CASE HISTORY
Spearhead Breakdown Acid - Enviro-Syn® HCR-7000FRAC Wireline®
July 2018

HISTORY
An E&P company operating in Western Canada was performing horizontal multi-stage slickwater completions on multi well pads. Using plug and perf completion technique they were targeting the Montney formation. Reservoir temperatures were approximately 90°C. Historically 15% HCl acid was used to breakdown the formation and assist in fracture propagation.

PROPOSAL
Often, 15% HCl acid is the most hazardous chemical on site in fracturing operations. “Hydrochloric Acid (and its fumes) will damage respiratory organs (irreversible), eyes, skin, and intestines and can cause death in some cases”. HCR-7000FRAC-WL® Modified Acid™ was selected as a safer, more environmentally friendly and technically advanced acid system to replace hydrochloric acid. HCl is often the cause of major corrosion integrity issues with regards to the casing and surface equipment.

OPERATIONS
HCR-7000FRAC® Wireline was delivered to location in concentrate to reduce trucking requirements. The acid tank was tied in so that HCR-7000FRAC-WL could be mixed on the fly with a 2:1 water-acid ratio to yield a 33% HCR-7000FRAC® Wireline. The BHA (plug and guns) were run in hole on wireline.

- 52 MPa with a line speed of 40m/min, gradually increasing our speed to 70m/min due to pressures.
- 2900m with 29.6m³ away, brought on acid at 500 lpm, stopping the winch while they pumped the 5 cubes (39MPa)
- Rate was brought up to 2m³ with water. 48MPa at 76m/min, 37m³ total volume away (32m³ left to displace acid above perfs).
- Pumps out. 56.8m³ away, acid approx. 10m³ above perfs.
- Pumped an extra 5m³ at 1m³/min to displace acid closer to the perforations while sitting static.
- Pumps out, pulled into position with Illusion plug with ball in place.
- Brought on pumps at 500 lpm while setting plug. Once plug was set, pressured up to 10MPa over wellbore.
- Perforated 8 intervals. Pulled out of the hole.

RESULTS
With the ability to pump acid with the plug and guns a significant amount of time and fluid was saved on this stage. Eliminating the need to pump acid down to the perforations after wireline is out of the hole the operator was able to save ~20 minutes and a hole volume of fluid ~40m³ on every stage. This equated to hours in efficiency gains as the frac crew was fully utilized in fracture operations instead of displacing fluid to spot acid.

Pressure drops were observed as the HCR acid reached the perfs and it was noted that breakdowns looked very similar to 15% HCl that had previously pumped. HCR also allows the acid to be spotted across the entire perf interval before guns are discharged allowing for better cluster breakdowns.

E&P company representative comments:
- Seen good reactions from all formations on 3 different pads.
- Saved an extra cycle for PBR which reduces chances of seals failing
- Trucking less hazardous product in concentrate form saved money and trucks on the road.
- Saved volumes of water.
- Reduces wear and tear on pumpdown equipment.
VALUE

By pumping HCR-7000FRAC® Wireline Modified Acid™ on location both the E&P and Pressure Pumping Company were able to use an acid that has an inherent safety profile that helps to minimize or eliminate the extremely dangerous properties associated with 15% HCl.

- Less-Corrosive to dermal tissue (HCR-7000 considered Non-Corrosive to dermal tissue)
- Low-Vapor Pressure effect (fuming)
- Low-Toxicity (Calculated LD-50 Rat)
- Lower Bioaccumulative Effect
- Biodegradable

Along with the safety aspect of the acid there is also the technical advantages it brings to the operations

- Low corrosion properties ~ < 0.02lb/ft² for +24hrs
  - Pump acid with wireline BHA (save time and water)
  - If surface equipment failures occur no need to flush acid out of wellbore
- Hauled as a concentrate and diluted on location
  - Ability to adjust acid strength for tougher breakdowns
  - Less acid trucks on the road (landowner optics)
  - Can dilute with available water (produced, seawater or fresh water)

BENEFITS

- Ultra-low long term corrosion effects (168hrs)
- Clear: Low fuming / vapor pressure
- Aggressive reaction rates on stimulations and workovers
- Custom blend allowing spotting of acid with perforating guns via wireline (patent pending process)
- Compatible with typical elastomers used in oil and gas
- Adjust concentrations on the fly to target optimal pay zones
- High thermal stability to ~190°C

CORROSION DATA

<table>
<thead>
<tr>
<th>Blend</th>
<th>Temp</th>
<th>Coupon</th>
<th>Time</th>
<th>Corrosion lb/ft²</th>
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<tbody>
<tr>
<td>50% HCR-7000FRAC</td>
<td>195°F</td>
<td>P-110</td>
<td>72 Hours</td>
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<td>316 SS</td>
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</tbody>
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* Indicates Specific SS Cl package to spot w/guns (patent pending process)