Economic Analysis of Liquid drop-out Minimization in Natural Gas Pipelines

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Abstract:

The main goal of this research work is to provide an economic evaluation about the controlling of natural gas liquid dropout. The devloped idea is to minimize the natural gas losses in pipeline integrity management companies for the sake of controlling Un-accounted for gas (UAFG). The main idea is to possibly recover those valuable liquids to convert them in a liquid fuel. The econoimc analysis of the overall problem has been discussed. The overall associated cost with the adsorber unit is calculated. Finally the Net present value, Pay back period, Accounting rate of return and Internal rate of return has been calculated.

Key words: Economic Analysis, Hydrocarbon Natural Gas Liquids (HNGL's), Natural Gas Pipelines

Introduction:

The specification and composition of natural gas is very important when transmitted through the long routes. The pipeline mangement companies have to take care about different technical measures in order to produce a streamline operations for natural gas transportation and distribution. Therefore, the pipeline management companies must deal with the undesirable components that are present in the produced natural gas obtained from well-head. The undesirable components like natural gas liquids are required to be cleaned and the natural gas can be safely transmitted between the long distances through those pipelines.[1] The main issues exit in natural gas operations are due to less processing and obselete transmission techniques. Hydrocarbon natural gas liquids(HNGL's) has direct impact on the quality and specification of natural gas. The natural gas liquid are very senstive to the base conditions of temperature and pressure of Natural Gas. At constant pressure, when the temperature of natural gas is dropped down, the condensation Hydrocarbon natural gas liquids(HNGL's) begins. This condition particularly happens in winter. So, Hydrocarbon natural gas liquids(HNGL's) are very senstive to temperature variation. The Hydrocarbon natural gas liquids(HNGL's) are mainly Propane, Butane and C_5^+ contents which liquifies from pipeline natural gas in cold climatic conditions. In such situations slugging may cause. Slugs are formed due to condensation of Hydrocarbon natural gas

liquids(HNGL's) . These slugs choke the pipelines which may arise several problems and unafe conditions in upstream and downstream operations of natural gas.In order to deal with the condensation of Hydrocarbon natural gas liquids(HNGL's) in high pressure transmission pipelines, advanced solutions may be developed. However, these require huge capital investments and technological improvements. The technology designed to control Hydrocarbon natural gas liquids(HNGL's) may involve chemical and physical treatements of natural gas.[2]

At present, consumers of pipeline natural gas are badly affected by Hydrocarbon natural gas liquids(HNGL's) phase change. Due to safety concerns, Managers and Stakeholders have identified several risks and hazards that are associated with Hydrocarbon natural gas liquids(HNGL's).[3] The natural gas having presence of Hydrocarbon natural gas liquids(HNGL's) can cause operational hazards for Indutrial, Commercial, Domestic and Residential consumers. Wet natural gas when entered in burners of furnaces, boilers and stoves may increase the chances of fire explosions and flames,creating unsafe conditions during operations.[4]

The Hydrocarbon natural gas liquids(HNGL's) can be used as a feed for many important chemicals and polymers. The chemical and allied industries has attracted towards Hydrocarbon natural gas liquids(HNGL's), since the improvements of technology to recover these liquids and cost effectiveness of upstream and downstream processes.[5] With the passage of time demand of Hydrocarbon natural gas liquids(HNGL's) will become increasing in pharmaceutical industry as well. This is due to advantegous and complimentary recovery of Hydrocarbon natural gas liquids(HNGL's) from crude natural gas.[6]

Methodology:

The main focus of this research work is to anlayze the recovery of Hydrocarbon natural gas liquids(HNGL's). The two options are compared to control the minimzation of Hydrocarbon natural gas liquids(HNGL's). One option was taken from DELTA FILTERS and analysed it in terms of Net present value, Pay back period, Accounting rate of return and Internal rate of return with another option with designed molecular seive adsorber for the adsorption of natural gas liquids. The systematic flowsheets of the options are given in fig 1.

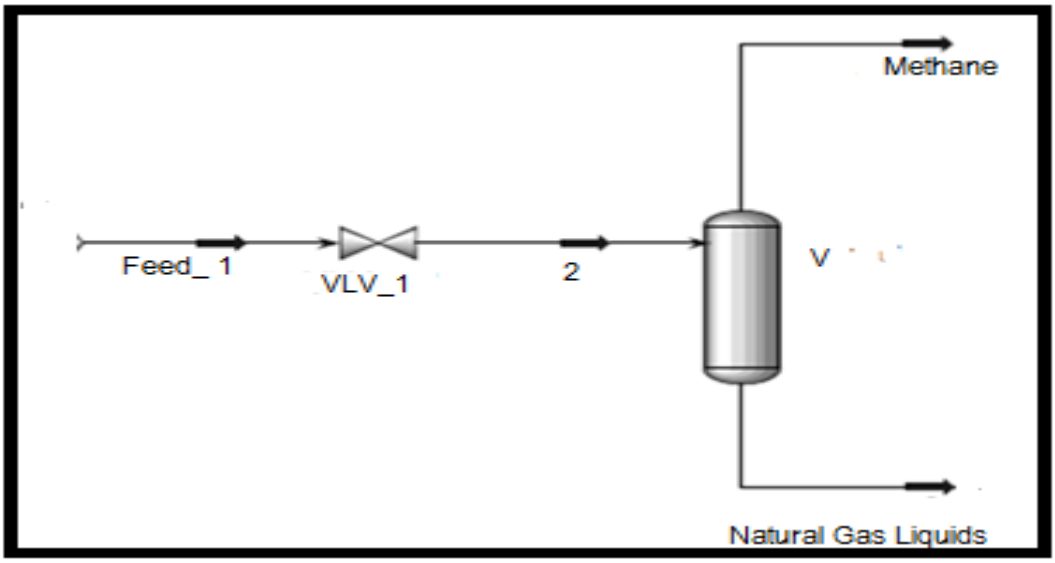

Fig.1 Cyclone seprator for Hydrocarbon natural gas liquids(HNGL's)

Fig.1 showed the Cyclone seprator provided by DELTA FILTERS for the minimization of Hydrocarbon natural gas liquids(HNGL's) in high pressure natural gas supply pipelines. The equipment cost was analyzed with the cost of designed adsorber with molecular seives.

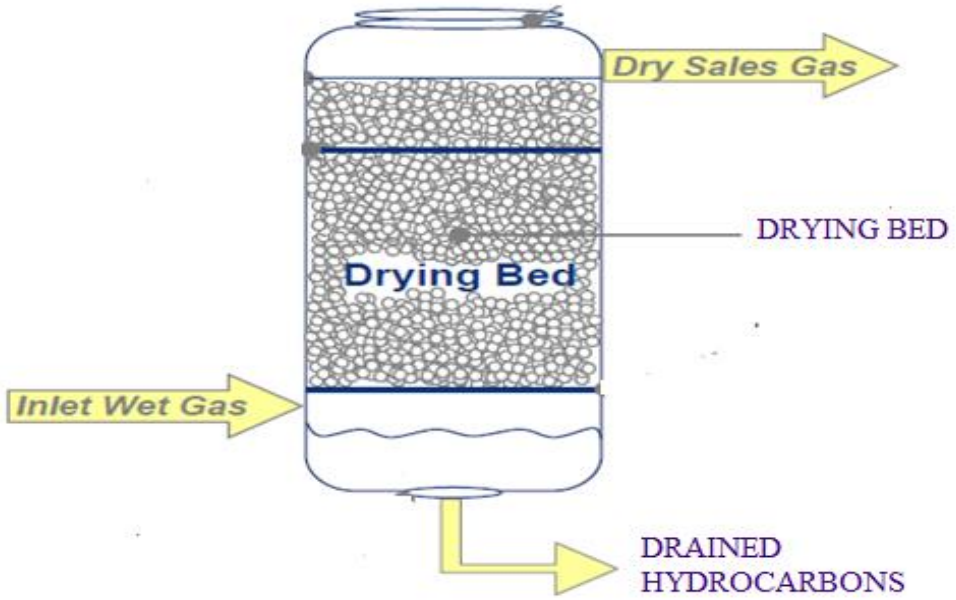

Fig.2

Designed Adsorber with molecular seives for the minimzation of Hydrocarbon natural gas liquids(HNGL's)

The Hydrocarbon natural gas liquids(HNGL's) are sperated while passed through the molecular seives. The gas compostion and flow rate of natural gas was taken from MISSA KESWAL managed by OGDCL Ltd**.**

Table.1 Molecular Sieve Adsorber Designing and Cost Calculations

Flow rate			Mole fraction of component that are adsorbed		Flow rate of components adsorbed		cycle time	Mass of sieve kg	bed volume m3		assumed dia
1MMSCFD	1179m3/h	n	2.85		36.22878		1m	805.08408	1.677259		1m
		co2	0.00054	0.030728		0.06		56350			
		c2	0.13					$56,350		length	
		c3	0.057							0.267079	
		c4	0.0109				Bulk density				
		nc4	0.0142				30lb/ft3			unit length	
		c5	0.00397				480		unit length	3* bed	
		nc5	0.00323						0.801238		
		c6+	0.003					Adsorber volume	2.515888		
										volume in gallons	
										664.1944	
								cost	$22,900		
									79250		

The equipment cost for MSA-natural gas adsorber was calculated and shown in Table1. It also showed estimated mass of molecular seive required in the MSA-natural gas adsorber.

Results and Discussions:

The plant data was taken from the MISSA KESWAL operated by OGDCL Ltd. This gas well provides gas supply to the national network of Pakistan of about 1 MMSCFD. The gas composition has different amount of Hydrocarbon natural gas liquids(HNGL's).

Economic Analysis:

Two options are evaluated in this research work to control the Liquid drop out in natural gas Transmission pipelines. The overall costs are calculated for the two options. Payback period, Accounting rate of return, Internal rate of return and Earnings are calculated for the options to control liquid drop out in natural gas.

Overall Costs

Different vendors are contacted throughout the world dealing with natural gas liquids. Equipment costs were taken from DELTA FILTERS for cyclone separators. The cost for MSA-natural gas adsorber is calculated from equipment sizing data discussed above. Further, the fixed capital investment and Total Capital investment are calculated. Finally the overall operating and maintenance costs were calculated in terms of Fixed and Variable costs. The results are shown in table.2.

Table.2. Calculation of Overall Costs for Controlling liquid drop out

	Case-I $	Case-II (with Molecular Seives) $
Equipment Cost Cyclonic Separator	1780	79250
Purchased equipment delivered	1780	79250
Purchased equipment installation	836.6	37247.5
Instrumentation and controls (installed)	640.8	28530
Piping (installed)	1210.4	53890
Electrical systems (installed)	195.8	8717.5
Buildings (including services)	320.4	14265
Yard Improvements	178	7925
Services Facilities	1246	55475
Engineering and supervision	587.4	26152.5
Construction expenses	729.8	32492.5
Legal Expenses	71.2	31700
Contractor's fee	391.6	17435
Contingency	783.2	34870
Fixed Capital Investment	8971.2	427950
Working capital cost (start-up cost)	269.136	12838.5
Total Capital Investment	9240.336	440788.5
Maintenance Cost	448.56	21397.5
Operating labour cost ($)	900	1800
Laboratory tests	207	414
Interest rates	897.12	42795
Insurance	897.12	42795
Fixed O&M Costs ($)	2542.392	70686
Variable Cost ($)	44.856	2139.75

The analysis of the system is done in EXCEL. Different factors comprising economic indicators like Pay Back Period, Accounting rate of return, Net Present value and the Internal rate of return for the available alternatives are calculated. Table.3 showed the results for 20 years period

Table.3. Economic Analysis report for proposed solution for Hydrocarbon natural gas liquids(HNGL's) in Natural gas supply pipelines Case-I

Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Natural gas Sales $		2190	65.7	67.71	69.7	71.792	73.94	76.16	78.44	80.802	83.2	85.7	88.2	90.9	93.6	96	99.3	102	105	108	111
Natural gas price escalator	3%	2190	2255	2323	2393	2464	2538	2614	2693	2774	2857	2943	3031	322	3216	3312	3411	3514	3619	3728	3840
Revenue Pay Back Period (years)		**-12.6**																			
Accounting rate of return (ARR)		**3.86**																			
Net Present Value (10%)		-36999	1990	1864	1745	1634	1530	1433	1341	1256	1176	1101									
Internal Rate of Return(IRR)		**1.93**																			
Costs $		79250																			
Fixed O&M Costs ($)		70686	2120	2120	2120	2120	2120	2120	2120	2120	2120	2120	2120	2120	2120	2120	2120	2120	2120	2120	2120
Variable O&M cost ($)		2139	6.417	6.417	6.417	6.417	6.417	6.417	6.417	6.417	6.417	6.417	6.417	6.417	6.417	6.417	6.417	6.417	6.417	6.417	6.417
Total Cost		152075	2126	2126	2126	2126	2126	2126	2126	2126	2126	2126	2126	2126	2126	2126	2126	2126	2126	2126	2126
Earnings		-149885	129.283	196.954	266.65513	338.	412.393	488.5	567.0	647	731	816	905	996	1089	1186	1285	1387	1493	1601	1713

The calculations showed that the earnings started after the second year of project. The natural gas price escalation was estimated to be 3%. This option is found to be feasible.

Case-II In second option the values of different economic indicators are reported. The calculations include revenue, Pay Back Period, Accounting rate of return, Net present value, and internal rate of return. The overall net present value of the system is calculated. The annual cash flow is also showed in Table 4.

Table.4. Economic Analysis report for proposed solution for Hydrocarbon natural gas liquids(HNGL's) in Natural gas supply pipelines Case-II

Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Natural gas Sales $		2190	65.7	67.671	69.7	71.792	73.94	76.16	78.44	80.802	83.2	85.7	88.2	90.9	93.6	96	99.3	102	105	108	111
Natural gas price escalator	3%	2190	2255	2323	2393	2464	2538	2614	2693	2774	2857	2943	3031	3122	3216	3312	3411	3514	3619	3728	3840
Revenue Pay Back Period (years)		**4.91**																			
Accounting rate of return (ARR)		**11.97**																			
Net Present Value (10%)		1990	1864	1864	1745	1634	1530	1433	1341	1256	1176	1101	1031								
Internal Rate of Return(IRR)		**24.81**																			
Costs $		9240																			
Fixed O&M Costs ($)		2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542	2542
Variable O&M cost ($)		44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
Total Cost		11826	2586	2586	2586	2586	2586	2586	2586	2586	2586	2586	2586	2586	2586	2586	2586	2586	2586	2586	2586
Earnings		-9636	-330	-262	-192	-121	-47	28	107	188	271	357	445	536	630	726	825	928	1033	1142	1254

In table.4, it is showed that cost to recover natural gas is more than the revenues. Therefore, this option is not so favourable for controlling Hydrocarbon natural gas liquids(HNGL's) in Natural gas supply transmission Pipelines.

Conclusion:

In spite of significant technological growth troubles still exist in natural gas pipeline integrity management. The Hydrocarbon natural gas liquids(HNGL's) generate problems in the natural gas transportation in high pressure transmission pipelines. These natural gas liquids condense during the flow and cause many operational issues in equipments installed for measurement and pressure adjustment of natural gas. These liquids may generate unsafe situations like over ignition of flames, flames quenching and blight the blades of turbines used to generate Electricity form Natural gas. In this study project investigation from technical data and real industrial data for liquid drop out minimization are compared. The data may be helpful to natural gas pipeline integrity management system to monitor the problem of natural gas liquids. This study may attract attention to control the natural gas dropout and associated economic benefits of the solution. These types of projects not only help mangers to generate profits for all stakeholders but could also improve the environmental management associated with natural gas liquids. The action is required by the natural gas regulators in this issue so that profits may start increase sooner.

The research work can be further extended to use membrane technology to separate these natural gas liquids. The use of membranes may be another economic option to improve the productivity of the scheme with more economic benefits and lower capital investment.

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