Practical Injection Procedure: BOS 100®

Product Handling

BOS 100® is stored and delivered in 90kg vacuum sealed drums. The product is a blend of activated carbon grains and Zero Valent Iron (ZVI). As the drums are opened in the field, these are flooded with fresh water to avoid oxygen to come in contact with the carbon grains hence having the oxydation process to start. The drums come under vacuum in a nitrogen filled environment.
The saturated BOS 100® is transferred to the mixing unit using a injector pump. Such operation should only be conducted by fully trained personnel.

Batch mixing and preparation

The density and volume of BOS 100® required for each injection point is determined by the Project Remedial Design Description (PRDD), and according to this plan, the calculated ratio of water, and BOS 100® is transferred to the injection system mixing tank. The injection system has a maximum BOS 100® density capacity of 120 g/l. If the PRDD density for an injection point exceeds this limit, a second injection event must be considered.
In cases with larger zones of free phase contaminant, additional electron donor and bacteria culture are added to the slurry mixture and iron dechlorination processes switch to enhanced reductive dechlorination processes via biological degradation.

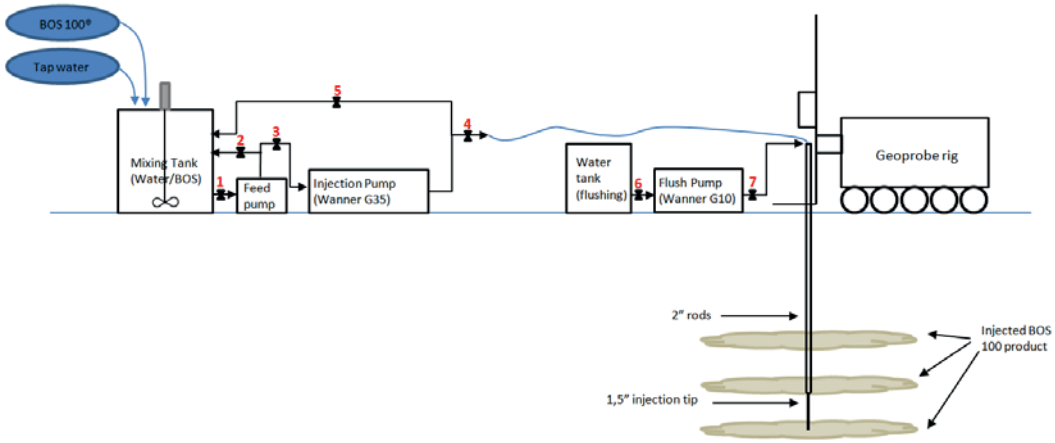

Figure 1 Schematic diagram of the injection system, drill rig, and subsurface.

Injection system

The blended BOS 100® product is pumped in a closed system from the mixing tank to the injection tip. This minimizes the potential for leakages and uncontrolled distribution in the subsurface.
The injection system consists of a mixing unit and a pumping unit. In the mixing unit, the calculated ratio of water and BOS 100® is prepared in a slurry. The pumping unit is divided into a feed pump and a high-pressure injection pump. The feed pump supports the injection pump and recirculates surplus product back into the mixing tank. This recirculation assists the mechanical stirring in the mixing tank and helps keep the BOS 100® product in suspension. This recirculation is controlled by valves 2 and 3 in Figure 1.
The injection pump (Wanner G35 High Pressure Pump) runs continuously to maintain a high pressure and instantaneously overcome any back pressure in the subsurface. The injection process is manually operated by opening and closing valves 4 and 5 (Figure 1). The volume of BOS 100® product injected into the subsurface is controlled by monitoring the water level drop in the mixing tank. The pump outlet pressure and the subsurface back pressure can be monitored at the control panel.

When an injection point has been completed, the vertical section of the injection rods from the ground surface to the injection top is flushed with water to prevent the BOS 100® grains clogging the injection tip.
All data is recorded manually in the field notes, along with injection depth volumes, product density, injection point number, and injection depths.

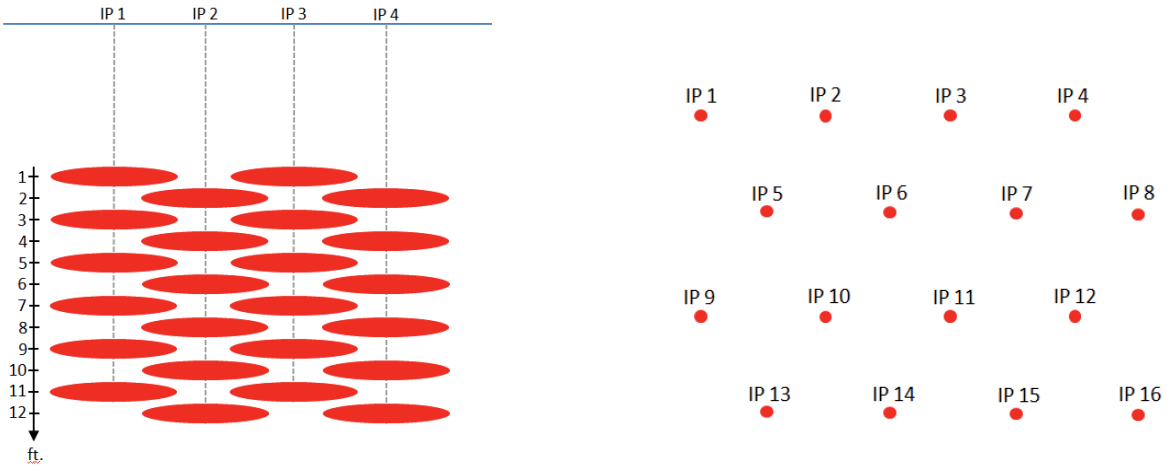

Figure 2 Vertical distribution and offset of injection levels (left) and horizontal triangular pattern of injection points (right).

Subsurface injections
Full distribution of BOS 100® in the subsurface is ensured by designing the injection points in a horizontal triangular pattern, and with vertical offset injection depths. The hydraulic properties of the subsurface formation, and the required BOS 100® density and volume determines the distance between the injections points in the horizontal triangular pattern, but is typically between 1.5-5.0 meters (Figure 2). The triangular pattern optimizes the horizontal product distribution compared to a traditional square injection grid. To further optimize the product distribution in the subsurface, the injection depths are offset 0.3 meters relative to neighboring injection points, as illustrated in Figure 2.
All injection points are sealed with bentonite following injection completion. A 1.5 m 2” rod is used to ensure that no “bridging” of the bentonite pellets occurs during the sealing process.