A Spreadsheet for Estimating the Air Flow from a Slotted Horizontal Well Screen

Sparging air (either for air stripping or enhanced bioremediation) through horizontal wells is an effective technique for remediation of environmental contamination. A properly designed horizontal air sparging well will ensure that air flow reaches the full length of the screened interval and is more or less evenly distributed along that length. However, few geologists or engineers have researched the mechanics of air flow as it applies to horizontal wells.

Geologists and engineers using remediation systems are invited to actively participate with the development of this spreadsheet to improve our understanding of flow through horizontal wells. With the free distribution of this spreadsheet, it is hoped that others will contribute to its further development. The spreadsheet was prepared in Excel and is unprotected so that others may modify it to fit their needs and/or incorporate other factors to gain a more accurate answer. The spreadsheet calculations were developed from the principles of fluid mechanics readily available in any entry level engineering textbook on fluid mechanics. The spreadsheet is a work in progress and will be continually improved.

The most important assumptions in the version 4 spreadsheet are: a) Pressure at any point along the screen can be calculated by subtracting the pipe frictional headloss from the input pressure, and b) Air flow velocity through any screen slot, can be calculated by knowing the pressure differential between inside and outside the screen.

The following is a step by step description of how the spreadsheet calculates the air flow from the screen:

1) Air is a fluid, and therefore headloss for air flow through a pipe can be calculated by using the Darcy-Weisbach equation. The spreadsheet uses the Colebrook equation (an easily solved estimate of the Moody Chart) to determine a friction factor to be used in the Darcy-Weisbach equation to calculate the headloss. Minor losses at each pipe joint are ignored.
2) The pressure inside the pipe is equal to the inlet pressure (top of casing pressure) minus the headloss calculated in step 1. The pressure outside the screen is equal to the pressure head caused by the depth of submergence of the screen plus atmospheric.
3) With a known pressure differential and orifice flow equations, the velocity of air moving through the slots is readily calculated.
4) With the slot velocity and area known, the air flow rate from each slot can be calculated.
5) Conservation of mass must be maintained- the total volumetric flow entering the pipe must equal that leaving the pipe. Therefore a calculation is made to

determine if there is enough flow entering the pipe to match that leaving the screen slots under the above calculated pressures. This is completed at the very end of the spreadsheet and is a straightforward subtraction using the number of slots x the average flow for the flow leaving the pipe, and the inlet flow for the air entering the pipe.

It is important to note that the spreadsheet provides an **estimate** of air flow from the screen, and does not predict the exact air flow. However, it is a starting point, and with improvement, will be able to better predict air flow from a well screen.

In its present state, the spreadsheet provides a jumping off or starting point for the geologist and engineer to begin designing their horizontal well screens. We look forward to email discussions and opinions about the next step on how to improve the spreadsheet.

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