Gas lift Optimization-An important tool to maintain Production

V.C.Singh, SE (P), N&H Asset, ONGC

Abstract

Wells in an oilfield are able to flow by self in the initial years of an Oil field development as the Reservoir pressure is high & water cut is low. More & more wells have to be put on artificial lift to keep them flowing & to maintain the production as the reservoir pressure declines & water cut increases in an ageing field. Gas lift is one of the oldest, simple & the most popular means of artificial lift.

The paper highlights the need to optimize the wells in an oil field regularly through lift gas tuning as well as replacing the existing Gas lift valves with newly redesigned valves to keep them flowing optimally. Examples of success of gas lift optimization job in wells of Neelam field of Western offshore of Oil & Natural Gas Corporation Limited (ONGC), India are illustrated in the paper. As the basic parameters for gas lift design like Reservoir Pressure, PI, Water cut, GOR, Surface conditions like Line pressure, Gas lift header pressure are changing in an oil field, GLV’S too have to be periodically examined for their proper functioning by carrying out flowing gradient survey & their functioning/ malfunctioning need to be analyzed. The suitability of existing GLV’S/CV’S need to be analyzed if it can give an optimum oil flow rate. They need to be replaced by redesigned valves if they are either found leaking or not suitable to give optimum production from a well.

Neelam field is an oilfield of Oil & Natural Gas Corporation Limited & is located approximately 45 Kms south west from Mumbai city in Arabian Sea. It was discovered in year 1987. Its initial oil in place is 109.7 MMT. Its Ultimate recoverable reserve is 32.325 MMT. Presently the Neelam field is producing approx. 23000 BOPD of oil, 1.37 MMSCMD of gas. Presently the average water cut from the field is 81%. Total 26.175 MMT of oil has been produced from Neelam field till 31.03.2007 & recovery from the field is 24 %. In year 2006-07, out of 72 gas lift wells in Neelam field, 57 nos. of gradient survey were carried out. Out of which in 50 wells, gas was found to be entering through CV & in 07 wells gas was not entering through CV. GLV replacement job was carried out in 10 wells employing Wire line unit resulting in a gain of 512 BOPD of oil & lift gas saving of 71184 SCMD of gas. In year 2007-08 (till September’ 2007), Flowing gradient survey was done in 16 nos. of wells & GLV replacement was done in 09 wells. In nine of those wells a gain of 713 BOPD of oil & lift gas saving of 62926 SCMD was observed & one well which was closed due to high gas consumption was opened after GLV replacement on account of less lift gas requirement. Some of the wells in the field are observed to be de-optimised on account of tubing leak or decline in gas lift header pressure due to shutdown of Process Gas Compressor on account of its maintenance or tripping. Lift gas tuning of well is a routine operation to maintain production from Neelam field & an on an average 05 wells & 08 wells were optimized each month & a gain of approx. 200 BOPD & 400 BOPD was achieved in years 2006-07 & 2007-08 (till September 2007) respectively. This gain was cyclic in nature as the reduced production of well was brought back by this effort.
Introduction:

Neelam field is a field of Oil & Natural Gas Corporation Limited & is located approximately 45 Kms south west from Mumbai city in Arabian Sea. It was discovered in year 1987. Its initial oil in place is 109.7 MMT. Its Ultimate recoverable reserve is 32.325 MMT. The production was started from this field in year 1990 from Neelam-01 wellhead platform. Production was started at Neelam -02 wellhead platform in year 1993. Neelam platform was commissioned in year 1994. Production from other 09 wellhead platforms was started in year 1994. The peak production expected from the field was 6 MMTPA. The peak production from the field was witnessed in December 1994 & it was 95000 BOPD. Rapid decline in production from the field was witnessed. It was observed that the wells started cutting water very fast. Wells from some of the wellhead platform like Neelam-05, Neelam-07, Neelam-09, and Neelam-06 started ceasing with in a few months of starting of production. It was observed that in the wells of Neelam-05, Neelam-07, Neelam-09, water cut increased very rapidly leading to their cease. In the feasibility study of Neelam field, Gas lift line was planned in year 2001 but as the wells started ceasing & production from field declining, wells had to be put on gas lift in year 1996, 05 years before the schedule. Putting of wells on gas lift helped Neelam field in arresting in decline in production from field. One more important thing that was witnessed in Neelam field was a very high GOR in wells of northern sector mainly those of Neelam10 & Neelam-11. High gas was preceded by high water cut from wells of Neelam-11 & Neelam- 10 & the well started ceasing. There are 91 wells in Neelam field. Out of which 73 oil wells are flowing .72 wells are on continuous gas lift mode of artificial lift & only 01 well is on self flow. 18 wells are either closed or ceased. The major reasons for wells not flowing is either high water cut (>97 %) or tubing leak in upper portion of tubing due to which they were found to be circulating only lift gas. Out of 72 flowing gas lift wells, 10 wells have tubing leak due to which they need to be optimized frequently as they get deoptimised whenever there is a disturbance in gas lift header pressure due to tripping of Process gas Compressor. Presently the Neelam field is producing approx. 23000 BOPD of oil, 1.37 MMSCMD of gas .Presently the average water cut from the field is 81%.Total 26.175 MMT of oil has been produced from Neelam field till 31.03.2007 & recovery from the field is 24 %. Figure1, Figure2 & Figure3 depicts the location map, well location & performance of Neelam field since year 1990 respectively.

Need for Gas Lift: Wells in an oilfield are able to flow by self in the initial years of an Oil field development as the Reservoir pressure is high & water cut is low. More & more wells have to be put on artificial lift to keep them flowing & to maintain the production from an ageing field as the reservoir pressure declines & water cut increases. Gas lift is one of the oldest, simple & the most popular means of artificial lift. Gas lift is used to increase the production from a well. By injecting gas into the tubing, the density of the fluid is reduced & thus pressure component due to gravity is reduced. However the gas lift also gives a larger component due to friction, giving a technical optimum lift gas rate. The following are the reasons for its preference.
1. It has high degree of flexibility with respect to design rate
2. GLV’s are Wire line retrievable
3. It handles sandy condition well
4. It requires minimal wellhead surface equipment
5. Multiwell production from Single compressor is possible
6. Allows for full bore tubing drift
7. Can be installed in Offshore Horizontal well.

Some of the limitations of Gas Lift are

1. Needs high pressure Compressor or gas well
2. One well may be uneconomical
3. Not suited for very high viscous oil
4. Needs certain Bottom Hole pressure
5. High Back pressure

**Need for Gas lift Optimisation:** The main objective in oil production system using gas lift technique is to obtain the optimum gas injection rate which yields the maximum oil production rate. The aim is to enhance production & reduce lift gas injection rate. Relationship between gas injection rate & oil production rate is described by a continuous gas lift curve (GLPC). Obtaining the optimum gas injection rate is important because excessive gas injection will reduce production rate & also increase operation cost. Fig. 4 illustrates the effect of increase in gas injection rate on liquid production of a typical well (NLM3#3) of Neelam field.

There is a need to optimize the wells in an oil field regularly through lift gas tuning as well as replacing the existing Gas lift valves with newly redesigned valves to keep them flowing optimally. At the time of gas lift design for a new well an engineer is faced with a lack of reliable data, the flexibility of gas lift is indeed of great value. The basic parameters for gas lift design like Reservoir Pressure, PI, Water cut, GOR, Surface conditions like Line pressure, Gas lift header pressure are changing in an oil field; GLV’S too have to be periodically examined for their proper functioning by carrying out flowing gradient survey & their functioning/ malfunctioning need to be analyzed. The suitability of existing GLV’S/CV’S need to be analyzed if it can give an optimum oil flow rate. They need to be replaced by redesigned valves if they are either found leaking or analyzed not suitable to give optimum production from a well.

**Activities of well optimisation in Neelam Field:** In Neelam field, the following activities are done regularly for optimisation of a gas lift well.

a) **Fine tuning of injection gas of wells:** Well parameters like GIP, FTHP, Flow arm temperature, Gas injection rate are continuously monitored in SCADA system 24X7 & corrective action is taken if well is found deoptimised. Lift gas tuning of well is a routine
operation to maintain production from the field & an average of 05 wells & 08 wells were optimized each month & a gain of approx. 200 BOPD & 400 BOPD was achieved in years 2006-07 & 2007-08 (till September 2007). This gain was cyclic in nature as the reduced production from field was brought back by this effort. Figure 5 depicts the effect of lift gas tuning on production of a field. It was observed that the wells were deoptimised due to one of the following reasons.

1. Disturbance in gas lift header pressure due to Compressor tripping or plant shutdown
2. Increase in back pressure due to Plant shutdown
3. Leak in production tubing of a well

**b) Performance analysis of a well:** Flowing gradient survey of wells is done periodically & data analyzed to see if the wells are flowing optimally or there is a scope for improvement. In year 2006-07, out of 71 gas lift wells in Neelam field, 57 nos. of gradient survey were carried out. Out of which in 50 wells, gas was found to be entering through CV & in 07 wells gas was not entering through CV. The following data were used to check if a well was flowing optimally.

1. Current Production test data
2. Flowing & Static gradient survey
3. Two pen recorder or continuous record (Chart) of FTHP & GIP in SCADA
4. Gas metering system
5. Gas lift design sheet
6. Well test history
7. Wireline job report
8. Well case history
9. Well file (Drilling, Well schematic)

From gradient survey data the point of injection or multipoint injection can be established. Flowing gradient survey pressure data can be matched to fit a vertical lift correlation. Vertical lift performance & Inflow performance curve are matched & sensitivity test run to find out the optimum gas injection rate. The potential gain by shifting the point of injection can also be found out.

On analysis, it was found that the gas was not able to enter through the CV due to various reasons like 1) Gas lift design pressure being more than present available lift header pressure due to which unloading valves did not open to unload a well. 2) The actual PI of well was found to be more than one considered at the time of design 3) Mandrel being choked with scales suspected of not being unloaded till the bottom most GLV/CV since last work over job 4) The gas lift design pressure for valves being lower than the pressure required to unload till the bottom most Mandrel station.5) Gas entry was through holes in tubing 6) Flowing bottom hole pressure had increased due to additional perforation job & lift system was not designed to lift more liquid. GLV replacement job was carried out in 10 wells resulting in a gain of 512 BOPD of oil & lift gas saving of 71184 SCMD of gas in year 2006-07. In year
2007-08 till September 2007, Flowing gradient survey was done in 16 nos. of wells & GLV replacement was done 09 nos. of wells & a gain of 713 BOPD of oil & saving of 71184 SCMD of gas was observed. The well wise gain for year 2006-07 & 2007-08 are given in Table 1 & Table2 respectively. Figure 6,7,8,9,10 depict the various stages of detecting the point of entry, verification of test data using quick look feature of “Prosper” software, matching of Vertical lift performance & Inflow performance data, Sensitivity test done to estimate the gain from GLV replacement & Actual gain achieved after GLV replacement done in well NLM2#4 of Neelam field respectively.

**Conclusion:**

1. Gas lift optimisation is an important tool in maintaining production from an oil field.

2. The well conditions change with the life of a well so there is a need to regularly record Flowing gradient survey & analyse the well data & see if a well is producing optimally & make interventions like GLV replacement or lift gas tuning to make the well flow optimally as lift tuning is a very important tool to maintain production from a field.

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**Reference:**


2. Real time automation optimizes production economics in Oman, World Oil, Oct1998 by Ron Cramer, Cleon Dunham, Alley Al Hinai

3. Gas lift Surveillance & Optimization, by Ron Cramer-Shell Global Solutions BV

4. Gas lift training Manual by Gatut Widianoko, Weatherford Artificial lift system
Fig. 1 Location map of Neelam field

Fig. 2 Well location in Neelam field

Fig 3: Performance of Neelam field
Figure 6: Flowing gradient survey chart of NLM2#4 showing multipoint injection & no gas entry through Orifice

Figure 4: A typical gas lift optimisation curve of well NLM3#3 well

Figure 5: Effect of lift gas tuning on production field with wells on gas lift

Figure 7: Quicklook performed on well test data of well

Figure 8: Matching of VLP & IPR curve
Fig. 9: Sensitivity test done to see the gain in production from shift in point of injection

Fig. 10: Gain achieved after carrying out GLV replacement in NLM2#4
Fig. 11: A Wellhead Platform in Neelam field

Fig. 12: A Wire line Winch

Fig. 12: A Wire line Mast
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<th>S.N</th>
<th>Well No.</th>
<th>Date of GLV replacement/CV cleaning</th>
<th>Liquid gain (BLPD)</th>
<th>Oil gain (BOPD)</th>
<th>Lift gas saving (SCMD)</th>
<th>Remark</th>
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Table 1: Gain through GLV replacement (2006-07)

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<th>S.N</th>
<th>Well No.</th>
<th>Date of GLV replacement/ CV cleaning</th>
<th>Liquid gain (BLPD)</th>
<th>Oil gain (BOPD)</th>
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<td>21220</td>
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<td>Well was closed before the job because of high Gas Injection rate.</td>
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Table 2: Gain through GLV replacement (2007-08) just after the job till September 2007