

MULTI-PHASE EXTRACTION

A CARBTROL Corporation Process Overview

Vacuum dewatering technology has been used in the construction industry for many years to temporarily dewater foundation excavations and other construction sites. Recently this technology, utilizing high vacuum extraction pumps, has been adapted for remediation of low permeability formations containing volatile organic contaminants.

The new MULTI-PHASE EXTRACTION (MPX) process can be used to extract groundwater, recover free product, or vent contaminated soils. Most importantly, the process can accomplish all of the above with a single extraction pump servicing a network of extraction wells.

The use of vacuum to increase the yield of a conventional remediation well is a relatively straight forward concept. Applying vacuum to a pumping well increases the effective hydraulic gradient and thus the pumping rate and radius of influence beyond that which could be achieved by pumping alone.

As an example, the drawdown in a conventional well operating without vacuum is equal to the difference in the static water level and the pumping water level. The effective drawdown in the same well under vacuum is equal to the difference between the static water level and the pumping water level plus the absolute value of the amount of vacuum applied. It is thus possible to create an equivalent effective gradient by substituting vacuum for drawdown .

Where the transmissivity of a formation is very low, resulting pumping rates and influence zones can be quite small. In these situations, a standard pump and treat approach may not be effective due to the large number of wells required or the time required to complete the remediation. The use of MPX can increase the pumping rate and enlarge the capture zones, resulting in a dramatic effect on both cost and cleanup time.

Additionally, application of sufficient vacuum to a well can completely eliminate the need to lower the static water level. This technique is particularly useful in situations where there is limited saturated thickness, or where it is desirable to eliminate free product smear that would normally occur if the water table were depressed.

The MPX extraction well is constructed similar to a conventional pumped remediation well. However, water and vapor withdrawal are achieved through the use of a small diameter suction tube extending to the liquid control point. The suction tube is sealed at the well cap and connected via a manifold to an extraction pump capable of simultaneously processing both liquid and vapor. The attached drawing shows a schematic of a typical MPX extraction well.

When hydraulic control is one of the objectives of MPX well design, the bottom end of the suction tube is positioned at or slightly below the static water level interface. Effective drawdown is achieved by applying a vacuum to the well casing via the suction tube. This vacuum creates a negative pressure gradient (radius of influence) in both the saturated and unsaturated zones and causes groundwater, free product and soil vapor to be drawn into the well casing. Inside the casing the mixed liquid/vapor stream is evacuated through the suction tube and carried to the surface where the component phases are separated.

On the other hand, where free product and/or soil vapor are the primary objectives of the remediation, extraction of groundwater can be minimized by raising the height of the suction tube. The elevated tube causes more of the vacuum influence to be exerted on the unsaturated and free product zones, minimizing the amount of groundwater which must be removed and treated. MPX systems are also very effective in dewatering soils so that volatilization and bioventing can be used to remove residual contaminants.

Since the practical maximum water lift by vacuum is limited to about 25 feet, suction lift might seem to limit the application of the MPX process. This lift is greatly increased however, when the extracted fluid is a much less dense two phase mixture of liquid and water. Additionally by maintaining a gas velocity in the suction tube of about 2500 - 3000 ft/min, water droplets pulled into the tube end become entrained in the high velocity gas flow and are swept up the tube to the surface. For deeper wells, the use of a vacuum induced air lift can further enhance liquid conveyance to the surface. See attached well detail.

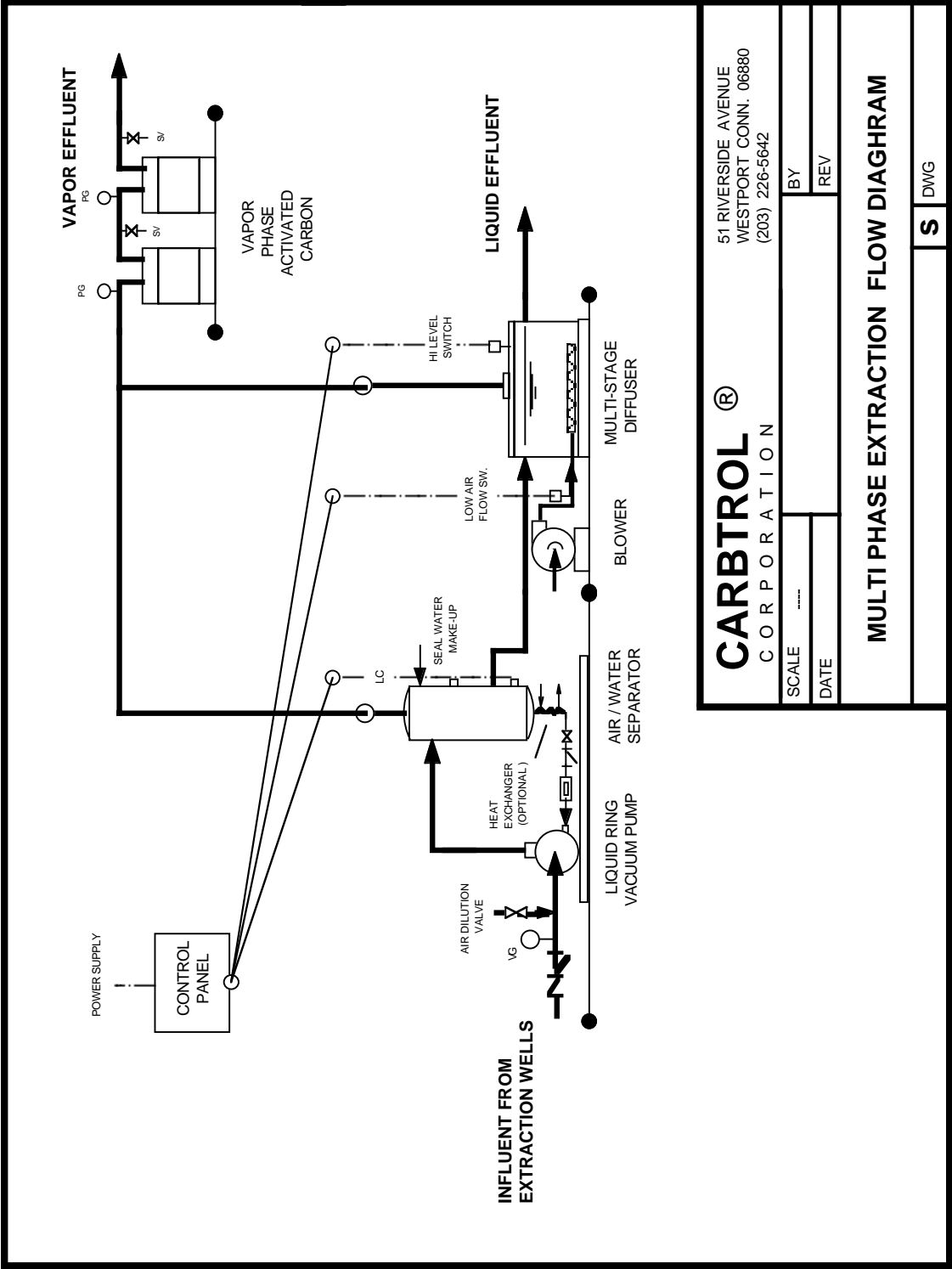
Numerous alternative well and trench extraction designs exist including several which claim proprietary status. Additionally, much private and public research continues on the optimization of various subsurface extraction configurations. The UOP Incorporated handbook "Groundwater and Wells" is a good starting point reference for basic extractive well point technology.

The attached schematic flow diagram shows how the MPX equipment can be incorporated into a typical treatment train. In the least complex configuration, the extracted mixed fluid stream is pulled from the wells through the liquid ring vacuum pump and directed to a high efficiency vapor / liquid separator. Liquid from the separator flows by gravity first through a barometric seal, and then through a conventional liquid treatment system prior to discharge.

This treatment may include oil / water separation, air stripping, activated carbon or other appropriate technology. Vapor from the separator is directed through a mist eliminator and then to treatment which may include oxidation or carbon adsorption. Maintenance of the vacuum seal on the liquid ring pump is achieved by recycling extracted groundwater from a reservoir in the separator.

Where there is potential for emulsification of free product or precipitation of dissolved solids, it may be desirable to add a preseparation tank ahead of the liquid ring pump. This approach prevents contact of the contaminated groundwater with the vacuum pump head. When a preseparation tank is used, a transfer pump must be provided to remove the extracted water from the separator. The transfer pump should be sized to pump against the maximum operating vacuum of the system.

In practice MULTI-PHASE EXTRACTION is most applicable to low transmissivity sites, where high vacuum extraction pumps can be best mated to groundwater and soil vapor flow conditions. Most applications have focused on extractive well depths of less than 50 ft., however successful use at depths greater than 100 feet have been reported. When applied properly, MPX provides a powerful addition to the range of technologies currently available to remediate volatile organic contamination.



CARBTRON[®]
CORPORATION

51 RIVERSIDE AVENUE
WESTPORT CONN. 06880
(203) 226-5642

SCALE	----	BY	
DATE		REV	

MULTI PHASE EXTRACTION FLOW DIAGRAM

S	DWG
----------	-----

TYPICAL MULTI PHASE EXTRACTION WELL
SHOWING VACUUM INDUCED AIR LIFT FEATURE

