2012 Gas/Electric Partnership Conference

Benefits of Gas Lift

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Major Types of Artificial Lift

- Rod Pump
- Electric Submersible Pump
- Gas Lift

Pros and Cons of Rod Pumps

- Major advantage of a rod pump is that it can provide a low bottomhole pressure
- Effective flow rate declines with depth
- Relatively high capital costs
- Relatively high operating costs
- Does not operate well in a deviated hole

Pros and Cons of Submersible Pumps

- Major advantage of a submersible pump is the high rate of flow it can achieve
- Flow rate does not decline with depth, only horsepower
- Relatively high capital costs
- Relatively high operating costs
- Must have source of electrical power

Pros and Cons of Gas Lift

- Major advantage of gas lift is its flexibility (ability to adjust for low to high fluid rates)
- Relatively low capital costs
- Relatively low operating costs
- Must have source of high pressure gas
- Injection pressure limits bottomhole pressure

Gas Lift Physics

- Forces restricting production
- Determination of critical velocity
- Critical flow rates for standard tubing sizes

Forces Restricting Production in a Flowing Well

- Surface pressure at the wellhead
- Hydrostatic pressure caused by the fluid in the tubing
- Friction due to flow in the tubing

Critical Velocity

- Velocity at which a liquid droplet falls
- Every well has a critical gas velocity below which liquids cannot be effectively transported from the well bore
- At a constant standard flow rate critical velocity is greatly affected by flowing wellhead pressure

Critical Flow Rate 2 3/8” Tubing

Tubing Press (psig)	Tubing I.D. (inches)	Gas Temp (deg F)	Water Rate (mcfd)
50	2	80	291
75	2	80	343
100	2	80	388
125	2	80	428
150	2	80	465
175	2	80	499
200	2	80	531
225	2	80	561

Critical Flow Rate 2 7/8” Tubing

Tubing Press (psig)	Tubing I.D. (inches)	Gas Temp (deg F)	Water Rate (mcfd)
50	2.500	80	454
75	2.500	80	536
100	2.500	80	606
125	2.500	80	669
150	2.500	80	727
175	2.500	80	780
200	2.500	80	830
225	2.500	80	876

Gas Lift Valves

- Why gas lift valves are necessary
- How gas lift valves operate

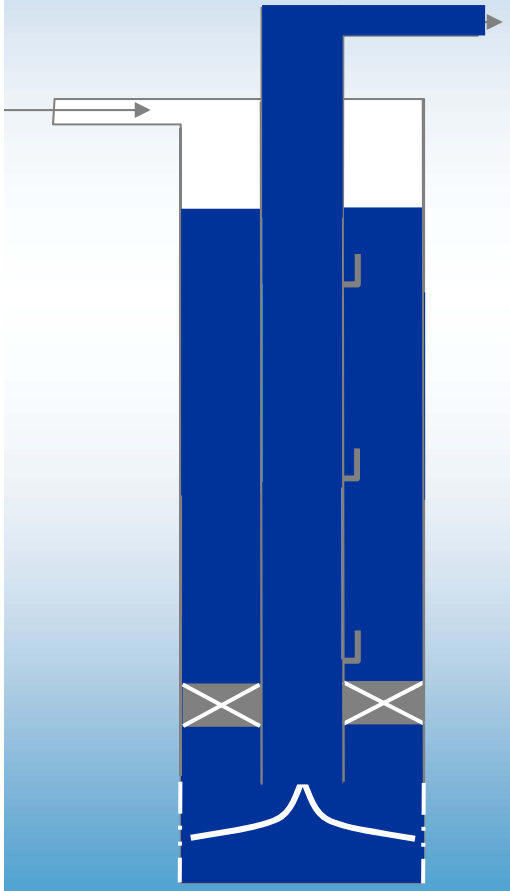
Why Gas Lift Valves Are Necessary

- To reduce the pressure requirements of pushing the gas to the bottom of the hole
- About one psi would be required for each two feet of depth for gas to reach bottom
- Greater depth means more valves
- Higher liquid flow rate means more valves

How Gas Lift Valves Operate

- A gas lift valve is basically a pressure regulator
- It opens and closes in response to gas pressure
- Gas lift valves are designed specifically for each well and must be run in the correct order

Gas Lift Operation



In response to gas pressure the liquid in the casing is forced into the tubing

Once gas reaches the first valve and is able to enter the tubing, the liquid in the tubing moves upward due to gas velocity

As the gas in the tubing reduces the head pressure, the formation starts to produce

As the pressure through the valve drops, the gas is able to work down to the next valve

Gas Lift Compression

- Gas lift compressor for a single well
- Gas lift compressor for multiple wells
- Compressor Flow Rate

Required Compressor Flow Rate

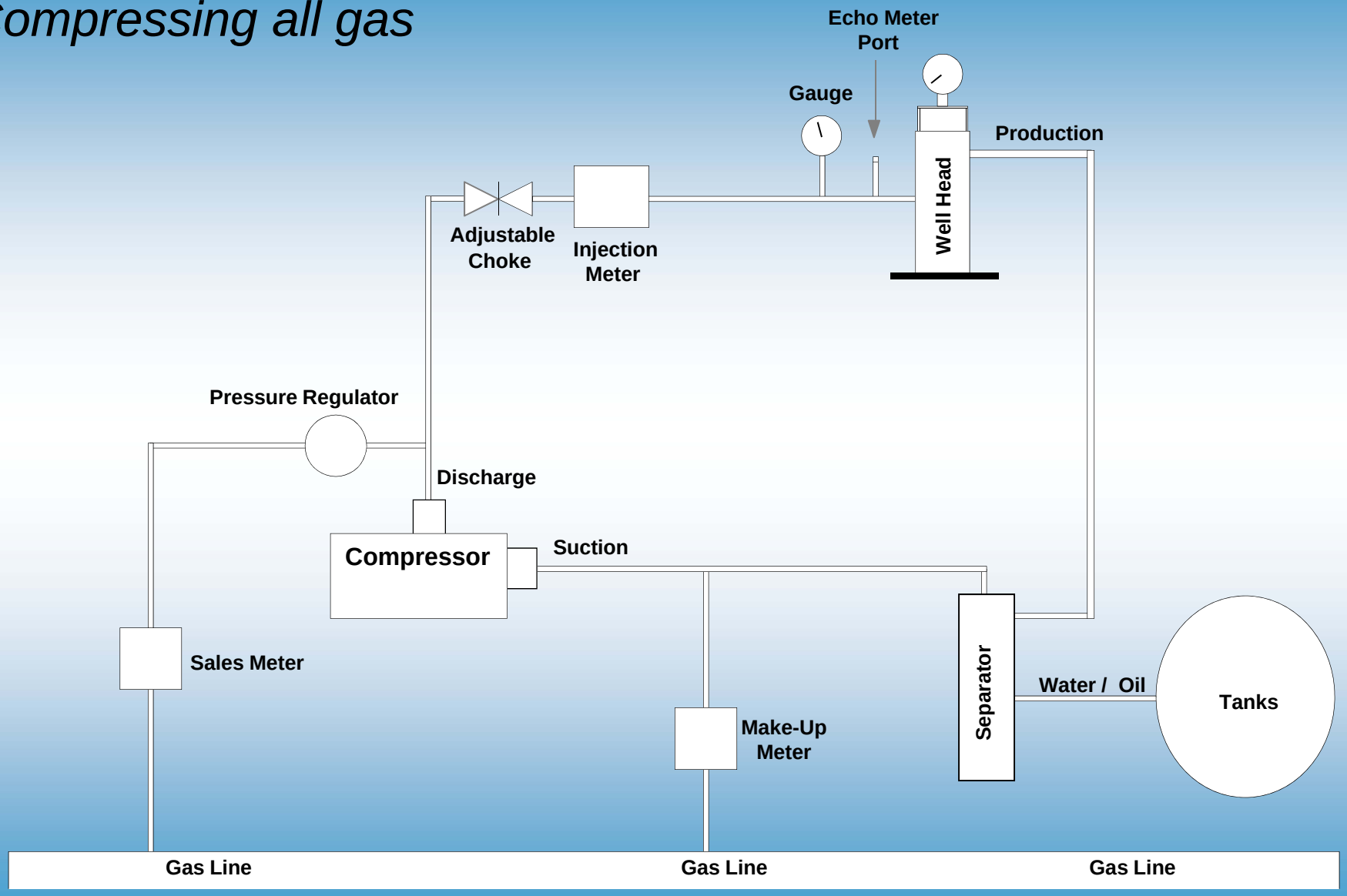
- Dependent upon the number of wells to be lifted
- Whether the entire well stream or only the injection gas will be compressed
- Flowing Wellhead Pressure
- Tubing size

Benefits of Compressing the Entire Well Stream

- Less injection gas required
- Lower bottom hole pressure / more reserves
- Fewer gas lift valves required

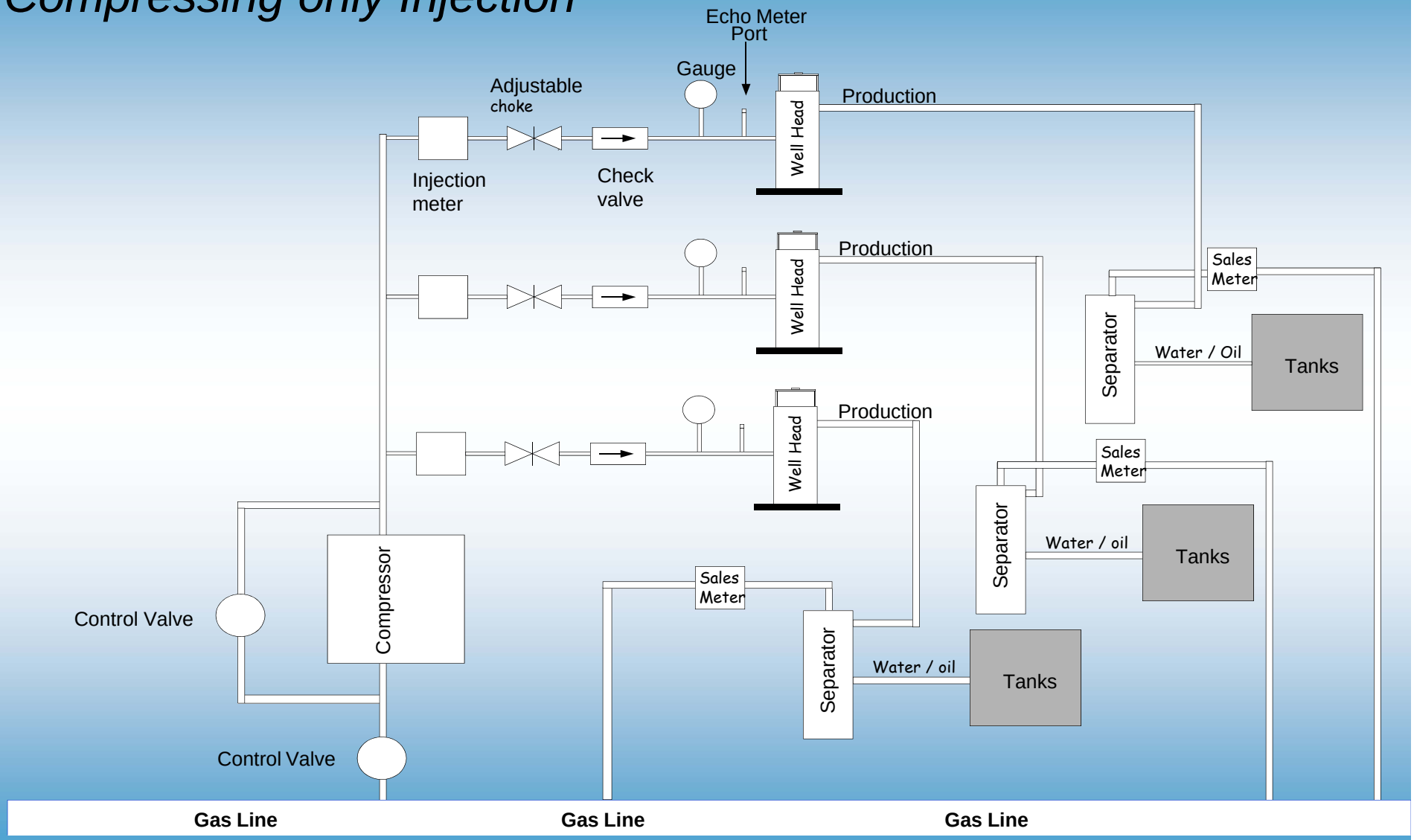
Compressor for a single well

Compressing all gas

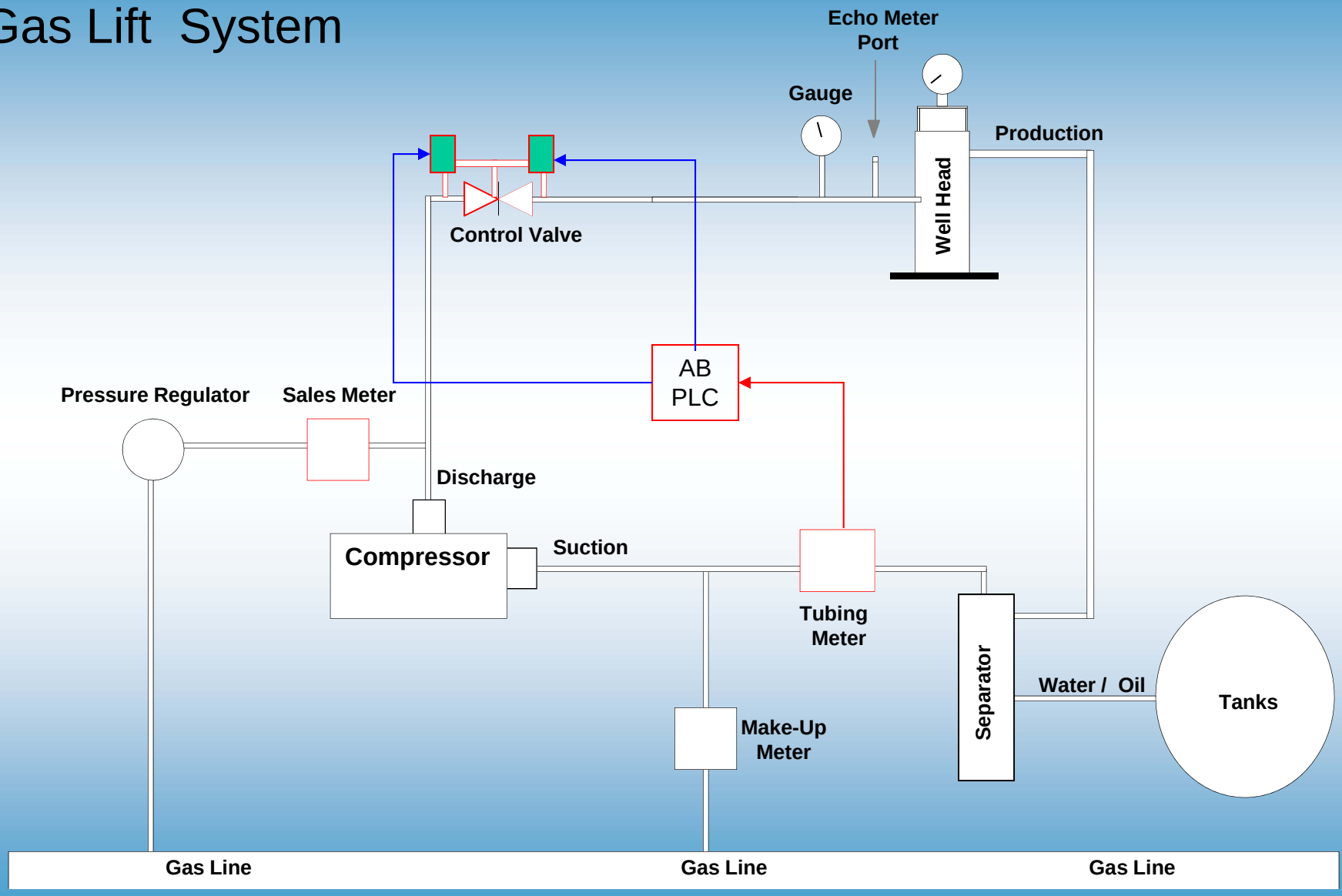


Compressor for Multiple Wells

Compressing only Injection



Patented Automated Gas Lift System



Questions?