

Guidelines for the Application of ECA Anolyte (Hydrolyte®) for treating and Mitigating General Heterotrophic (GHB), Acid Producing Bacteria (APB) and H₂S as well as H₂S Causing, Sulfate Reducing Bacteria (SRB)

David L. Holcomb,PH.D Pentagon Technical Services, Inc.

- I. **Application:** To treat vertical wells in the 1000 to 12,000 depth range ft having GHB, APB or SRB counts of 500 cfuto 2.5 million cfu per 100 ml. use 100 gallons of 600-800 ppm anolyte (Hydrolyte™) per net foot of pay zone thickness. Product can either be introduced down the tubing casing annulus (backside) and circulated if possible to surface or pumped down the tubing to cover the producing interval thickness. Shut-in the well for one to two hours and return to production. Perform follow-up tests (ATP) for bacteria and/or H₂S to confirm reduction in CFU and /or ppm H₂S concentration.
Expectations: Protection may range from one week to four weeks depending on production rates. The H₂S may decline significantly (60-90%) over a 7 day period, but the well may need up to four treatments (one per week) for four weeks to see a reduction of H₂S to near zero ppm. These results should be possible for wells making less than 50 BOPD ;<1000 BWPD ; up to 100 MCFPD. Of course results will vary with respect to bacteria mitigation and/or H₂S mitigation according to varying well parameters, temperature or re-contamination. Graphic results from actual treatments performed in West Texas and S.E. New Mexico wells in the Clearfork, San Andres, Pennsylvanian Cisco and Canyon formations. Illustrate the expected results from using treatments designed using the above guidelines. As can be seen, results vary well to well depending on the severity and extent of the bacteria/ H₂S issue and the production rate. Note that is sereral case hydrocarbon production rates increases! Generally, as noted mitigation is generally maximized between two and four weeks' time with cfu's lowered to below 100,000 and H₂S to near zero.
- II. **Application:** To adequately treat horizontal lateral pay zone lengths for bacteria, and more specifically SRB related H₂S issues up to 50,000

ppm H₂S or SRB concentrations up to 2 million cfu, utilize anolyte (Hydrolyte™ treatment volumes of 1-5 gallons per foot of perforated lateral calculated to be placed along the entire lateral length. One gallon per foot will treat H₂S contacted within the near wellbore region (1-3 feet radius). Volumes up to 5 gallons per foot may be used for deeper penetration into the reservoir adjacent to the immediate wellbore > 3ft and < 10 ft. In addition the treatment may be flushed with clean 2% KCL water or more desirably with the TVD volume of anolyte (Hydrolyte®). An optimum method is to over-displace the vertical plus lateral tubular volume by at least 10% using all Hydrolyte® anolyte.

Expectations: Optimum mitigation of H₂S to lower levels (between 60 and 99 % reduction may be achieved over a period of days to one week, but will vary according to production rates of oil, water and gas. Retreatment on a periodic basis (usually weekly) may be required as long as recurring high or dangerous levels of H₂S are produced.

- III. Application: Higher H₂S concentrations (> 50K) and corresponding SRB counts will require larger treatments and perhaps a surface bubble tower set-up for continuous operation in addition to the aforementioned downhole treatment. Also, the use of ECA Catholyte, the alkaline component of ECA can be used in sequence with the Anolyte as a separate treatment done either before or after the anolyte treatment . Super Catholyte (1500-2500 ppm NaOH or KOH) can also be used in situations where non-bacterial H₂S is generated for concentrations greater than 100 K ppm H₂S. Higher volumes can be calculated based on H₂S concentration and known Oil Gas and Water production rates. For concentrations this high the use of a downhole injection using the above parameters and longer lateral lengths (greater than 5000 ft) . In the case of an H₂S concentrations of 100K in produced fluids, a 10,000 ft lateral length may be treated with 2 gallons of Super Catholyte per foot of lateral length and flushed with Super Catholyte to the lateral tip. For a 10,000 ft lateral with 5 ½ inch casing the treatment may consist of 20,000 gallons catholyte pumped and allowed to soak one hour and then return the well to production.

Expectations: The Super Catholyte will effectively neutralize an equivalent amount of H₂S to soluble/ dispersible fines (sodium sulfide) which can be removed at the surface with oil water separator equipment.

- IV. **Application:** Perform a continuous treatment where the well production stream can be treated in a conventional bubble tower configuration containing anolyte (Hydrolyte). So that large daily amounts of excess H₂S < 10,000 ppm (after the downhole application) may be continuously treated. A separate design to treat the daily volumes produced for the concentration of H₂S depending on the changes in concentrations and production rates over time. In addition to the Hydrolyte[®] anolyte, the other ECA product, Super Catholyte[™] may be used in a bubble tower sequence as the first line of defense to first partially neutralize the sour production stream components, and then followed by flowing into a second tower containing Hydrolyte[®] anolyte. Volumes of Hydrolyte[®] and/or Super Catholyte[™] can be used in the bubble tower in volumes equivalent to one tenth to one half the daily production of total fluids (GOW)

Expectations: Reductions of between 60 and 99 % H₂S may occur within the first week with higher reduction (> 90%) possible after four weeks of continuous treatment. It should be determined what levels will be acceptable at the sales line ofr oil and gas.

***Cost Estimates:** The price for these applications will need to take into consideration the expected or known performance over time for the volumes used. This will vary from application to application due to variable production rates, oil gas and water ratios, and variable concentrations of H₂S.