Reservoir Flow Noise @model

While fluid percolates through porous media in infinitesimal volume δV generates the noise of the power δN in a wide frequency range:

(1) $$\delta N = A(f) \cdot \mathbf{u} \cdot \nabla p \cdot \delta V$$

where

$\mathbf{u}$	flow velocity
p	fluid pressure
$A(f)$	normalised noise spectrum, $\int_0^\infty A(f)\,df = 1$
f	noise frequency

While propagating through the rocks the different frequencies will decay at different rate $\alpha(f)$ and if noise sensor is located at $\mathbf{r}_0 = \{0, 0, 0\}$ then the it will capture:

(2) $$\delta N_S = \int_V A(f) \cdot \mathbf{u} \cdot \nabla p \cdot \exp[-\alpha(f) r] \cdot \delta V$$

The decay decrement $\alpha(f)$ is growing with frequency: $\frac{d\alpha}{df} > 0$.

There is no universal model but it can be approximated by a linear dependance:

(3) $$\alpha = \alpha_1 \cdot f$$

with $\alpha_1(f)$ having much slower dependance on frequency than $\alpha(f)$.

See also

Physics / Mechanics / Continuum mechanics / Fluid Mechanics / Fluid Dynamics / Fluid Flow / Percolation / Reservoir Noise

Reference

McKinley R.M., Bower F.M., Rumble R.C. 1973. The Structure and Interpretation of Noise From Flow Behind Cemented Casing, Journal of Petroleum Technology, 3999-PA

McKinley, R.M. 1994. Temperature, Radioactive Tracer, and Noise Logging for Well Integrity: 112-156