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## Open Area : Its True Impact on Well Efficiency

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# Well Design Process

In the well design process, it has become common practice to view the intake screen section as being the single-most important factor in achieving maximum well efficiency. Although the screen design is a significant contributor, evidence from multiple studies have proven the amount of open area is often over emphasized, and it has been confirmed other factors contribute to the overall productivity and efficiency of the well.

Understanding the impact of open area on well efficiency using different screen options was determined via three evaluations:

**#1** Controlled Laboratory Analysis

**#2** Computer & Numerical Modeling

**#3** Actual Field Testing

## 1. Controlled Laboratory Analysis

Dr. Christopher J. Harich published the thesis Field, and Laboratory Analysis of Water Design Parameters (2009) produced results from extensive testing of Louvered and Wire Wrap screen types. Utilizing the world's largest sand tank aquifer model at the University of Southern California's Geohydrology Laboratory, combined the findings with field data collected from over 100 wells and sieve analysis from over 400 aquifer samples.

The Louvered and Wire Wrap screens were tested using the same coarse grained aquifer material with no additional filter packs. Constant rate and step-pumping tests were performed on each screen and the data collected was used to calculate the efficiency value for each screen with its associated slot size. Data derived from the step tests were used to calculate efficiency.

### Well Screen Efficiency

| PUMPING RATE (GPM) | CWW .040 SLOT | OPEN AREA | LOUVER .040 SLOT | OPEN AREA | CWW .080 SLOT | OPEN AREA | LOUVER .080 SLOT | OPEN AREA |
|---|---|---|---|---|---|---|---|---|
| 100 | 50.1% | 21.9% | 50.3% | 2.8% | 55.1% | 36.0% | 56.2% | 5.7% |
| 150 | 40.1% | | 40.3% | | 45.0% | | 46.1% | |
| 200 | 33.4% | | 33.6% | | 38.0% | | 39.1% | |

**Key Findings:** Despite a wide range of open area options, well efficiencies remain remarkably consistent.

## 2. Computer & Numerical Modeling

Barcelona based consulting firm, AMPHOS 21, developed conceptual and numerical models to simulate groundwater flow into a well through a gravel pack and continuing through different well screen types. This study, Numerical Modeling of Head Losses in Water Well Screens (2019), focused on the small inter-phase zone between slot opening and gravel pack. This methodology allows calculation of well screen head losses using numerical simulation of ground water flow in porous media coupled with turbulent flow through well screens. It was a noteworthy achievement to couple the movement of ground water from laminar to turbulent flow through the well screen and within the screen open space.

| | PUMPING RATE | | SCREEN HEAD LOSS | |
|---|---|---|---|---|
| | GPM/FT | TOTAL GPM W/ 200' OF SCREEN | INCHES/FT | TOTAL INCHES IN 200' OF SCREEN |
| LOUVERED .060" SLOT | 8 | 1585 | 0.037 | 0.62 |
| | 16 | 3170 | 0.095 | 1.58 |
| WIRE WRAP .060" SLOT | 8 | 1585 | 0.001 | 0.02 |
| | 16 | 3170 | 0.002 | 0.04 |

**Key Findings:** The computer modeling by AMPHOS 21 determined initial head losses across any engineered well screen types are negligible. Furthermore, the numerical outputs for the velocity profiles and streamlines when graphically depicted, visually prove the downward facing slot geometry of louvered screens inherently promotes the upward flow of water with minimal turbulent flow developing inside the screen compared with other screen options.

## 3. Actual Field Testing

Both Laboratory Analysis and Computer & Numerical Modeling determined initial head losses across any engineered well screen types are negligible. This point is further exemplified when wells of similar design but different screen types are constructed in close proximity and their performance evaluated following pump testing. Los Angeles Department of Water and Power conducted a comparison study of wells constructed with louver and wire wrap screens.

| SCREEN TYPE | GPM | TOTAL DRAWDOWN (FT) | SPECIFC CAPACITY (GPM/FT) | WELL EFFICIENCY | OPEN AREA |
|---|---|---|---|---|---|
| LOUVERED .080" SLOT | 880 | 19.1 | 46.3 | 94 | 5% |
| | 1800 | 42.5 | 43.6 | 88 | |
| | 2050 | 46.6 | 43.7 | 87 | |
| | 2600 | 63.1 | 41.3 | 84 | |
| WIRE WRAP .080" SLOT | 880 | 17.2 | 50.8 | 91 | 27% |
| | 1800 | 38.7 | 46.6 | 83 | |
| | 2050 | 45.5 | 45.7 | 81 | |
| | 2600 | 60.6 | 43.3 | 77 | |

**Key Finding:** Open Area has almost no impact on well efficiency.

### Conclusion

Controlled Laboratory Analysis, Computer & Numerical Modeling, and Actual Field Testing all confirm open area and entrance velocity have negligible effects on well efficiency and well losses in the near-well zone. Near well losses occurring before water enters the well are the most important contributors to head loss, well efficiency and can be minimized utilizing proper gravel pack and screen slot design criteria.

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