

THE DECAY POWER LAW IN TURBULENCE GENERATED BY GRIDS

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Key words: turbulence generation, turbulence intensity, turbulence scale, grids, Reynolds number

Turbulence in the flow can be characterized by two main parameters: the intensity (level) of turbulence and turbulence scale (micro and macro scale of length, time or velocity). Changes in turbulence intensity and scale of the outer stream can be obtained by inserting to the flow an appropriate grid at the inlet to the measuring chamber of wind tunnel. Grids may have different structures: composed of round or square bars or wires, perforated plates or jet grids. In the literature, there are different correlations connecting level of turbulence, or only its longitudinal component, with the parameters of the grid. For example (Comte – Bellot et al., 1965):

$$1/Tu^2 = U^2 / \overline{u'^2} = A / ((x + x_0) / M)^n \quad (1)$$

where x – the coordinate, positive in the downstream direction with origin at the grid, x_0 – the virtual origin, M – the mesh size, A and n – respectively the decay coefficient and exponent determined experimentally. One can find different values for the decay exponent, determined in many experiments by different authors, e.g. 1, 10/7, 6/5, 1.43 or $1.16 \leq n \leq 1.37$ (Mohamed et al., 1990). The results of our investigations for five wicker grids of different dimensions are shown in figure 1. The mesh sizes were from 1 to 30 mm, and wire diameters from 0.3 to 3 mm. Greater value of the grid in figure 1 means greater grid dimensions M and d . The decay coefficient $A=22$ and exponent $n=1.58$. The virtual origin is very small, from about -0.1 to 0.3 mm and, in our opinion, can be negligible. Correlation coefficient is equal to 0.99.

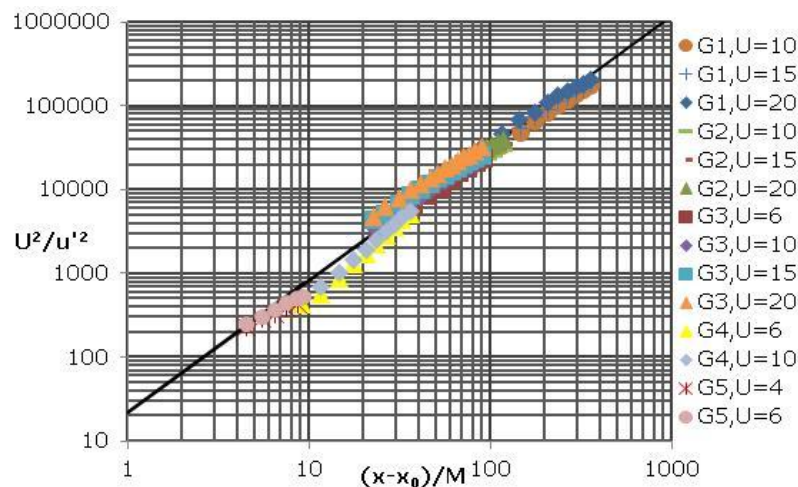


Fig. 1. The decay power law (1) behind different grids.

The decay power law can be also presented in the following form (2), (Roach, 1986):

$$Tu = c \left(\frac{x}{d} \right)^m \quad (2)$$

The decay exponent m is usually equal to $-5/7$. But there is a prediction the decay coefficient c and the exponent m both depend on the Reynolds number based on the grid dimensions M or d , (d – diameter of the grid rod), i.e. (3):

$$Re_M = UM/\nu \quad (3a)$$

$$Re_d = Ud/\nu \quad (3b)$$

where U is the flow velocity at the grid mesh center, and ν – kinematic viscosity of the fluid. Recent experiments seem to confirm this assumption (Fig. 2).

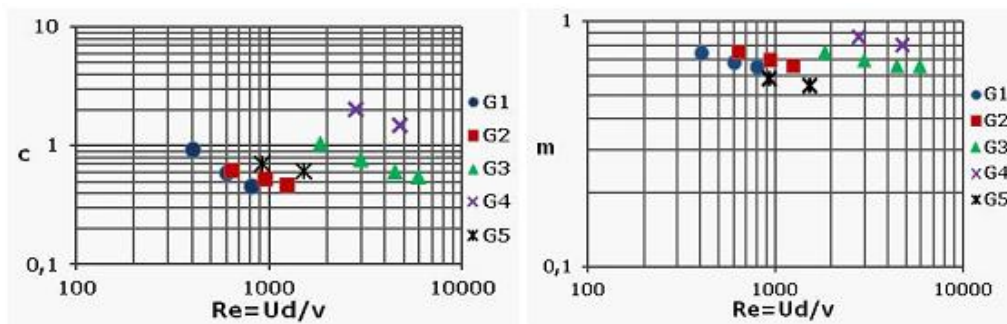


Fig. 2. The decay exponent c and coefficient m at the function of Reynolds number (3b).

To investigate isotropy and homogeneity of the turbulence generated by grids, the velocity skewness and the transverse variation of velocity was counted.

References

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