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Inverse-turbulent Prandtl number effects on Reynolds numbers of RNG *k-ε* turbulence model on cylindrical-curved pipe

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Abstract. Inverse-turbulent Prandtl number (α) is one of important parameters on RNG *k-ε* turbulence model which represent the cascade energy of the flow, which occur in cylindrical curved-pipe. Although many research has been done, turbulent flow in curved pipe is still a challanging problem. The range of α of the basic RNG *k-ε* turbulence model described by Yakhot and Orszag (1986) with range 1-1.3929 has to be more specific on Reynolds number (Re) and geometry. However, since the viscosity is sensitive to velocity and temperature, the specific value of α is needed on specific range of Re. This paper is aimed to gain optimum α of the flow in curved pipe with upper and lower Re which simulated numerically with CFD. The Re at the inlet side were; Re = 13000 and Re = 63800 on cylindrical curved-pipe with r/D of 1.607.The α were varied to 1, 1.1, 1.2, 1.3. The curved pipe was an cylindrical air pipe with 43mm inlet diameter. The computational grid that is used for CFD numerical simulation with CFDSOF®, hexagonal-surface fitted consist of 139440 cells. CFD simulation done with α varies by 1, 1.1, 1.2, dan 1.3. The wall is assumed to zero-roughness. The CFD simulation generated several results; at Re 13000, the value of α did not affect the turbulent parameter which also confirmed the basic therory of RNG *k-ε* turbulence model that the minimum Re of α is 2.5×10^4. At Re = 63800, the use of α of 1.1 shows more turbulent flow domination on molecular flow. Lower eddy dissipation by 1.67%, increasing turbulent kinetic energy by 2.2%, and Effective viscosity increase by 4.7% compared to α = 1. Therefore, the use of α 1.1 is the most suitable value to be used to represent turbulent flow in curved pipe with RNG *k-ε* turbulence model with Re 63800 and r/D 1.607 among others value that have discussed in this paper.

Nomenclature

c_ν : proportional k constant (0.09)

α_δ : Inverse Prandtl number (molecular)