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Analysis of iterative solution methods for the  
semi-implicit time discretization of the incompressible  
Navier-Stokes equation

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For the DNS and LES of unsteady incompressible flow problems the semi-implicit time discretization and the pressure-velocity iteration method following Chorin and Butler (Chorin-projection, marker-and-cell method, staggered grid discretization) for the solution of the resulting linear system of the form

$$\frac{1}{\tau} \mathbf{u}^{n+1} + \nabla p^{n+1} = \mathbf{f}(\mathbf{u}^n) \quad (1)$$

$$-\nabla \cdot \mathbf{u}^{n+1} = 0 \quad (2)$$

is still very popular. The reasons for that are i) the huge expenses for the development of new powerful cfd-codes, ii) the easy possibility to parallelize existing code, and iii) the good experiences of cfd-people with the robust method. The pressure-velocity iteration method was developed from a pure engineering point of view. In this contribution the method will be analyzed from a numerical linear algebra point of view, and the method will be compared to other more recent iteration methods for the solution of the equation system (1),(2).