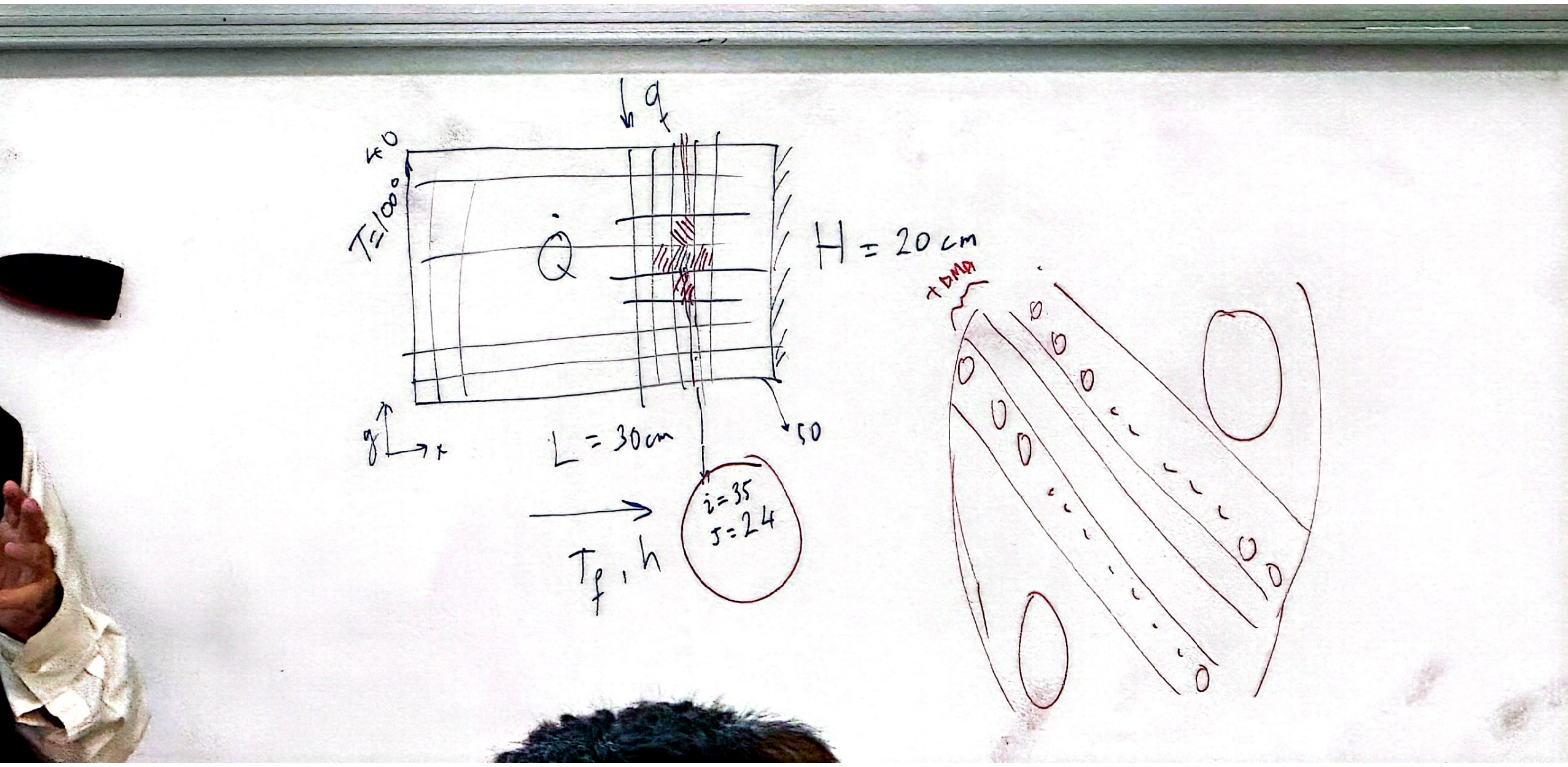

q
T=100°
40
Q̇
H = 20 cm
L = 30cm
50
i=35
j=24
T_f, h

Discretization equation for the three-dimensional case takes the form:

$$a_P T_P = a_E T_E + a_W T_W + a_N T_N + a_S T_S + a_T T_T + a_B T_B + b \quad (3.65)$$

where:

$$a_E = \frac{k_e \Delta y \Delta z}{(\delta x)_e} \quad (3.66)$$

$$a_W = \frac{k_w \Delta y \Delta z}{(\delta x)_w} \quad (3.67)$$

$$a_N = \frac{k_n \Delta z \Delta x}{(\delta y)_n} \quad (3.68)$$

$$a_S = \frac{k_s \Delta z \Delta x}{(\delta y)_s} \quad (3.69)$$

$$a_T = \frac{k_t \Delta x \Delta y}{(\delta z)} \quad (3.70)$$

$$a_B = \frac{k_b \Delta x \Delta y}{(\delta z)_b} \tag{3.71}$$

$$a_P^0 = \frac{\rho c \Delta x \Delta y \Delta z}{\Delta t} \tag{3.62}$$

$$b = S_C \Delta x \Delta y \Delta z + a_P^0 T_P^0 \tag{3.63}$$

$$a_P = a_E + a_W + a_N + a_S + a_T + a_B + a_P^0 - S_P \Delta x \Delta y \Delta z \tag{3.64}$$

Physical significance of the coefficients in the discretization equations:

$a_E, a_W, a_N,\quad, a_B$ - represent the conductance between the point P and the corresponding neighbour

$a_P^0 T_P^0$ - means internal energy (divided by Δt) contained in the control volume at time t

b - consists of the internal energy and the rate of heat generation x

Rys.4.3. Boundary conditions that make a left-to-right sweep direction more advantageous

4.3. ADI - method (Alternating Directions Implicit) –

$$a_P T_P = a_E T_E + a_W T_W + a_N T_N + a_S T_S + b$$

where:

subscripts E and W correspond to x-direction while subscripts S and N correspond to y-direction

4.5. Over- and underrelaxation

A general discretization equation:

$$a_P T_P = \sum a_{nb} T_{nb} + b \tag{4.9}$$

or

$$T_P = \frac{\sum a_{nb} T_{nb} + b}{a_P} \tag{4.10}$$

or

$$T_P = T_P^* + \left(\frac{\sum a_{nb} T_{nb} + b}{a_P} - T_P^* \right) \tag{4.11}$$

where: T_P^* – value from the previous iteration

The change of the dependent variable introduced in current iteration can be modified by a relaxation factor:

atankar_04-Linear Equation... Patankar_05-Coordinates.pdf Patankar_06_convergence.pdf Patankar_08_Convect...

8. Convection –Diffusion problem

Convection and diffusion flux of variable Φ will be considered in a given flow field – the velocity field can be obtained from the experimental data, theoretical solution or from numerical analysis. The method of numerical fluid flow prediction will be shown in the next chapter

8.1. Steady one-dimensional convection and diffusion

$$\frac{d}{dx}(\rho U \Phi) = \frac{d}{dx}\left(\Gamma \frac{d\Phi}{dx}\right) \tag{8.1}$$

where: U - velocity component along the x-coordinate

the continuity equation:

$$\frac{d}{dx}(\rho U) = 0 \quad \text{or} \quad \rho U = const. \tag{8.2}$$

5.1. Location of the control volume faces

Practice 1

The volume faces located midway between grid points

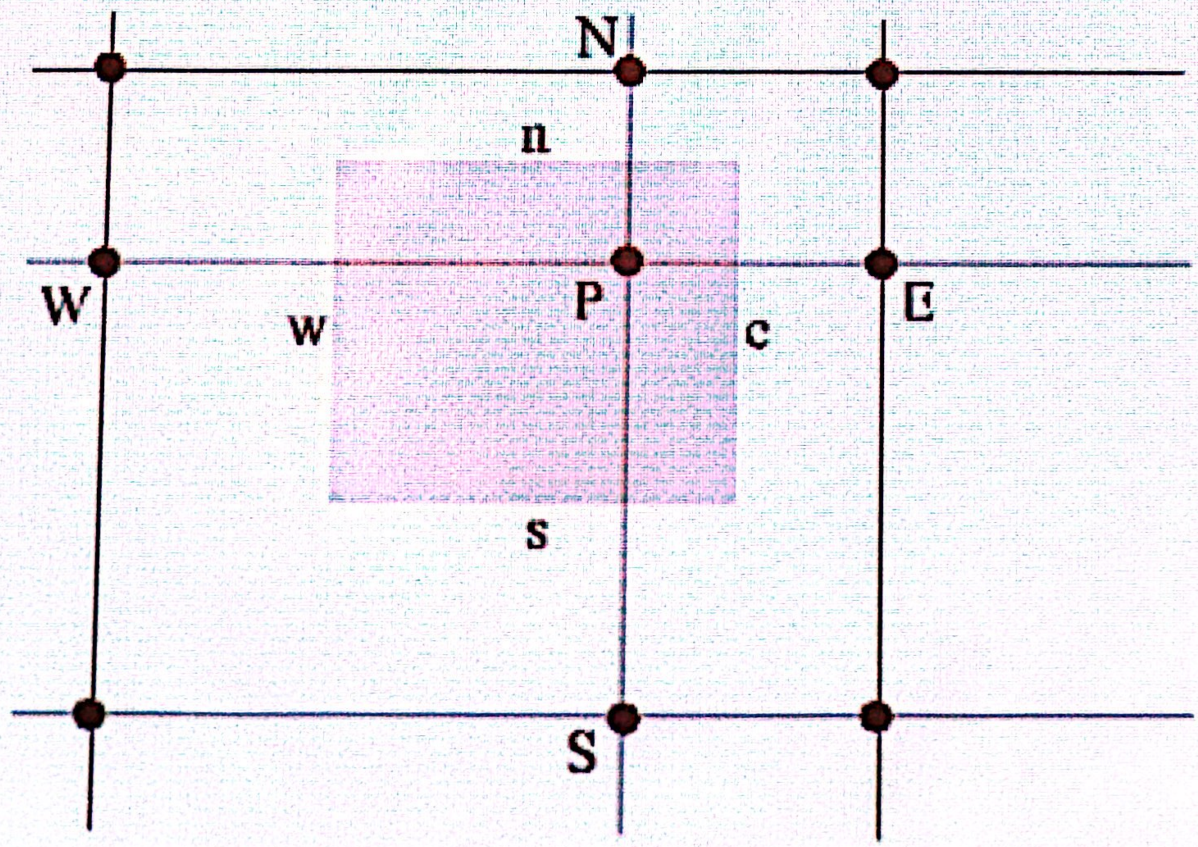

Fig.5.1. Control volume faces located midway between grid points

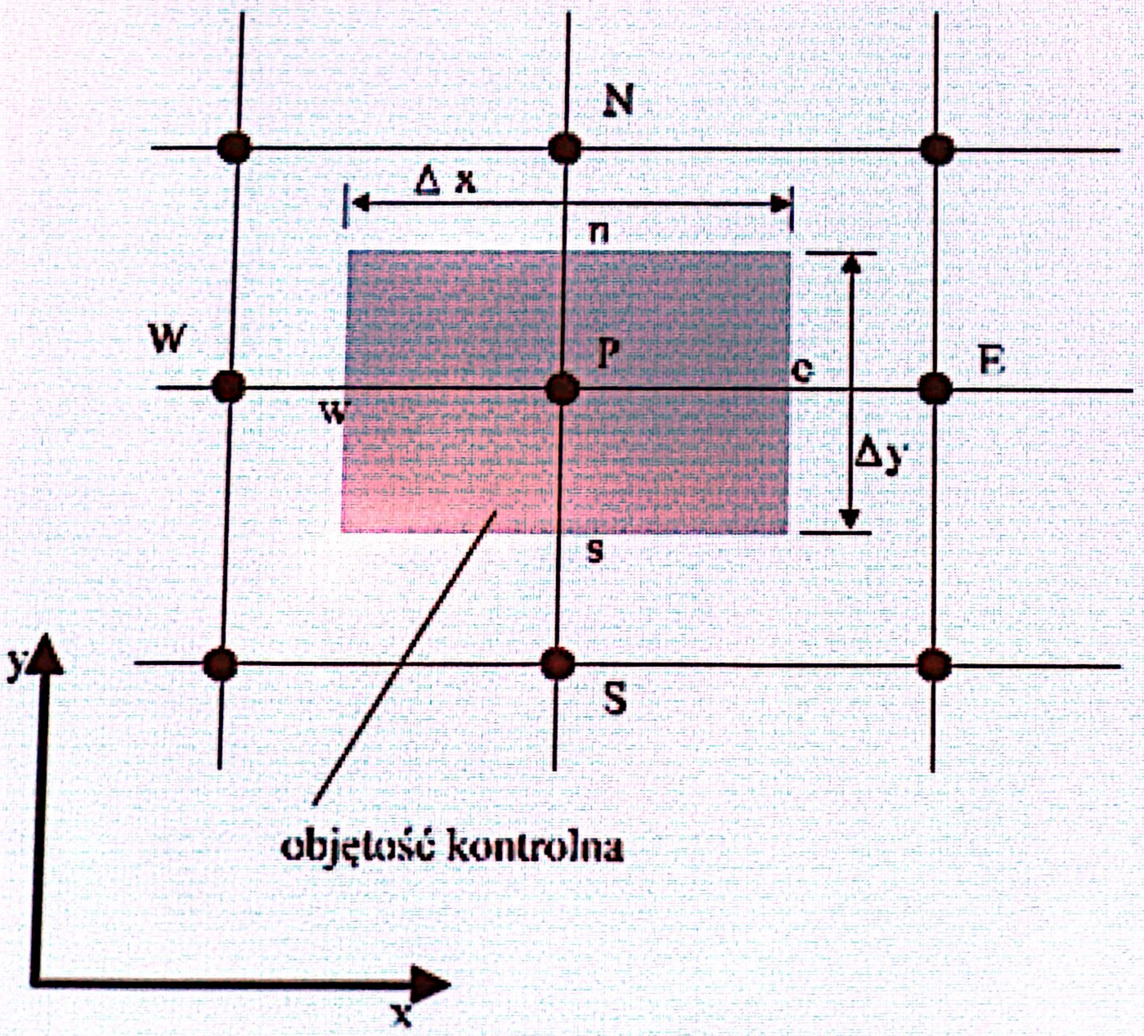

Fig.3.5.Control volume for the two-dimensional problem

ifferential equation governing unsteady, two-dimensional heat onduction can presented as follows

$$\rho c\frac{\partial T}{\partial t}=\frac{\partial}{\partial x}\left(k\frac{\partial T}{\partial x}\right)+\frac{\partial}{\partial y}\left(k\frac{\partial T}{\partial y}\right)+S \qquad (3.55)$$

5.2. Non-cartesian coordinate systems

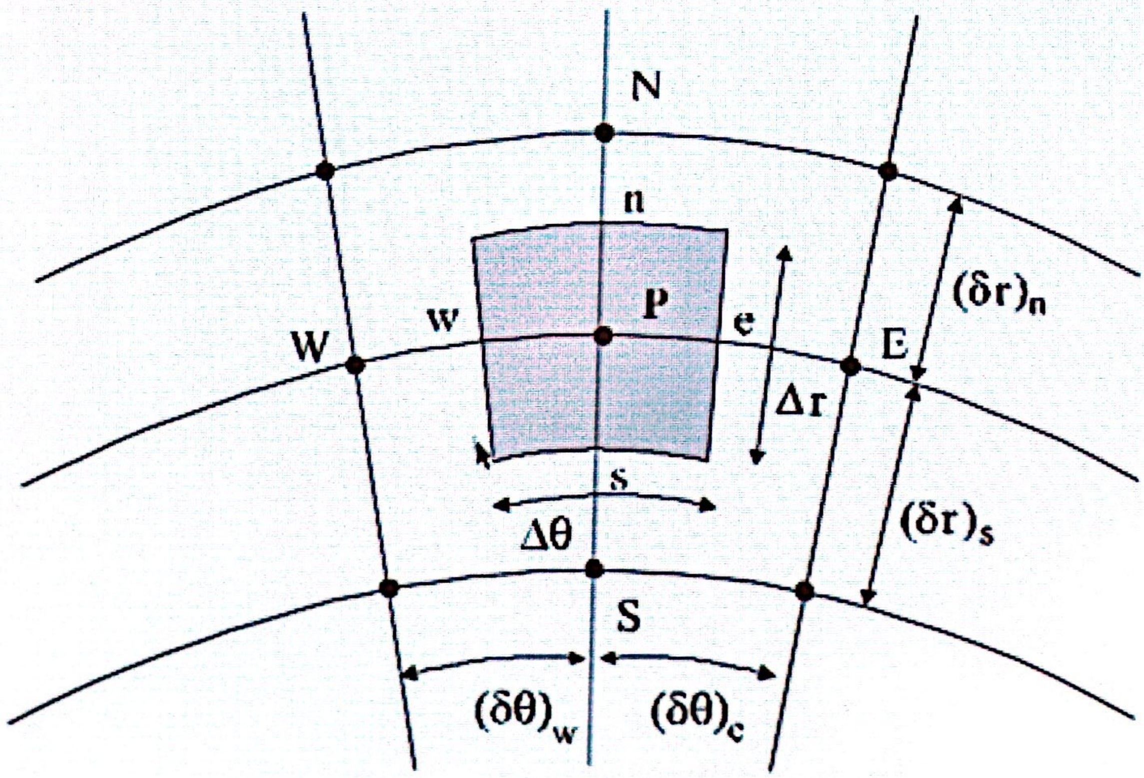

Fig.5.3. Control volume in polar coordinate system

The differential equation for unsteady two-dimensional heat transfer in the polar coordinate system can presented as:

4.2. Gauss-Seidel – line –by-line method

The combination of the Gauss-Sidel and direct TDMA method

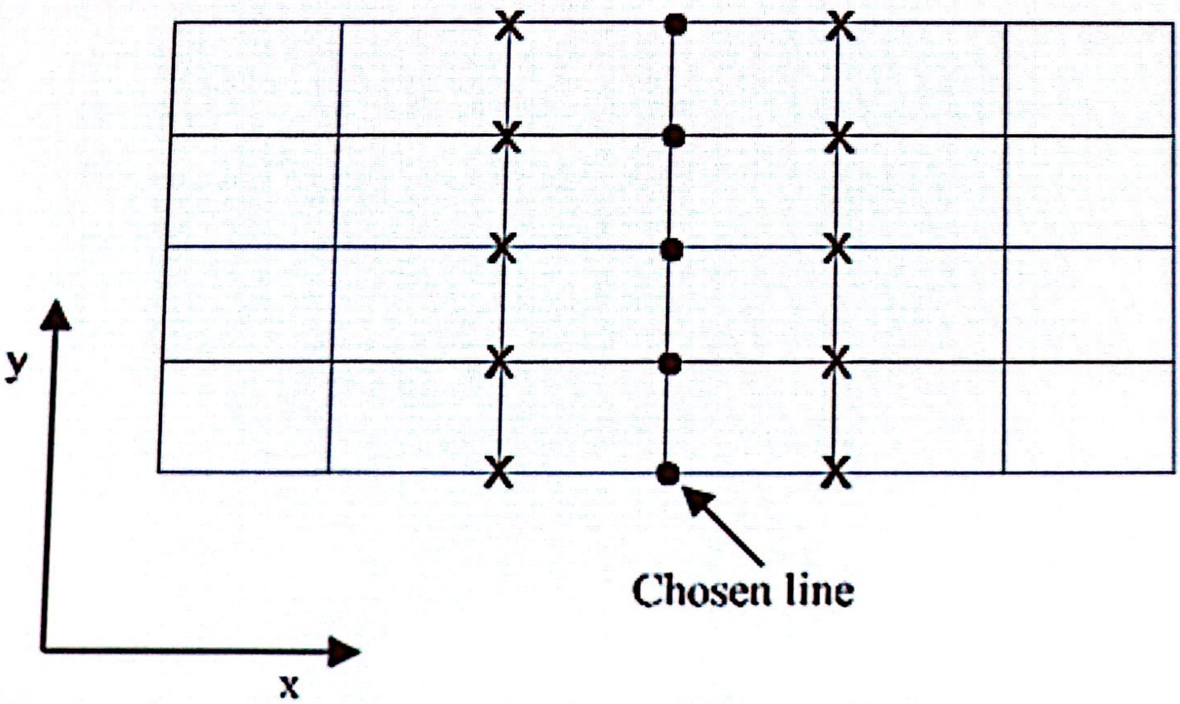

Fig.4.1. Representation of the line-by-line method

Comments:

1) The discretization equation for the grid points along a chosen line are solved by the TDMA scheme while the values of the dependent variable at grid points along the neighbour lines are