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Introduction of High Pressure (HP) Separator and Its Applications in Pakistan

Z. Maqbool, SPE, K. Khattak, SPE, J. H. Malik, SPE, Eastern Testing Services (Pvt.) Ltd., J. Ahmed, SPE, MOL Pakistan Oil and Gas Company B.V.

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Abstract

Well testing is an important tool for field appraisal, field development and reservoir surveillance and management. Some key measurements during well tests are flow rates of individual phases, fluid properties, fluid composition, flowing surface and downhole pressure and temperature etc. Analysis of this data helps in pinpointing where improvements can be made, how the productive potential of the reservoir can be enhanced and where the future investments are to be focused. So production testing campaigns of wells are to be conducted and should be conducted annually or bi-annually to get the aforesaid vital information of the well and the reservoir.

While gathering vital data during production testing, an apprehension is that the hydrocarbon produced and separated on surface should not be flared causing a huge financial loss and environmental harm. Therefore a zero flaring concept was adopted during production in which the separated gas was safely and effectively injected back to the production line and the fluids to the storage facility.

In Pakistan production testing is generally carried out using conventional 1440psi separator and implementing zero flaring concepts. But there are certain limitations associated with the conventional 1440 psi separators available in Pakistan. A few of them are that they can't be used on wells whose downstream pressure or injection line pressure is greater than the safety limit of 1440 psi separator, they can't be used on wells with high gas rates greater than the maximum limit of conventional 1440 psi separator which is 60 MMSCFD and the same limitation applies to condensate/oil/water rate as well. For this reason there are certain fields in Northern Pakistan where production testing campaigns with zero flaring cannot be carried due to the above mentioned limitations of 1440 psi separator.

This paper describes the introduction of the first ever High Pressure (HP) separator in Pakistan. This separator has overcome the limitations due to its high design pressure of 2160 psi and high gas and oil flow rate capacity which is 90 MMSCFD and 13000 bpd respectively. Successful field applications at three different fields in Pakistan are discussed in this paper covering lesson learned and best practices during the operations. Producing wells were tested without flaring or wasting any hydrocarbon which is harmful to environment. All the separated gas was injected back to the high pressure production line which resulted in a huge financial advantage. The application of the non-conventional high pressure separator and implementing zero flaring is proven to be a beneficial solution with huge potential for future applications in Pakistan.

Introduction

Well testing has been widely used for several decades in the oil and gas industry to collect data for the well deliverability, fluid types, pressure transient analysis for reservoir attributes like permeability, skin, completion efficiency and to identify reservoir boundaries etc. Information collected during well test consists of flow rates, pressure, temperature data and fluid samples. Important decisions such as production methods, well production equipment, reserve estimations and field development are made from this information. Well testing remains important throughout the productive life of the reservoir for assessment and exploitation of reservoirs. This importance does not diminish whether the well is in exploration, appraisal, development or commercial production phase.

Now putting an eye on the practical or operational aspects of well testing, we will come to the realization that a precise and specific set of well testing equipment is required to get the important information of the reservoir at dynamic and static

well conditions. An important equipment in production testing is the Separator which separates the well stream into different phases and measure their production rate separately.

Background

Production testing campaigns are carried out on many producing fields in Pakistan at regular intervals. Such campaigns are constrained on some fields by a number of factors. A few of them are:

1- The non-availability of equipment of required specifications for a particular well testing job.
2- Non availability of storage facility at the producing well location.
3- Flaring of hydrocarbon to atmosphere with its unfavorable financial and environmental implications.

Pakistan is facing serious energy crises at present. The drilling activities are on a good pace to meet this deficiency. Moreover, there are many fields in Pakistan that are currently operating at their maximum potential to overcome the shortfall. In such scenarios, vigilant reservoir surveillance is required to avoid excessive pressure draw down which may cause reservoir damage or decrease in production etc. This further enhances the need for production testing at regular intervals.

In many of the low pressure fields, production testing campaign are being carried out with the conventional set of well testing equipment. Most of the available conventional separators in Pakistan are the ones with a working pressure of 1440 psi and gas handling capacity of 60MMSCFD. **Fig. 1** shows the capacity of a 48" OD x 10ft 1440 psi working pressure separator.

There are certain fields in North of Pakistan where this conventional separator faces certain limitation. In those fields either gas production is too high that it is beyond the handling capacity of 1440 psi separator or the wells have a high downstream pressure, greater than 1440 psi, because of very low drawdown even at higher choke sizes. Similar limitation applies if the injection line pressure is higher than the maximum operating pressure of the conventional separator. This identified the need for HP separator which eliminates all the above limitations. This paper describes in detail the introduction of the HP separator and its successful application in North of Pakistan on high pressure and high production rate wells.

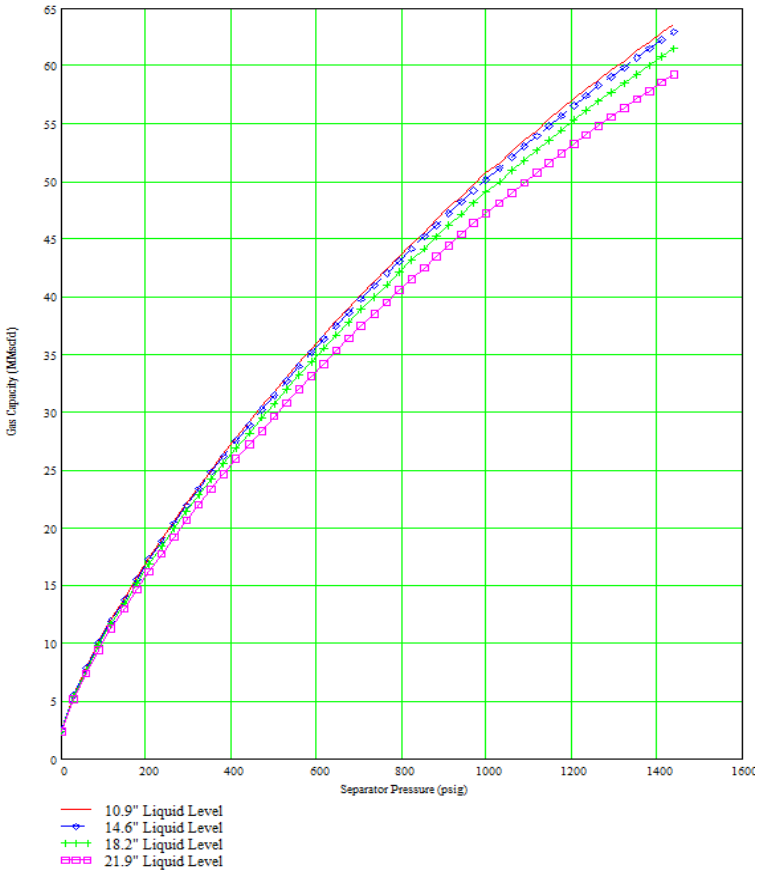

Fig. 1 Theoretical gas capacity of 48" OD x 10Ft 1440 psi separator

Objectives and Planning Of the HP Separator Job

One of the operators in the Northern Pakistan decided to test each of their well individually by using a three phase separator. At prevailing flowing conditions, the downstream pressure of wells, exceeded 1440 psi, the maximum working pressure of traditional three phase separators available in Pakistan. Therefore, a high pressure separator with working pressure of 2160 psi that could measure flow rates of individual wells and inject the high pressure gas back into the system, eliminating the need of gas flaring was recommended for inline testing campaign. The data gathered from HP Separator testing campaign was required to allocate production to individuals well, develop well head inflow performance and establish condensate to gas ratio and water to gas ratio under prevailing flowing conditions.

Based on the above requirements, a HP separator testing campaign was planned with the following objectives.

1- To determine the gas, water and condensate production of individual well.
2- To calculate precisely the GOR,CGR,WGR of each well
3- To conduct the whole campaign without flaring the gas and implementing zero flaring concept.
4- To inject the gas back to the production line to eliminate production loss.
5- To perform the test in a highly safe and efficient manner.

JOB EXECUTION

Based on the above targets and in coordination with an oil and gas service company, a HP separator was brought which was the first ever HP separator in Pakistan. This separator eliminates all the limitations of the conventional 1440 psi separator due to its high design specifications and a working pressure of 2160 psi with gas, condensate and water handling capacity of 90 MMSCFD,13000BPD and 1500 BPD respectively. The detailed specification sheet is attached in **Appendix A**.

The surface well testing (SWT) equipment was rigged up as per the equipment layout attached in **Appendix B**. The operational procedure followed is as under:

1- Conduct safety meeting and performed HAZARD analysis.
2- Rig up the SWT equipment as per the standard operating and rig up procedures.
3- Pressure test surface well testing equipment as per the Operator's program.
4- Open injection line valve to pressure up the SWT equipment.
5- Divert flow through HP separator and meter gas, condensate and water rates.
6- Flow well as per program at different chokes.
7- Divert flow towards plant.
8- Depressurize SWT equipment.
9- Rig down equipment.

In total nine producing wells were successfully tested at three different fields using HP separator. All the separated gas was injected back to the injection line by maintaining the separator pressure higher than the production line pressures. Condensate and water was sent to the storage facility after metering. No gas was flared to pit which not only resulted in huge economical advantage but also caused no environmental harm. **Fig. 2** shows the graph, at which separator was operating during the job at one of the wells.

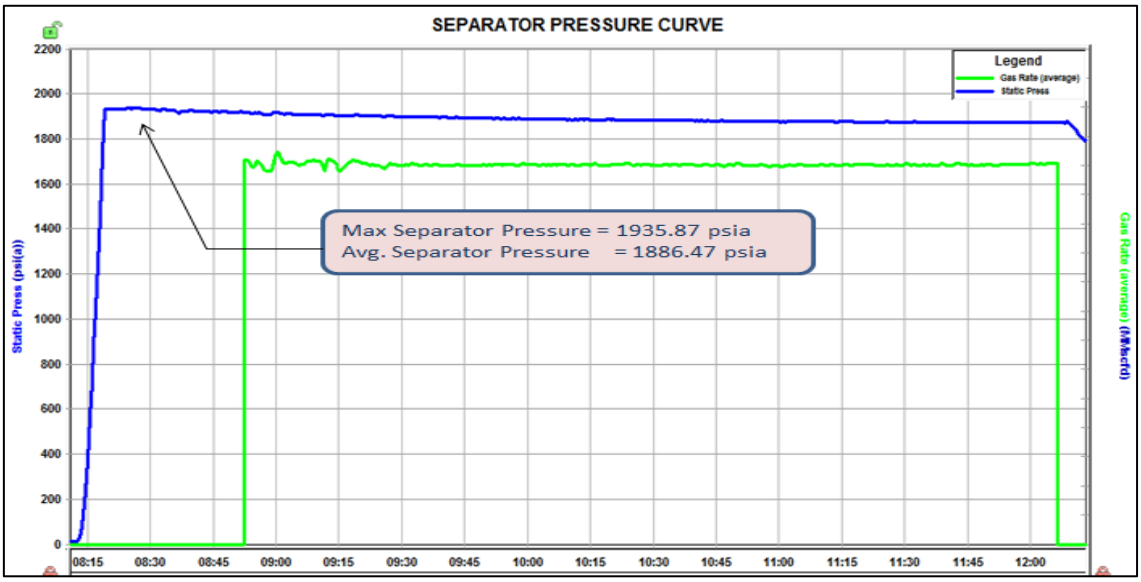

Fig. 2 Graph Showing Separator Operating Pressure

Advantages of HP Separator

HP separator has eliminated all the hindrance which was not letting production testing campaigns to take place at different fields in Pakistan. All the fields in Pakistan which are producing at rates higher than 60 MMSCFD or where the downstream pressures or production line pressure are higher than safety limit of the conventional separator, or where the requirement is to get the true representative values of the effluent coming from the well, then the 2160 psi HP separator is the right choice.

Conclusion

The introduction of the first ever HP separator in Pakistan has paved a way to a new era of production testing on high pressure/high volume producing fields and will assist in reservoir surveillance in a much more efficient manner. Its successful application shall provide other operators in Pakistan the opportunity of similar successes and applications in future.

Acknowledgement

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References

[1] Stuart McAleese, Operational Aspects of Oil and Gas Well Testing, Handbook of Petroleum Exploration and Production, 1.

Abbreviations

CGR: Condensate to Gas Ratio.

GOR: Gas to Oil Ratio.

WGR: Water to Gas Ratio.

HP: High Pressure

MMSCFD: Million Standard Cubic Feet per Day

SWT: Surface Well Testing

APPENDIX A

PROCESS DATA

Gas flow Rate: 90 MM SCFD
Oil flow Rate: 13000 BPD
Water flow Rate: 1500 BPD
Sour Gas Services: Sour (NACE MR-01-75)

DESIGN DATA

Design Press/Temp: 2160 Psi at 122° F, 1998 Psi at 250° F
Code of construction: ASME VIII Division 1/B 36.10 M/B 16.5/B31.3/ NACE MR0175/DNV 2.7.1/CSC Regulation.

EXTERNAL CONNECTION

Oil Inlet: 3" Anson Fig. 6O2 F
Oil/Water/Gas/Relief Gas Outlet: 3"/3"/ 3"/4 Anson Fig. 6O2M

MISCELLANEOUS BASIC EQUIPMENT

Shrinkage tester assembly Instrument air system
Level Controller Cage (Vessel, Shrinkage Tester)
Drain and Seal Pot for Barton Recorder
Instrument Air Scrubber
01 x ¼" x 1 Pressure Regulator (50-150 psi outlet pressure)
03 x ¼" x 1 Pressure Regulator (50 psi outlet pressure)
01 PSV set pressure 145 psi, ½" MNPT x 1" FNPT
09 x ½", 06 x ¼" Ball Valve

MAIN COMPONENT BRAND

Control Valve (Gas/Oil/Water): Emerson Fisher
Oil and Interface Controller: Emerson Fisher
Liquid LCV: Emerson Fisher
Gas Flow Orifice Meter: Senior Daniel Dual Chamber
Gas Flow Recorder: Barton 3 Pen Recorder
Liquid Turbine flow Meter: Nuflo
Ball Valves: Balon
Safety Relief Valve: Tyco – AGCO
Level Gauge: Penberthy / Ferguson
Thermometer & Thermowell: Wika/Ashcroft
Air Regulators: Emerson Fisher

VESSEL EQUIPMENT

01 x Oil Level Controller (3" 249K), Direct Acting.
01 x Oil Level Gauge
01 x Water Level Controller 3" 249K), Direct Acting
01 x Water Level Gauge
02 x PSV Set Press. 1990 Psi, 3" 900 # x 4" 300 #
01 x Temperature Indicator (0-200°C) c/w Thermowell
01 x Pressure Indicator 0-3000 PSI
01 x Vane Inlet Diverter
02 x Set of coalescing plates
01 x Gas exhaust demisters
02 x Liquid outlet cortex Breakers
12 x ¼ Ball Valve
12 x ½" Ball Valve
04 x 1 ½" Ball Valve

INLET LINE

01 x 4" LP Wafer Check Valve, 01 x ½", 01 x 4" Ball Valve
01 x ¾" Thermometer (0 - 160°C) c/w Thermowell

OIL OUTLET LINE

01 x ¾" Thermometer (0 - 200°C) c/w Thermowell
01 x ¾" Thermometer (0 - 160°C) c/w Thermowell
04 x½" 04 x 3", 02 x 2" Ball valve
01 x 1" Turbine Flow Meter, 170 – 1700 BPD.
EZIN # 900 RF,
01 x 2" Turbine Flow Meter, 1300 – 13000 BPD.
EZIN # 900 RF,
01 x 3" Level Control Valve, Actuator Type 667

WATER OUTLET LINE

04 x ½", 03 X 2" Ball valve
01 x 2" Turbine Flow Meter, 170 – 1700 BPD
EZIN # 900 RF
01 x 3" Level Control Valve, Actuator Type 667.

DRAIN LINE

01 x ½", 01 x 2" Ball Valve

GAS OUTLET LINE

01 x 6" Straightening vane
01 x 6" Senior Daniel orifice fitting (Flanged)
01 x 3" 3 3 Pen Recorder 2500 PSI, 0-400" WC DPU and temp., Sensor range 0 - 250°F.
01 Pressure Controller 0/3000 PSI
01 x 3" Pressure Control Valve, Actuator Type 657
01 x 3", 07 x ½" Ball Valve
01 x 1½" Thermowell
01 x ½" Bi-Metallic Thermometer (0-160°C)

BYPASS LINES

02 x ½", 01 x 4", 01 x 3", 01 x 2" Ball Valve

RELIEF LINE

01 x ½" Ball Valve

SKID DETAIL

Type	CSC Certified Standard Container
Length/Width/Height	6058 mm/2438 mm/2591 mm
Pay Load/Gross Weight	15000 Kg/24000Kg
Deign Specification	CSC/DNV 2.7.1

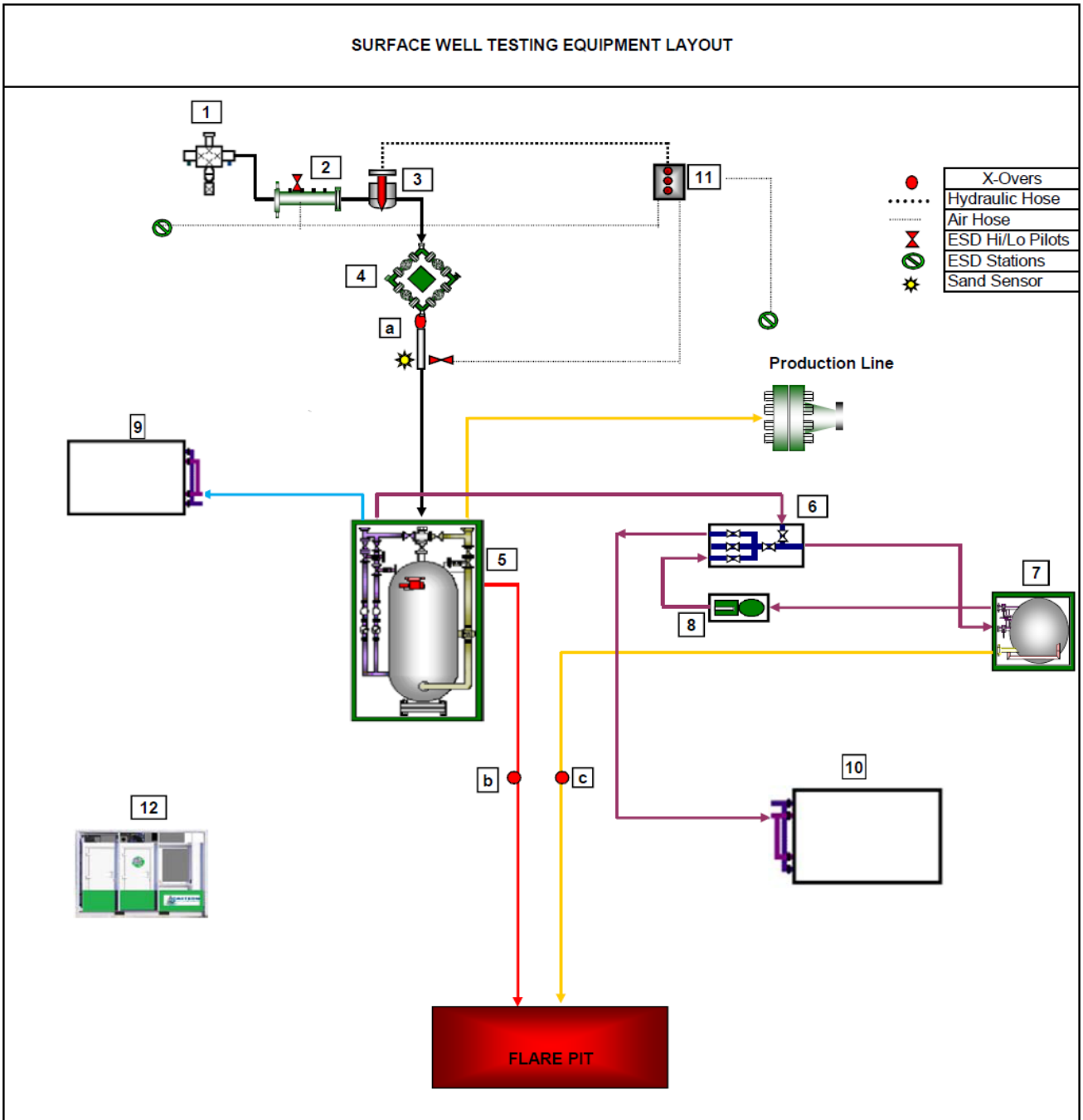
QUALITY

Radiography on vessel and Pipes as per code.
100% MPI on lifting lugs and primary structure
Hydrostatic Pressure Test as per code & Leak Test
100% Material Traceability

CERTIFICATION

For Vessel	ASME U stamp

APPENDIX B



Item	Equipment Description
1	X-mass Tree
2	10K Data Header
3	10K SSV Surface Safety Valve
4	10K Choke Manifold
5	2160 psi Test Separator
6	Oil Manifold
7	Surge Tank
8	Oil Transfer Pump
9	100 bbl Gauge Tank
10	500 bbl Storage tank
11	ESD
12	SWT Lab cabin

a	Choke Downstream X-Over
b	Flare Line X-Over
c	Flare Line X-Over

	GasLine
	Water Line
	Oil Line