Diverter Materials and Expected Degradation Products to be used at the Newberry EGS Demonstration

Allen Apblett, Ph.D. apblett@okstate.edu

Associate Professor of Chemistry, Oklahoma State University

The Newberry Volcano EGS Demonstration Project Environmental Assessment (EA) describes the use of diverters that will be used in the project. This document provides further information on the chemistry and benign nature of the diverters.

Diverters

Diverters are used at the end of a stimulation treatment to increase the volume of rock that is available for heat extraction. The purpose ultimately is to increase the amount of renewable electrical power that can be generated from a given well. This is a key part of the entire Newberry operation, as this could have a very significant impact on making EGS (Enhanced Geothermal Systems) power production much more cost competitive with existing forms of conventional power generation. These materials are designed to dissolve over time in the wellbore, with little or none being carried into the formation rocks.

Diverters are solid, particulate materials. They are added to water and pumped into the well in between stages of stimulation. The amount of material that will be used is expected to be between 300 and 600 lbs total during the entire operation carried by 24 million gallons of ground water for an average of about 3 ppm of added material. The chemical compositions of all these materials have been supplied to the BLM along with potential safety hazards in the form of a MSDS (Material Safety Data Sheet). The various MSDS forms provide information on how to handle and dispose of the materials if they are accidentally spilled on the ground. In addition, a table of degradation products from the diverters has been provided to the BLM, so that they can evaluate the potential hazard from the materials after they degrade in the well.

The diverters were designed with both functionality and the prevention of environmental hazards in mind. Diverter materials include substances used in the biomedical field, food storage, and even clothing. It is believed that the relatively small amount of material planned for use, the benign nature of them, the fact that they will dissolve into the well water as non-toxic compounds make them part of an environmentally friendly system. The AltaRock diverters are from two classes of materials: biodegradable plastics and naturally occurring minerals.

Degradable Plastic Diverters

Biodegradable plastics are plastics that will decompose in natural aerobic (composting) and anaerobic (landfill) environments. They may be composed of either bioplastics, which are plastics with components derived from renewable raw materials, or petroleum-based plastics, which utilize an additive that makes them biodegradable. The plastic diverters used by AltaRock fall mainly into the first category – they are polymers derived from natural products from plants. These polymers will hydrolyze in the hot well water, releasing the same natural, non-toxic plant-derived products that are the building blocks of the polymer. Notably, bacteria and other organisms easily metabolize the released small components if they reach the biosphere. For example, one of the diverter materials made from renewable biologic raw materials that AltaRock has used is BioVertTM, a polymer of lactic acid known as polylactic acid or PLA. This material is a hard plastic that is

available as grains that can be sorted by size. When heated, the chains in the polymer break down to lactic acid, a soluble substance found in human and animal tissue as a normal product of metabolism and exercise. Polylactic acid is used as absorbable sutures for surgery and wound stitching and is clearly non-toxic. Three of the other biodegradable plastics that could be used are also made from biologic materials (AltaVert 100, 101, 151). Three other potential plastic diverter materials are derived from petroleum, but break down into small components that are bioactive and can be metabolized in the environment (AltaVert 150, 154, 251). These were chosen because they are benign materials used extensively in clothing and food packaging, they have a very long history of safety (both human and environmental) and the polymer break down in hot water to non-toxic building-blocks that are readily further biodegraded.

Biodegradable plastics will be selected based on the temperature at which they melt and then the temperature at which they dissociate. The choice will be predicated on the temperature of the well at which the diverters will be used.

Mineral Diverters

Well NWG 55-29 is very hot (> 600 º F). The diverter material selected needs to stay in place long enough to stimulate the remaining zones. The first zone stimulated may not be cooled enough to make it possible to use a biodegradable plastic as a diverter. If this were the case, a mineral diverter will be selected for that zone.

The mineral diverters that may be used are all naturally occurring minerals containing common rock forming elements: Aluminum, Calcium, Magnesium, Chlorine, Silica, Carbon, Oxygen and Hydrogen. These minerals will be ground to a specific particle size and mixed with clean groundwater to pump into the well. A variety of diverters have been selected for varying solubility over a wide range of temperature. One possible mineral that has been tested is calcium carbonate (calcite). Because any natural mineral material can have contaminants that are toxic, AltaRock uses materials that have been quality controlled and tested to have very low contaminants. For example, the calcite selected for use as a diverter is very pure, with greater than 99% calcium carbonate and less than 0.3% quartz. This is the same material that is found in calcium supplements and many antacids. Similarly, the other mineral diverters that might be used also have common uses in consumer products in which they have displayed no toxicity or health problems.

Toxicity

I have reviewed the MSDS sheets of the diverters which were provided to the BLM as well as the breakdown products. At the concentrations expected in the water injected and flowed-back from the demonstration well, the diverter materials will definitely not pose a toxicity risk to the environment, wildlife or people. Not only will the injected materials be non-toxic, but their breakdown products will also be innocuous and the dilution in large amounts of water will ensure the absence of an impact that might be caused by supplying nutrients to bacteria and algae.

Yours sincerely,

Dr. Allen W. Apblett, 3/9/2012