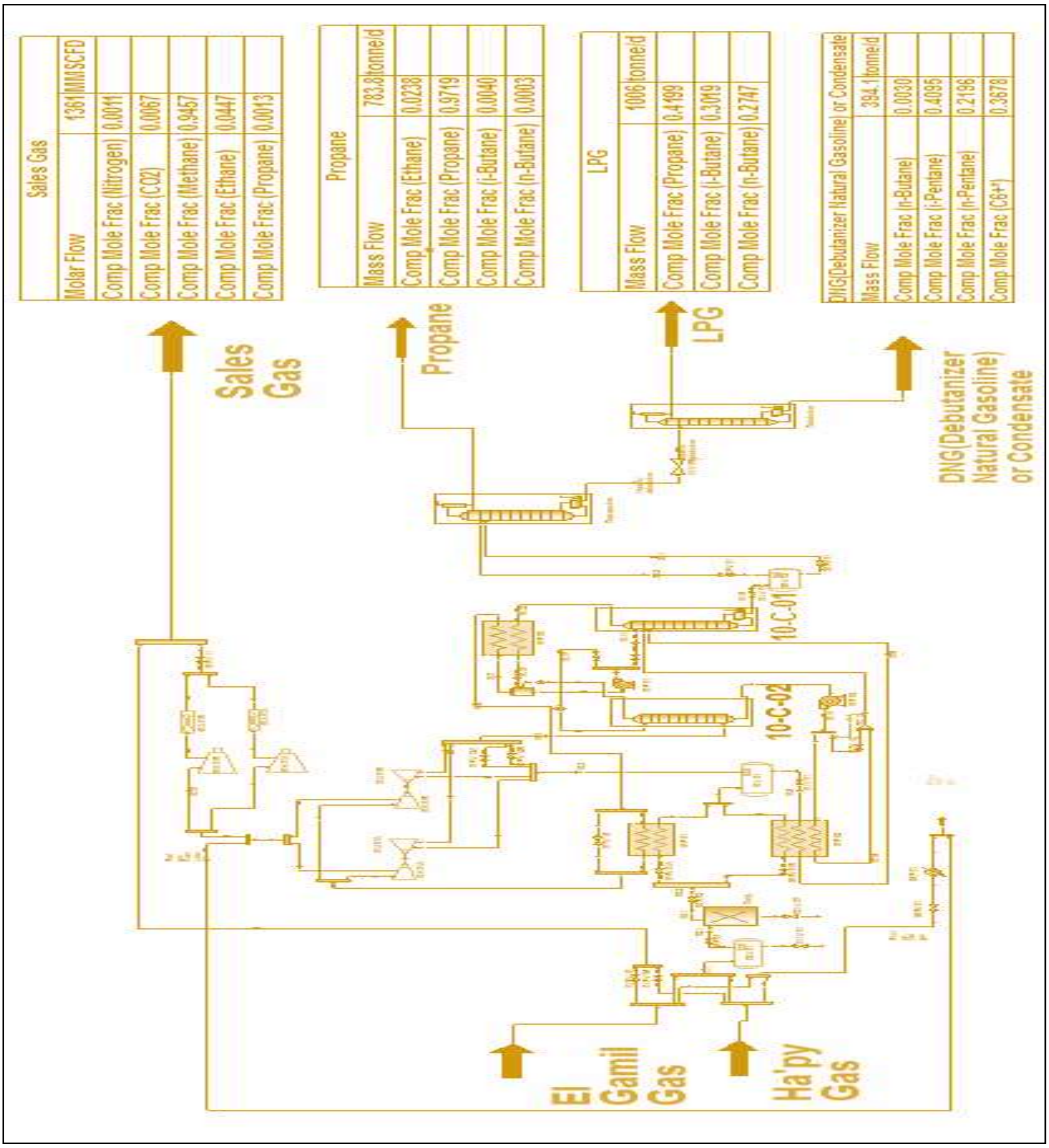


Figure 2 Improved Overhead Recycle Mechanisms (IOR)

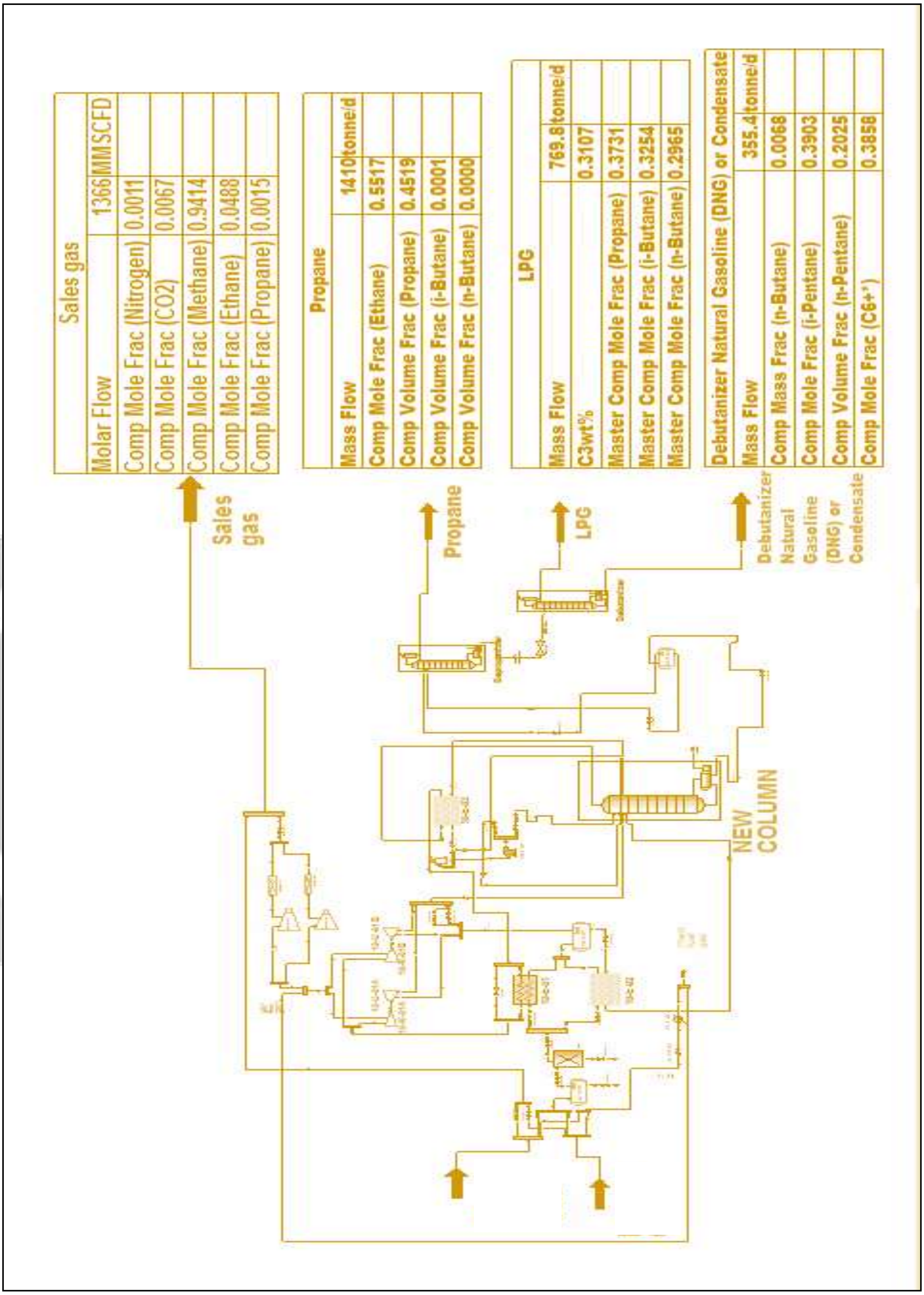


Figure 3 Single Colum Overhead Recycle Mechanisms (SCORE)

Table 4A Composition of the Lean Natural Gas Feed (IOR)

Feed	1	2	3	4	5	6	7	8	9	10
Nitrogen	1.06E-03	1.03E-03	9.87E-04	9.63E-04	9.06E-04	8.46E-04	7.94E-04	7.48E-04	6.13E-04	4.91E-04
CO2	7.24E-03	7.01E-03	6.74E-03	6.58E-03	6.19E-03	5.78E-03	5.43E-03	5.11E-03	4.18E-03	3.35E-03
Methane	0.918061	0.920646	0.92369	0.925566	0.929993	0.934573	0.938591	0.942144	0.952644	0.962035
Ethane	4.53E-02	4.39E-02	4.22E-02	4.12E-02	3.87E-02	3.62E-02	3.40E-02	3.20E-02	2.62E-02	2.10E-02
Propane	1.75E-02	1.70E-02	1.63E-02	1.59E-02	1.50E-02	1.40E-02	1.31E-02	1.24E-02	1.01E-02	8.13E-03
i-Butane	3.91E-03	3.79E-03	3.64E-03	3.55E-03	3.34E-03	3.12E-03	2.93E-03	2.76E-03	2.26E-03	1.81E-03
n-Butane	3.59E-03	3.48E-03	3.34E-03	3.26E-03	3.07E-03	2.87E-03	2.69E-03	2.53E-03	2.07E-03	1.66E-03
i-Pentane	1.36E-03	1.32E-03	1.27E-03	1.24E-03	1.16E-03	1.09E-03	1.02E-03	9.60E-04	7.86E-04	6.30E-04
n-Pentane	7.50E-04	7.26E-04	6.99E-04	6.81E-04	6.41E-04	5.99E-04	5.62E-04	5.30E-04	4.33E-04	3.48E-04
C6+*	1.18E-03	1.14E-03	1.10E-03	1.07E-03	1.01E-03	9.42E-04	8.84E-04	8.33E-04	6.82E-04	5.47E-04

Table 4B Composition of the Lean Natural Gas Feed (SCORE)

Feed	1	2	3	4	5	6	7	8	9	10
Nitrogen	0.00106	0.001027	0.000987	0.000963	0.000906	0.000846	0.000794			
CO2	0.00724	0.007012	0.006743	0.006577	0.006186	0.005781	0.005426			
Methane	0.918061	0.920646	0.92369	0.925566	0.929993	0.934573	0.938591			
Ethane	0.045312	0.043882	0.0422	0.041162	0.038714	0.036181	0.033959			
Propane	0.017536	0.016983	0.016331	0.01593	0.014982	0.014002	0.013142			
i-Butane	0.00391	0.003787	0.003642	0.003552	0.003341	0.003122	0.00293			
n-Butane	0.00359	0.003477	0.003344	0.003261	0.003067	0.002867	0.002691			
i-Pentane	0.00136	0.001317	0.001267	0.001235	0.001162	0.001086	0.001019			
n-Pentane	0.00075	0.000726	0.000699	0.000681	0.000641	0.000599	0.000562			
C6+*	0.00118	0.001143	0.001099	0.001072	0.001008	0.000942	0.000884			

Table 4A Composition of the Rich Natural Gas Feed (IOR)

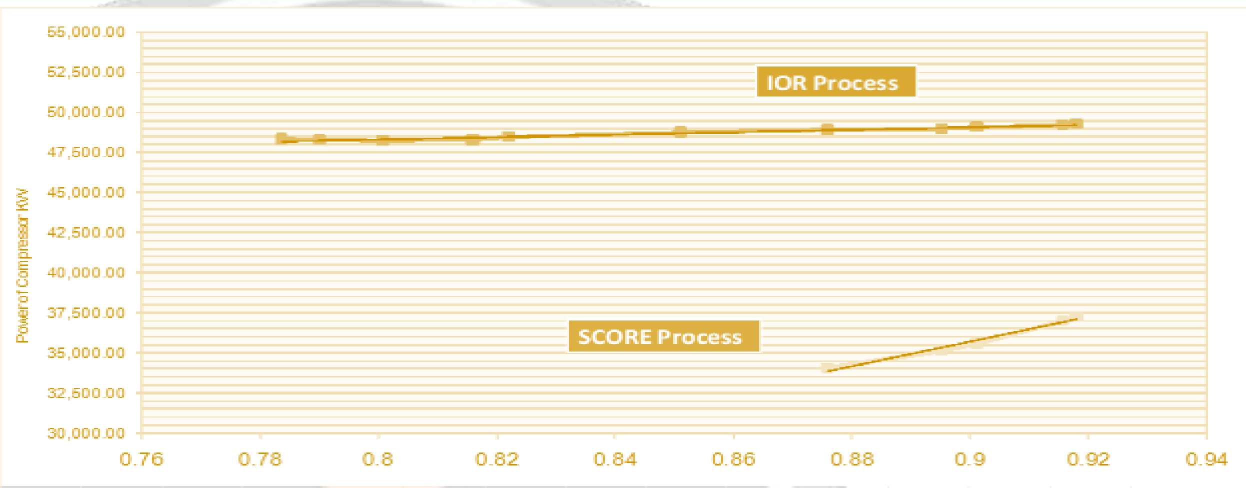
Feed	1	2	3	4	5	6	7	8	9	10
Nitrogen	1.06E-03	1.09E-03	1.28E-03	1.36E-03	1.60E-03	1.93E-03	2.30E-03	2.38E-03	2.58E-03	2.80E-03
CO2	7.24E-03	7.45E-03	8.73E-03	9.26E-03	1.10E-02	1.32E-02	1.57E-02	1.63E-02	1.76E-02	1.91E-02
Methane	0.918061	0.915696	0.901232	0.895211	0.875958	0.851123	0.822007	0.815946	0.800819	7.84E-01
Ethane	4.53E-02	4.66E-02	5.46E-02	5.79E-02	6.86E-02	8.23E-02	9.84E-02	1.02E-01	1.10E-01	1.20E-01
Propane	1.75E-02	1.80E-02	2.11E-02	2.24E-02	2.65E-02	3.19E-02	3.81E-02	3.94E-02	4.26E-02	4.63E-02
i-Butane	3.91E-03	4.02E-03	4.71E-03	5.00E-03	5.92E-03	7.10E-03	8.49E-03	8.78E-03	9.51E-03	1.03E-02
n-Butane	3.59E-03	3.69E-03	4.33E-03	4.59E-03	5.43E-03	6.52E-03	7.80E-03	8.06E-03	8.73E-03	9.48E-03
i-Pentane	1.36E-03	1.40E-03	1.64E-03	1.74E-03	2.06E-03	2.47E-03	2.95E-03	3.06E-03	3.31E-03	3.59E-03
n-Pentane	7.50E-04	7.72E-04	9.04E-04	9.59E-04	1.14E-03	1.36E-03	1.63E-03	1.68E-03	1.82E-03	1.98E-03
C6+*	1.18E-03	1.21E-03	1.42E-03	1.51E-03	1.79E-03	2.14E-03	2.56E-03	2.65E-03	2.87E-03	3.12E-03

Table 4B Composition of the Rich Natural Gas Feed (SCORE)

Feed	1	2	3	4	5	6	7	8	9	10
Nitrogen	1.06E-03	1.09E-03	1.28E-03	1.36E-03	1.60E-03	1.93E-03				
CO2	7.24E-03	7.45E-03	8.73E-03	9.26E-03	1.10E-02	1.32E-02				
Methane	0.918061	0.915762	0.901232	0.895211	0.875958	0.851123				
Ethane	4.53E-02	4.66E-02	5.46E-02	5.79E-02	6.86E-02	8.23E-02				
Propane	1.75E-02	1.80E-02	2.11E-02	2.24E-02	2.65E-02	3.19E-02				
i-Butane	3.91E-03	4.02E-03	4.71E-03	5.00E-03	5.92E-03	7.10E-03				
n-Butane	3.59E-03	3.69E-03	4.33E-03	4.59E-03	5.43E-03	6.52E-03				
i-Pentane	1.36E-03	1.40E-03	1.64E-03	1.74E-03	2.06E-03	2.47E-03				
n-Pentane	7.50E-04	7.72E-04	9.04E-04	9.59E-04	1.14E-03	1.36E-03				
C6+*	1.18E-03	1.21E-03	1.42E-03	1.51E-03	1.79E-03	2.14E-03				

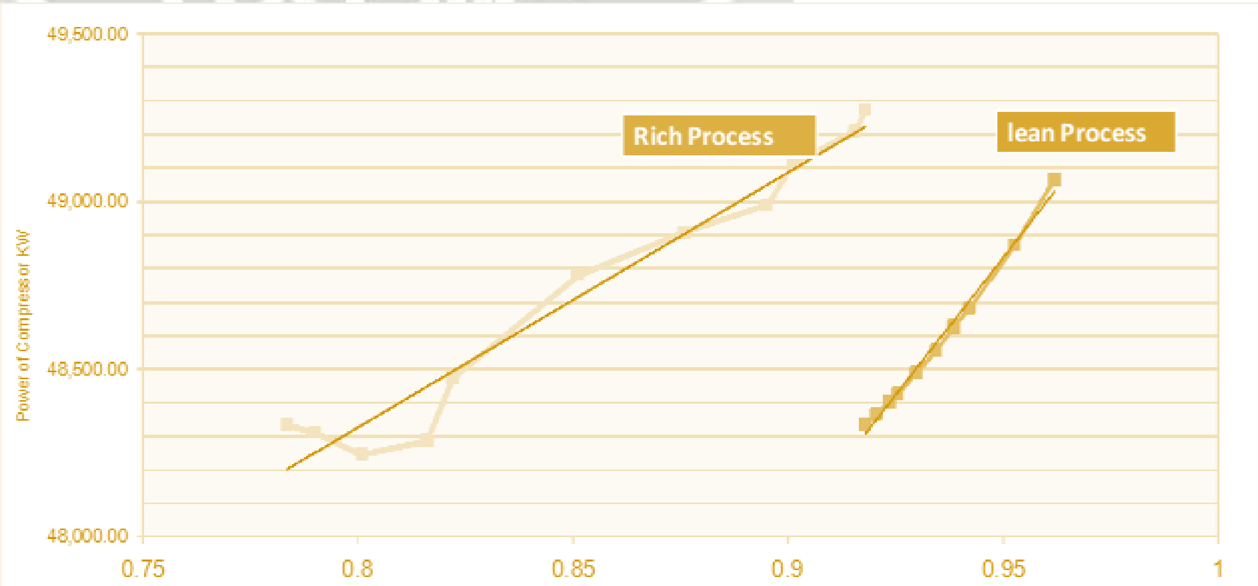
C1 % in Feed

Figure 6 Power of the compressor for Lean Gas in IOR and SCORE Mechanisms



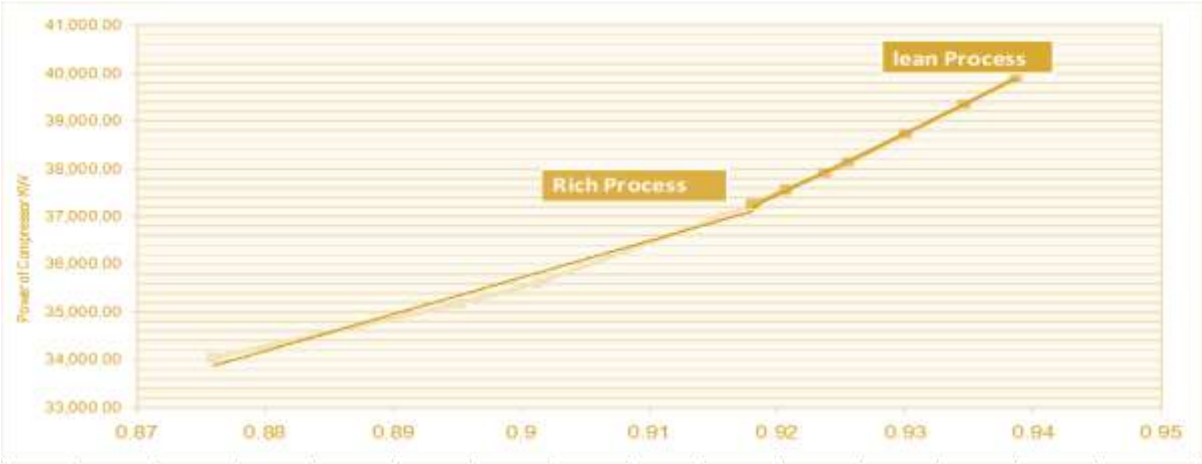
C1 % in Feed

Figure 7 Power of the compressor for Rich Gas in IOR and SCORE Mechanisms



C1 % in Feed

Figure 8 Power of the compressor for Rich and Lean Gas in IOR Mechanisms



C1 % in Feed

Figure 9 Power of the compressor for Rich and Lean Gas in SCORE Mechanisms

Table 6 Simulation Result and Cost Estimation for IOR Mechanisms

a-Simulation Result					
Top Product Composition	Methane (Sales gas)	Flow Rate	Composition (Mole Fraction Basis)		
		1361 MMSCFD	Nitrogen CO_2 Methane Ethane Propane		1.09e-003 6.65e-003 0.9457 4.4718e-002 1.323e-003
Bottom Product Composition	Propane	783.8 TONNE/DAY	Ethane	Propane i-Butane	2.375e-002 0.9719 3.99e-003
	LPG	1006 TONNE/DAY	Propane	i-Butane n-Butane	0.41992 0.30192 0.2747
	Debutanizer Natural Gasoline (DNG) or Condensate	394.1 TONNE/DAY	i-Pentane n-Pentane C6+		0.40951 0.21959 0.3678
Number of trays Column	C-01		24 tray		
	C-02		6 trays		
Compressor	Compressor power		48332. Kw		
b- Cost Estimation					
Fixed Capital Investment			Columns cost		66.03 E+0
Operating cost			Compressor Electricity cost		65.54 E+0

4.2 Cost estimation for the Production Profit

Appendix B and Table 8 present the results of the cost assessment for IOR and SCORE, which took into account both the fixed and variable costs of the project, as well as the product costs.

It is clear from the simulation results that the total profit calculation for single column overhead recycling mechanisms gained roughly $ 10.787E+6 per year more than the proven overhead recycle mechanisms, as shown in table 9.
The following is a picture of Figure 10. Show how IOR and SCORE vary in terms of overall cost, operational costs, and fixed costs.

Table 7 Simulation Result and Cost Estimation for SCORE Mechanisms

a-Simulation Result					
Top Product Composition	Methane (Sales gas)	Flow Rate	Composition		
		1366 MMSCFD	Nitrogen CO2 Methane Ethane Propane		1.094e-003 6.7015e-003 0.9414 4.8794e-002 1.5343e-003
Bottom Product Composition	Propane	1410 TONNE/DAY	Ethane	Propane i-Butane	0.55173 0.44409 5.9206e-005
	LPG	769.8 TONNE/DAY	Propane	i-Butane n-Butane	0.373139 0.325446 0.29652
	Debutanizer Natural Gasoline (DNG) or Condensate	355.4 TONNE/DAY	i-Pentane C6+	n-Pentane	0.390295 0.214439 0.385754
Number of Trays in Column	New Column		10 tray		
Compressor	Compressor power		37246 Kw		
b- Cost Estimation					
Fixed Capital Investment			Columns cost		52.97 E+0
Operating cost			Compressor Electricity cost		52.93 E+0

Table 8 Cost estimation for the Mechanisms Production Profit

Plant Design	IOR	SCORE
Sales gas Production, MMSCFD	**1361**	**1366**
Incremental Sales gas , MMSCFD	**5 (net heatin**	**g value 1000 btu/scf)**
Average price of Methane ($/t)	**3.5 $**	**/ 10E+6 btu**
Incremental	+	**6.205E+6**

Production Profit ($ /year)		
Propane Production/day	**783.8**	**1040**
Incremental Propane , T/day		**256.2**
Average price of Propane ($ /t)		**865**
Incremental Production Profit ($ / year)	**+**	**80.88E+6**
LPG Production/day	**1006**	**769.8**
Incremental LPG , T/day	**-236.2**	
Average price of LPG ($/t)	**885**	
Incremental Production Profit ($/year)	**-76.298E+6**	
Total production profit difference $ /year (SCORE in more than IOR)	**10.787E+6**	

Table 9 Overall Cost estimation for SCORE and IOR Mechanisms.

Plant Design	IOR	SCORE
Fixed Capital Investment $ /year	66.03 E+06 $	52.97 E+06 $
Operating cost $ /year	65.54 E+06 $	52.93 E+06 $
Total cost $ /year	131.57E+06	105.9E+06
	Total cost Difference $ /year (SCORE in less than IOR)	
	25.67E+06	
	Total production profit difference $ (SCORE in more than IOR)	/year
	10.787E+6	

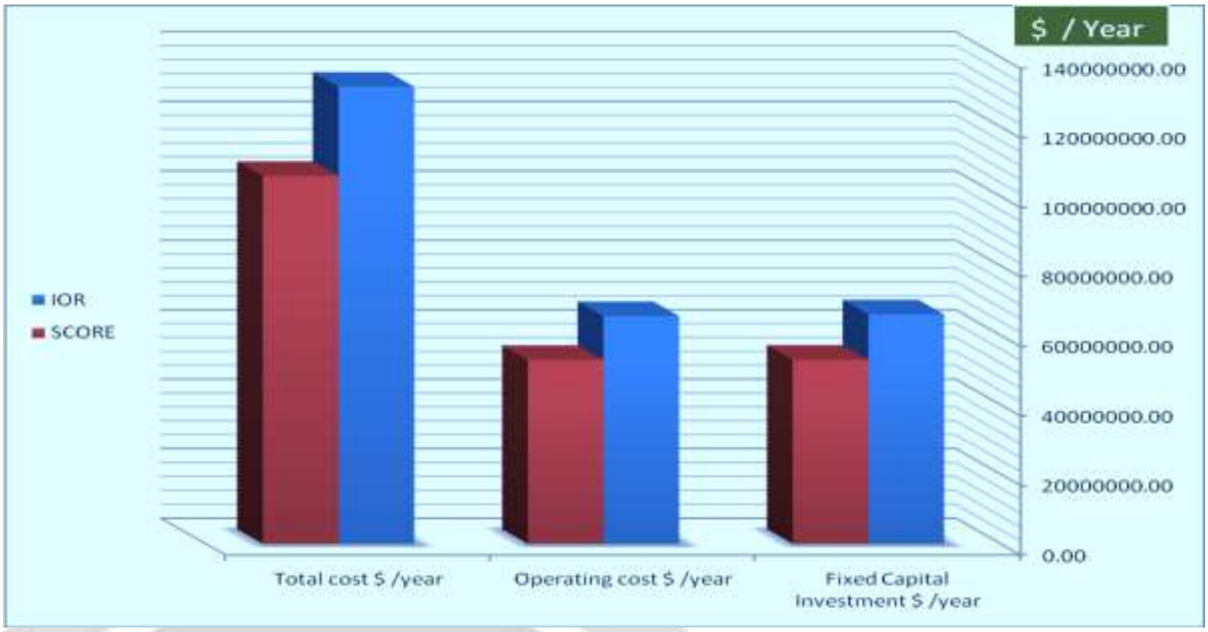


Figure 10 Cost Estimation for IOR and SCORE Mechanisms.

5. CONCLUSION

It was determined that the current Improved Overhead Recycle Mechanisms (IOR) UGDE at NLNG BONNY Rivers state , Nigeria Said could not compete on flexibility and affordability with Single Colum Overhead Recycle Mechanisms (SCORM) (SCORE).

The following is the study's unassailable conclusion:

✓ As a result of adjusting the natural gas supply composition, IOR mechanisms are more adaptable than SCORE systems.

✓ There is no difference between SCORE and IOR in terms of the methane mole fraction, but there is a significant difference between the two in terms of the ability to accept feed gas composition changes from lean to rich (0.91806-0.9620) and back again (0.91806-0.784) using IOR processes.

✓ SCORE mechanisms have a lower fixed capital investment and running cost than IOR mechanisms in typical operating circumstances by 25.67E+06 $ / year.

✓ SCORE mechanisms have a total output profit of 10.787E+06 $ / year more than IOR mechanisms do under typical operating circumstances.

✓ Because of its high propane recovery and efficiency, SCORE is the preferred technology in facilities where these factors are critical.

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REFERENCE

[1] Gas Mechanismsing supply association engineering data book GPSA, 2014

[2] Campbell. R.G., and Wilkinson ,J.D., U.S. paeten
NO.4278457,1986

[3] LNG and GTL drive 50 years of technology evolution in the gas industry | Castel, J., Technip, Paris, France; Gadelle, D., Technip, Paris,France; Hagyard,
P., Technip, Paris,France; Ould-Bamba, M., Technip, Paris, France …. Hydrocarbon mechanismsing,

07.01.2012.

[4] Campbell. R.G., and Wilkinson, J.D., U.S. paeten NO.4278556,1986.

[5] Aspen HYSYS, Simulation Basis Guide Copyright (c) by Aspen Technology, 2011.

[6] Elliot ,D.G,chen ,R.J.J., Brown T.S " the economic impact of fluid properties data expander plants "

[7] Campbell. R.G., and Wilkinson, J.D., U.S. paeten NO.
415904,1986.

[8] Buck.l.lU.S .paeten NO.4617039, 1986.

[9] Wiilinson,J.D and Hudson,H.M " Improvement NGL recovery designs maximize operating flexibility and product recoveries, Oil and Gas Journal, 104, 5862,2012.

[10] Wiilinson,J.D and Hudson,H.M " Tuboespander plant designs can provide high ethane recovery without inlet Co2 removal " oil & gas Gornal May 3,2002.

[11] Aspen HYSYS, Unit Operation Guide Copyright (c) 1981-2011 by Aspen Technology Douglas, J. M. Conceptual Design of Chemical Mechanisms, McGraw-
Hill, New York, 1988.Lokh and wala and Jacobs (2000) [12] Eduardo Díez, Paul Langston, Gabriel Ovejero, M. Dolores Romero (Economic feasibility of heat pumps in distillation to reduce energy use) Elsevier Ltd 2008

[13] Carl R.P.,Editor ,"rules of thunb for chemical engineers manual of quick ,accurate solution to everyday mechanisms engineering problems " , fourth edition 2005.

[14] Solan,E D.,kol,A.k. " Clathrate hydrate of natural gas " 3rd edition, CRC press Taylor and Fances group, USA 2008.

[15] Max,s.p.khausD.T.,"Plant design and economics for chemical engineers", fifth edition Mcgrawhill INC.2003.