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Research Article

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Increased productivity and access to turbo compressors in compressor stations in fourth refinery of South Pars with removal of flaring time

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ABSTRACT

Iran ranks first in terms of natural gas reserves among the world's countries. According to statistics provided by the World Bank in 2011, Iran ranks third in the world and ranks first in the flared in the Middle East. The volume of gas production in South Pars Gas Complex will be reached 720 million cubic meters per day until 2017. Reduced flaring in refineries is of great importance in terms of wasted energy and producing environmental pollutants. In this regard, the study of reduced flaring in gas compressor station in the fourth refinery in the South Pars has been made with the start reform process and launch of Siemens turbocompressors(SGT-600). As a result of this scheme, by reducing the start of each turbocompressor unit from about one hour to about 25 minutes, the flaring 5,290,264cubic meters in per hour will reach to zero for a period of one year, and the loss of $1587079as well as the release of environmental pollutantsCO_2,SO_X and NO_X will be prevented per year.

Keywords: Flaring, compressor stations, South Pars, Turbo Compressors, Siemens

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INTRODUCTION

Iran ranks first in terms of the world's natural gas reserves (BP, 2014) and South Pars, the world's largest gas field was discovered in 1990(U.S. Energy Information Administration (EIA), 2015). Gas reserves of the field include about7.5 percent of the world gas reserves and approximately half of the gas reserves of the country (POGC, 2014).The gas production of South Pars Gas Complex will be increased 720 million cubic meters per day until 2017)(National Iranian Gas Company, 2015).

According to the latest World Bank in 2011, more than 140 billion cubic meters of natural gas burns in flares. In 2011, Iran produced about4.11billion cubic meters of natural flare gas in the world and ranked third in the world and has been ranked first in the Middle East(The World Bank, 2015).

The amount of flare gas in Assaluyeh, Iran is MMSCMD 10.09(Rahimpour, jamshidnejad, Jokar, & Karimi, 2012). In 2013, Hosseinzadeh and Ehsaninejad by providing the right strategy to reduce the consumption of gas in sweeping gas in the main grid of flare avoided the burning of 3.0 million standard cubic meters on the day(Hosseinzadeh & Ehsaninejad, 2013).

Also through the studies of Davodi et al., it was clear that the primary source of flaring in phase one is the gas returning from the demercaptanization unit and in phases 2 and 3, sweeping gas and in phases 4 and 5 stabilized flared gas, which in phase one with the recirculation of gas in mercaptan removal unit, flaring can be reduced by 55 percent (Davoudi, Rahimpour, Jokar, Nikbakht, & Abbasfard, 2013).

In 2014, M. Saidi et al., among the flare gas recovery methods in South Pars, announced electricity production, GTL, compression and wells injection and the production of solid oxide fuel cells as the most economical way after compression to produce cells solid oxide fuel gas, in this way the recovered flare gas must be sweetened(Saidi, Siavashi, & Rahimpour, 2014).

Until the end of 2017, South Pars Gas Complex plans to reduce its flaring to 6/2million cubic meters in the week. To achieve this goal requires the implementation of action plans to reduce flaring involved in process units(National Iranian Gas Company, 2015).

Many solutions have been proposed to manage the flare gas that is more based on a process unit reform. Compressor stations in refinery gas, due to high pressure process and high volume of gas flow, are one of the processing units with high flaring.

As a result, the case study of the fourth refinery gas compressor station has been studied as one of the largest refineries in South Pars Gas Complex for the management and reduction of flare gas. One of there commended appropriate solutions is to reduce flaring at the start and operation of Siemens turbo compressors in the fourth refinery gas compressor stations.

In the process units, especially chemical plants, many facilities and equipment are used to provide proper conditions for chemical reactions.

Turbo compressor is one of equipment used with different technologies and dimensions. It is composed of turbine and compressor words. Gas turbine is a rotary device that operates on energy from the combustion gases(Wikimedia Foundation, 2015).

Compressor can be used to increase gas pressure in order to provide the appropriate operational conditions in process plants for a variety of uses, or transfer it from one place to another.

With increasing pressure and decreasing volume, the turbo compressor increases the kinetic energy of the fluid flow and then converts kinetic energy into potential energy in static pressure(Sorokes, 2013).

In gas turbine, Siemens holds the second share in overall market. Siemens competition for gas turbine market takes place through two sections: power generators (Siemens Power Gen (Power Gen) and oil and gas Siemens Oil & Gas (SOG). Siemens share in the oil and gas sector is 8.21 throughout the world(McCoy Power Reports, 2015).

In Iran, 207 turbo compressors have been installed and operated by OTC company (OIL TURBO COMPRESSOR) or are being set up.

As can be seen in figure, SGT-600 is made of double-shaft.

The reason for the use of separate shaft in the turbo compressor is to prevent the mechanical effects of processing gas compressor on the gas turbine. One shaft belongs to the gas turbine and the other for the process gas compressor(Siemens Industrial Turbo machinery AB, 2007).

Gas turbine is consisted of three parts. An air compress or to compress air, a combustion chamber for fuel combustion and air and a turbine to convert energy from the high-pressure gas from combustion chamber.

Context

Based on the preliminary design of the fourth refinery gas compression unit, during the initial start, all of the processing routes, such as inputs and outputs of compressor, inlet and outlet of knock out drum, output and input of external coolers, anti-surge valve should be purged by processing gas. Gas purge is defined as sweep operations or the discharge and cleaning equipment by gas that caused the loss of a significant amount of sour gas produced by refinery processing units, and wasting energy and emissions of environmental pollutants, so in order to reduce flaring in the South Pars gas complex, we decided to study the logic of the START process and to change the quo status and improve it.

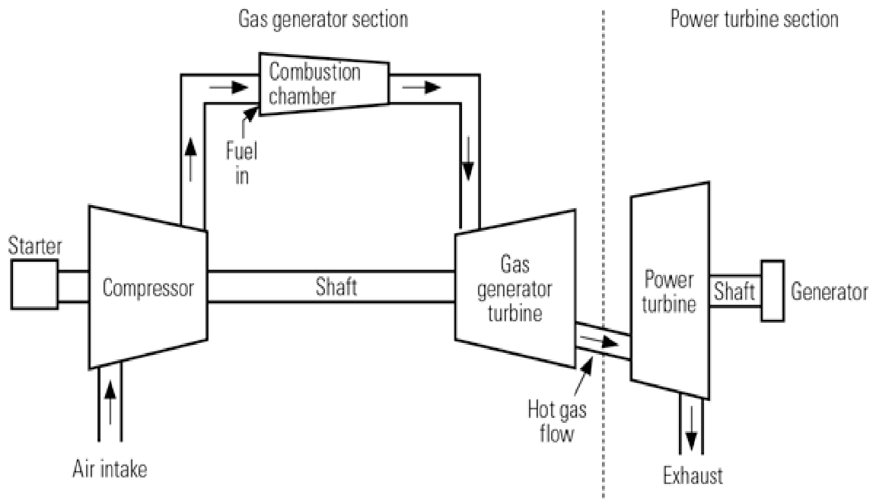

Figure 1: Schematic of turbo compressor with two shafts (Almasi, 2011)

Table 1: Composition of sent flare gases to South Pars refinery based on a design of Total Company

H2O	3/83	97/152
N2	2/86	0/211
CO2	0/847	0/094
H2S	0/044	0/139
C1	73/11	2/058
C2	5/98	0/148
C3	8/92	0/629
i-C4	1/59	0/0126
C4	1/08	0/0198
i-C5	0/284	0/800
C5	0/234	0/00718
C6	0/143	0/0117
C7	0/210	0/00629
C8	0/135	0/0
C9	0/93	0/0
C10	0/0	0/0
COS	0/0	0/0
Toluene	0/0	0/0126
Benzene	0/0	0/0307
Xylene	0/0	0/024
Cyclohexane	0/0	0/0

Table 2 shows the analysis of emissions from the fourth refinery developed by the laboratory. A significant percentage of this gas is consisted of valuable compounds like 87 percent methane and 5 percent ethane. As mentioned before, this gas is used for purging process in the units that leads to the high-value gases.

Table 2: Compounds of emitted and sent gases into compressor station in the fourth refinery

	Composition	Spec	Unit	Export Gas
1	N_2		Mole%	/49223
2	CO_2		Mole%	2/1646
3	H_2S		Mole%	0/3881
4	C_1		Mole%	87/4146
5	C_2		Mole%	5/3113
6	C_3		Mole%	0/9480
7	i-C_4		Mole%	0/1020
8	n-C_4		Mole%	0/1243
9	i-C_5		Mole%	0/220
10	n-C_5		Mole%	0/0144
11	C_6S		Mole%	0/0086
12	Benzen		Mole%	0/0010
13	C_7S		Mole%	0/0032
14	Toluene		Mole%	0/0006
15	C_8^+		Mole%	0/001
16	H/C Dew	≤-10	Deg C	42/3
17	H۲O Dew	≤-10	Deg C	25/0
18	Molecular wt		g/mole	18/3
19	SP.GR			0/6321
20	GHV		MJ/M^3	37/9
21	RSH		Ppmmol	13/0

The process of increasing the gas pressure in the unit takes place as follows: firstly, refined sour gas from processing unit enters into the first stage of compressor station (106) with 40 bars and then by 60 bars in the second stage (551). Imported gas to any stage passes a knock out drum and after compression in the compressor with air coolers is cooled and entered into the pipeline.

In the facilities mentioned, in 106 units, five turbo compressors in arrangement 4 + 1 and five turbo compressors in arrangement 4 + 1in 551 units have been installed by the transmission capacity of 75 million cubic meters.

Each compressor in the fourth refinery compressor station is driven by a gas turbine unit manufactured by Siemens - SGT-600 model. Design conditions for the start of each turbo compressor are in such a way that firstly all routes of refined sour gas are purged by sour gas and then the desired unit is compressed and turbo compressor is started.

All of these steps are guided and commissioned by UCP turbine. According to figure 2, purge operations at the start of turbo compressor are as follows:

1. First, purge is related to knock-out drum discharge caused by the drain valve (1).
2. Second, purge is related to process compressor routes where closure of valve 1 is done and the second valve is opened.
3. The third phase is related to the bypass (BYPASS) of air coolers that is done with the closure of valve 1 and opening of 3 and 5 valves purge operations is done through the valve 5.
4. The fourth phase is related to the purge of air conditioners 3 that takes places by valve number 3 and opening valve 4through valve 5.

The operation of each turbo compressor takes about75minutes.In all the time(except for the start of turbine for 10minutes) the purgegas is directed to the flare, as well as in emergency conditions and unplanned stops when the unit is in need of quick starts, the mentioned time causes wasting of gas.

By examining the logic of turbo compressors, field investigations were begun. In order to maintain safe conditions for equipment and personnel due to the sensitive nature of the situation in the respective compressor station, the following strategies are proposed to reduce flaring in the station.

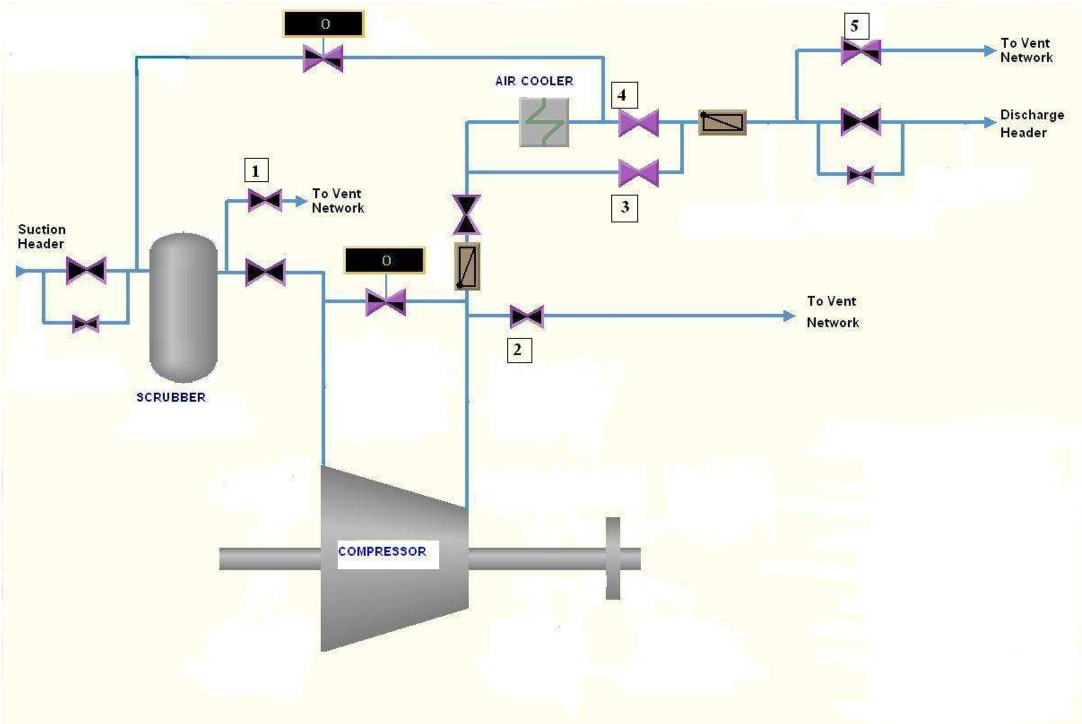

Figure 2: The gas purge phases in compression station

Solutions
1. Change the timer on the compressor discharge pressure system
2. Compression of compressor in downtime
3. Change the logic of compressor start stages

In the first strategy, by examining the relevant logic, we reached to the conclusion that an increase in pressure compressor timing of the drainage system only can increase up to 24 hours and after this period the pressure is discharged and has no significant effect in reducing the duration of flaring. Therefore, this solution was excluded from the study.

In the second solution with studies of mechanical maintenance group, we found that compression of the compressor by sour gas damages to compressor seals (exhaust gas from the fourth refinery is not sweetened and it contains hazardous and corrosive compounds such as H_2S).

Damages to the compressor seals are higher compared with the flared gas. So the second proposed approach was excluded from the study.

In the third solution, by accurate evaluation of the logic of starting phase, some conditions are created by instrument maintenance, and compressor stations operators to define a system command face plate so that the operator can start the process by two methods.

First, completely follow the start process (based on pre-defined start and setup).

Second, start the purge of the content and system faster and pass the start phase faster and without the gas purge operation.

In the second method, the start of each unit (in case of normal and uninterrupted start), is about an hour reduced to about 25 minutes by removing the purge processes.

It is felt more when the unwanted stop prevented normal activity of compression station.

In the case of an emergency stop, all the products are directed to flare when they were over 3 million standard cubic feet per day.

In cooperation with various groups of operation, safety and maintenance of the refinery, steps of evaluating change, deletion and change process are conducted one by one and by writing the preliminary flowchart. After changes and pilot testing on one of the units, the project concerned was completed with the through removal of flaring at the start process and significant reductions were achieved at start time.

2.2 Estimated financial savings in the plan

The flared gas is calculated according to the Ideal Gas conditions for each unit start to the m ^ 3 / hr88000 cubic meters per hour.

This flaring is calculated due to technical calculations of opened valve and through the analysis of gas pressure for a Siemens compressor unit. Through the studies of normal start and emergency stop statistics in a year, we consider the number of starts per unit per year at least6times for every compressor unitand60times for 10 Siemens compressor units which is equivalent to 5280000 cubic meters flaring per hour.

The number of sudden and emergency stops for the entire station was considered 15 times that about 5 times led to a purge unit to the 84950 cubic meters per day (3 million cubic feet per day) at the station 17698 cubic meters per hour (424,750 cubic meters per day). By lowering the start of the unit in the range of 35 minutes, flaring will be reduced to 25 minutes at a rate of 10264 cubic meters per hour.

The total flaring (at the normal start and set up + start and operation in emergency and unintended stops) is 5,290,264 cubic meters per hour.

By examining the price of gas and the world in recent years and the price fluctuations of 30 to 60 cents per cubic meter (US Energy Information Administration (EIA), 2015)), 30 cents rate was considered for per cubic meters of sour gas (Natural Gas Europe, 2014) and was calculated equal to $ 1,587,079.

Table 3: The amount of CO2 emissions by the Middle East (Tons per year)

2013	2012	2011	2010	2009	2008	2007	2006	2005	Country	Row
0	0	0	0	0	0	0	0	0	Bahrain	1
30/29	31/22	30/57	30/44	29/14	30/86	28/81	29/06	22/03	Iran	2
22/62	21/81	17/04	13/42	12/38	10/65	12/76	13/65	14/01	Iraq	3
0	0	0.05	0.05	0.05	0.05	0.05	0.05	0.03	Israil	4
0	0	0	0	0	0	0	0	0	Jordan	5
39/0	41/0	38/0	38/0	35/0	35/0	44/0	1.59	1.77	Kuwait	6
0	0	0	0	0	0	0	0	0	Lebanon	7
2/78	2/36	1/63	2/28	2/55	2/49	2/48	2/53	1/75	Oman	8
0	0	0	0	0	0	0	0	0	Palestine	9
1/34	1/27	1/08	5/40	7/66	6/94	6/18	5/98	7/53	Qatar	10
0	0	0	0	0	0	35/0	12.0	35/05	Saudi Arabia.	11
0	0	42/.0	26/6	26/0	26/0	26/0	43/0	49/0	Syria	12
1/85	1/85	1/78	1/76	1/80	1/78	1/62	1/72	1/58	Emirates	13
56/0	56/0	56/0	94/0	1/42	85.5	1/13	0	0	Yemen	14
59/88	60/50	53/50	54/98	55/64	54/26	54/12	55/18	49/57	The Middle East	

2.3 Estimated reduction of environmental pollutants

Natural gas, propane, ethylene, propylene, butadiene and Bhutan make up more than 95 percent of the flare gas (Kahforoushan, Bezaatpour, & Fatehifar, 2014). To better understand the composition of flare gases, you can see table 1 which has been designed based on the Total company design and according to the documents.

Flaring produces a lot of environmental pollution such as NOX, SOX and greenhouse gases such as CO2 and CO and unburned hydrocarbons (BOTT, 2007). Also it causes climate change and local and regional environmental problems such as acid rain effects on agriculture, forests, and other associated physical infrastructure (Saheed Ismail & Ezaina Umukoro, 2012).

CO_2 and CH_4 cause about 80 percent of global warming (Ajugwo, 2013). Table 3 shows that Iran holds more than 50% of CO_2 emissions from natural flare gas in the Middle East (US Energy Information Administration (EIA), 2015).

Considering that for every million cubic meters of gas, 60 tons carbon dioxide is produced on average, we may prevent from emission of 8/316 tons of carbon dioxide for 5280000 cubic meters per hour(The World Bank, 2015).

RESULTS AND CONCLUSION

This plan can be implemented at all compressor stations, including Siemens turbo compressors and other turbo-compressors in compressor station that use gas purge at the start and set up of turbo compressors.

Through changes on the logic of SGT turbo compressors 600-, the loss of capital at the initial start and operation can be reduced (loss of 88000 cubic meters of gas per hour in per unit) and prevent sudden and emergency stop and the production of greenhouse gases.

Reduced start time can decrease operating hours and increase efficiency in turbo compressors.

Since Siemens turbo compressors are constructed and assembled in the country and use of oil and gas is increasing, capital losses can be reduced and productivity can be increased in the project.

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REFERENCES

[1] Rahimpour, M., jamshidnejad, Z., Jokar, S., & Karimi, G. (**2012**). A compare study of three methods for flare gas recovery of asalooye Gas Refinery. *Journal of Natural Gas Science and Engineering*, 17-28.
[2] Saheed Ismail, O., & Ezaina Umukoro, G. (**2012**). Global Impact of Gas Flaring. *Energy and Power Engineering*, 290-302.
[3] Saidi, M., Siavashi, F., & Rahimpour, M. (**2014**). Application of solid oxide fuel cell for flare gas recovery as a new approach: a case study for asalouyeh gas processing plant,Iran. *Journal of Natural Gas Science and Engineering*, 13-25.
[4] Siemens Industrial Turbomachinery AB. (**2007**, January). SIEMENS Document, Operating instruction. Texas, USA: Siemens Energy.
[5] Sorokes, J. (**2013**, May 22). *American Institute of Chemical Engineering (AIChe) and Dresser-Rand.* Retrieved from www.aiche.org/cep
[6] The World Bank. (**2015**, May 15). *The World Bank Group*. Retrieved from http://www.worldbank.org/en/programs/gasflaringreduction
[7] U.S. Energy Information Administration (EIA). (**2015**, July 01). *www.eia.gov*. Retrieved July 20, 2015, from http://www.eia.gov/dnav/ng/hist_xls/N9100US3m.xls
[8] Wikimedia Foundation. (**2015**, july 2). *Wikipedia*. Retrieved july 12, **2015**, from https://fa.wikipedia.org