The 2013 World Congress on
Advances in Structural Engineering and Mechanics (ASEM13)
Jeju, Korea, September 8-12, 2013

Study of manifold backpressure estimation and surge volume analysis for infield flowlines

*Juneyoung Kim[1) and YutaekSeo[2)

[1), 2)] *Division of Ocean Systems Engineering, KAIST, Daejeon 305-600, Korea*
[1)] *jjune@kaist.ac.kr*
[2)] *yutaek.seo@kaist.ac.kr*

ABSTRACT

This paper reports upon a study of line sizing that was conducted for infield flowlines. Manifold backpressure estimation and surge volume analysis are among the important elements used in understanding flowline sizing. The impact of one line size above and one line size below a reference line size of 18″ on manifold backpressures and surge volumes arriving at topsides is investigated. The manifold backpressure estimation assures that wells have sufficient FTHP(flowing tubing head pressure) to achieve the design rates, based on the infield flowline system sizes and production profile. The surge volume analysis shows that a slug catcher surge volume of 50 m^3 is adequate for liquid management.

1. INTRODUCTION

In this paper, a study of line sizing was conducted for infield flowlines. The study was aimed at ascertaining the impact of one line size above and one line size below a reference line size of 18″ (dual flowlines) on manifold backpressures and surge volumes arriving at topsides. More specifically, the aims of this study were to validate the reference line size of 18″ (dual flowlines), to investigate the impact of different line sizes on the current production profile phasing and production plateau period, and to provide information on the impact of line sizing on surge volumes arriving at topsides, with an emphasis on reducing surge volumes, using smaller diameter flowlines.

2. DESIGN PREMISE

The fluid composition, along with the condensed and formation water rates and MEG injection rates, as shown in Table 1, was used to generate the fluid file for infield flowline sizing.

Table 1 Fluid Compositions

Components	Mole %
H_2O	4.02

MEG	1.40
N_2	0.42
CO_2	7.95
C_1	66.45
C_2	9.78
C_3	3.98
$I\text{-}C_4$	0.66
$N\text{-}C_4$	1.18
$I\text{-}C_5$	0.47
$N\text{-}C_5$	0.41
C_6	0.50
C_7+	2.78

A single flowline, as shown in Figure 1, was modeled between a pair of DCs (drill centers) and a CPF (central processing facility). A matrix of cases that comprised three different diameters for each flowline, as shown in Table 2, was simulated. In addition, CPF arrival pressures of 8.8 MPa.a were used.

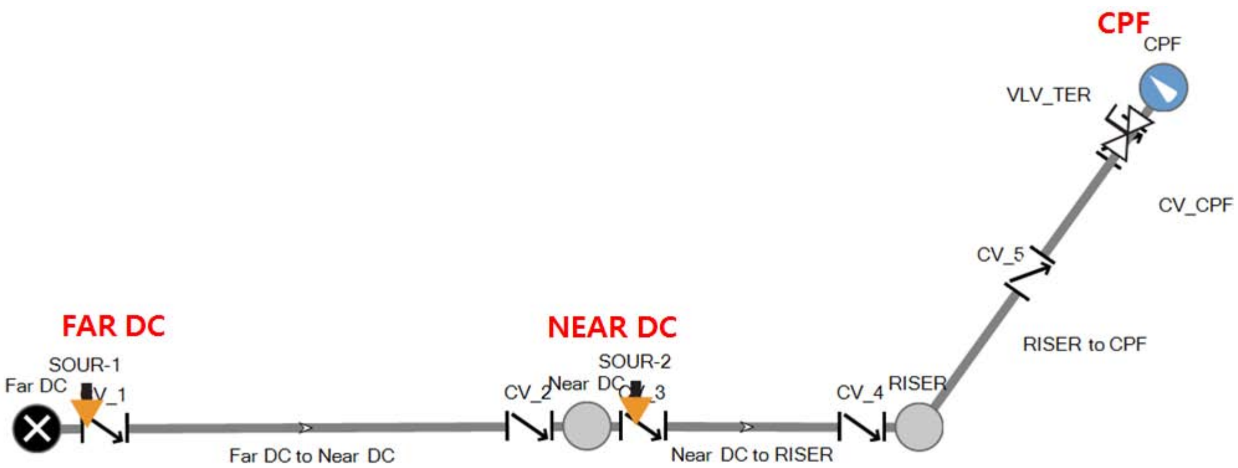

Figure 1 Infield Model (OLGA, Version 7.0)

Table 2 Matrix of Cases

Flowline Diameter (inches)	CPF Arrival Pressure (Mpa.a)	Near DC Flowrate (MMscfd)	Far DC Flowrate (MMscfd)
16’’ 18’’ 20’’	8.8	0, 100, 200, 300, 400, 450	0, 50, 100, 150, 200, 250, 300, 350, 400, 450

The mean FTHP (flowing tubing head pressure) and dry wellstreamflowrate for the respective DCs for the selected production years are presented in Table 3.

Table 3 Mean FTHP and Dry WellstreamFlowrates

Production year (year)	Mean FTHP (MPa.a)		Dry Wellstream Flowrate Per Flowline (MMscfd)	
	Far DC	Near DC	Far DC	Near DC
0	Before Phasing	27.2	Before Phasing	133
0.83	Before Phasing	25.0	Before Phasing	135
0.84	25.3	23.3	268	181
2	18.4	18.9	251	195
2.25	20.3	21.3	181	139
5.75	13.7	14.4	173	149
6	15.0	16.4	122	103
8.75	11.8	12.4	135	126
9	12.0	12.9	117	109
10.25	11.0	11.6	114	112
10.50	11.1	11.8	102	99
11.25	10.6	11.0	101	100
11.5	10.0	10.8	115	99
14	7.7	8.0	111	101
15.25	6.6	6.4	107	103

Bathymetry profiles of the infield flowlines, as shown in Figure 2, were modeled between a pair of DCs and the CPF. The diameters and wall thicknesses used in the simulation are given in Table 4. Mean seawater velocities of 0.17 m/s and 0.21 m/s were used for the infield flowlines and production risers, respectively. A mean seawater temperature of 27 °C and an air current of 4.5 m/s were used for the riser sections above the water and the topside piping.

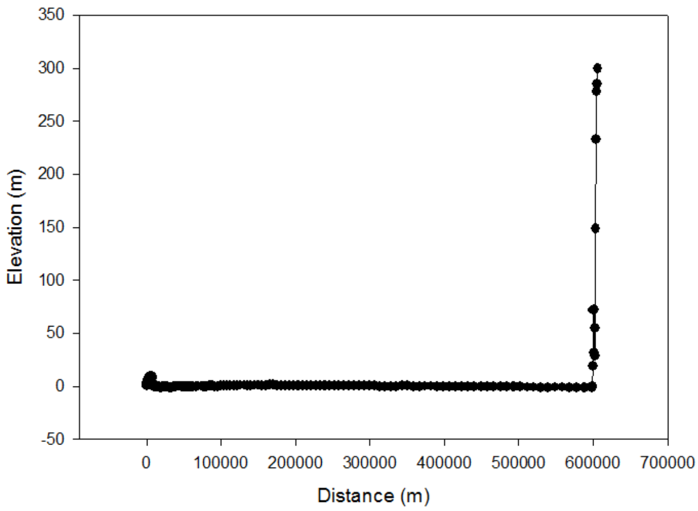

Figure 2 Bathymetry Profiles of Infield Flowlines

Table 4 Flowline Diameters and Wall Thicknesses

Nominal Flowline Diameter (inch)	Inner Diameter (mm)	Wall Thickness (mm)
16’’	362	23.2
18’’	406	25.6
20’’	452	28

3. RESULTS AND DISCUSSION

The calculated manifold backpressures produced in these simulations were used to generate the estimated manifold backpressure and FTHP plots. Figure 3 and Figure 4 show these plots for the near DC and far DC, respectively. As shown in the figures, 16″ and 18″ flowline FTHPs are sufficiently high to maintain a Brewster production plateau until production years 13 and 15, respectively. Similarly, 20″ flowlines are capable of delivering the required design DC flowrates until production year 15.

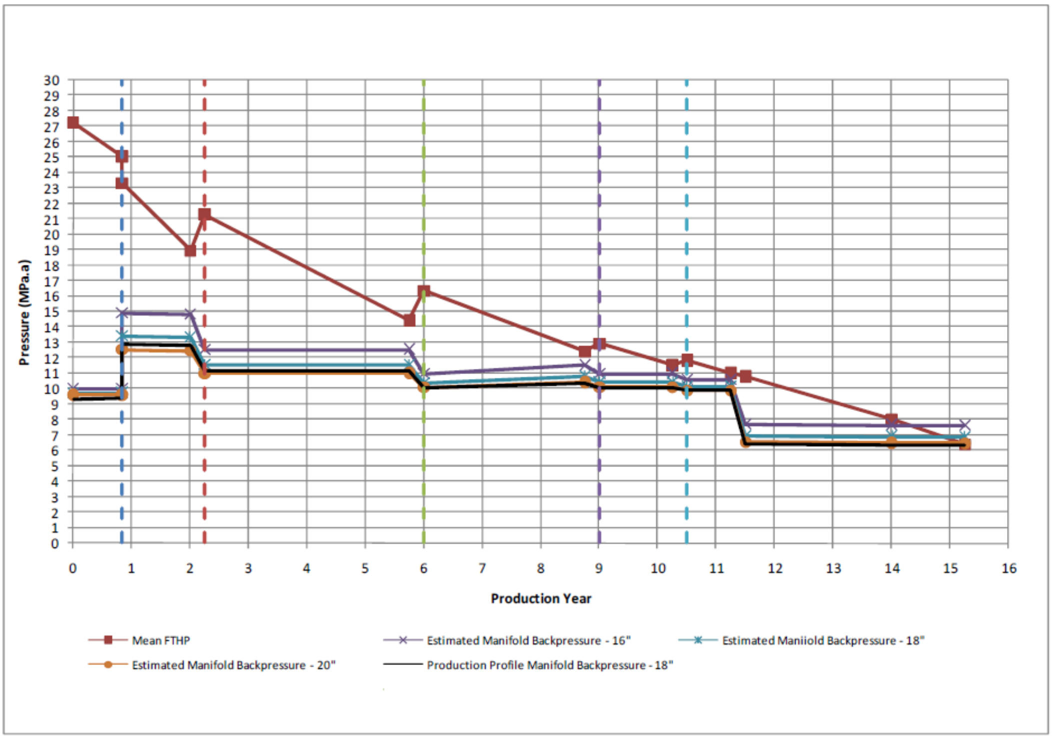

Figure 3 Near DC – Manifold backpressure and FTHP

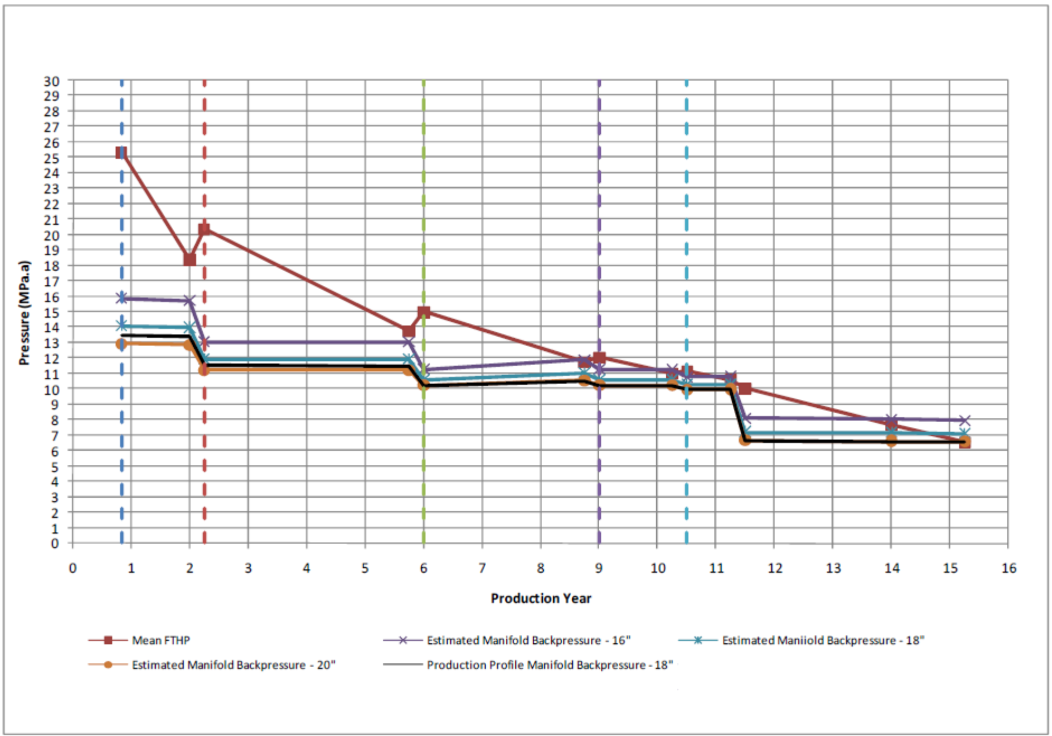

Figure 4 Far DC – Manifold backpressure and FTHP

Table 5 summarizes the results of the surge analysis study. The results indicate that there is a greater opportunity to reduce topside surge volumes by moving to a 16″ flowline size. In addition, for restart times of more than 12 h, it is possible to keep the surge volumes with a 50 m^3 limit, even with a 20″ flowline. Restart times of 8 h and 6 h are required in order to keep surge volumes within this surge limit in the case of flowline sizes of 18″ and 16″, respectively.

Table 5 Comparison of Surge Volumes

Restart Time (hours)	Surge Volume (m^3)		
	16''	18''	20''
Instantaneous	346	445	564
4	121	215	350
6	51	121	214
8	5	61	141
10	0	12	83
12	0	1	36
14	0	0	6

4. CONCLUSIONS

In this study, the manifold backpressure values and FTHP plots indicated that the FTHPs are sufficiently high for all DCs for the required manifold backpressures, even for the case of 16″ flowlines, until production year 13. Additionally, all line sizes are deemed acceptable in terms of flow assurance, provided that there are no requirements for ramp-up/restart times of less than around 12 h. Hence, the selection of an optimal line size will ultimately be driven by the outcome of an economic analysis and the impact of the line size on the CPF topsides surge volume, along with any operational constraints that may be imposed.

ACKNOWLEDGE

This work was supported by the Global Leading Technology Program of the Office of Strategic R&D Planning (OSP) funded by the Korea Evaluation Institute of Industrial Technology, Ministry of Trade, Industry and Energy, Republic of Korea.

REFERENCES

Bai, Y., and Bai, Q. (2010), “Subsea engineering handbook”, Elsevier

Ken, A. (2008), “Surface production operations”, third edition, Elsevier