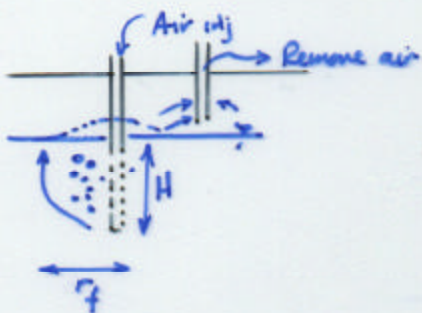


5.1 Air Sparging and Vacuum Extraction

Air sparging in sat zone.

Vacuum extraction in vadose zone.



Inject air

Bubbles in large surface area.

Gas partition across bubble skin.

- perhaps coalesce in channels

Heterogeneities may affect movement

Install spargers below contaminated zone.

Air entry pressure governs entry into soil

$\downarrow p_c \rightarrow$ larger radius of influence, r_f .

\therefore reduce number of wells.

Less than soil fracturing pressure.

Effectiveness of sparger - judged by:

1. Height of groundwater mounding
2. Pressure in vadose zone wells.
3. Rise in vapor concentration in neighboring wells
4. Concentration of dissolved O_2 in neighboring wells (monitoring).

$r_{inf} \sim 5-20$ ft coarse soils

$r_{inf} \sim 20-60$ ft stratified environments

Up to $r_{inf} \sim 300$ ft if geomembrane cover.

Vacuum extraction continuous or pulsed.

Bioremediation may be improved with excess O_2 (Aerobic).

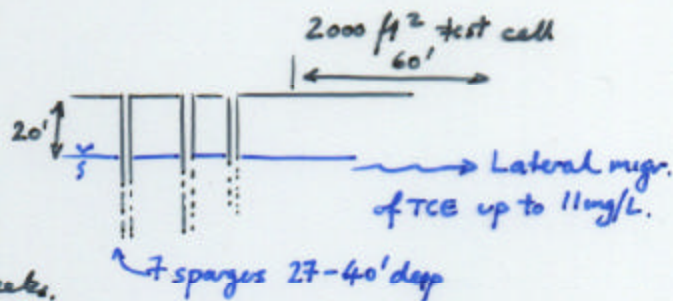
Field Implementation

- EPA - Soil Vapor Extraction Technology - Reference Handbook (1991).
- Injection & vacuum wells 1-1.5" dia. PVC or stainless steel pipe.
- Well points also used - Screen ~ 3ft max (reduce pump capacity and air only enters at screen top).
- Vertical nesting used.
- Dual use injection/recovery wells.

Level of Demonstration

- Numerous sites in North America and Europe
- PCE, TCE, TCA, BTEX compounds. 10-1000 ppb.
- Mainly sands and coarse silts

- CT study. 4 wk pilot study.
- Extraction wells 15°-20° H₂O
- 4 pounds VOCs removed.
- Concentrations returned in 2 weeks.



- Groundwater mounding 60' outside site
- Lateral migration due to stratification
- Off site VOC up to 150 ppm. ∴ pulsed injection

Applicability/ Limitations

- Contaminants with $H > 10^5$ atm.m²/mole viable for removal.
 - i.e. volatile and semi-volatile compounds
- For sufficient airflow $K > 10^{-3}$ cm/s.
- Stratigraphic heterogeneities (gravel layers) strongly control behavior/success.
- Lateral migration possible.

May mobilize free product due to movement up through NAPL.
May stimulate bioremediation (aerobic).

Cost and Availability

Used in US (late 1970s) to supplement bioremediation } well developed
Used in Germany mid 1980s for VOC removal } technology on
hundreds of sites.

Remediation of dissolved plumes (good candidates).

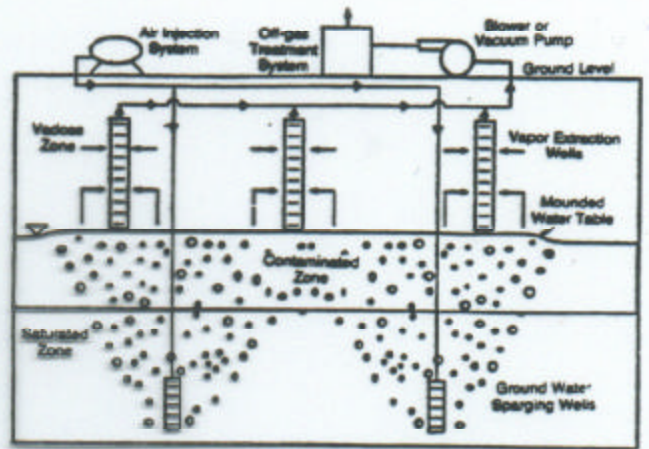
Hot-air injection → enhance stripping.

Potential remobilization of NAPL may be problematic

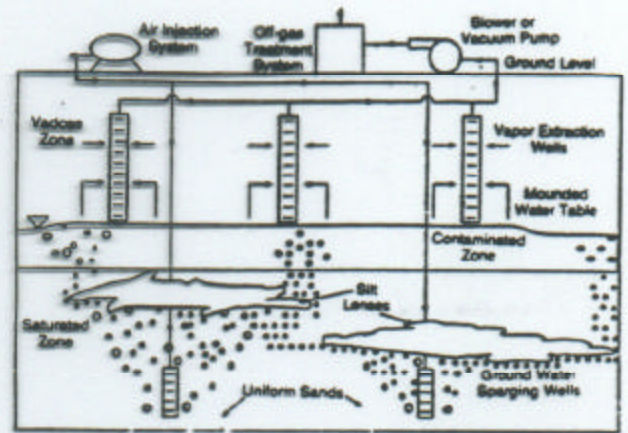
Costs site specific: Poorly reported

Possibly \$ 75-150/yd³

Collected gases passed through activated carbon.



(a)



(b)

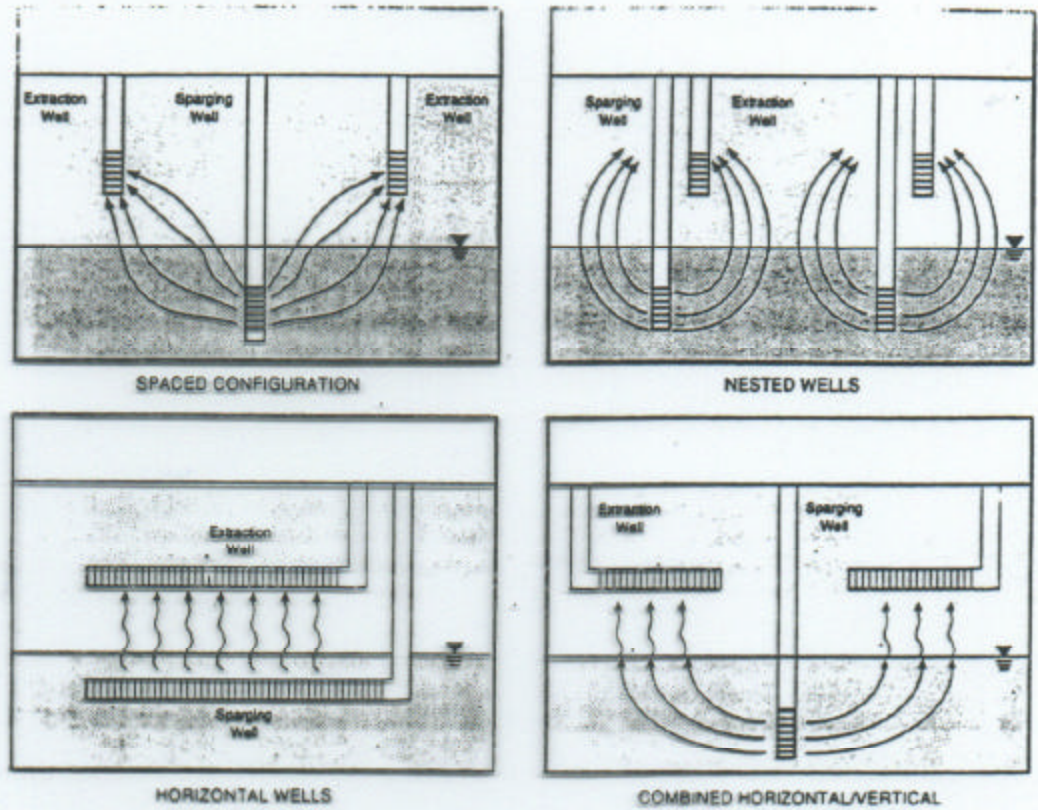


Figure 3.6.1.3 Possible air sparging well configurations [Loden and Fan, 1992].

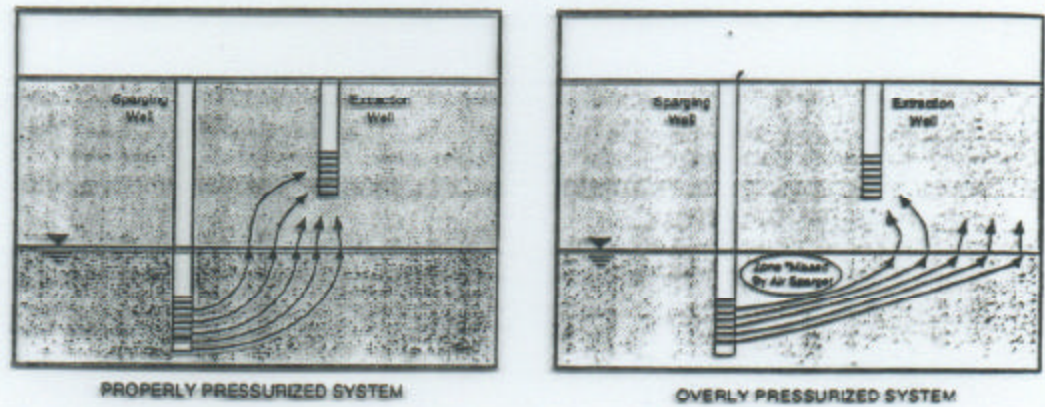


Figure 3.6.1.4 Effect of gas injection pressure on air sparging system [Loden and Fan, 1992].