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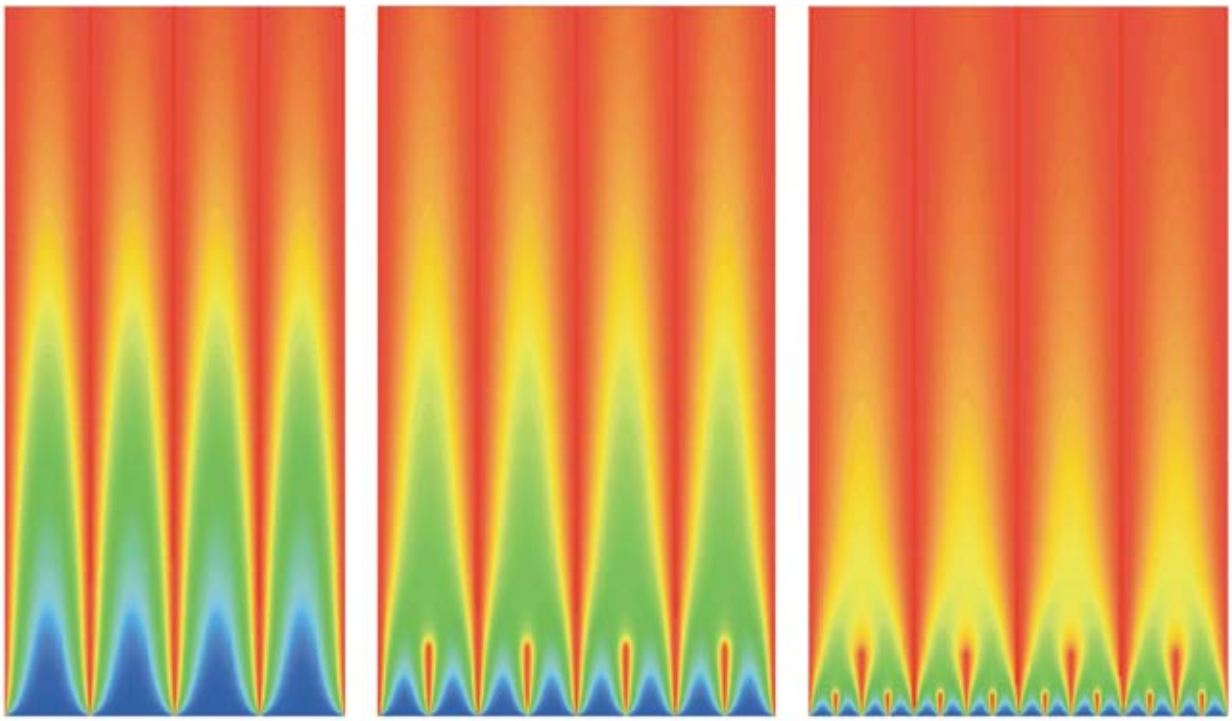

One length scale | Two length scales | Three length scales

Constructal multi-scale package of vertical channels with natural convection and maximal heat transfer density.

CONSTRUCTAL DESIGN: THE GENERATION OF MULTI-SCALE HEAT AND FLUID FLOW STRUCTURES

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This is a new constructal design concept for generating multi-scale structures in natural convection with the objective of maximizing the heat transfer density, or the heat transfer rate per unit of volume[§]. The flow volume is filled with vertical equidistant heated blades of decreasing lengths. The spacings between the blades are optimized for maximal heat transfer density. Smaller blades are installed in the center plane between two adjacent longer blades, in the entrance region where the boundary layers are thin and the fluid is unheated. New generations of smaller blades are added stepwise to the multi-scale structure. Constructal theory is applied to each new generation of blades.

The above figures show the dimensionless numerical temperature distribution inside a flow volume composed of four main channels, for optimized structures with one, two and three length scales, at $Ra = 10^6$ and $Pr = 0.7$. The temperature ranges between two main colors, red ($\tilde{T} = 1$) and blue ($\tilde{T} = 0$). As the number of length scales increases, the color red is distributed more uniformly, illustrating the progress towards maximal heat transfer rate density, i.e. the constructal principle of "optimal distribution of imperfection". The average heat transfer density increases by 12% from the simplest structure (one length scale) to two length scales, and by 6% from two

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§ Alexandre K. da Silva and Adrian Bejan, Constructal multi-scale structure for maximal heat transfer density in natural convection, *International Journal of Heat and Fluid Flow*, v. 26, n. 1, p. 34-44, 2005.

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