तेल एवं गैस उत्पादन प्रौद्योगिकी संस्थान

Institute of Oil and Gas Production Technology

पनवेल, नवी मुंबई

Panvel, Navi Mumbai

Project Report

on

बीपीबी प्लेटफॉर्म के कंडेनसेट सर्ज वेसल वी-660 के लिए प्रक्रिया अनुकूलन

Process Optimization for Condensate Surge Vessel V-660 of BPB Platform

फ़रवरी – 2023

ओएनजीसी
ONGC

तेल एवं गैस उत्पादन प्रौद्योगिकी संस्थान
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पनवेल, नवी मुंबई
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क्र.सं.: IO.22I.PT_BS.014S *दिनांक: 10/03/2023*

विषय: बीपीबी प्लेटफॉर्म के कंडेनसेट सर्ज वेसल वी-660 के लिए प्रक्रिया अनुकूलन
Subject: Process Optimization for Condensate Surge Vessel V-660 of BPB Platform

"बीपीबी प्लेटफॉर्म के कंडेनसेट सर्ज वेसल वी-660 के लिए प्रक्रिया अनुकूलन" रिपोर्ट की प्रति आपके अवलोकनार्थ एवं संदर्भ के लिए संलग्न की गई है।

Please find enclosed a copy of the report on "Process Optimization for Condensate Surge Vessel V-660 of BPB Platform" for your kind perusal.

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बीपीबी प्लेटफॉर्म के कंडेनसेट सर्ज वेसल वी 660-के लिए प्रक्रिया अनुकूलन
Process Optimization for Condensate Surge Vessel V-660 of BPB Platform

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Institute of Oil and Gas Production Technology
Panvel, Navi Mumbai

Executive Summary

This pertains to the project titled "**Process Optimization for Condensate Surge Vessel V-660 of BPB Platform**" taken up by IOGPT as a scheduled project under AWP 2022-23 at the behest of B&S Asset.

At BPB Process Complex; gas, condensate and water are separated in 3-phase HP separators. Condensate separated is sent to a condensate surge vessel V-660, which is presently operating at 5-6 ksc. Condensate surge vessel also receives condensate from BCPB2 compressor suction KODs, test separators etc. Condensate separated in V-660 is dispatched through trunk lines to Hazira along with dehydrated gas. Flash gas from the condensate surge vessel is being flared.

In order to minimize gas flaring from condensate surge vessel, two options, viz. utilization of screw compressor and utilization of ejector have been explored. In both the options, gas at 5-6 ksc from V-660 can be compressed to 14 ksc suction pressure of the existing compressors.

Study for the present case indicates that screw compressors will require around 64 m2 foot print area, 90 kW power, and various equipment such as oil-tank separators, coalescing filter, oil heater and other auxiliary equipment such as lube oil system etc. It was observed that maintaining the quality of lube oil is sometimes difficult due to condensation of heavier hydrocarbons and water vapor leading to non-functioning of screw compressors. On the other hand ejector system is a static equipment, it's a standalone system which can be fitted in the existing piping, does not require any rotating, heating equipment and requires motive gas instead of external power requirement. Motive gas requirement in the present case can be met from GDU outlet which is at present at around 73-81 ksc. Foot print area requirement for ejector works out to be around 6 m^2.

Ball-park analysis reveals that installation of ejector will fetch higher return with a payback period of 4 months whereas in screw compressors payback period will be 1.2 years.

Study concludes that ejector can be installed to minimize flaring from V-660. The details such as the required motive gas quantity, ejector size, case study and other details are brought out in the report.

Rajiv Nischal

Rajiv Nischal

GGM-HOI

Table of Contents

1.0	**Introduction**	**01**
2.0	**Scope of work**	**01**
3.0	**Existing process details**	**01**
4.0	**Input data and study basis**	**02**
5.0	**Scheme conceptualization**	**03**
6.0	**Comparision between screw compressor and ejector**	**06**
7.0	**Summary** `	**07**
8.0	**Conclusion**	**08**

1. Introduction

At BPB Process Complex; gas, condensate and water are separated in 3-phase HP separators. Condensate separated in HP separators is sent to a condensate surge vessel V-660, which is presently operating in the range of 5 to 6 ksc. Condensate surge vessel also receives condensate from BCPB2 compressor suction KODs, test separators etc. in addition to HP separators. Condensate separated in V-660 is pumped and dispatched through trunk lines to Hazira along with dehydrated gas. Flash gas from the condensate surge vessel is being flared.

In order to minimize gas flaring from the condensate surge vessel, B&S Asset has referred a project titled "Process Optimization for Condensate Surge Vessel V-660 of BPB Platform" to IOGPT under AWP 2022-23.

2. Scope of work: The scope of work for this project is as follows:

- Study of existing condensate processing scheme
- Analysis of the existing system to utilize the low pressure gas from the vessel
- Simulation study
- Suggest remedial measures, if any

3. Existing Process Description

BPB Process platform consist of five bridge connected platform viz,

- BC (well platform),
- BPB (well fluid manifolds, well fluid coolers, HP separators, condensate surge vessels), GDU, condensate pumps, condensate coalescers)
- BLQ-2 Living quarters
- BCPB (Compressors: 2+1, capacity 7.5 MMSCMD each)
- BCPB-2 (Compressors: 3+1, After retrofitting total compressor capacity of BCPB-2 is 9.6 MMSCMD)

3.1. Gas Handling Process Description

Refer Figure 1. BPB Process complex receives well fluid from well head platforms for separation, processing and dispatch. It consists of two parallel trains of separation and processing system. Wellfluid from well manifolds is routed to HP separators for phase separation of gas, condensate and water. At present HP separators are operating at around 12 ksc. Gas liberated from the separators is routed to bosster gas compressors located at BCPB-2 which are operating at suction pressure in the range of 11-12 ksc. After boosting the pressure to 37-40 ksc in compressors at BCPB-2 platform, gas is sent to BPB platform for further compression, where its pressure is enhanced to around 74-82 ksc. After the final stage of compression, gas is sent to gas dehydration unit (GDU) for removal of water vapur. After dehydration, gas is dispatched to Hazira Plant through 36” and 42” trunk lines. Water separated in separation system is treated in Produced Water Conditioning (PWC) system.

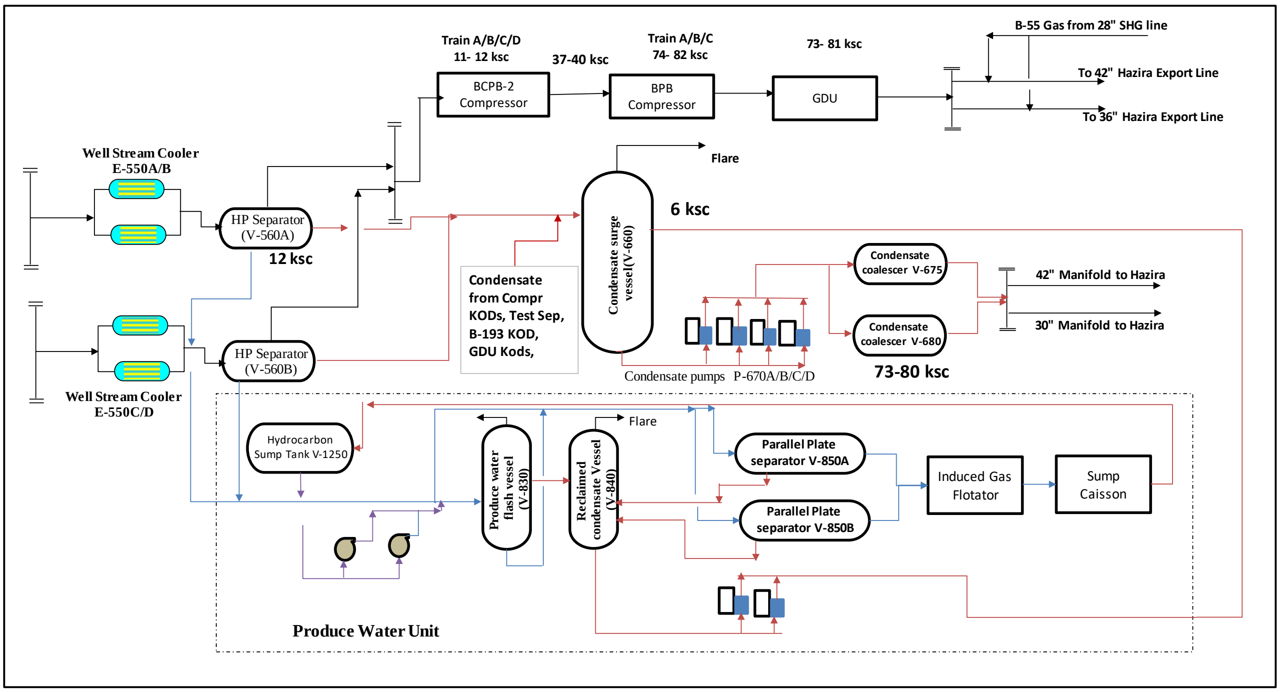

Figure 1: Process Flow Diagram of BPB Process Complex

3.2. Condensate Handling at BPB

Refer Figure 1. Condensate separated in HP separator is routed to condensate surge vessel (V-660), presently operating at around 6 ksc. Condensate surge vessel also receives condensate from test separator, gas dehydration units, suction KODs of BCPB compressors and BCPB-2 compressors, produced water conditioning skid and B-193 KOD. Condensate separated in V-660 is dispatched to Hazira Plant using condensate transfer pumps.

Flash gas from condensate surge vessel is presently being flared.

4. Input data and study basis

Folowing input data received from Asset is used for the present study:

- Present operating parameters of equipment
- Gas quantity, presently being flared: 16,000 SCMD

- PFD, P&IDs of modified/ retrofitted compressors
- PFD, P&ID of condensate surge vessel V-660
- ASTM D-86 data of condensate: Shown in Table-1

Table-1: ASTM D-86 data of condensate Condensate distillation data	
Temperature Range	Cummulative Distillate (ml)
IBP-50	1
50-75	14
75-100	40
100-125	64
125-150	79
150-175	86
175-200	90
200-220	93

- Gas composition: Shown in Table-2

Table-2: Gas Composition	
Composition	mole %
Methane	79.94
Ethane	7.23
Propane	4.59
i-Butane	0.95
n-butane	1.11
i-pentane	0.27
n-pentane	0.19
hexane	0.0012
CO2	5.1
N2	0.63

5. Scheme Conceptualization

As mentioned earlier, gas liberated in the condensate surge vessel V-660, which is presently operating at 5-6 ksc, is being flared presently. Study of the surge vessel operation reveals that the gas being flared can be meaningfully utilized by compressing it to suction of BCPB-2 compressors which is at 11-12 ksc. Literature survey indicates that based on type of the copressors commercially available for the gas quantity and operating range, there are two types of flare gas recovery system suitable for the instant case.

1. Screw compressor based flare gas recovery system
2. Ejector based flare gas recovery system

The details of the schemes for above mentioned vapour recovery systems are elaborated in the following sections.

5.1 Screw compressors

Screw compression is one of the prominent methods used for flare gas reduction in E&P industry. Two types of screw compressors are available viz oil flooded screw compressors and oil free screw compressors. Oil flooded screw compressors are widely preferred due to higher capacity control 0 to 100%, easy startup and no pulsation, less noise compared to oil free compressors.

Refer Figure 2. In oil flooded screw compressors, gas will be drawn from the condensate surge vessel (V-660) and will be routed to the flare gas compressor system. The inlet gas which will be at pressure of around 6 kg/cm^2(g) and at temperature of around 50-60 deg C will be sent to a Knock Out Drum (KOD) to remove the condensed liquid, if any. The gas from the KOD is passed through an inlet strainer to remove the foreign particles, if any, before routing to the inlet of the gas compressor. The compressed gas is mixed with the lube oil and is routed to the oil tank/separator for separation of lube oil and gas.

Primary separation of the lube oil mixed with the gas is achieved in the oil tank separator. A heating coil is attached in the oil tank separator to maintain high temperature of around 110 deg C. Secondary separation takes place in a wire mesh element of separator. The separated lube oil drains into the oil tank separator.

Lube oil from the oil tank separator is passed through the lube oil pumps. Lube oil is passed through a lube oil air cooler, where it is cooled to around 60 deg C. Cooled lube oil is passed through micronic filters (Duplex oil filter) to remove the foreign particles, if any, and is routed to bearings, balance piston, shaft seal, compression chamber and hydraulic actuator.

The gas after secondary separator is cooled in an air cooler, where it is cooled to less than 55 deg C. Finally the gas outlet which will be at around 15 kg/cm^{2}g and less than 55 deg C is routed to the suction of the process gas compressor at BCPB2. The lube oil separated is usually drained into the lube oil system through a small bore pipe which is fitted with a protective filter and an isolation valve.

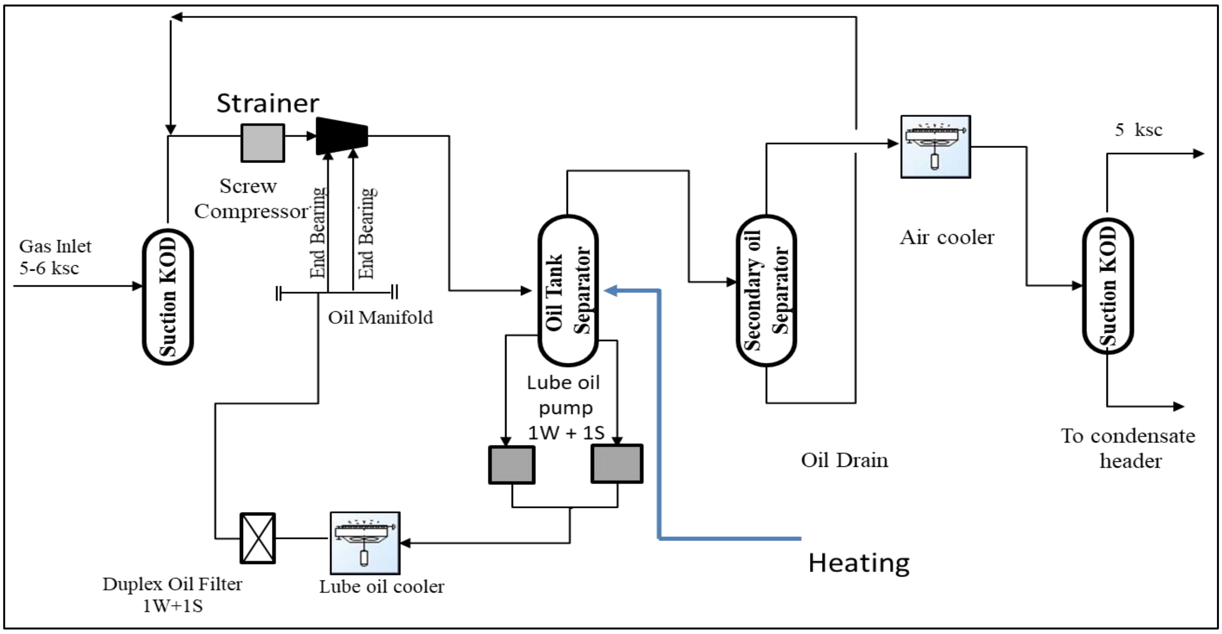

Figure 2: Schematic of Screw Compressor

5.2 Ejector system for gas compression

Ejector based flare gas recovery systems are closed loop systems without any rotating and heating parts. An ejector works by accelerating a high pressure stream, also called motive gas, through a nozzle, converting the pressure energy into velocity. In the present case, the motive gas will be taken from GDU outlet at 73-81 kg/cm^{2}g. Around the nozzle tip, where velocity is highest, a low pressure region is created. This is often called the suction chamber of the ejector. Where the pressure in this region is lower than the pressure of the suction fluid connected to the ejector side-inlet or ‘suction branch’, it will be entrained/sucked into the body of the ejector. In the present case, the low pressure gas will be from condensate surge vessel (V-660). The two fluid streams then travel through the diffuser section of the Ejector, where velocity is decreased as a result of the diverging geometry and pressure is regained.

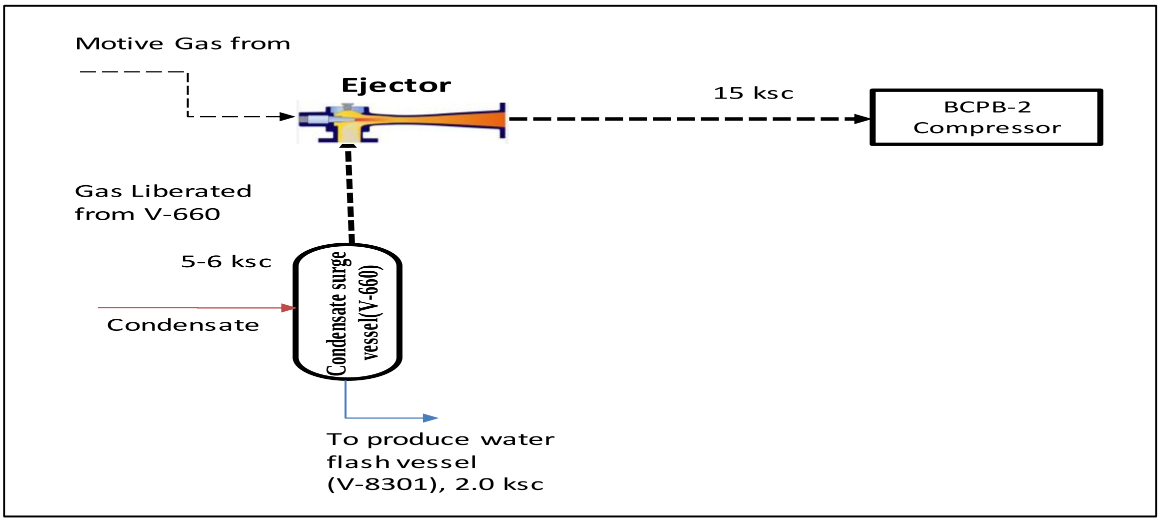

Figure 3: Schematic of ejector system

A single stage ejector system is envisaged to boost the pressure from around 5 kg/cm2g to around 15 kg/cm^{2}g. The outlet gas from the ejector will be routed to the existing booster gas compressor of BCPB-2, which is operating at suction pressure of around 11-12 kg/cm^{2}g. The general schematic diagram of ejector based flare gas recovery system is shown in Figure 3.

Motive gas of around 65,000SCMD is envisaged to compress around 16,000SCMD gas from 5 ksc to 15 ksc. At present around 8 MMSCMD gas is being compressed in existing booster compressors, with addition of motive gas and LP gas from condensate surge vessel, total gas load in booster compressors will be around 8.81 MMSCMD. The design capacity of compressor is 9.6 MMSCMD and hence, existing booster compressors can handle the envisaged load of 8.81 MMSCMD

6. Comparision between screw compressor and ejector

6.1 Technical Comparision

Literature study for the present case indicates that screw compressors will require around 64 m^2 foot print area, 90 kW power, and various equipment such as oil-tank separators, coalescing filter, oil heater and other auxiliary equipment such as lube oil system etc. On the other hand ejector system is a static equipment, it is a standalone system which can be fitted in the existing piping, does not require any rotating, heating equipment and requires motive gas instead of external power requirement. Motive gas requirement in the present case can be met from GDU outlet. Foot print area requirement for ejector works out to be around 6 m^2.

Summary of comparative analysis is shown in Table-3.

Table-3: Comparision between Screw compressor and Ejector

Parameters	Screw Compressor	Gas-Gas Ejector
Inlet KOD	Yes	No
Compressor	Yes	No
Air Cooler	Yes	No
Outlet KOD	Yes	No
Heater	Yes	No
Lube oil system	Yes	No
Motive gas	No	Yes- 65000 m3/d
Power requirement	Yes- 90 kW	No
Foot Print Area	64 m2	6 m2

It is observed that in case of screw compressors, maintaining the quality of the lube oil is sometimes difficult due to condensation of heavier hydrocarbons and water vapor leading to its non-functioning.

6.2 Economic Comparision

Ball park economic analysis was carried out. The details of the analysis are shown in Table-4.

Table-4: Ball Park Economic Analysis

Parameters	Screw Compressor	Gas-Gas Ejector
CAPEX, INR Crore Rs	4.2	~1
Payback period, month	15	4
IRR, %	50	>50

Ball-park analysis reveals that installation of ejector will fetch higher return with a payback period of 4 months, whereas in screw compressors payback period will be 1.2 years.

The above ball park economic analysis are indicative only and for comparative study only. Asset may work out this during detailed engineering with real cost data.

7. Summary

- At BPB Process Complex; gas, condensate and water are separated in 3-phase HP separators. Condensate separated is sent to a condensate surge vessel V-660, which is presently operating at 5-6 ksc. Condensate surge vessel also receives condensate from BCPB2 compressor suction KODs, test separators etc. Condensate separated in V-660 is dispatched through trunk lines to Hazira along with dehydrated gas. Flash gas from the condensate surge vessel is being flared.

- In order to minimize gas flaring from condensate surge vessel, two options, viz. utilization of screw compressor and utilization of ejector have been explored. In both the options, gas at 5-6 ksc from V-660 can be compressed to 15 ksc suction pressure of the existing compressors.

- Study for the present case indicates that screw compressors will require around 64 m2 foot print area, 90 kW power, and various equipment such as oil-tank separators, coalescing filter, oil heater and other auxiliary equipment such as lube oil system etc.

- It was observed that maintaining the quality of lube oil is sometimes difficult due to condensation of heavier hydrocarbons and water vapor leading to non-functioning of screw compressors.

- On the other hand ejector system is a static equipment, it's a standalone system which can be fitted in the existing piping, does not require any rotating, heating equipment and requires motive gas instead of external power requirement. Motive gas requirement in the present case can be met from GDU outlet which is at present at around 73-81 ksc. Foot print area requirement for ejector works out to be around 6 m2.

- Ball-park analysis reveals that installation of ejector will fetch higher return with a payback period of 4 months whereas in screw compressors payback period will be 1.2 years.

8. Conclusion

Study concludes that ejector can be installed to minimize flaring from V-660.

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