Improving Performance of Gas Lift Compressors in Liquids-Rich Gas Service

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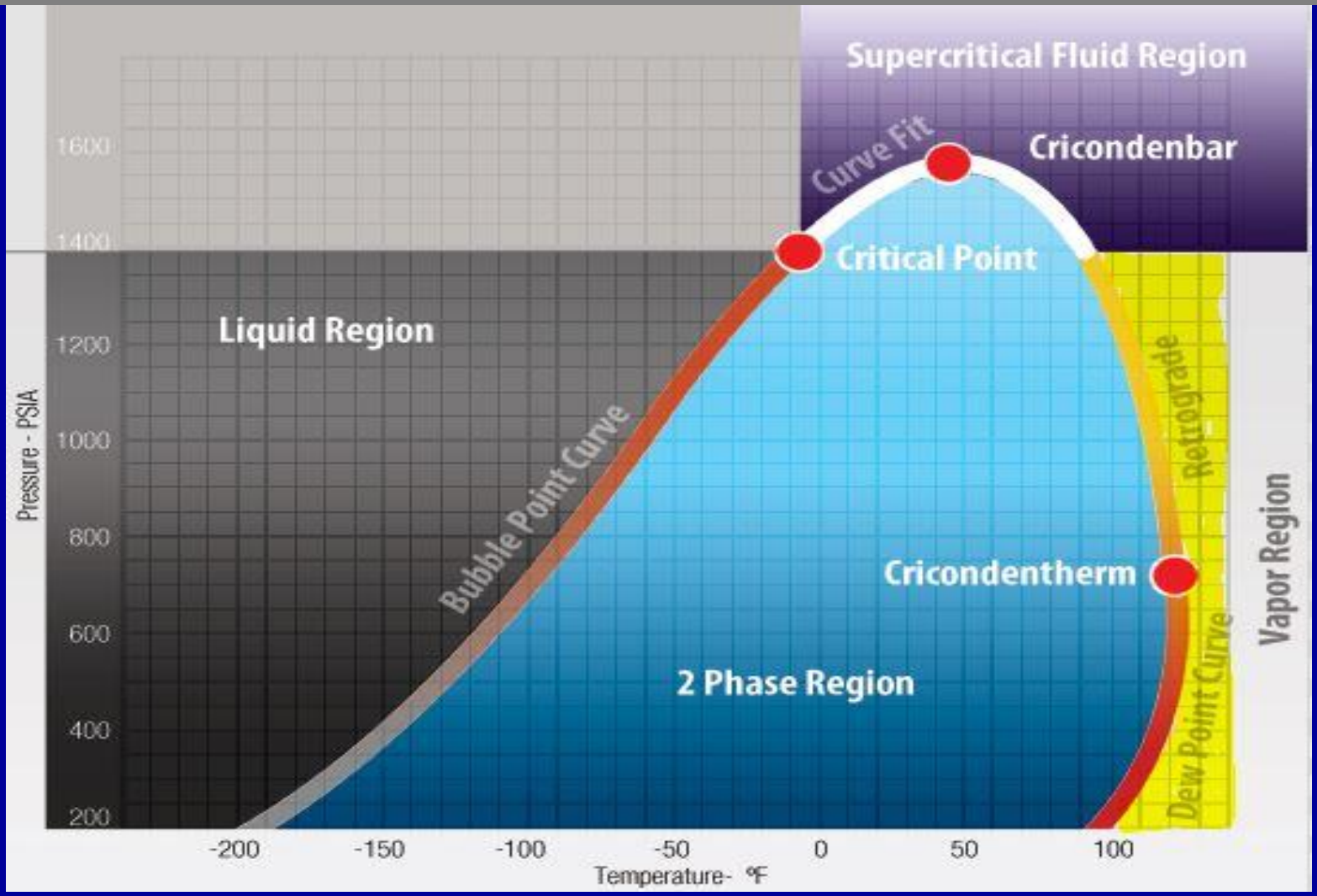
Outline

- **Financial Impact of Compressor Downtime**
- **Understanding Compression**
  - **Designed for Gas Sales from lean gas wells**
  - **Condensation issues with liquids-rich gas**
- **Impact of condensation to operations**
- **Methods to mitigate operating problems**
- **An Alternative: Prevention by design change**

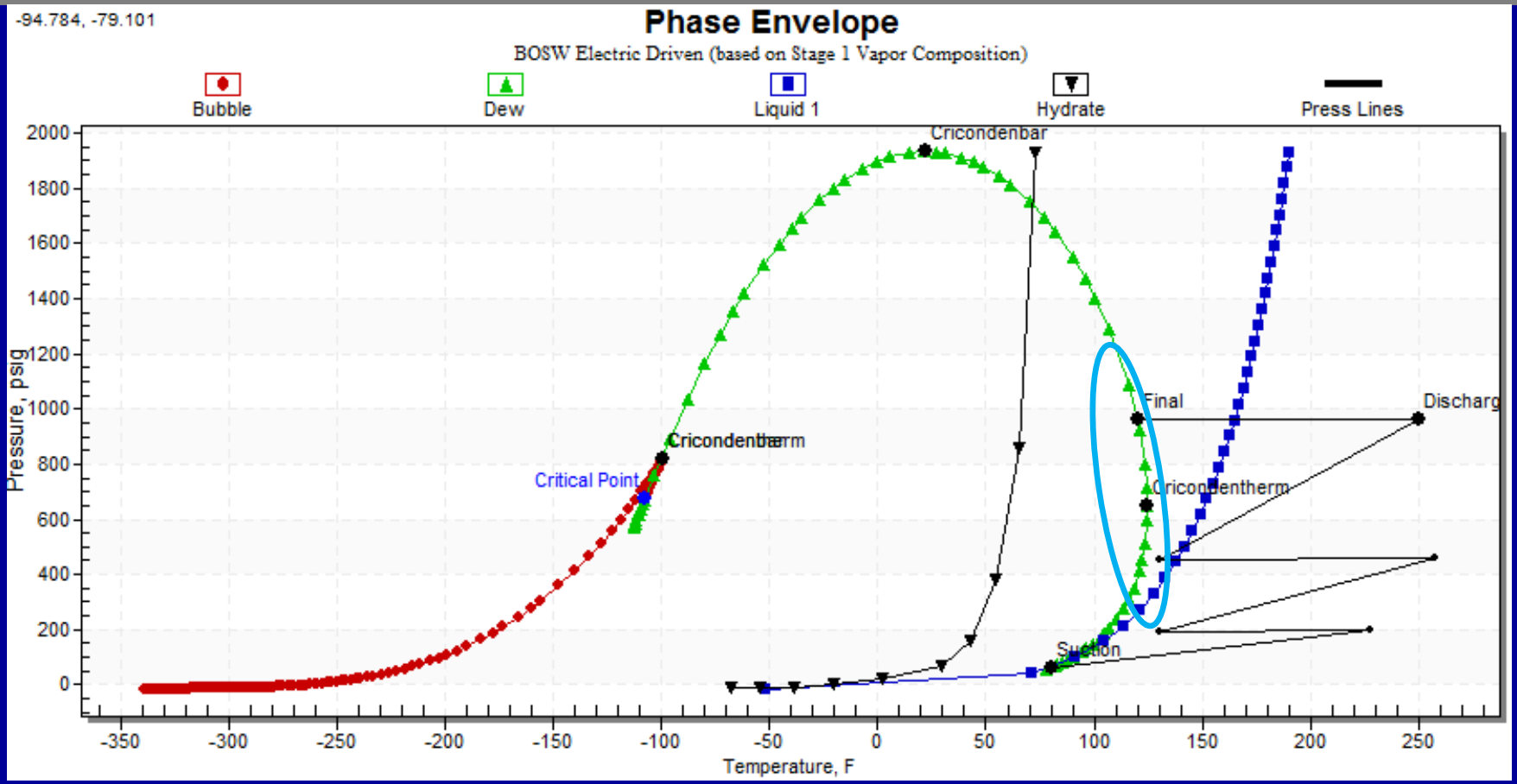
Financial Impact of 5% Downtime

- **Gas Sales: 750 MCFPD**
  - **$3.00 MCF, 75% NRI: $3,420 per month**
- **Gas Lift of 750 MCFPD**
  - **Producing 250 BOPD, 500 BWPD, 250 MCFPD**
  - **$5.00 MCF, $50 Oil, $1 SWD, 75% NRI: $14,415**
  - **4.6 times more impact to cash flow**
- **Rental Rate Refund for 5% Downtime**
  - **$6000 monthly rental fee x 5% = $300**

Understanding Compression: The Phase Diagram

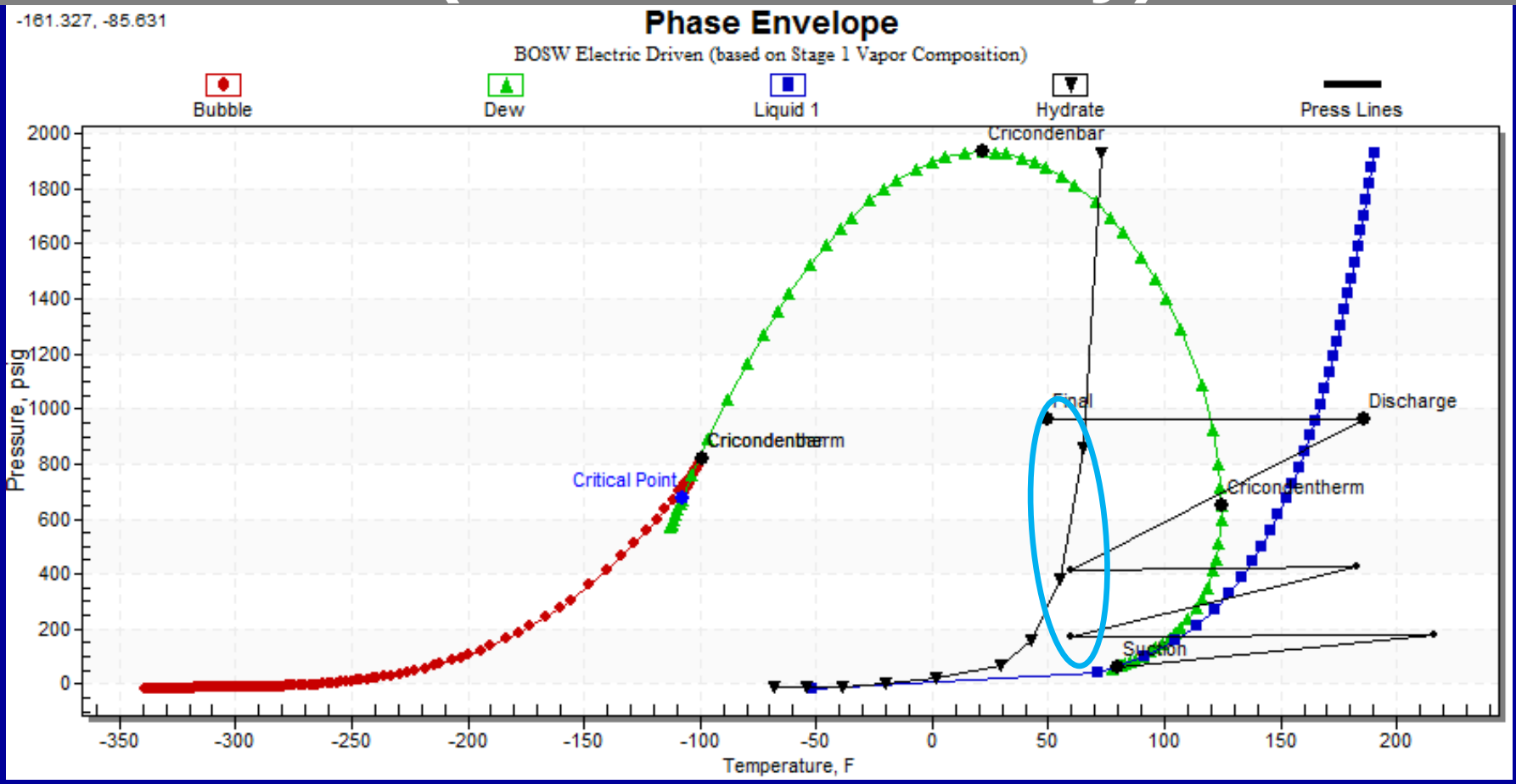


Phase Diagram for 100 F Ambient Gas Well Sales (Lean 0.65 Gravity)



- Temps kept above 120 F, no hydrocarbons condense

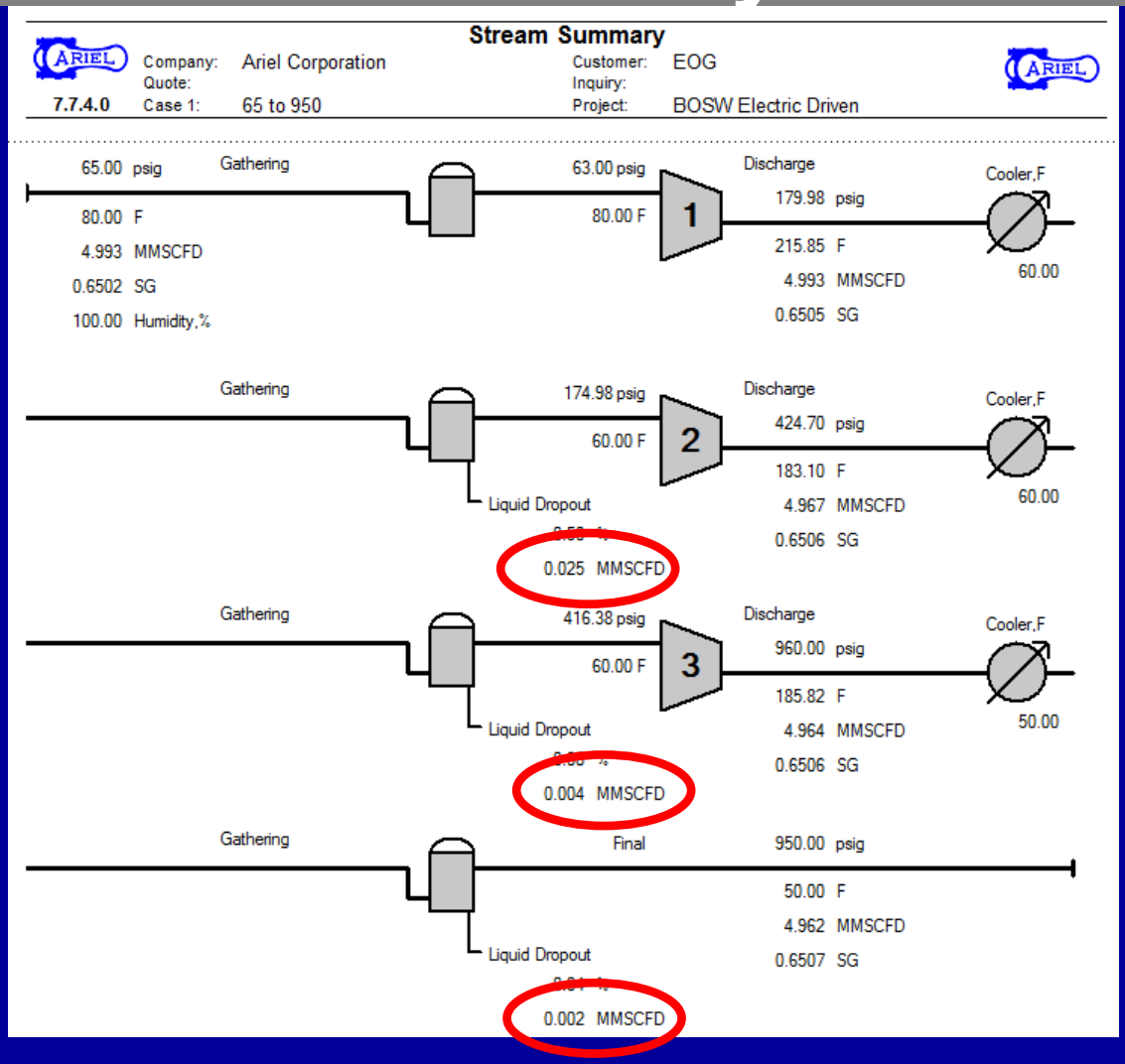
Phase Diagram for 30 F Ambient Gas Well Sales (Lean 0.65 Gravity)



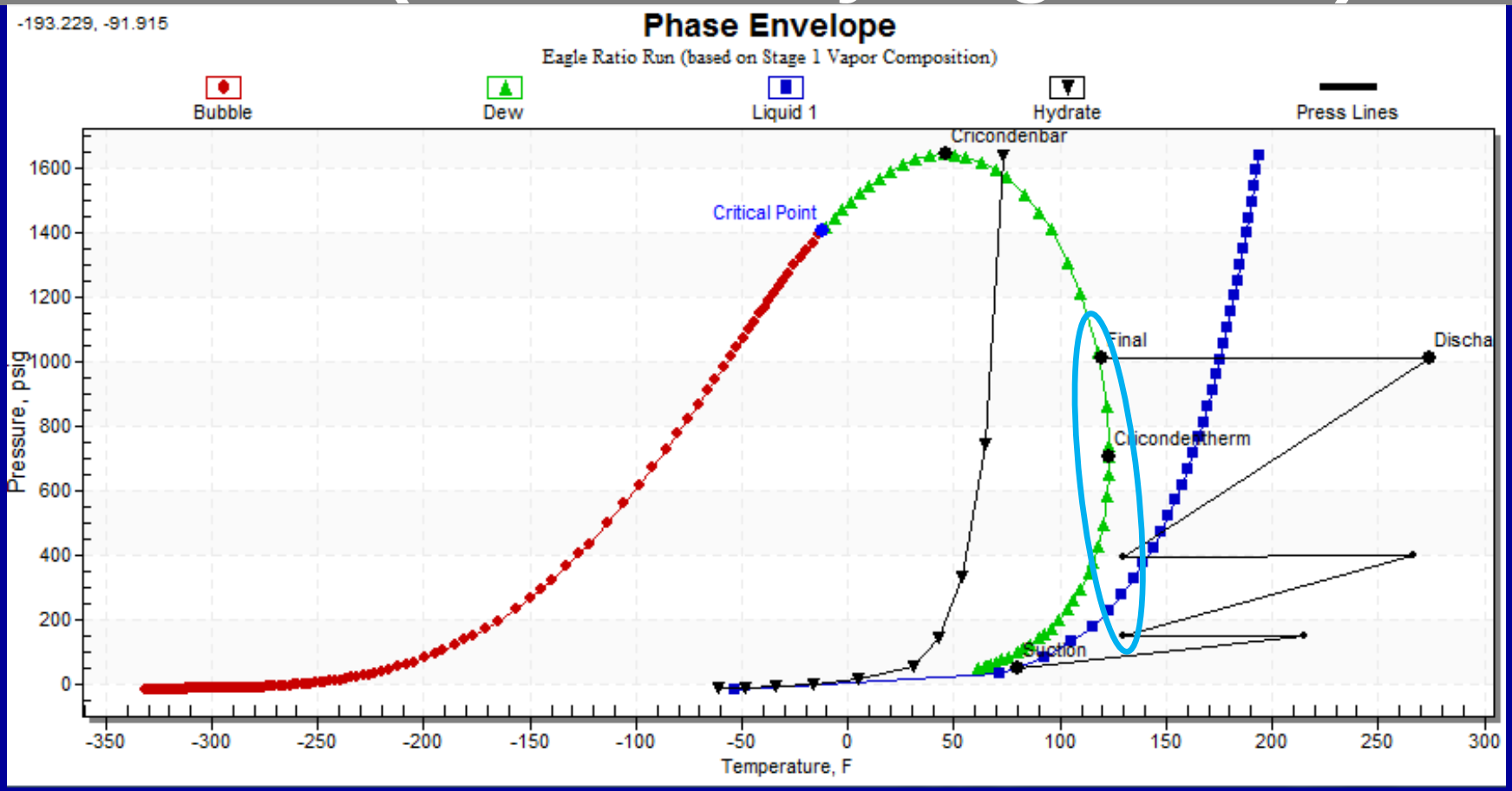
- **Temps fall below 120 F, allowing hydrocarbon condensation**
- **Since gas is lean, not much will condense**

Liquid Dropout for 30 F Ambient Gas Well Sales – water only

4993 MSCFD

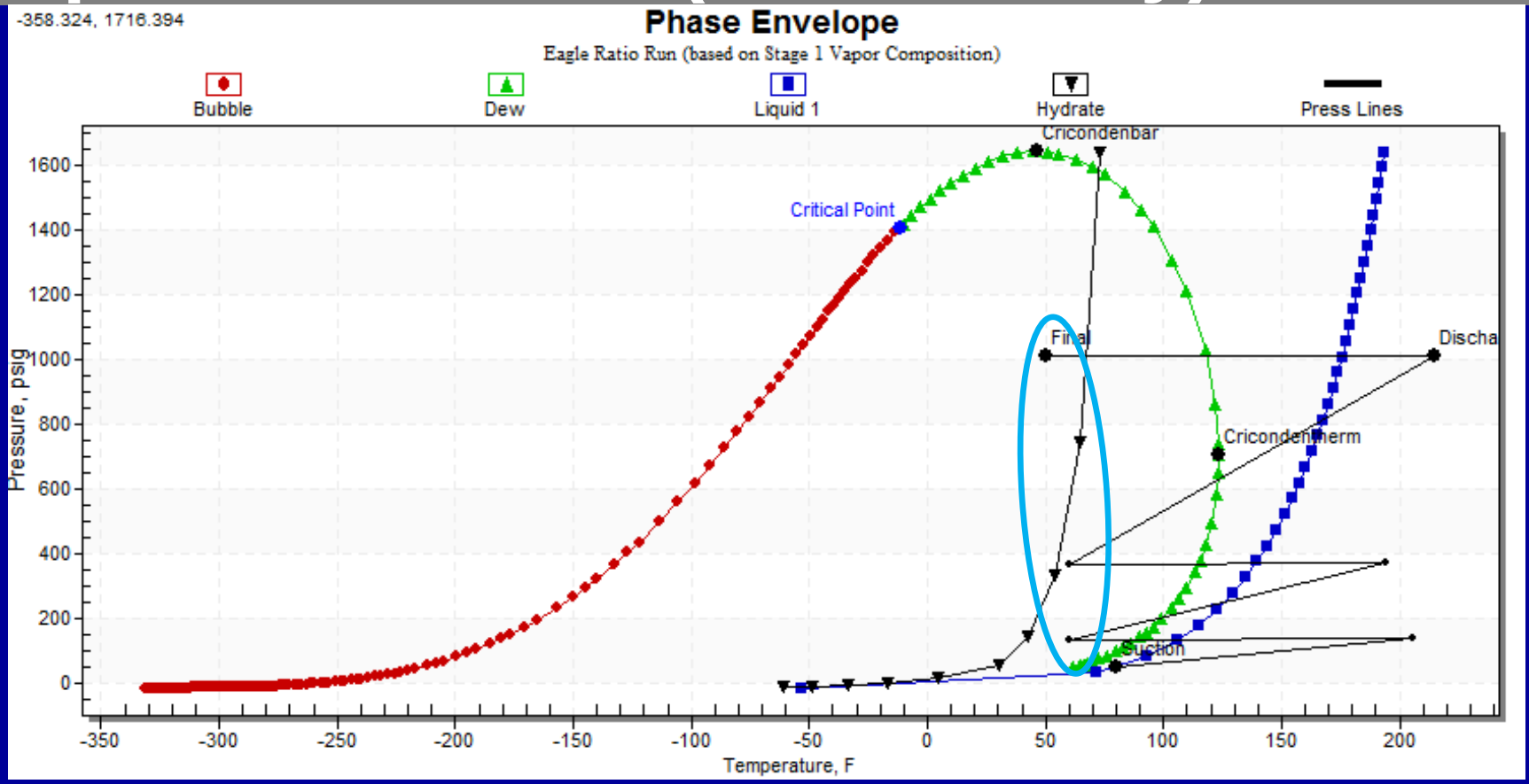


How does this change for richer gas? 100 F Ambient (0.76 Gravity Eagle Ford)



- Temps kept above 120 F, no hydrocarbons condense

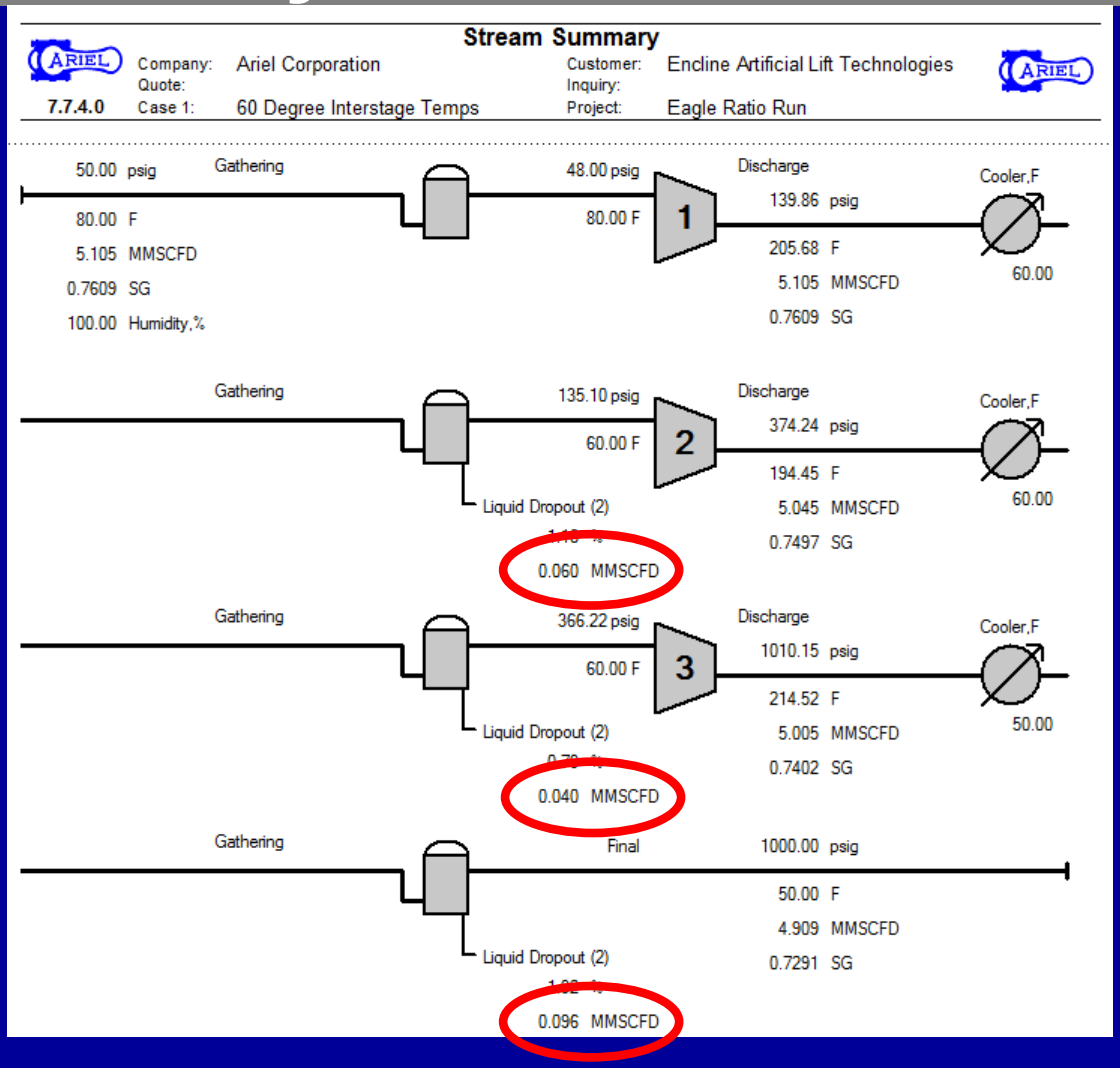
Phase Diagram for 30 F Ambient Liquids Rich Gas (0.76 Gravity)



- **Temps fall below 120 F, allowing SIGNIFICANT hydrocarbon condensation since gas is richer**

Liquid Dropout for 30 F Ambient 0.76 SG – 3.06% Hydrocarbons Condense

5105 MSCFPD



Summary Table – Condensation as percentage of inlet gas volume

Gas Type	Gas Gravity	Water Cond at 100 F Ambient	HC Cond at 100 F Ambient	Water Cond at 30 F Ambient	HC Cond at 30 F Ambient
Gas Well - Lean	0.65	0.46%	0	0.62%	0
Eagle Ford - Rich	0.76	0.59%	0	0.74%	3.06%
Permian – Rich	0.80	1.08%	0	1.27%	7.63%
Permian – Rich+	0.97	1.08%	12.38%	1.23%	23.72%

- **Permian shows winter challenge of maintaining rich gas in vapor state**

Impact of Liquid Dropout to Operations

- **Frequent Interstage Scrubber Dumps**
  - **Lines cool as light ends re-vaporize**
  - **Freezes from inside-out, plugging line**
  - **Heat tracing and insulation helps prevent high level shutdowns**

Condensed liquids to tank?

- Can overwhelm TVRU capability
  - 5% of 5000 MCFPD is 250 MCFPD (45 HP)
  - Results in excessive flaring, less gas sales
- Plumb interstage scrubbers to low pressure separator upsteam of sales meter, relieving TVRU, reducing recycle
- Inlet and fuel scrubbers still dump to tanks
- <u>Are your compressors pre-plumbed for this?</u>

Impact of Liquid Dropout to Operations

- **Compressor output reduced**
  - **Well performance suffers**
  - **Mitigate by oversizing compressor**

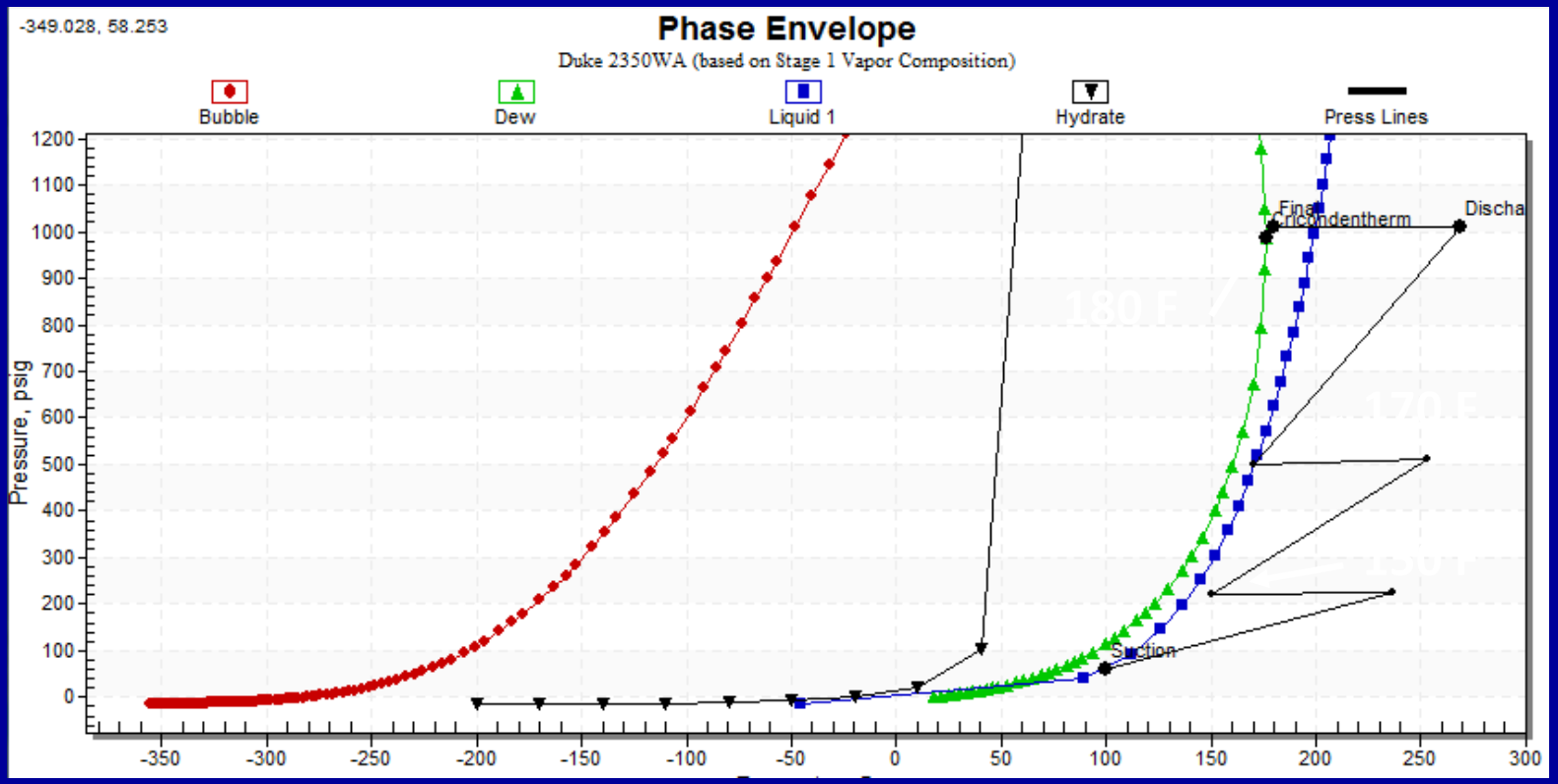
- **Safety Issues**
  - **Blowing down compressor sweeps liquids from horizontal piping onto location**
    - **Install slow rate auto blowdown into gas sales**
  - **Hydrates plug final cooler and discharge pipe**
    - **Inject Methanol**

Presence of Liquid at Wellsites

- Reduces gas measurement accuracy
- Gas lift valves may handle slug of liquid
  - If centralized compression, slugging an issue
  - Significant slug may cut orifice, or multipoint
- Last well on common line may receive 100% of condensation

Obvious Solution: Prevent by Elevating Gas Temperatures

- **Even super-rich 0.97 gravity gas can remain vapor with 150 to 180 F temps**



What if temps could be kept in 100% Vapor range to the wellhead?

- Increased compressor uptime
- Minimize hydrate formation
- No increase in VRU load or flare emissions
- No need for methanol injection
- Warm corrosion chemicals work better
- No mess when blowing down compressor
- No need to oversize compressor
- Well performance improved
- Paraffin deposition prevented

Reality: Facility Engineers prefer old ways of centralized compression

- **Pipelines may cool gas to earth temp ~ 70F**

Gas Type	Gas Gravity	Condensation %	BBL per MM
Eagle Ford	0.76	3.85%	23.1
Permian - Rich	0.80	8.46%	52.4
Permian - Rich+	0.97	34.5%	216.6

- **Some of this will re-vaporize as reaches downhole temps, but how much?**

Wellsite compression mitigates this problem

Barriers to Maintaining High Temps

- Compressors designed for gas sales struggle to achieve high cooler outlet temps
- Cooler outlet temps not normally monitored, nor controlled
  - Pneumatic Kimray T-12 marginal control answer
  - Several better methods available
- Compressor industry thinks it's not their problem, but operator gas quality issue

Breaking down these Barriers

- **Educate yourself**
- **Look at the entire picture and not compartmentalize**
  - **Compressors impact entire facility operation**
- **Operators and compression companies need to address these problems jointly, perhaps in consortium environment**
- **Collaborative environment will result in multiple options, and good results**
  - **Improved safety, reliability, revenue, emissions**

Suggested Changes

- **Refine compressor packages designs to prevent hydrocarbon condensation**
  - **Reduce cooler sizes / alternative coolers**
  - **Install automatic cooler bypasses**
  - **Install automatic louver control systems**
- **Install near wells to prevent temp loss**
  - **Design injection piping to maintain elevated temperatures to wellhead**

Conclusions

- **Predictable hydrocarbon condensation occurs when compressing liquids rich gas, causing gas lift operating problems**
- **These problems can be solved by proper engineering design**
- **Old habits of facility engineers and most compressor rental companies adversely impact well performance, wellbore integrity, and economics, while increasing product losses, flare emissions, and safety risks**

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