Flow regimes in the wake of a circular cylinder

Erik Stålberg
Department of Mechanics, KTH
eriks@mech.kth.se tel:08-790 71 61

Reynolds number $\mathbf{Re} = \frac{\mathbf{U}_\infty \mathbf{D}}{\boldsymbol{\nu}}$, where $\mathbf{U}_\infty$ is the flow speed in the farfield, **D** the cylinder diameter and **ν** the kinematic viscosity.

Strouhal number $\mathbf{St} = \frac{\mathbf{f}\,\mathbf{D}}{\mathbf{U}_\infty}$, where **f** is the frequency of the Karman vortex street.

Reynolds number regime **Re** [1]	 **Re** [2]	Flow regime	Flow characteristics	Strouhal number **St**
$\mathbf{Re} \to 0$	$\mathbf{Re} \to 0$	Laminar Creeping flow	Steady No wake	–
$3 - 4 < \mathbf{Re} < 30 - 40$	$\mathbf{Re} < 49$	Laminar Vortex pairs in wake	Steady symmetric separation	–
$30 - 40 < \mathbf{Re} < 80 - 90$	$49 < \mathbf{Re} < 140 - 194$	Laminar Onset of Karman vortex street	Laminar unstable wake	–
$80 - 90 < \mathbf{Re} < 150 - 300$		Laminar Pure Karman vortex street	Karman vortex street	$0.14 < \mathbf{St} < 0.21$
$150 - 300 < \mathbf{Re} < 10^5 - 1.3 \cdot 10^5$		Subcritical regime	Vortex street (turbulent) instabilities	$\mathbf{St} = 0.21$
$10^5 - 1.3 \cdot 10^5 < \mathbf{Re} < 3.5 \cdot 10^6$		Critical regime	Laminar separation Turbulent reattachment Turbulent separation Turbulent wake	
$3.5 \cdot 10^6 < \mathbf{Re}$		Supercritical regime	Turbulent separation	

[1] "*Boundary Layer Theory*" H. Schlichting
[2] *"Vortex Dynamics in the Cylinder Wake"* C. H. K. Williamson. Annu. Rev. Fluid Mech. 1996. 28: 477-539