

Gas inFusion™ Introduction

Gas inFusion™ has been developed by inVentures Technologies incorporated (iTi) for dissolving gases into **liquids without bubbles**.



Figure - 1

The microporous hollow fibre, illustrated in Figure 1, provides the interfacial area needed to accomplish efficient mass transfer. The fibre has an enormous surface area to volume ratio - in excess of 7000 m² per m³ - and is hydrophobic (water will not pass through the pores of the fibre). The added gas, on the other hand, fills the pores of the fibre. The gas pressure is maintained at less than the liquid pressure, in order to ensure that mass transfer takes place without a bulk passage of gas into the liquid. Bulk transfer of gas creates bubbles. **Gas inFusion™ is mass transfer without**

bubbles.

Henry's Law governs the 'driving force' for this mass transfer. Increasing the pressure of the system raises the solubility of the gas allowing greater levels of dissolved oxygen to be achieved. Conventional methods of oxygenation are limited to low atmospheric dissolved oxygen levels - typically ranging from about 15 ppm (mg/l) at 0°C to about 7 ppm at 35°C under 1 atmosphere of pressure. iSOC™ using Gas inFusion™ technology can achieve ultrasaturation dissolved oxygen concentrations of 40+ ppm in water in a relatively stable condition. iSOC™ provides a supply of oxygen that remains in a dissolved state, rather than allowing the oxygen to escape from the water surface. The decay of even very high dissolved oxygen concentrations has been determined to be several days.

iSOC™ Introduction

iSOC™, or in situ **S**ubmerged **O**xxygen **C**urtain, is based on iTi's proprietary Gas inFusion™ technology.

Although it is primarily used to enhance natural bioremediation of hydrocarbons in groundwater using oxygen, iSOC™ can also be used to infuse any gas into groundwater, including gases used to enhance natural degradation of chlorinated solvents.



Figure - 2

The iSOC™ unit, illustrated in Figure 2, is made of stainless steel and is 1.62 inches in diameter and 15 inches in length. The sizing allows the iSOC™ to be placed inside any two-inch diameter groundwater monitoring well.

The top of the unit is equipped with a 'push-loc' fitting to accommodate ¼-inch diameter Polyflow tubing. This is used to connect the unit to a source of pressurized oxygen, usually a compressed oxygen cylinder. Although the tubing

and fitting will support a considerable tensile strength, a 'lifting eye' is also installed on the top of the unit for attaching to a lifting/security wire.

The bottom section of the iSOC™ unit drains and collects any water which may occur in the infusion section due to improper operating conditions. The drain fitting on the bottom allows this water to be removed and the unit to be purged.

iSOC™ Performance

An oxygen-saturated zone is quickly established around the device at the bottom of the groundwater well, due to the enormous surface area present in the iSOC™ unit. The pressure of the water column and atmosphere on the iSOC™ governs the dissolved oxygen content that can be achieved by the unit.

This saturated dissolved oxygen concentration is consistent throughout the groundwater column, and diffuses out of the well. Higher in the well, the head pressure is less. This results in water that is now supersaturated. Conventionally produced supersaturation is unstable. However, with Gas inFusion™, the release of oxygen from this supersaturated

state is at such an extremely slow rate, that a relatively stable supersaturated state is created. This is especially true in the absence of other bubbles, which tend to strip out dissolved gases from a liquid.

The supersaturation 'half-life' has been demonstrated to be up to 7 days in a ten-foot by two-inch diameter column. The extended half-life results in a supply of oxygen that is easily transferred to the groundwater entering the well zone. This increased dissolved oxygen content groundwater will enhance the biological activity of the existing aerobic biomass.

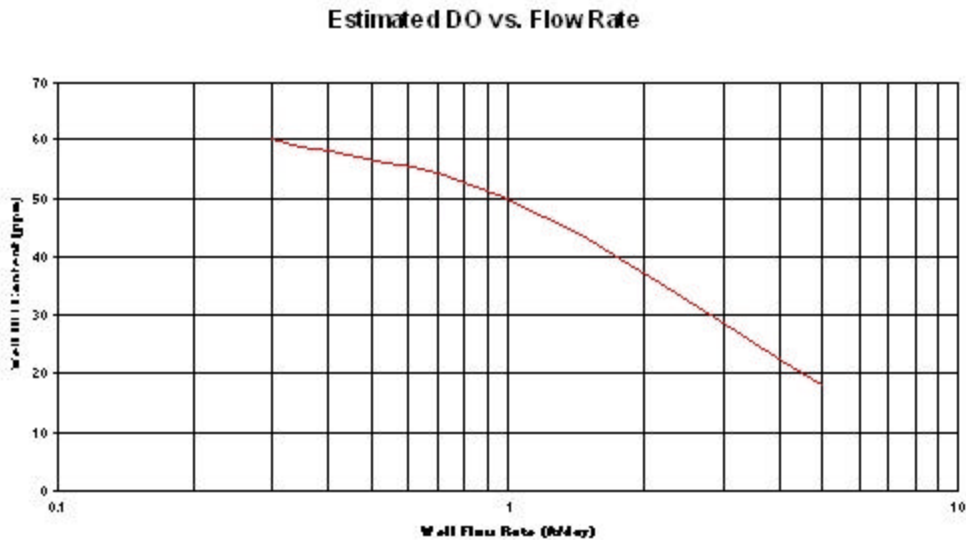


Figure - 3

The graph illustrated in Figure 3 indicates the expected dissolved oxygen concentration of each iSOC™ equipped groundwater well as a function of groundwater flow rate. This example assumes a water depth to be ten feet above the iSOC™. Obviously, as the groundwater flow rate increases to very high levels, the achievable dissolved oxygen concentration will be reduced.

iSOC™ Infusion of Other Gasses

The addition of oxygen has proven to be effective in the enhancement of biodegradation of hydrocarbon related compounds including MTBE. Gas inFusion™ technology is also effective in the infusion of any gas into groundwater. The controlled addition of gases such as hydrogen, methane and propane to groundwater has been successfully used to enhance the natural attenuation of chlorinated solvents such as TCE and PCE.

Figure 4 illustrates potential dissolved gas concentrations for five gases based on water column of different depths.

Gas Type	Water Column Depth (feet)				
	5	10	15	20	50
Oxygen	42	55	62	69	111
Methane	22	30	33	37	59
Propane	66	88	99	110	175
Hydrogen	2	2	3	3	5
Ethane	57	75	85	95	150

Figure - 4