**Turbulence Modelling**

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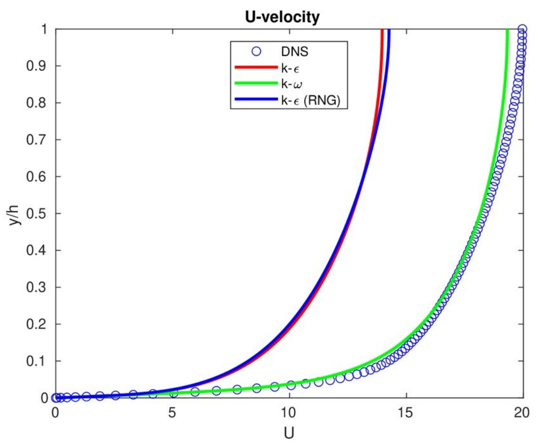
## 1. Boundary Conditions:

At wall, i.e., @y = 0, U=0, k = 0, ε = 2νk/(y^2)
At centreline i.e., @y = 1, Symmetric boundary condition is applied for U,k and ε.

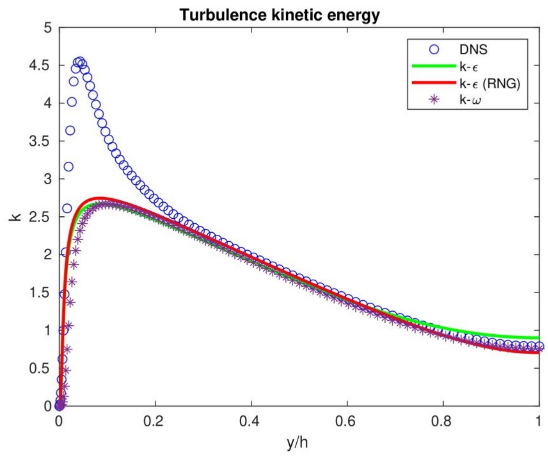
## 2.Results:

### A. Velocity:

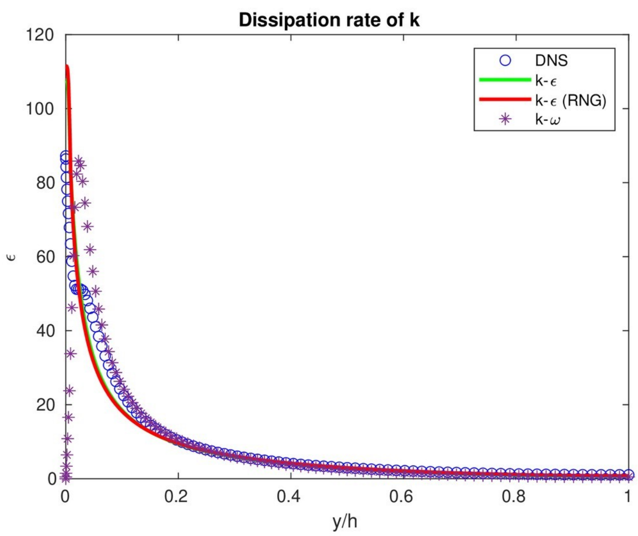



c.

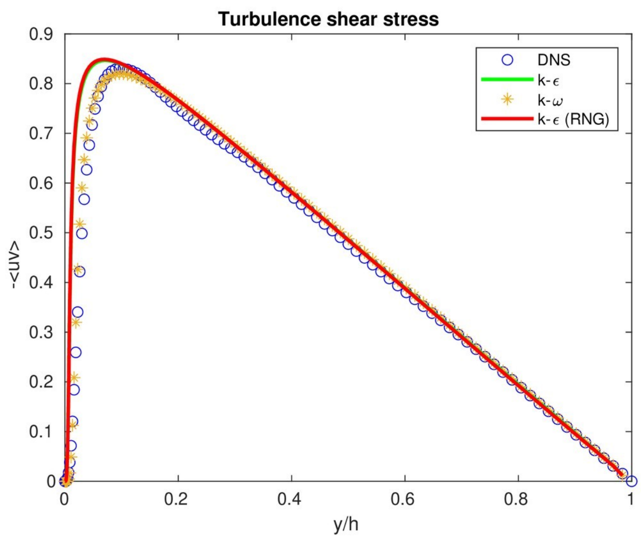
### B. kinetic energy:



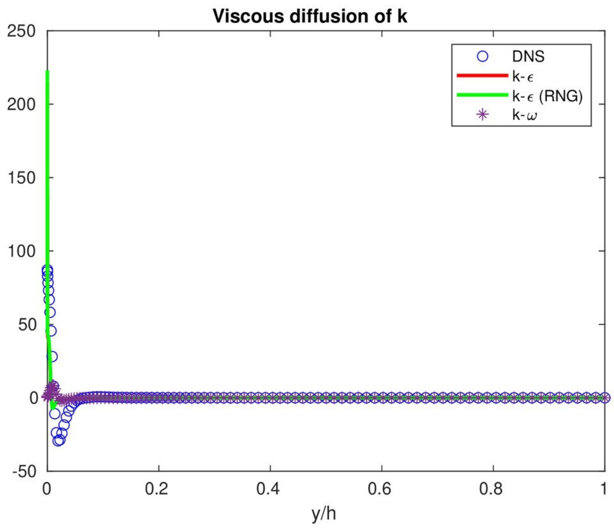

### C.Dissipation(ε):



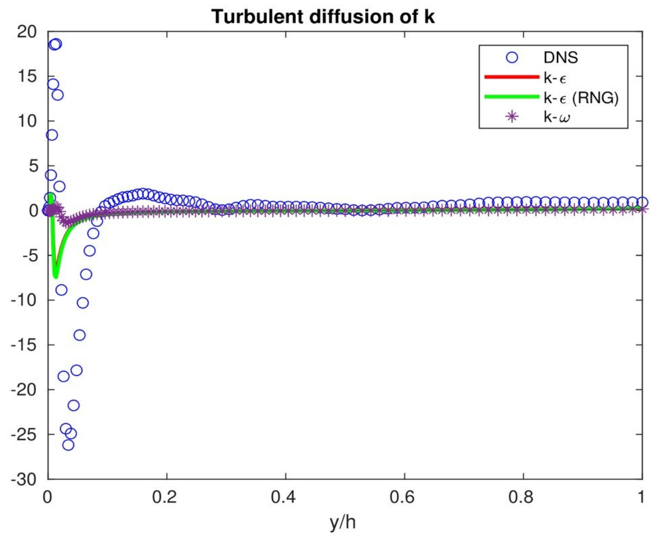

### D.Turbulent Shear Stress:



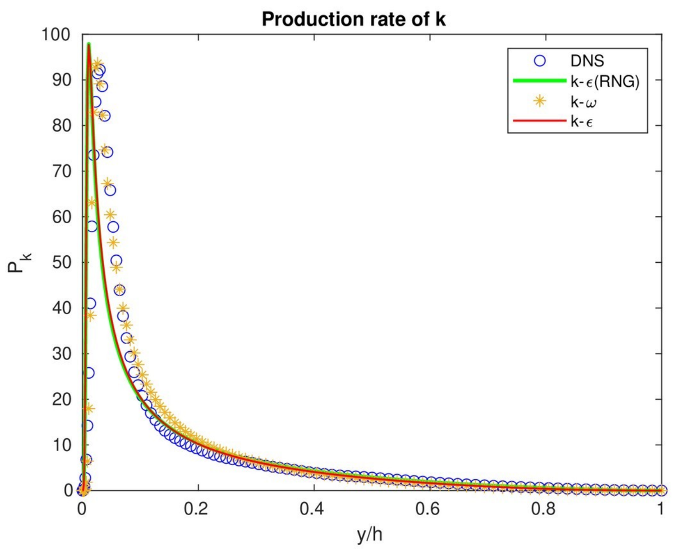
## E.viscous Diffusion of K:



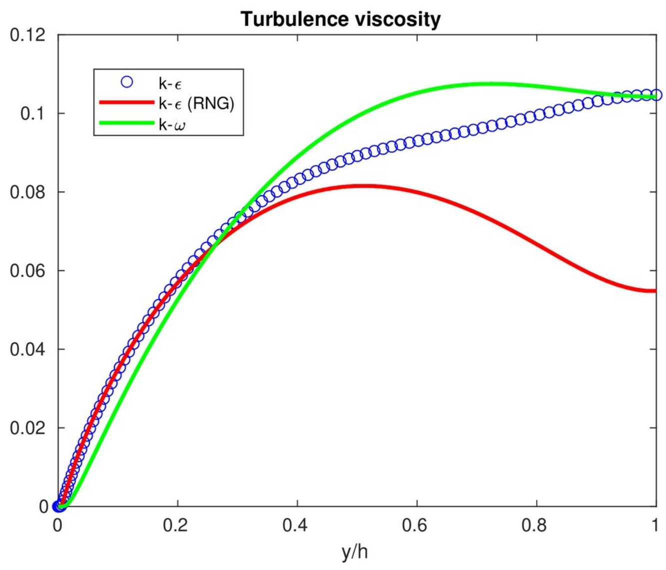

## F. Turbulent Diffusion of K




## G.Production rate of K:

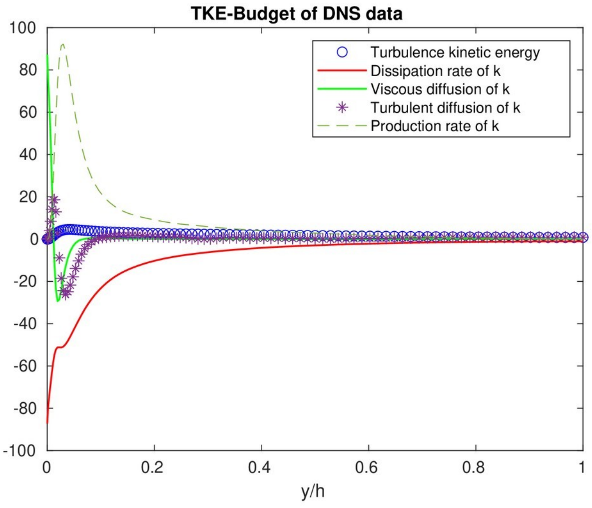



## H.Turbulent viscosity:

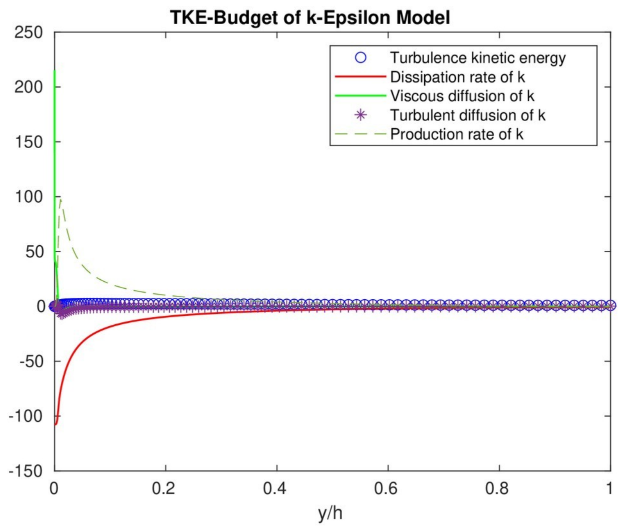


## TKE -Budget:

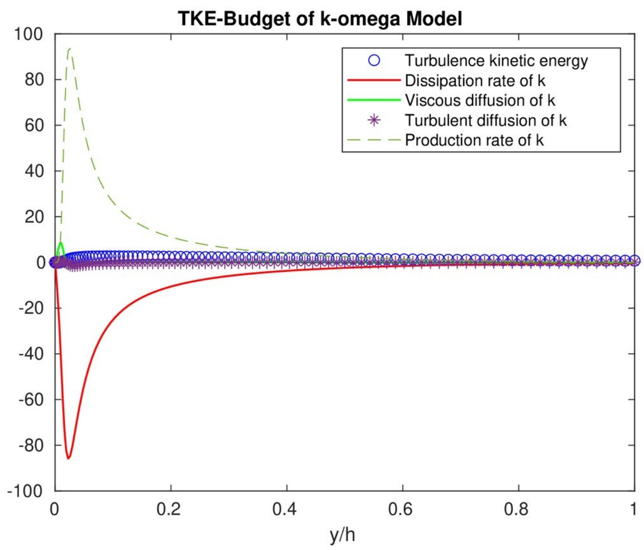
i) DNS




ii) k-epsilon




iii) k-omega




## Boundary Conditions:

i) velocity=0 at the wall.
ii) production rate=0 at the wall
iii) Turbulence Kinetic Energy k=0 at the wall
iv) Eddy Viscosity $\nu t$ =0 at the wall
v) Calculate the wall-normal gradient of velocity using a finite difference method.
vi) $\varepsilon = 2\nu k/(y^2)$ wall function for $\epsilon$ for wall-normal distances within a certain range ($y+\leq 3$).
vii) At centreline i.e., @y = 1, Symmetric boundary condition is applied for U,k and $\varepsilon$.

**$\tau w = -\partial P/\partial x$:**

Given the momentum equation for fully developed flow:

$0 = (-1/\rho) *(\partial P/\partial x) + \partial [(\nu + \nu t)\, \partial U/\partial y]/\partial y$

IIntegrating the equation from wall to channel centerline(from 0 to $\delta$ ):

$\int(-1/\rho)*(\partial P/\partial x)dy + \int\{\partial[(\nu + \nu t)\, \partial U/\partial y]/\partial y\}dy = 0$

Now, we have:

$(-1/\rho)*(\partial P/\partial x)\delta + [(\nu + \nu t)\, \partial U/\partial y]\delta = 0$ from (0 to $\delta$)

Given that $\nu t=0$ at the wall (y=0) and $\partial U/\partial y=0$ at the channel axis ($y=\delta$):

$(1/\rho)*(\partial P/\partial x) = -\nu[\partial U/\partial y]$

Given $\rho=1$ and $\delta=1$

$-(\partial P/\partial x) = \tau w$.