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Intensification of heat transfer in chaotic modes

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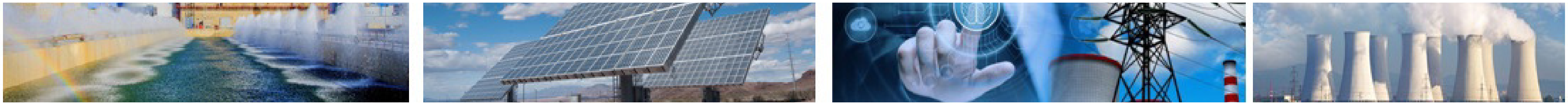
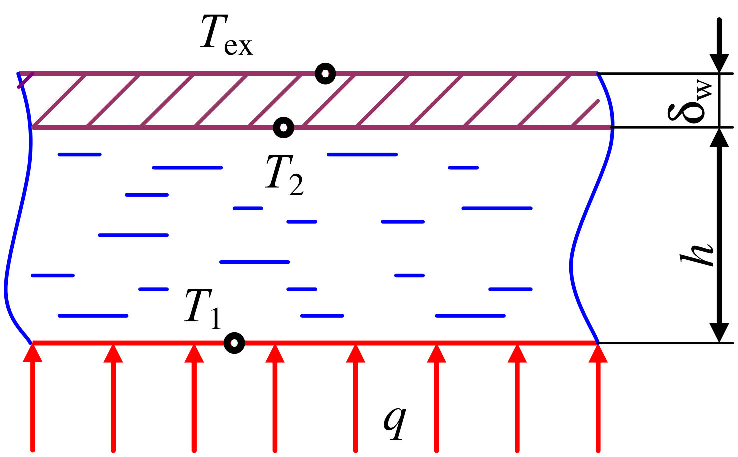


Heat transfer process physical model



The Navier-Stokes equation

$$\frac{\partial \mathbf{v}}{\partial t} + (\mathbf{v}\nabla)\mathbf{v} = -\frac{1}{\rho}\nabla p + \nu\nabla^2\mathbf{v} + \mathbf{g};$$

The fluid flow continuity equation

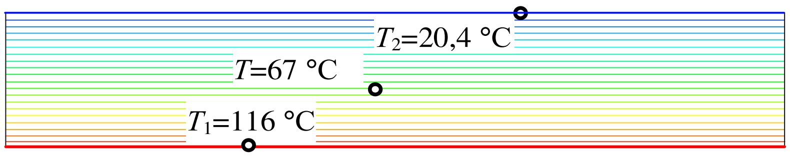
$$\frac{\partial \rho}{\partial t} + \nabla(\rho\mathbf{v}) = 0;$$

The heat transfer equation

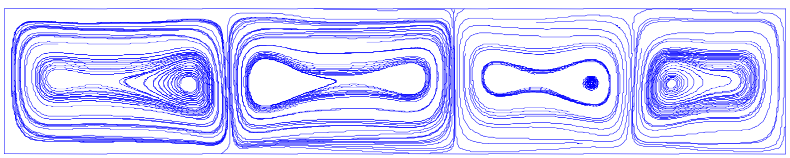
$$\frac{\partial T}{\partial t} + \nabla(T\mathbf{v}) = k\nabla^2 T,$$



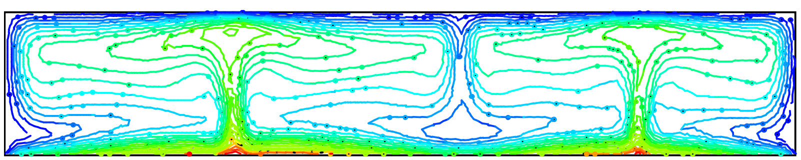

The temperature field and the fluid flow



The temperature field in diffusion mode.



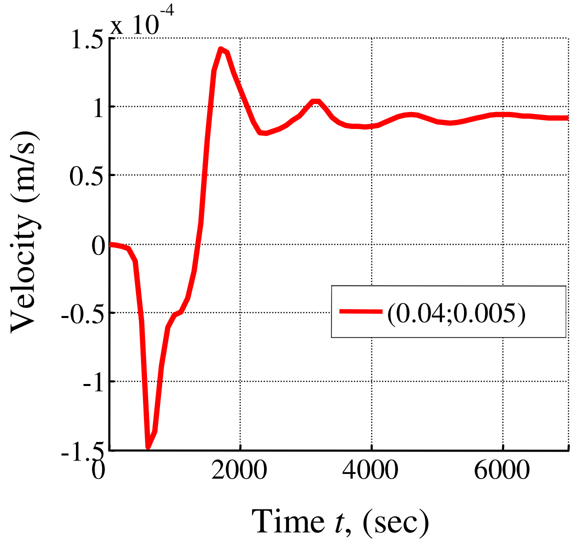
The fluid flow lines in the steady state convective heat transfer.



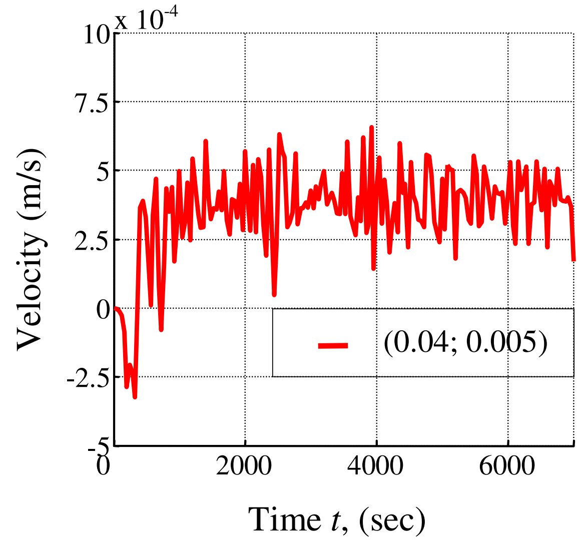
Temperature field in convection mode.




Change in the fluid particles velocity



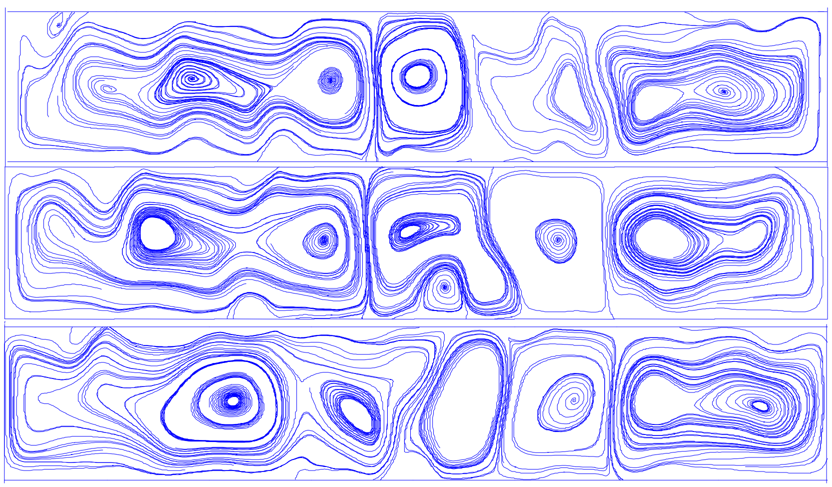
Fluid particles velocity change at the stage of convective heat transfer.



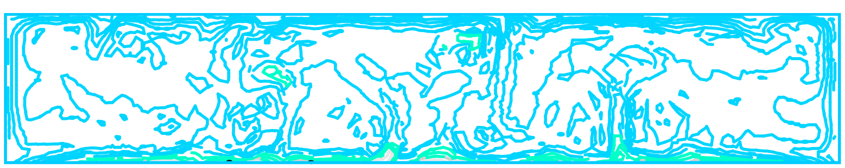
Change in the fluid particles velocity in the turbulent heat transfer mode.




Mode of turbulent heat transfer



Fluid flow lines in unsteady mode of turbulent heat transfer at successive time point with 40 s intervals.



Temperature field distribution in turbulence mode.



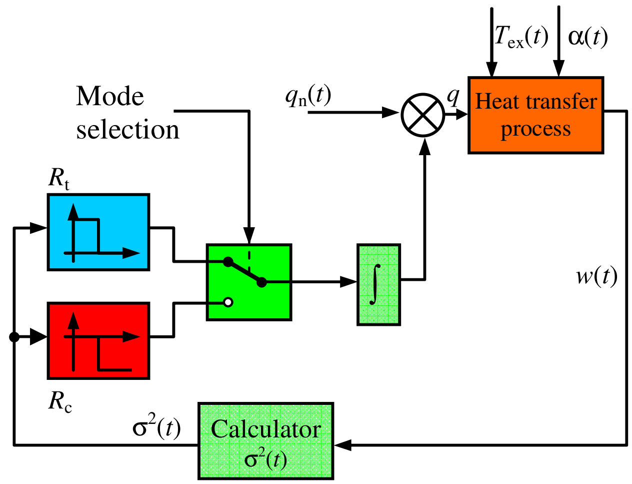

Comparative characteristics of critical heat transfer modes

Heat transfer mode	T_1 (°C)	T_2 (°C)	q (W/m^2)	r (W/(m^2·K))
Diffusion	116	20.4	200	2.06
Convection	35	20.4	200	13.49
Turbulence	150	24	2000	15.73

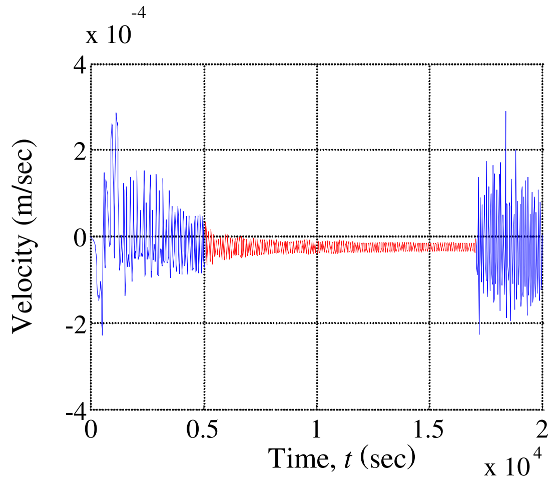
$$r = \frac{T_2 - T_{\text{вн}}}{T_1 - T_2} \cdot \frac{1}{\left(\frac{\delta_{\text{ст}}}{\lambda_{\text{ст}}} + \frac{1}{\alpha}\right)}$$




Heat exchange process control system



Heat exchange control system structural diagram.



System performance check in the turbulent heat transfer stabilization mode.

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