Simple algorithm and its variants, PISO algorithms

The SIMPLE (Semi-Implicit Method for Pressure-Linked Equations) algorithm and its variants, as well as the PISO (Pressure-Implicit with Splitting of Operators) algorithm, are widely used in computational fluid dynamics (CFD) for solving the Navier-Stokes equations, particularly in flow field analysis involving turbulent flows. Here's an overview of these algorithms:

SIMPLE Algorithm and Variants:

SIMPLE Algorithm:

The SIMPLE algorithm is an iterative approach used to solve the coupled system of equations arising from the discretization of the Navier-Stokes equations.

It consists of three main steps:

Pressure Correction: An intermediate velocity field is calculated using the previous pressure field. This step ensures that the divergence of the velocity field satisfies the continuity equation approximately.

Pressure Poisson Equation: A pressure correction equation, often called the pressure Poisson equation, is solved to obtain a new pressure field that satisfies the continuity equation more accurately.

Velocity Update: The velocity field is corrected using the new pressure field obtained in the previous step.

The process is repeated iteratively until convergence is achieved.

SIMPLE Variants:

SIMPLEC (SIMPLE-Consistent): A variant of the SIMPLE algorithm that enforces consistency between the pressure and velocity corrections, leading to improved convergence properties.

SIMPLEST (SIMPLE for Staggered Grids): Designed for staggered grid arrangements commonly used in finite volume methods, where pressure and velocity variables are located at different locations within the grid cells.

SIMPLEC-PRF (Pressure-Retaining Fraction): An extension of SIMPLEC that introduces a parameter to control the degree of pressure-velocity coupling, allowing for more flexible convergence behavior.

PISO Algorithm:

PISO Algorithm:

- The PISO algorithm is an extension of the SIMPLE algorithm that addresses some of its limitations, particularly in handling transient and compressible flows.
- It stands for Pressure-Implicit with Splitting of Operators.
- PISO introduces an additional corrector step to the SIMPLE algorithm, allowing for a more accurate treatment of time-dependent terms in the Navier-Stokes equations.
- In the corrector step, the momentum equations are solved again with the updated pressure field to obtain a more accurate velocity field correction.
- PISO is particularly useful for flows with strong transient effects or where the Courant-Friedrichs-Lewy (CFL) condition imposes stringent time step restrictions.
- Applications in Flow Field Analysis and Turbulent Models:

- Both SIMPLE and PISO algorithms are widely used in CFD simulations for various applications, including flow field analysis in aerospace, automotive, and environmental engineering.
- They are particularly important for simulating turbulent flows, where accurate treatment of pressure-velocity coupling is essential for capturing turbulent transport phenomena.
- Turbulent models such as
- The choice between SIMPLE and PISO depends on the specific characteristics of the flow being simulated, such as its transient behavior, compressibility effects, and numerical stability requirements.
- In summary, both the SIMPLE algorithm and its variants and the PISO algorithm are powerful tools for flow field analysis and turbulent modeling in CFD simulations, offering robustness, efficiency, and versatility in handling a wide range of flow scenarios.