PERFORMANCE IMPROVEMENT OF COMPRESSOR TO RECOVER FLARE GAS USING DESIGN OF EXPERIMENT TECHNIQUES

Naseem Ahmad[1], Sahar Noor[1], Rehman Akhtar[1*], Misbah Ullah[1], Khizar Azam[2]

ABSTRACT

The main purpose of this research work is to deploy engineering experimental design techniques to recuperate large quantity of flare gas with the help of a new proposed plant process. Some factors responsible for disturbing routine of compressor are categorized and pertinent information is togethered from various resources. The information is thoroughly studied to enhance factors performance and the factors were set up according to the modified compressor compression system. The suggested equipped factors guide to enhance the recuperate of low pressure burn gas and the proposed approach of the performance parameters guide to cost effective taking out the low pressure flare gas minimizes harmful environmental impacts and achieve financial benefits.

KEYWORDS: *Oil Company, Gas flaring, Factorial Design, Environmental, Economics*

INTRODUCTION

In Pakistan the oil and gas sectors need to operate efficiently to be able to meet the prevailing countrywide demands. The oil and gas are two main factors of the energy and both oil and gas contribute round about 70%-80% of energy requisite in the whole nation. In Pakistan the industry gas and oil sector developing rapidly. Approximately thirty million barrels of reservoir are available in Pakistan. Industries of exploration and production in Pakistan that are operational including MOL Pakistan, POL, OGDCL, and Orient petroleum limited. Different oil and gas fields of the different industries are placed in various locations in Pakistan.

A mixture of crude oil is produced from oil and gas wells. To make this mixture flow useful the mixture is shifted to plant through its natural pressure. First, the crude stream is infuseed to three stage separator of high pressure, that split the flow of the three phases. The eleven hundred pound per square inch gage gas is send to dehydration plant to remove water and other contents and make the gas useful. The gas is send to Sui Northern Gas Pipeline Limited (SNGPL) pipeline after dehydration plant. Water is send to pit after separation. The crude oil of high pressure separator having pressure three hundred to four hundred pound per square inch gage is send to three phase medium pressure separator. From medium pressure separator the crude oil is shift to low pressure separator and after that the crude oil is send to crude oil storage tanks. The medium pressure gas is passed through compressor where the pressure of the gas is increase to eleven hundred pound per square inch gage and injected to Sui Northern Gas Pipeline Limited piping network. Hence, the gas which has low pressure is being flared. The flare gas which has low pressure is to be recover in the compressor existing system. This whole process is depicted in Figure 1. The minimization of flaring gas or waste gas is a sever ecological confrontation which is facing all the oil and gas industries. Therefore, the developed method in this research helps in minimizing gas flaring. This research will help in reducing negative environmental impacts, preserve natural resources and energy which is secure for company employees' consumers and communities. Flares are necessary safe technology for cheap and hygienic of flammable gases. For more than 60 years flares has been in commission in different gas processing plants, steel mills and chemical companies. Burn gas stream action determination must be necessary by launching revitalization design structure facility and pace for gas flare average is important stride in calculating economic of project and benefits.

LITERATURE REVIEW

Flare gas activities are related to the oil and gas field, refineries and chemical industries and these activities not only created sever intimidations to the environment but also huge loss of economic. There are always limited resources, so it is necessary to minimize the losses. Different approaches are used for the recovery of flare

1 Department of Industrial Engineering, University of Engineering and Technology, Peshawar, Pakistan.*
2 Department of Mechanical Engineering. University of Engineering and Technology, Peshawar, Pakistan.

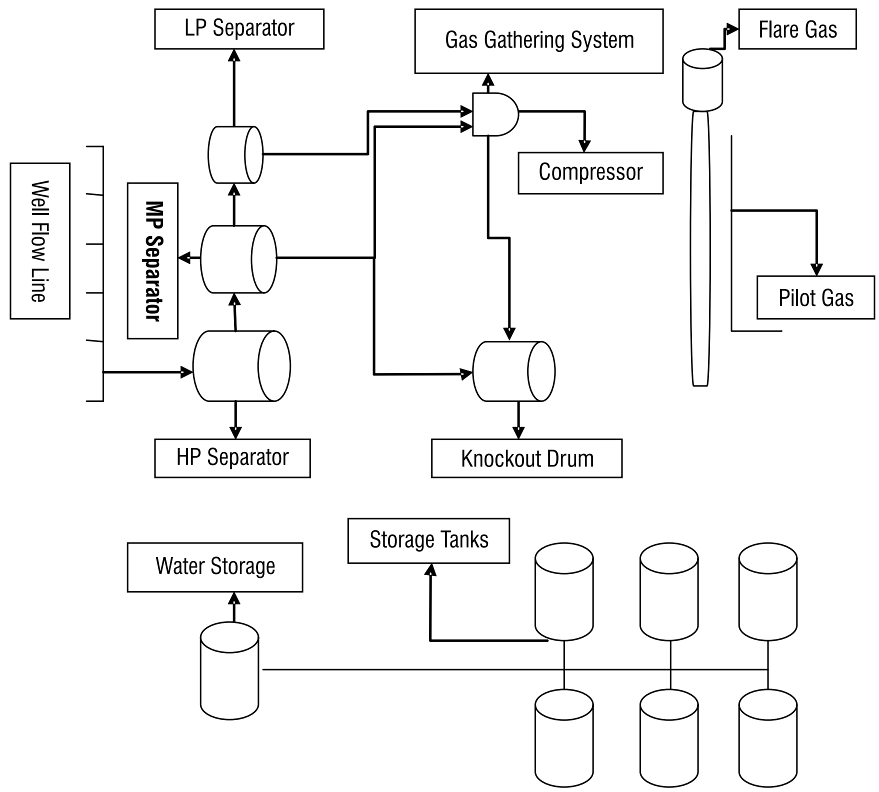

Figure 1: Plant Gas Flaring Process

gas for useful purposes up to date. Flare gas is the surplus natural gas which is burn in open air. The flare gas is consist of different gases and discharge emanation into open atmosphere. this is key component in innate gas amenities and drilling operation. flare gas produces risk to member of staff and near inhabitants. The gas flaring system is used in the whole petroleum industries. In pure methane (CH_4) flaring carbon monoxide is produced. During the combustion the Nitrogen is oxidized which is present in open air and make nitrogen oxides. Emanation of gas flaring effects human health, live stock, environment, animals and plants. These harmful impacts depend on occurrence, period and degree which are being depicted by the dangerous gases. In addition, these gases give global warming. If hydrogen sulphide is present in natural gas than carbon sulphide and carbonyl sulphide is produced by emission[1]. Akpan studied on burning of gas and his study explains that large quantity of gas is used in chemical companies. To control natural gas the country the method is support petrochemicals compounds of the organization based gas that is put away huge sum of volume required to reduce gas flaring. They further proposed if Nigeria properly control the natural gas by set up petrochemicals gas industries than for long term they can make foreign exchange earnings[2]. Moore, Boom, Randall and Hill[3] worked on gas flaring. They have worked on gas flaring for more than two years and they applied various engineering developed method for the recovery of liquid gas recovery, gas treatment, residual gas compression and power generation which can utilized efficiently and cost effectively[3]. Onwukwee in Nigeria has worked on gas liquid technology. The choice of sustainable utilization of natural gas converted from gas to liquid technology is explained by his work. They explained that gas to liquid technology make the possibility of natural gas chemical conversion to clean diesel, kerosene, naphtha and light oils as profitable product. Their work is based on the reduction of flare gas and minimizes trade in refined petroleum product in which the whole country depends on[4]. Gas flaring is consider to be financial desecrate and also ecological risk. In gas and oil region different problems has been written by different canvassers at different times. Kimberly, Blasing and Hang worked in cement manufacturing in the united status on natural gas flaring monthly carbon emission. They found that all fossil fuel and carbon emission amounted to 0.1% and it has not continual and plain annual model[5]. Odigure and Abdul Kareem worked in Nigeria on financial benefits of consumption of natural gas and their case study is related to the industry of food processing. Their study concentrate on the amount of high temperature emission from flaring of gas and the usefulness of replacing usual energy and fuel sorts like motor vehicle gas oil (low fuel, motor vehicle oil diesel and electrical energy) in fiscal period to use mathematical principles in calculation in Nigeria in the industry of food processing. This study explains that approximately 69% on diesel, 33% on low pour fuel and 59% on electricity can be save by the company and if usual energy and fuel is replaced with natural gas than in five years this can convert to millions of dollars[6]. Elvidge, Bough, Erwin, Ziskin, Pack, Tuttle, Gosh performed experiment on global natural gas flaring for fifteen years and the data is recorded from satellite. They concluded that per barrel flared gas of volume of crude oil is the efficiency of gas flaring. They also found that it is stable from the last fifteen years and this array is varying which is starting from to one hundred seventy billion. Furthermore, it established that universal gas flare have reduced to nineteen percent from 2005 that is guided by flare gas diminution in Nigeria and Russia are two nations by utmost rank of flared gas. Their work study in literature explain prominent lack of effort that is organized to evaluate the difference between the flaring of gas actions of the key Nigeria gas and oil and the disparities among formed and gas flared[7]. Pakistan per day gas production is round about 6.8 billion. Production and exploration corporations of Pakistan carry the Pakistan institute of petroleum for enchanting ideas in petroleum sector. Through jagged guess low gas and gas reservoir set at sixty billion cubic feet per day. Due to low pressure 150-200 mmcfd gas is wasted per day in Pakistan. The gas which is wasted have small BTU and management gas and oil desires to purify gas. For this purpose, the houses of mobile power is installed by the management to recover low pressure gas. In this study, a method is developed to minimize hazardous low pressure gases. The main objective of this research is to develop a method to lessen carbon emanation and recuperate gas flared to utilize by investigating several factors and the factors are temperature, suction pressure, RPM, compression ratio and specific gravity.

METHODOLOGY

In this research, five main factors were identified for the performance of compressor improvement. Table 4 depicts the selected factors. For low pressure recovery of gas first one-factor-at-a-time (OFAT) approach is deployed (i.e., suction pressure was analyzed by varying and other factors were held constant). Furthermore, factorial experiment was conducted by varying various factors together.

Existing System

From main medium pressure gas header the medium pressure gas to enter to knockout vessel V0.In flash tank V2 the condensate present is recovered. After that the gas is passed through inlet separator V1 and from there the gas is passed by fan cooler it cools the gas. The gas is then passed into first stage inlet Vessel V4 of the Compressor. In vessel V3 first stage condensate is recovered. From inlet vessel V4 the gas is sent to first stage suction, and after that the gas is passed through first stage discharge after first stage. From there the gas again passed through from cooler. The gas is then entered the second stage inlet V7, from there the gas is enter into second stage V8. The gas is passed through discharge V9 after 2nd stage and again the gas is seat to from cooler to cool the gas . This is existing system

Modified System

In modified system the compressor first stage is used for low pressure gas. The compression ratio of the compressor is adjusted for low pressure gas. In second stage the first stage discharge pressure gas and the medium pressure gas is combined in second stage. In second stage both low pressure and medium pressure gas is sucked for compression by the compressor.

Table 1: Selected parameters

S No		Factors Unit
1	Suction Pressur	Pound per square Inch
2	Temperature	Forenhite
3	Specific Gravity	Unitless
4	Compression Ratio	Unitless
5	RPM	

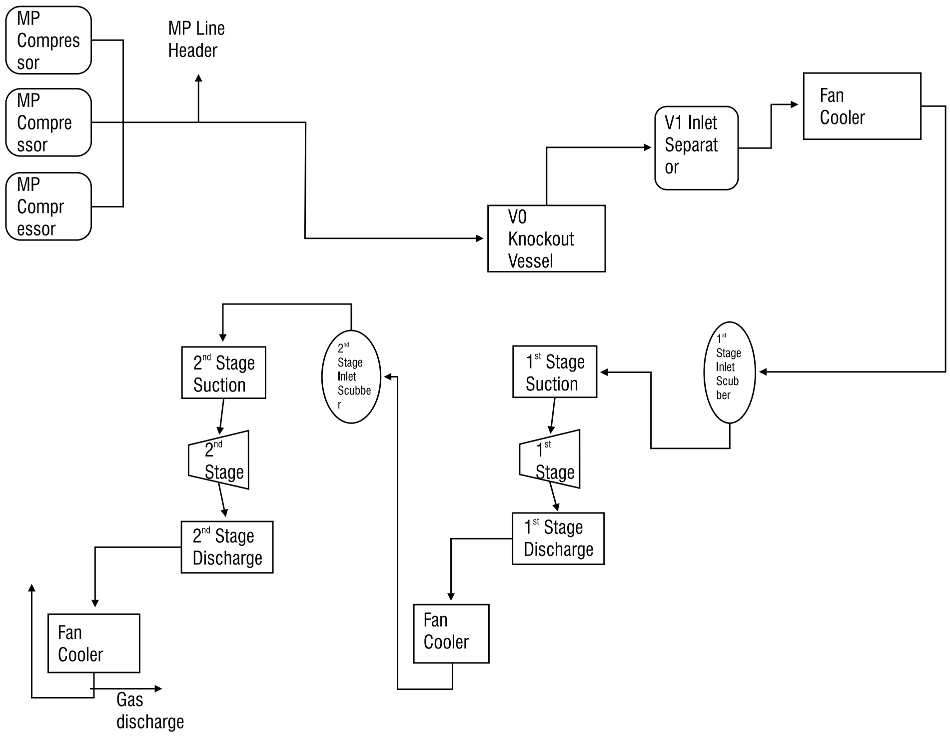

Figure 2: Process flow diagram of the existing system

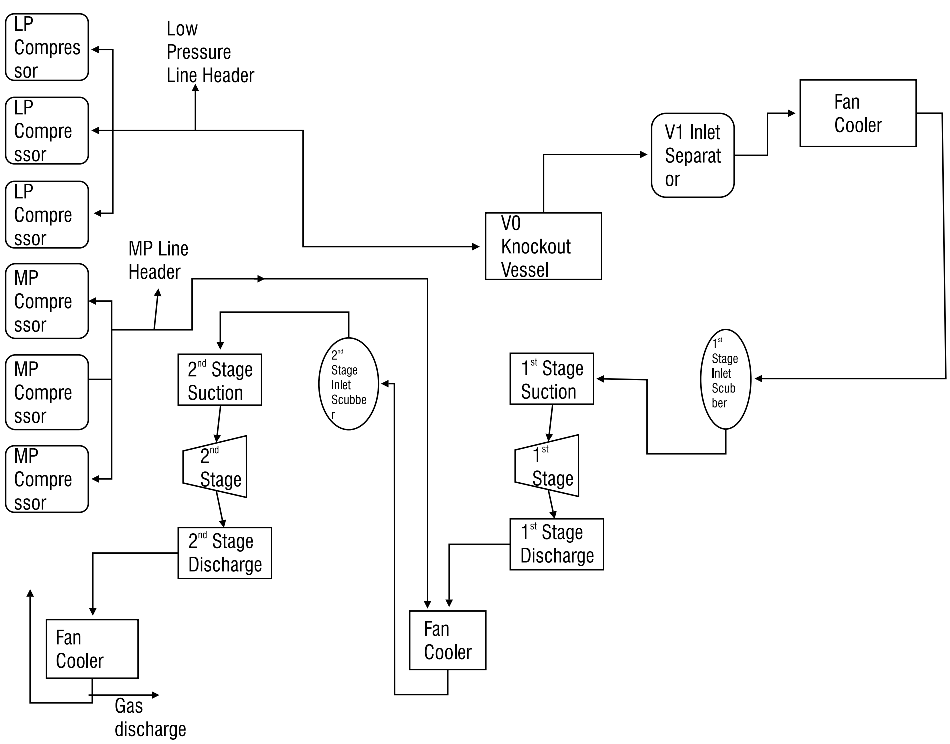

Figure 3: Process flow diagram of the modified system

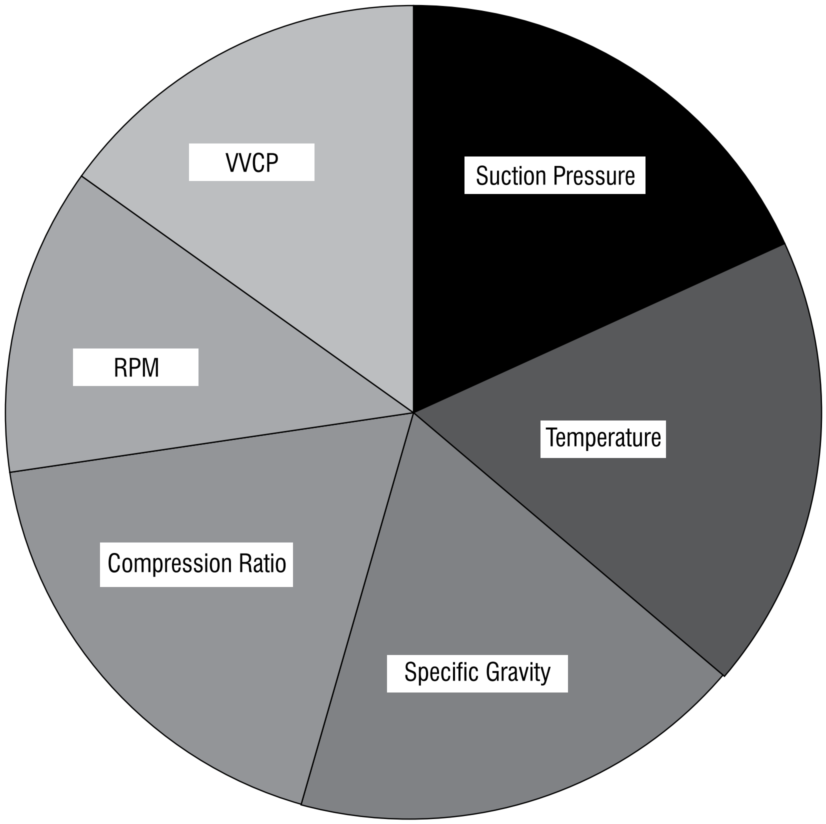

Figure 4: Selected Factors Chart

One factor at a time (OFAT):

In this scenario, one factor is varied within respective ranges by holding other factors unchanged. Temperature is changed from 130-1400F. Specific gravity is varied from 0.66 to 0.70. Range of RPM is started from 950 and reached to 1120. Compression ratio is varied from the range of 2.70 to 2.90 respectively. In table 2 compression ratio, RPM, temperature, suction pressure and specific gravity are shown. In the first case, only suction pressure is varied with respect to the range and the other four factors are unchanged. Temperature is varied after suction pressure. In the third case specific gravity is varied and RPM is changed in the forth case. Finally compression ratio is changed for both stages. The notations C and c is used for constant and variable.

Table 2: One Factor At A Time Method

S No	Factor Change	Value Range	Gas Flow
1	Suction Pressure	125,130 , 135, 140, 145, 150	2.60, 2.65, 2.70, 2.75, 280, 2.85
2	Temperature	130	
3	Specific Gravity	0.65	
4	RPM	950	
5	Compression Ratio	2.90/2.85	

Table 3: One Factor is Changed

S. No	Compres-sion Ratio	RPM	Tem-perature	Specific Gravity	Suction Pressure
1	C	C	C	c	c
2	C	c	C	C	c
3	c	c	C	C	c
4	C	c	C	c	C
5	c	C	C	c	C
6	C	c	C	c	C

Two factors at a time (TFAT)

This section shows, two factors were varied according to the series remaining factors were unchanged. In table 4 compression ratio, specific gravity, suction pressure, RPM and temperature are shown. In first case, temperature and suction pressure are varied and the other three factors are constant. In the second scenario, specific gravity and suction pressure are varied and other three factors are unchanged. In the third case, RPM and suction pressure are varied. In the fourth scenario, compression ratio and suction pressure are changed. In the fifth, specific gravity and temperature are varied. In the seventh scenario, RPM and temperature are changed. RPM and Specific gravity are changed in the eighth case. Compression ratio and specific gravity are changed in the nineth scenario. Finally, RPM and compression ratio are changed. In Table 5, two factors temperature and suction pressure are varied and remaining factors are held constant. The notations C and c is used for constant and variable.

In table 5 specific gravity, RPM , temperature, suction pressure, and compression ratio are given. In the first set of experiment, suction pressure and temperature are varied and remaining factors are kept unchanged. In the second scenario, suction pressure and specific gravity are changed while additional factors are unvarying. Suction pressure and RPM are changed in the third scenario. In the fourth scenario, suction pressure and compression ratio are changed. Temperature and specific gravity are changed in the fifth scenario. In the seventh scenario, temperature and RPM are varying. Specific gravity and RPM are varying in the eighth scenario. Specific gravity and compression ratio are changed in the nineth scenario. In the last scenario, RPM and compression ratio are changed while holding other factors constant. In Table 5, two factors factors (pressure and temperature) are varied and remaining factors are kept constant.

In table 4 specific gravity, RPM, temperature, suction pressure, and compression ratio are given. In the first set of experiment, suction pressure and temperature are varied and remaining factors are kept unchanged. In the second scenario, suction pressure and specific gravity are changed while additional factors are unvarying. Suction pressure and RPM are changed in the third scenario. In the fourth scenario, suction pressure and compression ratio are changed. Temperature and specific gravity are changed in the fifth scenario. In the seventh scenario, temperature and RPM are varying. Specific gravity and RPM are varying in the eighth scenario. Specific gravity and compression ratio are changed in the nineth scenario. In the last scenario, RPM and cpmpression ratio are changed while holding other factors constant. In Table 5, two factors factors (pressure and temperature) are varied and remaining factors are kept constant.

Table 4: Two Factors Are Changed

No	Compression Ratio	RPM	Tempera-ture	Suction Pressure
1	C	C	c	C
2	C	C	C	C
3	C	c	C	C
4	C	C	C	C
5	C	C	c	C
6	C	c	c	C
7	C	C	c	C
8	C	c	C	C
9	C	C	C	C
10	C	c	C	C

Table 5: Two Factors At A Time Method

S No	Factor Change	Value	Gas Flow
1	Suction Pressure	130, 135, 140, 145, 150	2.98, 2.82, 2.66, 2.50, 2.34
2	Temperature	132, 134, 136, 138, 140	
3	Specific Gravity	0.65	
4	RPM	950	
5	Compression Ratio	2.90/2.85	

Three factors at a time (TFAT)

Varied only three factors in scenario by given ranges and remaing factors held unvarying. Table 6 shows a method in which a set of three factors is taken at a time. The notations C and c is used for constant and variable.In table 6 three factors are changed within the respective range and other factors are unchanged. In the first scenario, temperature, specific gravity and suction pressure are varied and remaining factors are unvarying. Temperature, RPM and Suction pressure are varied in the second case, temperature, compression ratio and suction pressure are changed in the third scenario while other factors are constant. In the forth case, specific gravity, temperature, and RPM are varied inside the respective ranges. compression

ratio, specific gravity and temperature varied in fifth case. In the last scenario, specific gravity, RPM and compression ratio are varied and remaining factors are kept constant.In Table 7, three factors method is given. Specific gravity, temperature and Suction pressure are varied while compression ratio and RPM is unchanged. The value of all the three factors are varied in each case and the flow is also changed in each case and is given in table 7.

Table 6: Three Factors At A Time Method

S No	Factor Change	Value	Gas Flow
1	Suction Pressure	130, 135, 140, 145, 150	2.40,2.54, 2.7, 2.90, 3.0
2	Temperature	132, 134, 136, 138, 140	
3	Specific Gravity	0.66, 0.67 ,0.68, 0.69, 0.70	
4	RPM	1000, 1030, 1060, 1090, 1120	
5	Compression Ratio	2.90/2.85	

Table 7: Hree Factors Are Changed

No	Compres-sion Ratio	RPM	Tem-perature	Specific Gravity	Suction Pressure
1	C	C	c	c	c
2	C	c	C	c	c
3	C	c	c	c	C

Four factors at a time (FFAT)

In this scenario, four factors are varied while holding other factors constant. All factors are varied within its range. This is shown in table 8. The notations C and c is used for constant and variable.

In table 8, four factors are varied in particular range. In the first, scenario specific gravity temperature, compression and suction pressure are changed. In the second scenario, only temperature is constant while the other four factors are. In the last scenario, suction pressure is contant and specific gravity, temperature compression ratio and RPM are changed. Four factors specific gravity, RPM temperature and suction pressure are changed in table 9 by factorial design method and the compression ratio is unchanged in the said table. Each factor value is changed in each case in the table 9.

Table 8: Four Factors At A Time Method

SNo	Compres-sion Ratio	RPM	Tem-perature	Specific Gravity	Suction Pres-sure
1	C	C	C	c	c
2	C	c	C	C	c
3	c	c	C	C	c
4	C	c	C	c	C
5	c	C	C	c	C
6	C	c	C	c	C

Table 9: Four Factors Are Changed

No	Compres-sion Ratio	RPM	Tem-perature	Specific Gravity	Suction Pressure
1	c	c	c	c	c

All factors at a time

Each and every factor is changed in this method w.r.t ranges in this section. The flow of gas for each experiment is given table 11. The notations C and c is used for constant and variable.

In table 10 all factors are changed within the respective range. In Table 11 compression ratio, specific gravity suction pressure, , RPM and temperature are changed at all factor at a time method. by this method, the value of each factor is varied in each experiment. Hence, for each experiment the flow of gas calculation is shown in table.

Table 10: All Factors At A Time Method

No	Factor Change	Value	Gas Flow
1	Suction Pressure	130, 135, 140, 145, 150	
2	Temperature	132, 134, 136, 138, 140	
3	Specific Gravity	0.66, 0.67, 0.68, 0.69, 0.70	2.25,2.34, 2.43,2.52, 2.61
4	RPM	950	
5	Compression Ratio	2.90/2.85	

Table 11: All Factors Are Changed

No	Factor Change	Value	Gas Flow
1	Suction Pressure	130, 135, 140, 145, 150	
2	Temperature	132, 134, 136, 138, 140	
3	Specific Gravity	0.66, 0.67, 0.68, 0.69, 0.70	2.50, 2.62, 2.74, 2.86 ,3.0
4	RPM	1000, 1030, 1060, 1090, 1120	
5	Compression Ratio	2.85/2.80,2.85/2.75, 2.80/2.75, 2.80/2.70, 2.70/2.75	

DATA ANALYSIS

The factorial design of experiments is depolyed to investigate simultaneous effects of several factors on the gas process. Varying different factor levels by factorial design, and noted the result of the experiment, and at the same time the interaction between different factors can be revised. The selection is done to reduce the input variables that affect the quality of gas and to focus only on few important factors.

The general factorial design of experiment approach is used for selection the important variables/factors that affect the process response measures. The helpful data is gathered and the main affinity to guide for further experiments and optimum settings. The relationship between input parameters/factors and response variable (gas flow) is modeled and investigated by full factorial analysis. The Minitab software package is deployed for the analysis.

Histogram of the residuals:

Figure 5 depicts that the residuals for histogram demonstrates the allotment of the all observations of residuals. This graph illustrates that the normal distribution of residuals produced by a model for gas process.

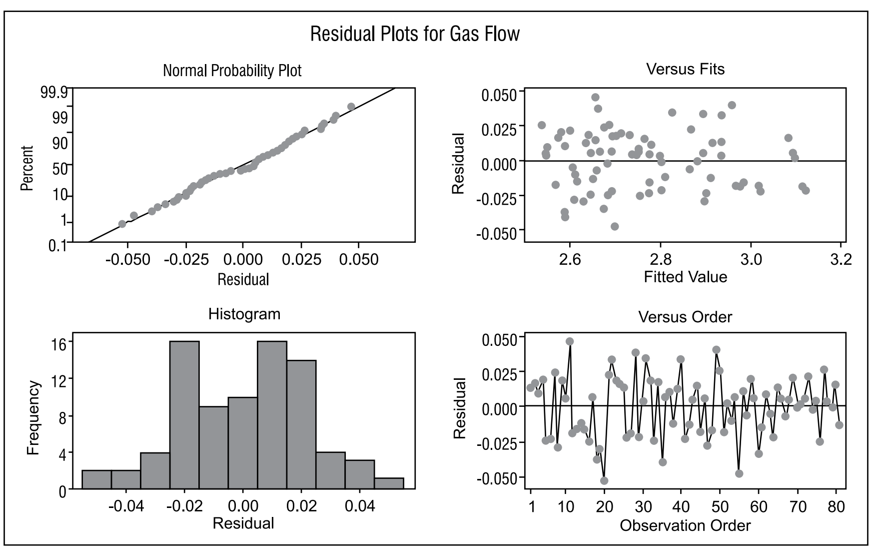

Figure 5: Residuals plots for gas flow

Residuals versus fits

This is employ to validate the statement that residuals is indiscriminately scattered and the variation is unvarying. preferably, the points must plunge arbitrarily on 0 from both sides, no identifiable models between points. A graph is shown in figure 5 depicts the variable, which explains the variation in the response variable. The residuals and fitted values are two sets of values which has a distribution. The residuals are the amount of variability in a dependent variable, so it can be positive or negative. The fitted value is the value which is obtained from the results of different experiments. The graph indicates that the absolute value of residuals is correlated through integral values. Positive values for the residuals means that forecast is stumpy while minus values means with the purpose of forecast is soaring. This graph do not show any pattern, which means that the data is normally distributed. This graph depicts that there are no unusual points in the data set and it illustrates that the variation around the estimated regression lines is constant and tells that the assumption of equal error variance is reasonable.

Residuals versus order

This stratagem demonstrates the residuals inside the array data is togethered. By using order of residuals versus intrigue to verify the statement that residuals are self-determining from each other. As the intrigue demonstrates the annotations are in array that it entered in patterns spreadsheetand these points might show that residuals near to one another might be interconnected and therefore, not self-determining. Preferably, residuals lying on the stratagem must drop indiscriminately about the midpoint of line.The graph in figure 5 indicates the data is fall randomly around the centre line. In this diagram, the residuals jump haphazardly about the residuals zero streak. Hence, residuals displaying usual arbitrary sound approximately the residual zero streak, which recommend that no successive correspondence is there.

RESULTS DISCUSSION

Figure 6 depicts relation between gas flow and pressure. This graph shows that both gas flow and suction pressure is changed although other factors hold constant. The gas flow in this graph starts from 2.6 million and

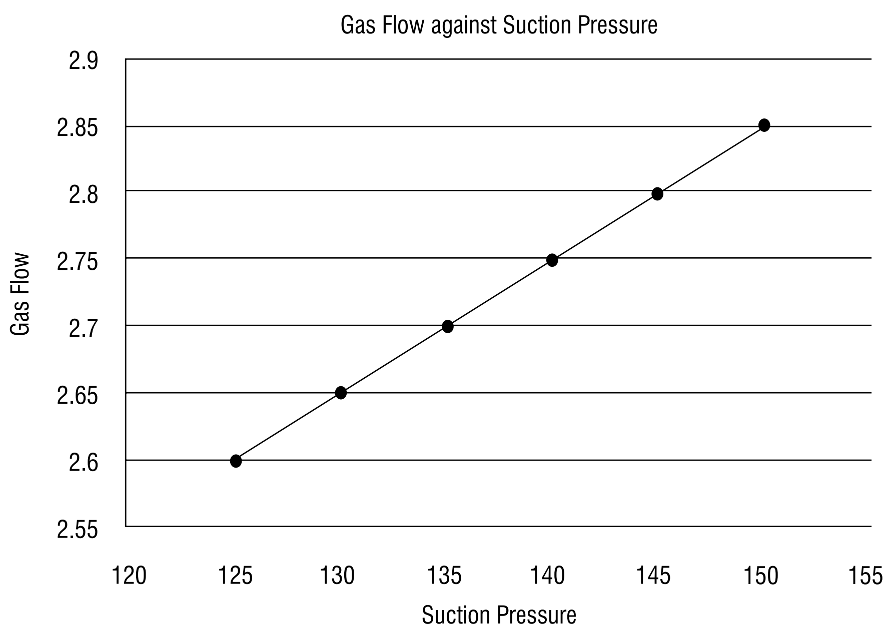

Figure 6: Graph between gas flow suction and pressure using OFAT method

finally gas flow is attained 2.85 million. Initially, temperature 130 F, specific gravity 0.65,suction pressure is set on 125 PSI, , RPM 950 and compression ratio 2.90 for first stage. For second stage, 2.85 compression ratio and 2.60 mmcfd (million cubic feet per day) gas flow is achieved. In next step, the suction pressure is set on 130 PSI and all other factors are held constant, flow of gas got by this conducted test is 2.million. Furthermore, the value of pressure be varied to 135PSI 2.70 million gas flow is achived. Finally, the suction pressure is set on 150 PSI the gas flow achived is 2.85 million. Figure 6 shows a straight line, which reveals that the flow of gas continuously increasing.

Fig. 7 depicts a scenario in which temperature and suction pressure is varied and remaining factors are constant. Firstly flow of gas goes high and gain maximum position and than flow is decreasing slowly. Temperature and suction pressure are varied at the temperature is kept on 132 F and suction pressure 130 PSI and remaining factors are unchanged so gas flow gained is 2.98 million. In the next step, when suction pressure and temperature is set on 135PSI and 132 F, respectively while gas flow decreased to 2.82 million. lastly, when pressure and temperature got value 150 PSI and 140 F than the flow of gas decreased than streamvof gas decreased toward 2.34 million. Gas flow is constantly decreasing when both

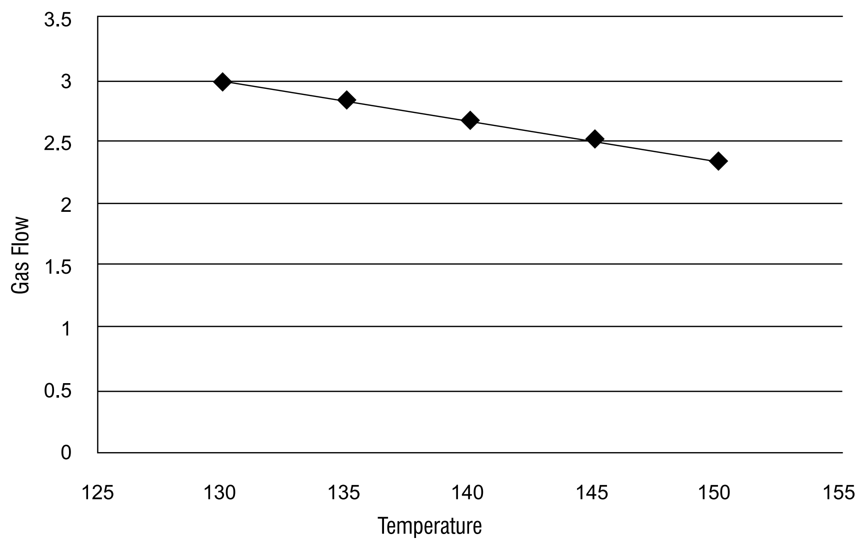

Figure 7: Temperature and suction pressure is varied and remaining factors are constant.

factors are changed to their respective ranges. Figure 7 depicts relation between suction pressure, temperature and gas flow. In this figure, the flow of gas is continuously decreasing and a straight graph is shown from higher gas flow to lower gas flow.

Figure 8 depicts relation between Temperature, suction pressure and specific gravity against gas flow. In this figure, three factors are changed while holding other factors constant. Initially, when the three factors suction pressure, temperature and temperature are set at 130 PSI, 132 F and 0.66 than 2.25 mmcfd of gas flow is achived. In next step, the value of suction pressure, temperature, and specific gravity are changed to 135 PSI, 134 F and 0.67, respectively. The gas flow reached to 2.34 million in this experiment. Five experiments are performed in this method. In the final step, the value of preesure is varied to 150 PSI, specific gravity to 0.70, temperature 140F, 2.61 million gas flow is achieved. Hence, three factors are varied at time and flow is start from 2.34 million and lastly flow reached to 2.61million. In each case the gas flow is continuously increasing. Hence, it is concluded that by changing the factors to its respective ranges and increasing the number of factors will result in an increased gas flow. Figure 8 dipicts Fig. 7 : Suction pressure and temperature are changed and gas flow is given. (two factors) that the gas flow is contionously increasing (i.e., revealing that by varying three factors inside range the gas flow is increasing).

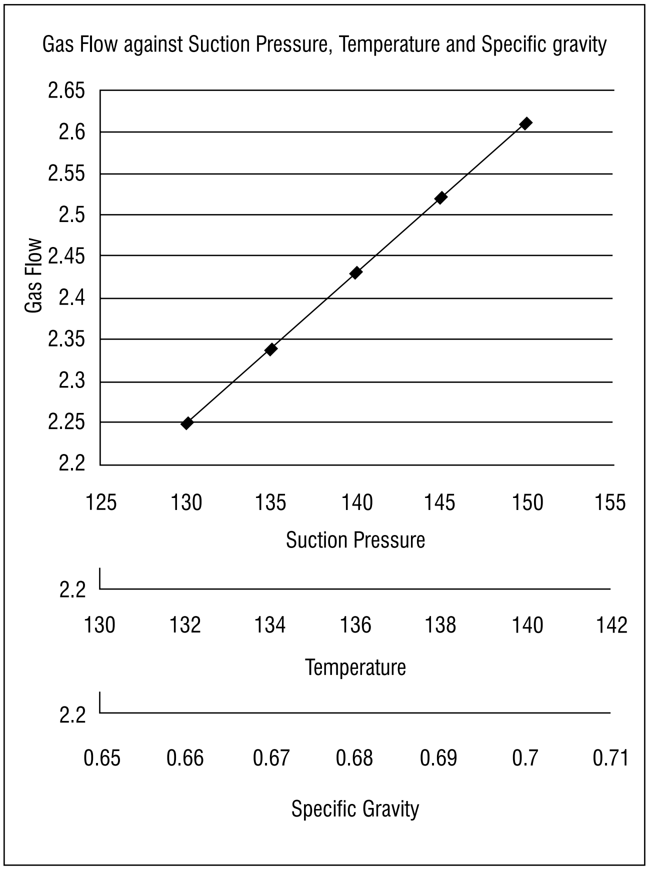

Figure 8: Temperature,specific gravity and pressure are varied against gas flow (Three Factors)

Figure 9 illustrates relation among specific gravity, RPM, temperature and suction pressure against gas flow. In this scenario, varied four factors inside the limit of range and flow for the gas is calculated. Figure 9 reveals that by changing factots flow of gas is increased. Initially, when the temperature, RPM, suction pressure and specific gravity are set at 1320F, 1000, 130 PSI,0.66 so 2.4 million gas flow is achived. Next, four factors changed again and and kept the value of suction pressure 135 PSI, temperature 134 F, specific gravity 0.67 and RPM 1030. In this case, the flow of gas reached to 2.54 million. Furthermore, change in factors is increasing the gas flow and finally set the suction pressure, temperature, specific gravity, and RPM at 150 PSI, 140 F, 0.70 and 1120 so in this scenario three million gas flow is achieved. The flow is smoothly increasing in this set of experiments. Hence, it is concluded that gas flow is increased by increasing factors and operation is running smoothly.

Figure 10 depicts when the factors are varied inside the range, gas flow is increased. Initially in this method when temperature and suction pressure is varied to 132 F and 130 PSI, RPM is set on 1000, specific gravity is varied to 0.66 and for the first stage compression ratio is set on 2.85 and 2.80 is for second stage. The flow of gas is reached to 2.52 million through this set of experiment. For 2nd phase when temperature, RPM, suction pressure, specific gravity are varied to 134 F 1030, 135 PSI, 0.67 and compression ratio set for both stages is 2.85 and 2.75 respectively than 2.64 million gas is achieved by this experiment. Now for the third set of experiment the values of all factors are changed to 136 F, 140PSI, 1060 RPM, 0.68 and 2.80 and 2.75 compression ratio for both stages, than in this case the flow achieved in this case is 2.76 million. Different values of the factors are changed for the fourth set of experiment and the values are 138 F, 0.69, 145 PSI, 1090 RPM and 2.80 and 2.70 compression ratio for both stages the gas flow is reached to 2.88 million. lastly when all factors are changed are changed to 140 F temperature, 150 PSI suction pressure, 1120 RPM, 0.70 specific gravity and 2.70 and 2.75 compression ratio for both stages, three

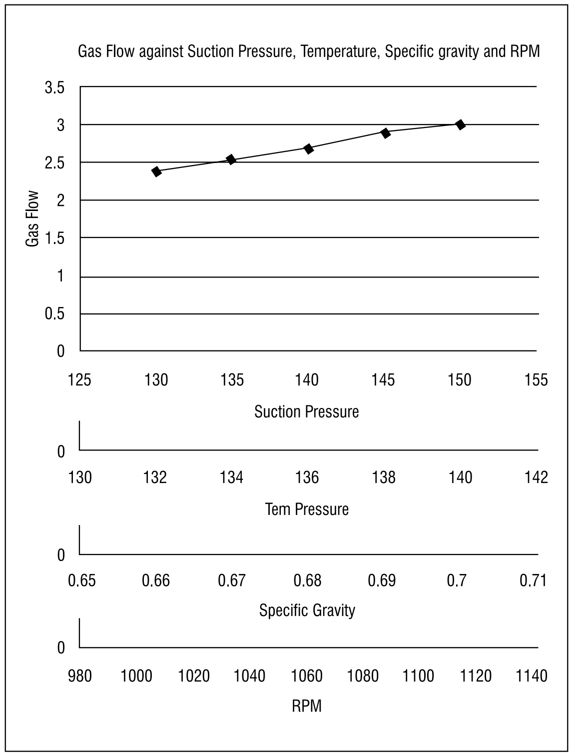

Figure 9: temperature, RPM, specific gravity and Suction pressure are varied against gas flow is shown. (Four Factors)

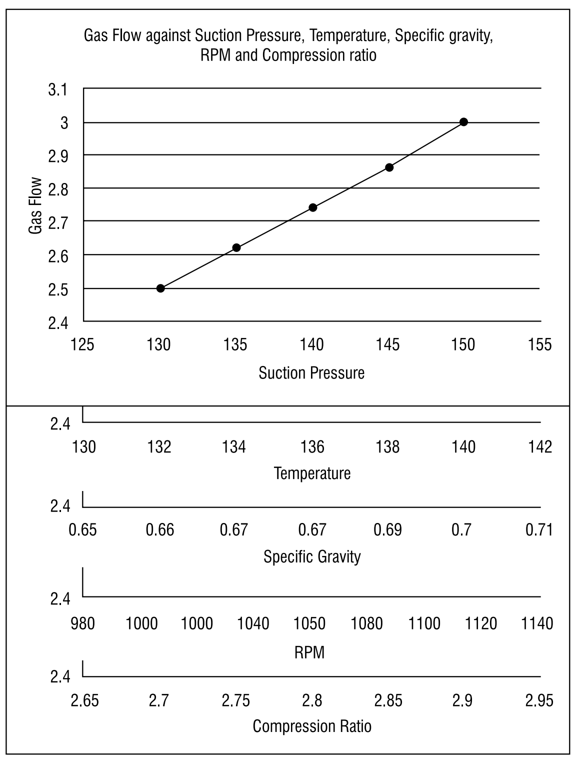

Figure 10: Suction pressure, temperature, specific gravity, RPM, compression ratio, against gas flow

million gas flow is achieved by this experiment. Figure 10 shows that the flow of gas is increasing constantly. To recover three million gas this set is the alternative set of the compression customized system. Hence, this is the most excellent case to recuperate large quantity of gas. The core reason of this research is to recuperate three million gas by customized system. The system is functioning correctly when all the factors are changed with respect to specified ranges.

ECONOMIC BENEFITS

Significant economic gain and other benefits can be achieved in the investment in oil and gas discovery and production such as energy increased. The key factors are price geology and other accessible technology that find out the future oil and gas production for exploration and recovery. 2.13 million dollars is the whole profitable gain from gas recovery of Nashpa oil and gas field. This figure shows large saving of a single field. The economic analysis is calculation is below.

Per day income = 3 * 2,000

= $6,000

Monthly income of the gas = $18, 0000

So yearly income = $216, 0000

Maintenance cost per year

= Service charges + Spare parts cost

Maintenance cost per year = $ 5000+ $ 7000

=$ 12000 per year

Operational cost = $ 12000 per year

Total Cost = Maintenance cost + Operational cost

=$ 12000 + $ 12000 = $ 24000

Total Saving = Yearly saving – (Maintenance cost + Operational cost)

Total Saving = $216, 0000 - $ 24000

= $ 2136000

=$2.13

ENVIRONMENTAL BENEFITS

Gas and oil petrochemical plants, industry and refinery based on kind of manufactured yields produce ravage supplies. In addition, industrial and chemical processes create contamination. By the result of these hazads, it is contaminating air weather, soil, and it causes severe harm to human beings and surroundings. Table 12 shows pollutants amount of gas flaring in 2014 and 2015. So it is concluded from the comparison of table that the recuperation of gas flared affect pollutant gas has been minimized.

Table 12: Pollutant Amount For Each Mg/M3 Of Burn Gas Of Nashpa Field 2014 And 2015

Pollutant Name	Micrograms pollutant for every m3 2014	Micrograms pollutant for every m3 2015
NO	4.91	0.46
SO2	1.52	0.30
NOx	3.58	0.70
CO	1.91	0.75

SUMMARY AND CONCLUSIONS

Flaring of gas is a massive problem for community, atmosphere and also results in economic losses. There is growing concentration to decrease gas flaring, due to which the pollution emissions generated by flaring of gas and possible large emission sources within a plant. In this research, the method the recovery of flare gas has been assessed by deploy design of experiment techniques one factor at a time and furthermore, factorial experiment was carry out by varying various factors together for the recovery of flare gas. The existing system is modified leading to recovery of flare. The data is analysed by minitab software and the data produced is unbiased coefficient with the minimum variance. For new system, temperature is 140F, specific gravity is 0.70, RPM is set on 1120, suction pressure valueis 150 PSI, , compression ratio for both stages is 2.70 and 2.75 and. Recovery of large amount of flare gas decreases the negative environmental impacts. The NO, CO, SO2 and NOx are decreased and the new values of these gases are 0.46,0.75, 0.30 and 0.70.

REFERENCES

1. *EPA., Environmental Protection Agency., (1995),"Emission factorsand AP42,Compilation of air pollutant Emission factors". http://www.epa.gov.*

2. *Akpan, S., (2009), "The production and utilisation of Natural gas resources in Nigeria": A review. Nigerian annual international conference and exhibition in August of the Society of Petroleum Engineers in Abuja, Nigeria..*

3. *Hill, R., C- E Offshore production systems Inc, Moore, J, Continental oil Co. OfIndonesia, Boone D and Randall C., (1985), "Associated gas utilisation with liquid recovery".Offshore technology conference.*

4. *Onwukwe, S., (2016), Gas-to-Liquid technology: Prospect for natural gas utilization in Nigeria.*

5. *Blasing, T., Hand, J., and Kimberly, B., (2007), "Monthly carbon emissions for natural Gas flaring and cement manufacture in the United States", Tellus B.59 (1) 15 –28.*

6. *Abdulkareem, A., and Odigure, J., (2010), "Economic benefit of natural gas utilisation in Nigeria": A case Study of the food processing Industry. Energy sources, Vol.5 (1), pp.106 – 114.*

7. *Elvidge, D., Ziskin, D., Baugh, B., Tuttle, B., Ghosh, T., Pack, D., Erwin, E., Zhizhin, M., (2009),"A Fifteen Year Record of Global Natural Gas Flaring Derived from Satellite Data", Energies, Vol.2(3), pp. 595–622.*

8. *www.pcq.com.pk Assessed on 3/6/2013 "Definition of gas flaring, retrieved at www.ehow.com*

9. *American Petroleum Institute website, Environmental regulations of the Explorationand Production in the Oil and Gas Industry. Retrieved at www.ipo.org on 03/23/13.*

10. *Douglas, C., Montgomery (2016), " Design and Analysis ofExperiments" fifth Edition.*

11. *Daniel, D., FREY, and Hungjen, WANG., (2006), "Adaptive One-Factor-at-a-Time Experimentation and Expected Value of Improvement".*

12. *ARIEL Heavy Duty Balanced Opposed Compressors Technical Manual For Models JGE, JGH, JGK and JGT.*

13. *U.S., Energy Information Administration. "Natural Gas Pipeline Development and Expansion".*

14. *Pell Research Report on Oil and Gas Pipeline Construction cited with permission.*

15. *"Opportunities in Pakistan's upper stream oil and gas sector Ministry of Petroleum and Natural Resources Government of Pakistan". www.mpnr.gov.pk, Accessed on 10/2/2016.*

16. *Imail, O.S., Umokoro, GE., (2012), "Global Impact of Ga Flaring.Energy and Power Engineering" Vol.4, pp.290-302. doi: 10.4236/epe.2012.44039.*

17. *API 521. , (2007), "Pressure-relieving and depressuring systems". 5th Edition. American Petroleum Institute.*

18. *Ismail O., Sahad, and Umukoro, G., Ezaina., (2012), "Global Impact of Gas flaring," Energy and Power Engineer, vol.4 issue 4, 290-302.*