CentraleSupelec **TC5**
Master PPF

Temperature homogenization in a building

A ventilation system can achieve air mixing, and therefore temperature homogenization in a building. In the present project, we propose to study the temperature mixing in a room numerically by transport and diffusion in a canonical flow.

1 Turbulent flow

We consider a square box of size $L = 3m$. The boundary conditions are of the Dirichlet type. To model the ventilation system, we use the Taylor-Gree vortices, whose flow field are described by the following equations:

$$u_g(x,y) = -U_0 \sin\left(4\pi\frac{x}{L}\right)\cos\left(4\pi\frac{y}{L}\right) \tag{1}$$

$$v_g(x,y) = U_0 \cos\left(4\pi\frac{x}{L}\right)\sin\left(4\pi\frac{y}{L}\right) \tag{2}$$

with $U_0 = 0.01m/s$ the velocity magnitude. The flow field is represented in Fig. 1.

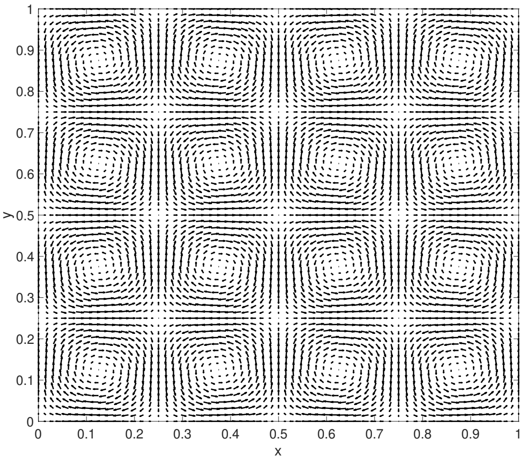

Figure 1: Velocity field of the Taylor-Green vortices.

2 Transport equation for a scalar field

In this flow field, we solve for the scalar field of temperature $T(t,x,y)$:

$$\frac{\partial T}{\partial t} + u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial y} = D\left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2}\right)$$

where $D = 20 \times 10^{-6} m^2/s$ is the thermal diffusivity, u the gas velocity in the direction x et v the gas velocity in the direction y.

3 The problem

We consider the following initial and boundary conditions:

$$\begin{array}{ll} T(t=0,x,y)=293 & si \quad (x,y)\in\Omega \\ T(t\geq 0,x,y)=273 & si \quad (x,y)\in\partial\Omega \end{array}$$

where Ω is the interior of the Domain et $\partial\Omega$ is its boundary. We will consider that the temperature T is homogeneous if its average is below $288\ K$.

4 The project itself

What is the time required to get an homogeneous distribution?