तेल एवं गैस उत्पादन प्रौद्योगिकी संस्थान

Institute of Oil and Gas Production Technology

पनवेल, नवी मुंबई

Panvel, Navi Mumbai

Project Report

on

राजमुंदरी परिसंपत्ति के बंटुमिली साउथ फील्ड में बहने वाले उच्च दबाव वाले कुओं के लिए योजना संकल्पना

Scheme Conceptualization for Flowing High Pressure Wells at Bantumilli South Field, Rajahmundry Asset

मार्च-2022

तेल एवं गैस उत्पादन प्रौद्योगिकी संस्थान
Institute of Oil and Gas Production Technology
पनवेल, नवी मुंबई
Panvel, Navi Mumbai

क्र.सं. : : IO.21I.PT_RJ.078S

दिनांक: 08//07/2022

विषय: राजमुंदरी परिसंपत्ति के बंटुमिली साउथ फील्ड में बहने वाले उच्च दबाव वाले कुओं के लिए योजना संकल्पना

Subject: Scheme Conceptualization for Flowing High Pressure Wells at Bantumilli South Field, Rajahmundry Asset

"राजमुंदरी परिसंपत्ति के बंटुमिली साउथ फील्ड में बहने वाले उच्च दबाव वाले कुओं के लिए योजना संकल्पना" रिपोर्ट की प्रति आपके अवलोकनार्थ संलग्न है।

Please find enclosed a copy of the report on "Scheme Conceptualization for Flowing High Pressure Wells at Bantumilli South Field, Rajahmundry Asset" for your kind perusal.

नितीन जोशी

नितिन बी. जोशी
N.B. Joshi
Head of Department, SF & PE

वितरण / Distribution :

1. परिसंपत्ति प्रबंधक, राजमुंदरी परिसंपत्ति / Asset Manager, Rajahmundry Asset
2. भूतल प्रबंधक, राजमुंदरी परिसंपत्ति / Surface Manager, Rajahmundry Asset
3. आईओजीपीटी समन्वयक, राजमुंदरी परिसंपत्ति / IOGPT Coordinator, Rajahmundry Asset

तेल एवं गैस उत्पादन प्रौद्योगिकी संस्थान
Institute of Oil and Gas Production Technology

पनवेल, नवी मुंबई
Panvel, Navi Mumbai

Project No: IO.21I.PT_RJ.078S
Acc No: 3030

राजमुंदरी परिसंपत्ति के बंटुमिली साउथ फील्ड में बहने वाले उच्च दबाव वाले कुओं के लिए योजना संकल्पना
Scheme Conceptualization for Flowing High Pressure Wells at Bantumilli South Field, Rajahmundry Asset

कार्यकेंद्र :राजमुंदरी परिसंपत्ति
Work Centre: Rajahmundry Asset

मुख्य अन्वेषक Chief Investigator	राजशेखर कामराजु , उप- महाप्रबंधक (उत्पादन) Rajshekhar Kamaraju, DGM (P)
सह–अन्वेषक Co-investigator	नरेंद्र वी. कटरे, अधीक्षक अभियंता (उत्पादन) Narendra V. Katre, SE(P)
	अमन शर्मा, सहायक कार्यकारी अभियंता (उत्पादन) Aman Sharma, AEE(P)
प्रभारी Incharge	वी. के. सिंह, महाप्रबंधक (उत्पादन) V. K. Singh, GM (P)
कार्य संघ Work Association	पी जे प्रसाद राव. महाप्रबंधक (उत्पादन), राजमुंदरी परिसंपत्ति P. J. Prasad Rao, GM (P), Rajahmundry Asset
समीक्षित Reviewed by	एन.बी. जोशी , मुख्य महाप्रबंधक (उत्पादन) - विभागाध्यक्ष N.B. Joshi, CGM (P) – HOD
अनुमोदित Approved by	रवि रमन, समूह महाप्रबंधक- संस्थान प्रमुख Ravi Raman, GGM - HOI

ओएनजीसी
ONGC

Institute of Oil and Gas Production Technology
Panvel, Navi Mumbai

Executive Summary

This pertains to the project titled "**Scheme Conceptualization for flowing high pressure wells of Bantumilli south field, Rajahmundry Asset**" taken up by IOGPT as a scheduled project under AWP 2021-22.

In Bantumilli South Field, wells BTSAA (BTS#1) & BTSAB (BTS#2) established HC potential of Raghavapuram (3430-3460 m) & Nandigama (4165-4216 m) formation as gas bearing but were abandoned due to technical reasons. Subsequently, 4 wells were identified as gas bearing viz. BTSAD, BTSDA, BTSDB and BTSDC.

As per requirement of the Asset, for monetization of the gas of Bantumilli South field, in September 2016 a report was submitted by IOGPT for conceptualization of surface facilities with the available gas composition of BTS#2 containing high CO_2 (15%) and N_2 (16.5%). Later, in 2018 as per results of drilled well BTSAD, IOGPT conceptualized a scheme for EPS at Bantumalli South with changed gas composition of CO_2 and H_2S instead of earlier composition of CO_2 and N_2.The scheme designed surface facilities for a capacity of 2.5LSCMD of Gas,10m3 of Condensate and 30 m3 of Effluent

Recently, one more well location namely BTSAE about 15km from the BTSAD Surface facility has also been identified as potential gas bearing. Based on the same well profile & gas composition as that of the drilled well BTSAD, Asset desired for a scheme for flowing the High pressure well/s at BTSAE to the Surface facility at BTSAD location.

The scheme has been conceptualized for flowing high pressure wells without hydrate formation, considering the long distance transport of well fluid and the appropriate process facilities for handling 2.5LSCMD gas, 10m3 condensate and 30m3 Effluent. Two scenarios were considered for simulation study after interaction and finalization with the Asset team as below

1) At maximum Wellhead pressure & temperature of 650 kg/cm2 and 61 Deg C: Pressure reduction with multiple chokes from 650 kg/cm2 to 70 kg/cm2 done at well site and delivered to the surface facility at 65 kg/cm2 ,without any hydrate formation levels having reached.

2) At a Pressure of 548kg/cm2 & mimimum temperature of 41 Deg C: Due to low well head outlet temperature, hydrate formation levels are reached during pressure reduction with multiple chokes at 160 kg/cm2 approx. To carry out pressure reduction with hydrate mitigation in this scenario, 3 options were explored as below:

2.1 Heating or Methanol injection of well fluid at 160 kg/cm2, before further pressure reduction and delivery to the surface facility.

2.2 Transporting the well fluid to surface facility after pressure reduction from 548kg/cm2 to 200kg/cm2 at well site, after which two alternatives are applicable for further pressure reduction at surface facility:

2.2.1 Heating/methanol injection after receipt of well fluid at surface facility at 200 kg/cm2 and 23 deg C to mitigate hydrate formation during further pressure reduction upto 65 kg/cm2 .

2.2.2 Pressure reduction from 200 kg/cm2 to 65 kg/cm2 done at surface facility with a Turboexpander by which useful power of 130kw is generated along with dew point depression of the gas being achieved.

2.3 Pre -heating the well fluid upto 70 Deg C irrespective of Well head temperature before carrying out the pressure drop at well site, and then sending it to the surface facility without encountering any hydrate formation tendency.

Accordingly, for Scenario1, no additional hydrate mitigation measures are necessary, whereas for Scenario 2, Options 2.3 and 2.1 in that order are recommended in terms of ease of implementation, safety and CAPEX, although each of the 3 options for high pressure reduction and hydrate mitigation outlined above has its own benefits.

Asset may accordingly choose an option suitably based on technical feasibility and overall project economics.

Ravi Raman 31/03/2022
GGM (P)
Head of the Institute

Contents

1.0 Background

In Bantumilli South Field, wells BTSAA (BTS#1) & BTSAB (BTS#2) were drilled earlier to establish HC potential of Raghavapuram (3430-3460 m) & Nandigama (4165-4216 m) formation. Subsequently, 5 well locations namely BTSAD, BTSDA, BTSDB, BTSDC and BTSAE were identified as gas bearing.

In September 2016, as per requirement of Asset for monetization of the gas from Bantumilli South field, a study was carried out by IOGPT for conceptualization of surface facilities with the available gas composition of BTS#2 containing high CO_2 (15%) and N_2 (16.5%). Later in 2018 after drilling of the well BTSAD, IOGPT conceptualized a scheme for EPS at Bantumilli South with changed gas composition of CO_2 and H_2S instead of the earlier composition of CO_2 and N_2 as required by Asset. Scheme had conceptualized an EPS near BTSAD consisting of surface facilities for processing well-fluid having 2.5 LSCMD gas, 10 m^3/d condensate and 30 m^3/d water.

Recently one additional well at location BTSAE, about 15 km from the envisaged BTSAD EPS has been identified as gas bearing. Considering the same well profile & gas composition of the earlier drilled well BTSAD, Asset has desired for a scheme for flowing high pressure well-fluid of BTSAE to BTSAD. Accordingly, IOGPT has taken up the study titled "Scheme Conceptualization for Flowing High Pressure Wells of Bantumilli South Field, Rajahmundry Asset" as a scheduled project in AWP 2021-22.

2.0 Scope of Work

The scope of work includes:

- Simulation study for pressure reduction from 650 Kg/cm^2 to 65 kg/cm^2
- Hydrate Mitigation
- Scheme conceptualisation for process facilities

3.0 Basis of Study

Various input data considered for this study as provided by Asset are briefed below:

- Location of the well: At 15 km from EPS
- The inlet battery limit of the EPS is considered at 65 kg/cm^2
- Meteorological data:
    - Ambient temperature : 15-35 °C (Max.)

- Envisaged peak production rates and pressure/temperature values are taken from the data provided by Asset for the well BTSAD and are mentioned below.
  - Peak condensate rate: 10 m^3/d
  - Peak Gas rate : 2.5 LSCMD
  - Peak water rate: : 28 m^3/d
  - Tubing head pressure : 63-647 kg/cm^2g
  - Tubing head temperature: 41-61 ^0C
  - Bottom hole pressure: 175-760 kg/cm^2g
  - Bottom hole temperature: 224 ^0C
- As per the well testing report of BTSAD obtained from Asset in 2018 (Ref.: an earlier project no. IO.18I.PT_RJ.092U titled "Scheme Conceptualization for EPS at Bantumilli South" by IOGPT issued in November, 2018); the highest THP is 647 kg/cm^2 and the minimum THT is 41 ^0C at 548 Kg/cm^2. For simulation at 650 kg/cm^2 pressure, the maximum temperature of 61 ^0C has been taken.

  A snapshot of well testing report and gas compositions of the well BTSAD are placed at Annexure-1.
- Desired Parameters of Sales Gas:
  - Water dew point < 0°C
  - Hydrocarbon dew point < 0°C
  - CO_2 < 6%
  - H_2S < 5 ppm
  - Sales gas pressure: 55 kg/cm^2
- Desired Parameters of Oil/Condensate:
  - RVP < 10-12 psia
  - BS&W < 0.2%

4.0 Scheme Conceptualization

Scheme for flowing well-fluid of BTSAE having 2.5 LSCMD gas, 10 m^3/d condensate and 30 m^3/d water has been conceptualised. Various alternatives were explored for flowing well-fluid about 15 km from BTSAE at 650 Kg/cm^2 to the envisaged BTSAD EPS at 65 Kg/cm^2 without encountering issue of hydrate formation. These are described in the following sections.

Based on the well test reports provided by the Asset, following two states of maximum pressure and minimum temperature of well-fluid were considered for simulation study:

- Scenario-I: Maximum pressure of 650 kg/cm^2 & temperature of 61 ^0C
- Scenario -II: Pressure of 548 kg/cm^2 & minimum temperature of 41 ^0C

4.1 Scheme Conceptualization for High Pressure Reduction

4.1.1 Scenario-I: Wellhead pressure of 650 kg/cm^2 & temperature of 61 ^0C

The envisaged scheme consists of gradual pressure reduction of well-fluid from 650 Kg/cm^2 to 70 Kg/cm^2 at the well-site with a series of chokes and then sending it to EPS, where it reaches at 65 kg/cm^2 pressure and 16 ^0C temperature.

The simulation study for this case reveals no hydrate formation as a result of pressure reduction. The hydrate formation temperature at 70 Kg/cm^2 is 14 ^0C and at 65 kg/cm^2 is 13 ^0C. As the well-fluid arrival temperature at EPS is 16 ^0C, hydrate formation is not likely to take place.

The schematic of Scenario-I is shown in Fig 4.1.

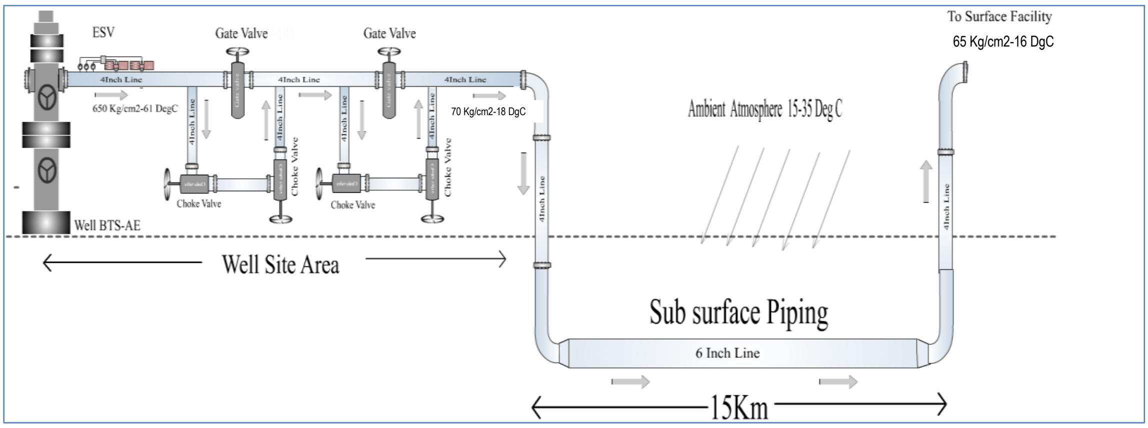

Fig 4.1: Scheme of pressure reduction for Scenario-I

A broad list of equipment is placed at Annexure-2. As mentioned earlier, no additional hydrate mitigation provision is required in this case as temperature of gas remains well above hydrate formation temperatures.

4.1.2 Scenario-II: Wellhead pressure of 548 kg/cm^2 & temperature of 41 ^{0}C

Three different options have been considered for flowing well-fluid in this case.

4.1.2.1 Scenario-II Option-I

The scheme consists of pressure drop from 548 kg/cm^2 up to the minimum allowable pressure corresponding to temperature above hydrate formation temperature and provision of hydrate mitigation at the well-site before further pressure drop. From simulation, hydrate formation is observed at temperature of 20 ^{0}C. Keeping a margin, temperature after pressure reduction has been taken as 22 ^{0}C; the corresponding pressure is 160 kg/cm^2. To mitigate hydrate tendency on further pressure drop, either the temperature is raised to 48 ^{0}C by electrical / solar heating or methanol injection is done. Pressure of well-fluid is then dropped across the choke up to 70 kg/cm^2. Afterwards, well-fluid is sent to EPS through pipeline.

A schematic of this option is shown in Fig 4.2. In this, Stream-A denotes the path of well fluid, if routed through the heater and Stream-B denotes the path of well fluid if routed through the methanol injection system depending on the type of hydrate mitigation facility installed. The corresponding outlet conditions of Stream-A and Stream-B are also indicated.

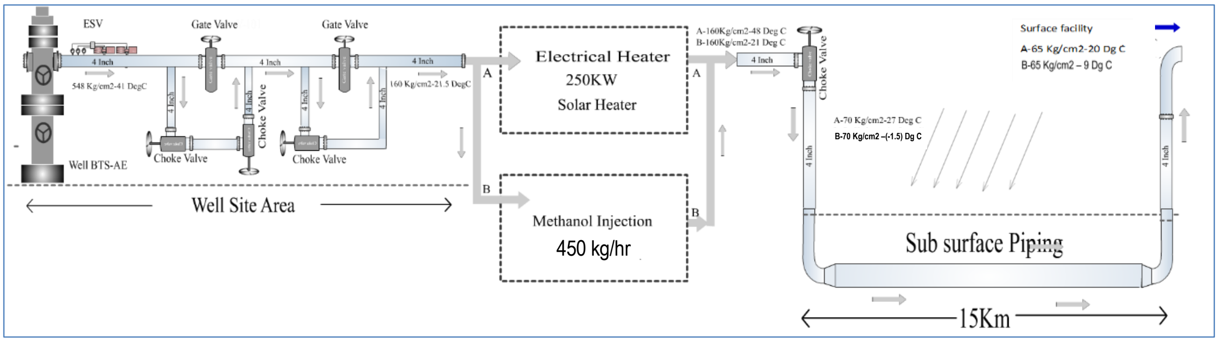

Fig 4.2: Scheme of pressure reduction for Scenario-II Option-I

Pros/Cons of the Scheme:

Pros**:** High pressure reduction completely at well site

Cons: Hydrate mitigation equipment installed at well site 15 km away from EPS, hence will require continuous monitoring and maintenance.

A broad list of equipment is placed at Annexure-2.

4.1.2.2 Scenario-II Option-IIA

The scheme in this option, consists of pressure reduction at the well site from 548 kg/cm^2 until maximum allowable pressure for sending it to EPS without hydrate formation in the pipeline. In this option, no hydrate mitigation provision is envisaged at the well-site. Accordingly, simulation has been carried out, which indicates pressure drop up to 200 kg/cm^2 & temperature of 28 ^{0}C at the well-site for sending through the pipeline without hydrate formation. With an inlet pressure of 196 kg/cm^2 & 25 ^{0}C at EPS, further pressure drop up to requisite pressure of 65 Kg/cm^2 is done after pre-heating or methanol injection. The schematic of this option is shown in Fig 4.3. As explained earlier in Option-I, Stream-A & Stream-B indicate the streams of gas & condensate through heater and methanol injection system respectively.

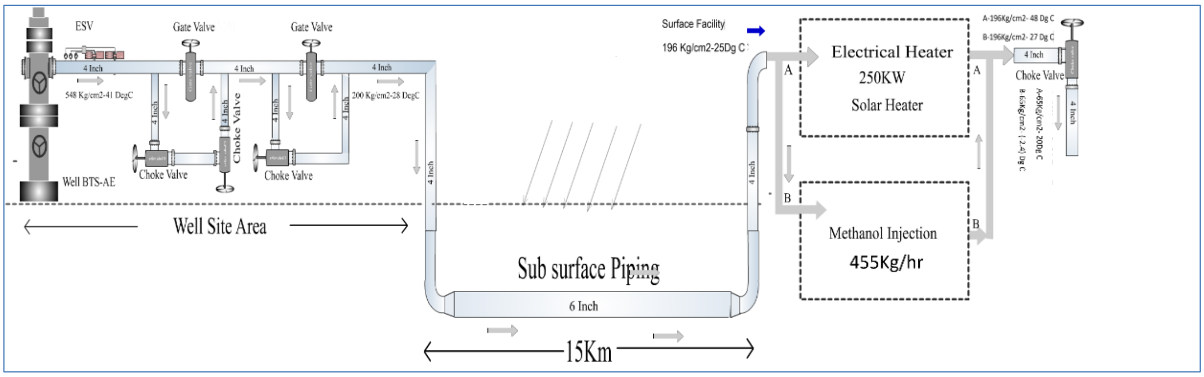

Fig 4.3: Scheme of pressure reduction for Scenario-II Option-IIA

Pros/Cons of the Scheme:

Pros: Hydrate mitigation system is not required at well site eliminating its monitoring and maintenance at well site.

Cons: 1. The scheme involves transportation of well fluid at high pressure in long distance pipeline leading to higher safety issues.

A broad list of equipment is placed at Annexure-2.

4.1.2.3 Scenario-II Option-IIB

This option aims at extracting useful power of ~140 kW during pressure reduction of gas at EPS. In this scheme, well-fluid enters EPS at 195 kg/cm^2 as in Scenario-II Option-IIA. Subsequently after phase separation in HP Separator, pressure of gas is dropped with turbo expander from 195 kg/cm^2 to 65 kg/cm^2. Temperature of gas after expansion at 65 kg/cm^2 will be (-) 37 ^{0}C. Gas after pressure reduction will be a two-phase vapor and liquid stream and will be sent to a cold separator. The schematic of this option is shown in Fig 4.4.

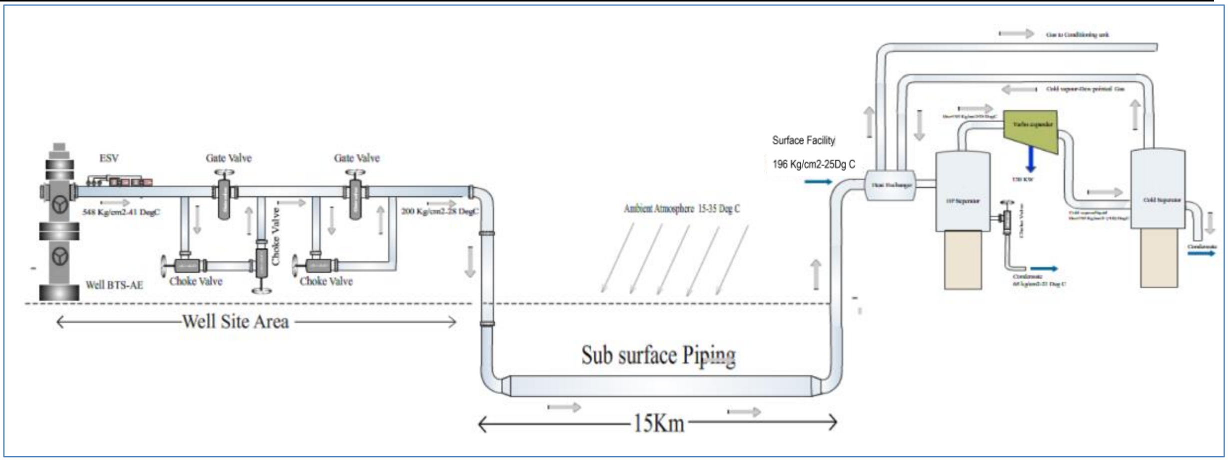

Fig 4.4: Scheme of pressure reduction for Scenario-II Option-IIB

The cold vapor separated in cold separator is sent through a gas/gas exchanger upstream of the HP separator, where it gains heat from the inlet gas at 23 ^{0}C and then sent to conditioning unit for H_2S and CO_2 removal. It may be noted that for this gas, dew point depression is already done, as it is chilled after expansion and liquid separated in cold separator. The condensate from HP separator after pressure reduction with choke along with condensate from cold separator is sent to oil tank. Detailed view of turbo-expander and its downstream process is shown in Fig 4.5.

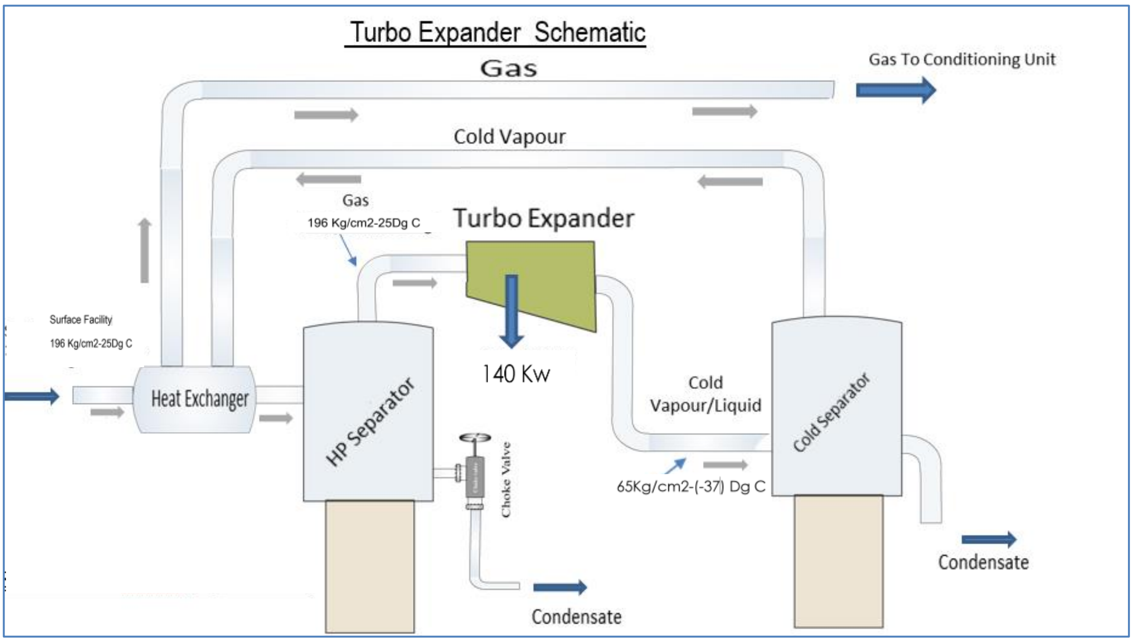

Fig 4.5: Schematic of turbo-expander for Scenario-II Option-IIB

Pros/Cons of the Scheme:

Pros: 1. Hydrate mitigation system is not required as pressure reduction is being done with turbo-expander after which cold gas/liquid separation is done in downstream cold separator.

2. For the gas separated in the cold separator, dew point depression done and no need of further dew point depression

3. Useful Power of ~140 kW is generated during turbo-expansion, which may be used for electricity consumption.

Cons: 1. The scheme involves transportation of well fluid at high pressure in long distance pipeline leading to higher safety issues.

2. High pressure separator for operating pressure of 200 kg/cm^2 will be required at EPS, which may not be readily available with suppliers and needs to be custom-ordered.

A broad list of equipment is placed at Annexure-2.

4.1.3 Option-III for both Scenario-I & Scenario-II

Scenario-I: Wellhead pressure of 650 kg/cm^2 & temperature of 61 ^{0}C

Scenario-II: Wellhead pressure of 548 kg/cm^2 & temperature of 41 ^{0}C

In this scheme, well-fluid is preheated to 70 ^{0}C irrespective of well-head temperature and then its pressure gradually brought down to 70 kg/cm^2 at the well site with multiple chokes. Temperature after pressure reduction will be 27 0C, which is above hydrate formation temperature of 13 ^{0}C. Afterwards, well-fluid is sent to EPS through 15 km pipeline. The required power of heater is estimated to be around 250 kW and can be supplied with solar paneled heating or conventional electrical heater. A schematic of this option is shown in Fig 4.6.

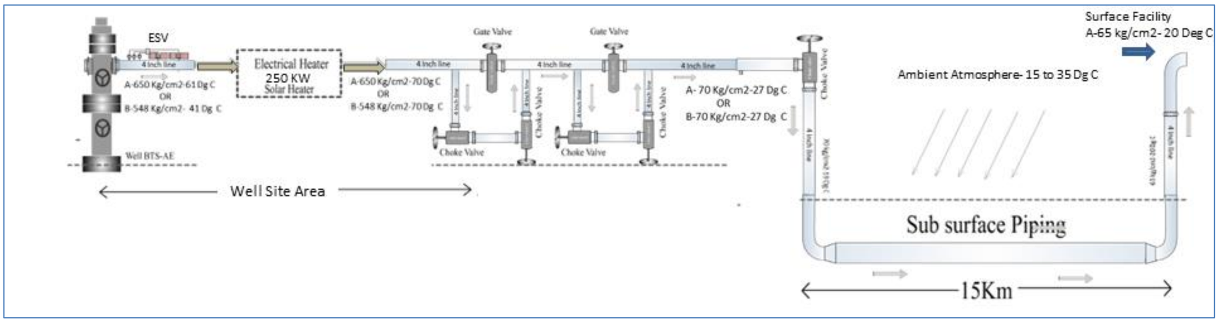

Fig 4.6: Scheme of pressure reduction for Scenario-I & Scenario-II Option-III

Pros/Cons of the Scheme:

Pros: 1. Setting a fixed optimum well fluid temperature of 70 ^{0}C downstream of pre-heater irrespective of well head temperature of 60 ^{0}C before pressure reduction, thereby mitigating hydrate formation until the well fluid reaches EPS.

Cons: 1. Heater with high pressure rating may not be readily available with suppliers and needs to be custom ordered.

2. Monitoring of safe functioning of solar / electric heater at well site may be difficult for process personnel.

A broad list of equipment is placed at Annexure-2.

5.0 Summary

A scheme for Flowing High Pressure Well BTS-AE at Bantumilli South along with surface facilities has been conceptualised for handling 2.5 LSCMD gas, 10 m^3/d condensate and 30 m^3/d water. Based on the well testing report of drilled well BTSAD, two scenarios of maximum pressure & temperature (650 kg/cm^2 and 61 ^{0}C) and minimum pressure and minimum temperature (548 kg/cm^2 and 41 Deg ^{0}C) of well fluid have been considered as desired by Asset.

Simulation and analysis have been carried out for both the scenarios.

5.1 In case of **<u>Scenario-I</u>** of maximum pressure of 650 kg/cm^2 and temperature of 61 ^{0}C, simulation indicates that there is no likelihood of hydrate formation when well-fluid pressure is reduced to the desired pressure of 70 kg/cm^2. Hence, well-fluid can be sent to EPS at BTSAD without any hydrate formation tendency.

5.2 In simulation for **<u>Scenario-II</u>** of well-fluid pressure of 548 kg/cm^2 and lower temperature of 41 ^{0}C, hydrate formation tendency is observed. Three options have been explored to mitigate the hydrate formation.

5.2.1 **<u>Option-I</u>**<u>: Heating or Methanol injection</u> of well fluid at 160 kg/cm^2, before further pressure reduction and delivery to EPS at BTSAD.

5.2.2 <u>Transporting the well fluid to surface facility</u> after pressure reduction from 548 kg/cm^2 to 200 kg/cm^2 at well site, after which two alternatives are applicable for further pressure reduction at EPS.

5.2.2.1 **<u>Option-IIA</u>**<u>: Heating/methanol injection after receipt of well fluid at EPS</u> at 200 kg/cm^2 and 23 ^{0}C to mitigate hydrate formation during further pressure reduction up to 65 kg/cm^2.

5.2.2.2 **<u>Option-IIB</u>**<u>: Pressure reduction from 200 kg/cm^2 to 65 kg/cm^2 done at EPS with a turbo-expander</u>, by which useful power of ~130 kW is generated along with dew point depression of the gas being achieved.

5.3 **<u>Option-III</u>**<u>: Pre -heating the well fluid up to 70 ^{0}C:</u> For both Scenario-I and Scenario-II, irrespective of wellhead temperature before carrying out the pressure drop at well site, and then sending it to EPS without encountering any hydrate formation tendency.

6.0 Conclusion & Recommendations

As per the above in Scenario II, Options III and I in that order are recommended in terms of ease of implementation, safety and CAPEX, although each of the three options for high pressure reduction and hydrate mitigation outlined above has its own benefits. Asset may accordingly choose an option suitably based on technical feasibility and overall project economics.

Asset may take up HAZOP study in consultation with IEOT as communicated earlier.

The design for process facilities comprising gas liquid separation, gas conditioning, condensate stabilization, condensate and effluent storage and evacuation are same as those recommended in an earlier project no. IO.18I.PT_ RJ.092U titled "Scheme Conceptualization for EPS at Bantumilli South" by IOGPT issued in November, 2018 and the same may be referred.

7.0 Annexures

Annexure-1 Gas Composition of Well BTSAD

Table 3.1: Gas composition			
	Adavipalem GCS	Kaikaluru GCS	Nandigama EPS
Components	Mole%		
Methane	85.01	72.29	69.72
Ethane	2.83	12.68	11.38
Propane	0.19	6.77	5.61
i-Butane	0.12	1.29	1.38
n-Butane	0.03	1.76	2.01
i-Pentane	0.03	0.65	0.73
n-Pentane	0.01	0.65	0.51
n-Hexane	0.09	0.97	0.68
Carbon di-oxide	11.61	2.75	7.79
Nitrogen	0.08	0.06	0.02
H2S	45 ppm	0.15	0.16

Well testing Report of BTSAD

WELL BTS-AD
DOM 4050 m MD/TVD
Perforation Interval 4201-03.54184.5-4186.54176-79
SAND Obj-VI

SL. No.	Date of study	Type of Study	Duration (hrs)	Bean	THP Psi	THP Ksc	BHP psi	BHP Ksc	THT (°F)	THT (°C)	BHT (°F)	BHT (°C)	Qg (m3/d)	Qo / Qc (m3/d)	Qw (m3/d)	Remarks
1	25-Dec-17	Clean up	4	16/64"	7800	548			106	41						Pressure not stablized
2	26-Dec-17	Clean up	2	12/64"	7000	492			122	50						Pressure not stablized
3	26-Dec-17	Clean up	3.5	14/64"	6000	422			130	54			1,71,218	7	Traces	Salinity 4935ppm Nacl Condensate API 46
4	27-Dec-17	SPGS	14	S/I	9003	633	10811	760			330	166				Avg. SPG = 0.31Ksc/10m BHT 330F
5	27-Dec-17	S/I	19	S/I			10513	739								Fall in pressure as compared to SPGS is due to bleeding of gas from lubricator for operational requirement
6	28-Dec-17	Bean	12	10/64"	6400	450	7181	505	120	49	435	224	75,580			Traces of condensate
7	28-Dec-17	Bean	12	12/64"	5585	393	6469	455	122	50	435	224	1,20,216	Traces	3	Water Salinity 1945ppm @ Nacl
8	30-Dec-18	FPGS/Bean	16	15/64"	4550	320	5748	404	142	61			1,58,242		4	Avg. FPG = 0.20Ksc/10m Water Salinity 4935ppm @ Nacl CO2=10%
9	01-Jan-18	B/U	48	S/I	8335	586	9843	692			335	168				
10	02-Jan-18	SPGS	60	S/I	8216	578	9875	694								Avg. SPG = 0.29Ksc/10m During bleed off H2S 36ppm CO2=12%
11	04-Jan-18	S/I		S/I	9200	647										Before suduing the well

Dial Gauge Reading/ Dead Weight Tester Reading

Annexure-2

Broad List of Equipment

Scenario-I

SN	Equipment Reqd	Size and specification	Qty
1	Set of adjustable chokes (for pressure reduction from 650 kg/cm2 to 70 kg/cm2)	-	4
2	Pipeline from wellhead outlet to downstream of final choke at well site BTSAE	4 Inch / 22 Chrome (UNS no. 31803) Material (Pl refer MOC Study report enclosed at Annexure-3)	As per Detailed Engg
3	15 km underground pipeline from downstream of final choke to EPS at BTSAD	6 Inch/Carbon steel Material (Pl refer MOC Study report enclosed at Annexure-3)	1
4	High/low valve or HIPPS at well head (To be finalized with IEOT)	To be installed as per IEOT Safety Recommendation	1

Scenario-II Option-I

SN	Equipment Reqd	Size and specification	Qty
1	Set of adjustable chokes (3 at well site & 1 at BTSAD EPS)	-	4
2	Pipeline from wellhead outlet to downstream of final choke at well site BTSAE	4 Inch / 22 Chrome (UNS no. 31803) Material (Pl refer MOC Study report enclosed at Annexure-3)	As per Detailed Engg
3	Hydrate mitigation Equipment like Solar/Electrical heater or methanol Injection	Solar/Elec heater- 250 kW Or Methanol Injection Package- 197 kg/hr	1
4	15 km underground pipeline from downstream of final choke to EPS at BTSAD	6 Inch/Carbon steel Material (Pl refer MOC Study report enclosed at Annexure-3)	1
5	High/low valve or HIPPS at well head (To be finalized with IEOT)	As per IEOT Safety Recommendation	1

Scenario-II Option-IIA

SN	Equipment Reqd	Size and specification	Qty
1	Set of adjustable chokes (3 at well site & 1 at BTSAD EPS)	-	4
2	Pipeline from wellhead outlet to downstream of final choke at well site BTSAE	4 Inch / 22 Chrome (UNS no. 31803) Material (Pl refer MOC Study report enclosed at Annexure-3)	As per Detailed Engg
3	Hydrate mitigation Equipment like Solar/Electrical heater or methanol Injection at EPS	Solar/Elec heater-250 kW Or Methanol Injection Package-197 kg/hr	1
4	15 km underground pipeline from downstream of final choke to EPS at BTSAD	6 Inch/22 Chrome(UNS no 31803) (Pl refer MOC Study report enclosed at Annexure-3)	1
5	High/low valve or HIPPS at well head (To be finalized with IEOT)	To be installed as per IEOT Safety Recommendation	1

Scenario-II Option-IIB

SN	Equipment Reqd	Size and specification	Qty
1	Set of adjustable chokes (3 at well site & 1 at BTSAD EPS)	-	4
2	Pipeline from wellhead outlet to downstream of final choke at well site BTSAE	4 Inch / 22 Chrome (UNS no. 31803) Material (Pl refer MOC Study report enclosed at Annexure-3)	As per Detailed Engg
3	Turbo Expander	Pr rating-200 kg/cm^2, Exp ratio-1:3	1
4	HP Separator	Pr rating-200 kg/cm^2	1
5	15 km underground pipeline from downstream of final choke to EPS at BTSAD	6 Inch/22 Chrome(UNS no 31803) (Pl refer MOC Study report enclosed at Annexure-3)	1
6	High/low valve or HIPPS at well head (To be finalized with IEOT)	To be installed as per IEOT Safety Recommendation	1

Scenario-II Option-III

SN	Equipment Reqd	Size and specification	Qty
1	Set of adjustable chokes (for pressure reduction from 650 kg/cm2 to 70 kg/cm2)	-	4
2	Pipeline from wellhead outlet to downstream of final choke at well site BTSAE	4 Inch / 22 Chrome (UNS no. 31803) Material (Pl refer MOC Study report enclosed at Annexure-3)	As per Detailed Engg
3	Hydrate mitigation Equipment like Solar/Electrical heater or methanol Injection	Solar/Elec heater-250 kW Or Methanol Injection Package-197 kg/hr	1
4	15 km underground pipeline from downstream of final choke to EPS at BTSAD	6 Inch/Carbon steel Material (Pl refer MOC Study report enclosed at Annexure-3)	1
5	High/low valve or HIPPS at well head (To be finalized with IEOT)	To be installed as per IEOT Safety Recommendation	1

Recommendation:

6.1 4" Pipe segments with multiple chokes:

22 Chrome (UNS no. 31803) or a superior alloy has been found suitable and is recommended for use as metallurgy for the multiple choke pressure reduction segment.

6.2 6" X 15 kms Pipeline:

A carbon steel pipeline with increased thickness (corrosion allowance of 6 mm) with mandatory continuous dosing of corrosion inhibitor is recommended.

Corrosion & Scale Management