Environmental friendly technologies
KEE/ENT

ESF II project of the University of West Bohemia in Pilsen

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Lecture 3

Dry mechanical separators

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Separation proces

separation from transport medium

removal from separatin surfaces

Principles of separation

– gravitational

– inertial

– centripetal

– diffusional

– interceptional

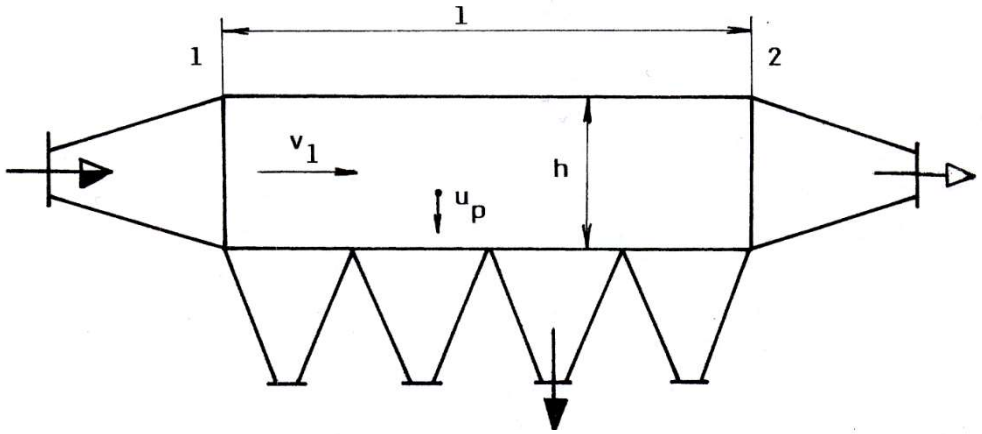
– Electrical

– Combination of principles

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Gravitational principle



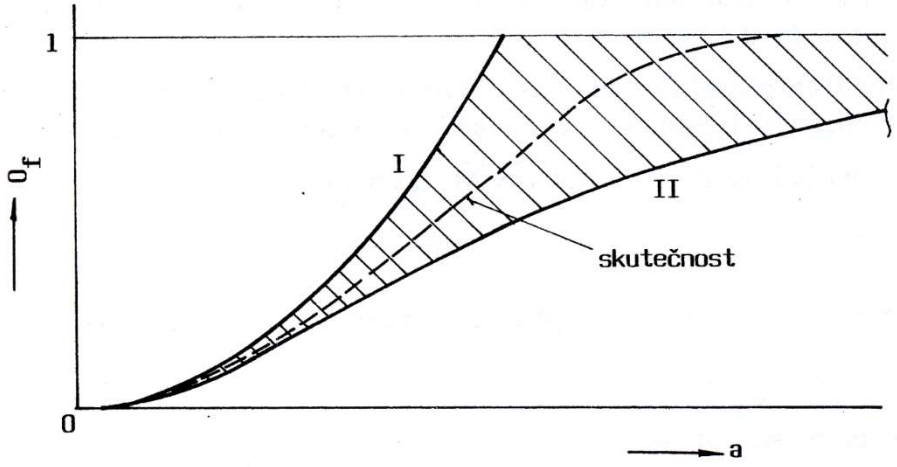
$$\dot{M}_p = C_1 v_1 A_1$$

$$\dot{M}_z = C_1 u_p S$$

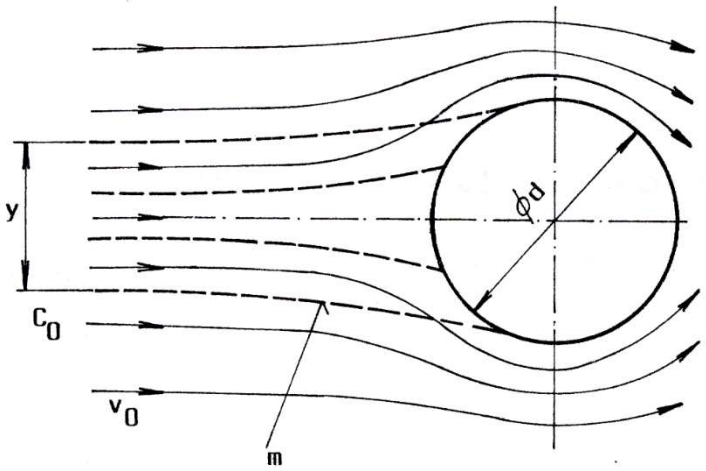
$$\dot{M}_z = C_2 u_p S$$

$$O_I = \frac{\dot{M}_z}{\dot{M}_p} = \frac{u_p S}{v_1 A_1} = \frac{u_p l}{v_1 h}$$

$$O_{II} = \frac{\dot{M}_z}{\dot{M}_p} = \frac{C_2 u_p S}{C_1 v_1 A_1}$$



Inertial principle



$$\dot{M}_p = d\, C_0\, v_0$$

$$\dot{M}_z = y\, C_0\, v_0$$

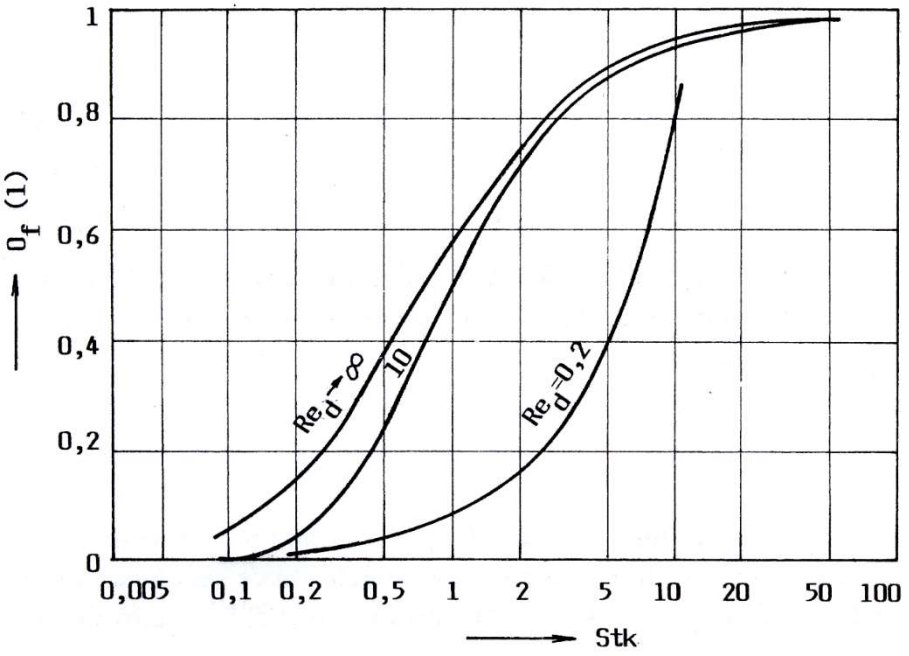
$$O_f = \frac{\dot{M}_z}{\dot{M}_p} = \frac{y}{d}$$

$$\mathrm{Re}_d = \frac{v_0\, d\, \rho}{\eta}$$

$$Stk = \frac{\tau_{\dot{c}}\, v_0}{d}$$

$$O_f \doteq \frac{4\,Stk^2}{(2\,Stk + 0{,}66)^2}$$

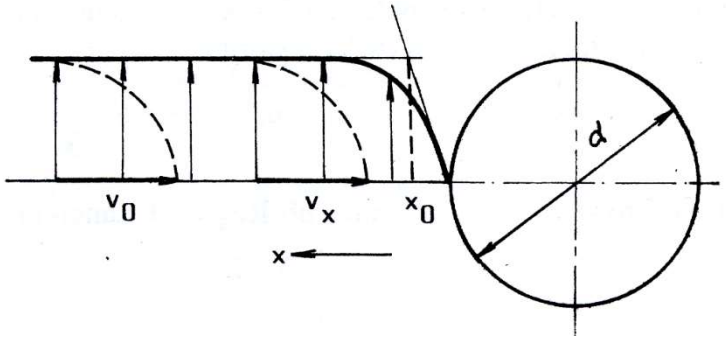
$$O_f = 0{,}08\,Stk \qquad \mathbf{Re_d} = 0{,}2$$



For every Re exists Stk:

$$Stk < Stk_{krit}$$

$$O_f = 0$$



$$v_x \doteq -\alpha x$$

$$\alpha = \frac{4 v_0}{d}$$

$$\tau_č \frac{du}{dt} = -\alpha x - u$$

$$\tau_č \frac{d^2x}{dt^2} + \frac{dx}{dt} + \alpha x = 0$$

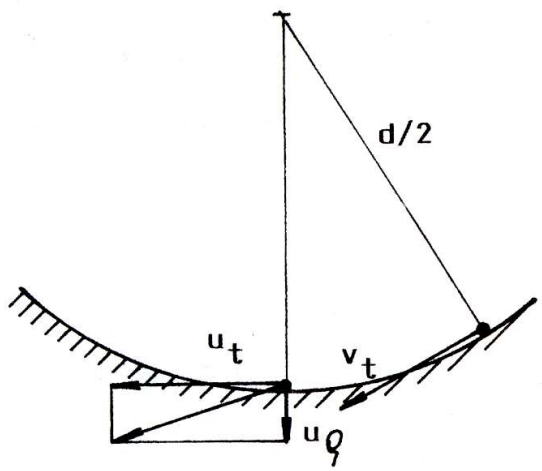
$$x = C_1 e^{\lambda_1 t} + C_2 e^{\lambda_2 t}$$

$$\lambda_{1,2} = \frac{-1 \pm \sqrt{1 - 4\,\tau_č\,\alpha}}{2\,\tau_č}$$

$$x = e^{-\frac{t}{2\,\tau_č}} \left(x_0 + \frac{x_0}{4\,\tau_č} t \right)$$

$$\tau_č \frac{v_0}{d} = Stk_{krit} = \frac{1}{16}$$

Centripetal principle



$$3\pi\eta a\vec{u}_r = \vec{F}_e$$

$$F_o = M_č \frac{2v_t^2}{d}$$

$$3\pi\eta a u_\rho = M_č \frac{2v_t^2}{d}$$

$$u_k = \frac{a^2 \rho_č}{18\eta} \frac{2v_t^2}{d} = \tau_č \frac{2v_t^2}{d}$$

$$\dot{M}_p = \dot{V}_p C_p = A\, v_d C_p$$

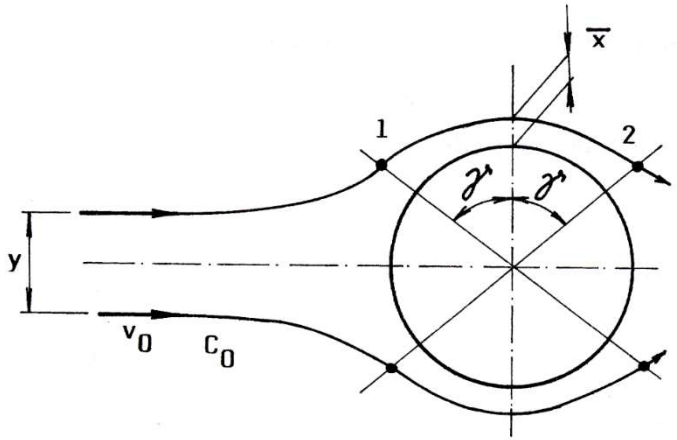
$$\dot{M}_z = C S u_k = C S \tau_č \frac{2v_t^2}{d}$$

$$O_f = \frac{\dot{M}_z}{\dot{M}_p} = 2\frac{C}{C_p}\frac{S}{A}\left(\frac{v_t}{v_d}\right)^2 \frac{\tau_č v_d}{d}$$

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Diffusional principle

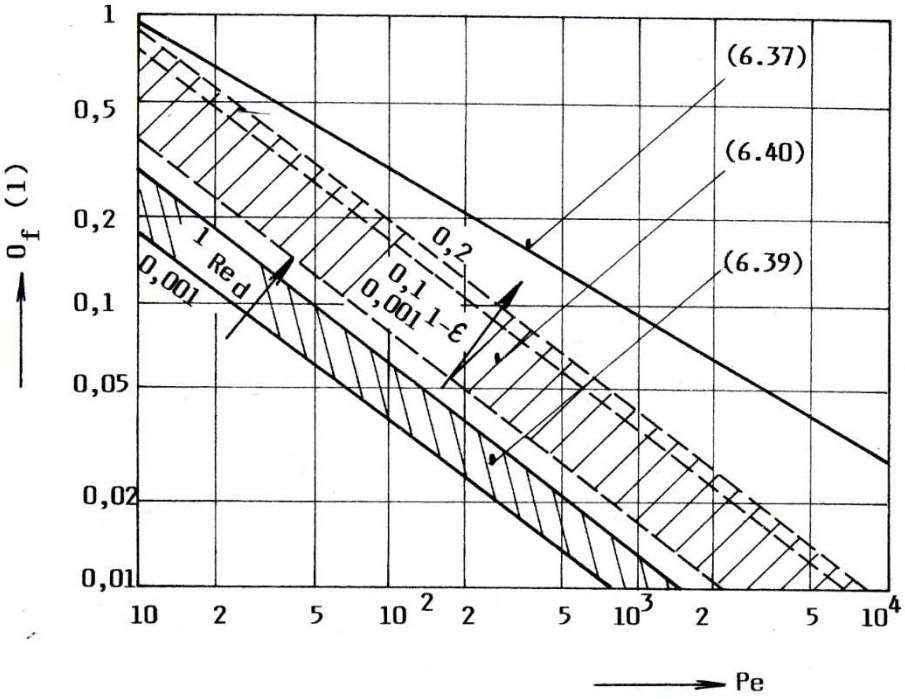


$$O_f = \frac{y}{d}$$

$$O_f = 5{,}2(1-\varepsilon)^{1/6}\, Pe^{-2/3}$$

$$Pe = \frac{v_0 d}{D_B}$$

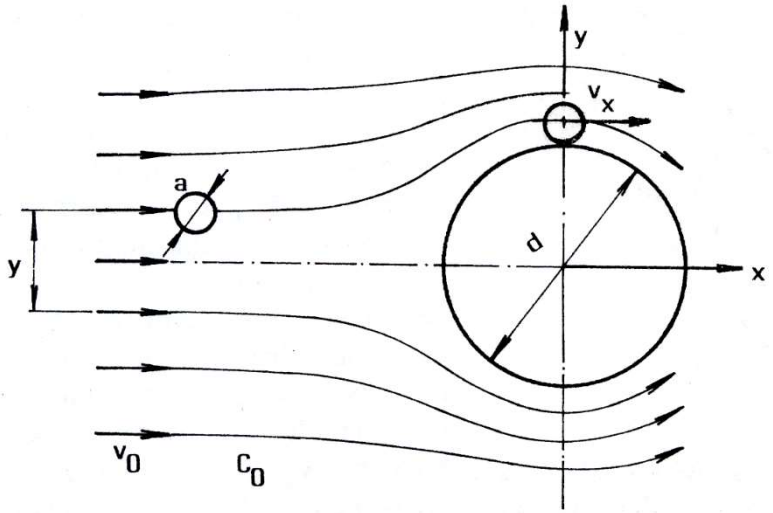
$$D_B = k\,T\,\frac{1 + K_C \frac{l_m}{a}}{3\pi\eta a}$$



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Interceptional principle



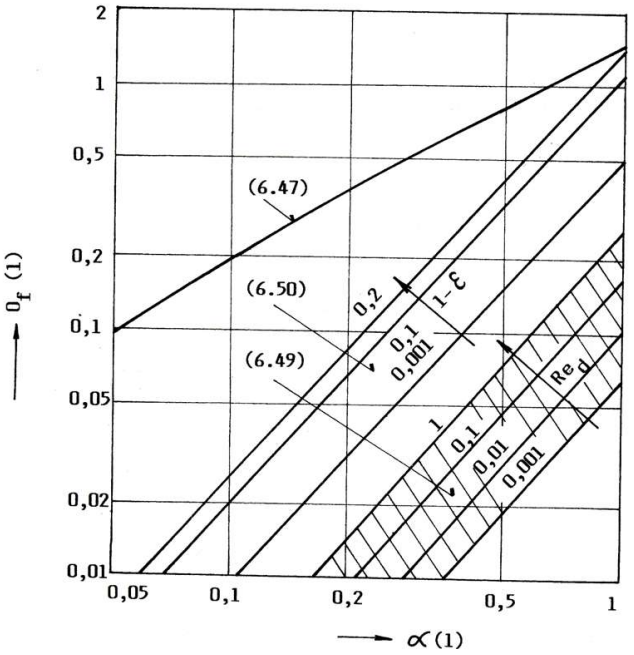
$$O_f = \frac{y}{d}$$

$$v_0 \frac{y}{2} = \int_{d/2}^{d/2+a/2} v_x \, dy$$

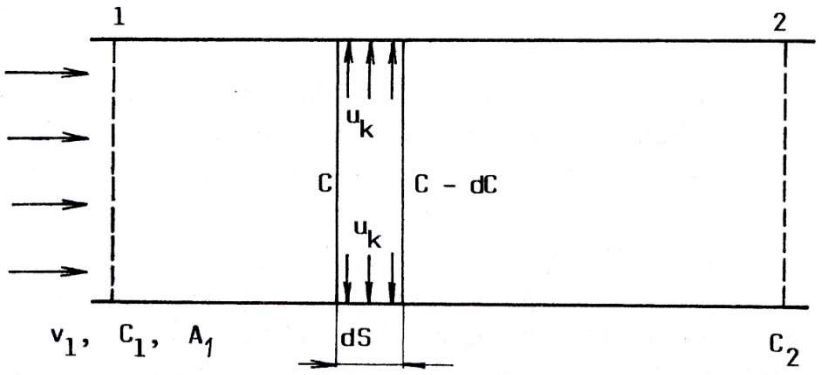
$$\alpha = \frac{a}{d}$$

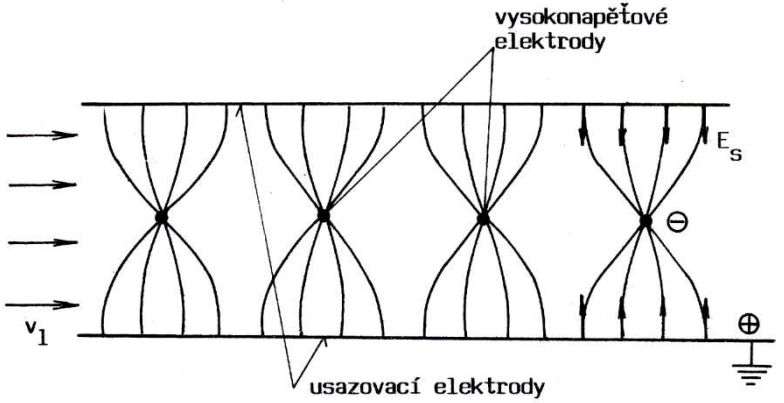
$$O_f = 1 + \alpha - \frac{1}{1+\alpha}$$

$$O_f \doteq 0{,}26 \, \mathrm{Re}_d^{0,2} \, \alpha^{1,82}$$



Elektrical principle





$$0 = \vec{F}_\tau + \vec{F}_Q$$

$$F = \frac{Q_k Q_č}{4\pi r^2 \varepsilon_0}$$

$$u_{r,y} = u_k = \frac{F_Q}{3\pi\eta a}\left(1 + K_C \frac{l_m}{a}\right)$$

$$-\dot{V}\, dC = C\, u_k\, dS$$

$$\frac{C_2}{C_1} = \exp\left(-\frac{u_k S}{\dot{V}}\right)$$

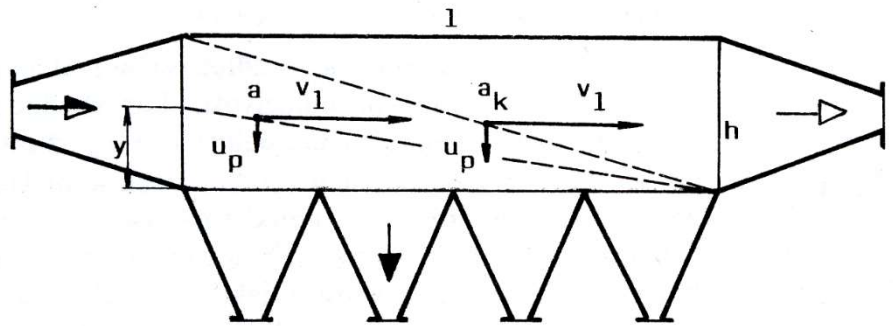
$$O_f = \frac{\dot{V}(C_1 - C_2)}{\dot{V} C_1} = 1 - \exp\left(\frac{u_k S}{\dot{V}}\right) = 1 - \exp\left(-\frac{u_k S}{v_1 A_1}\right)$$

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$$u_p \doteq \frac{a^2 \rho_č}{18\eta} g$$

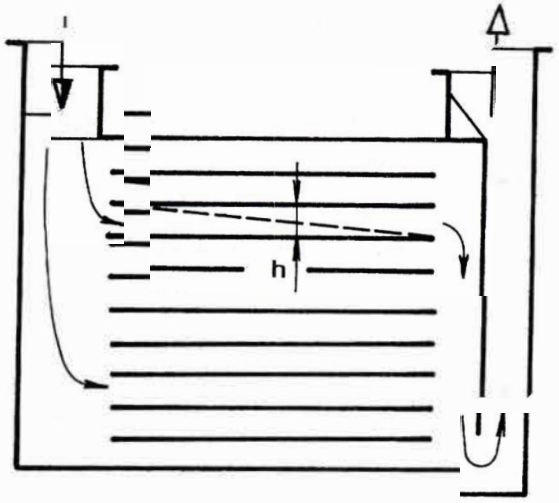
$$\frac{u_p}{v_1} = \frac{h}{l}$$

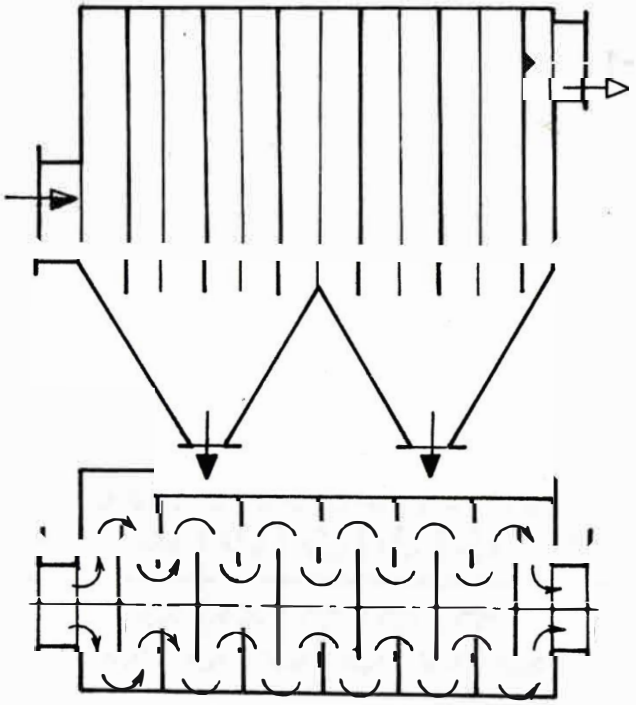
$$a_k = \sqrt{\frac{18\eta v_1 h}{\rho_č g l}}$$

$$O_f = \frac{y}{h}$$

$$\frac{u_p}{v_1} = \frac{y}{l}$$

$$O_f = \frac{u_p\, l}{v_1\, h}$$

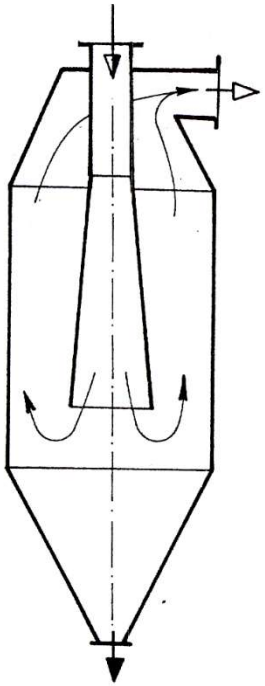


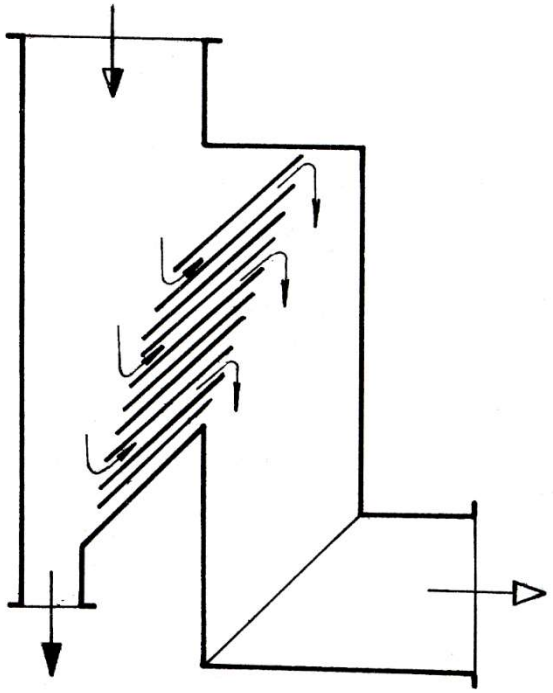


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Dusters – gravitational and inertial principle

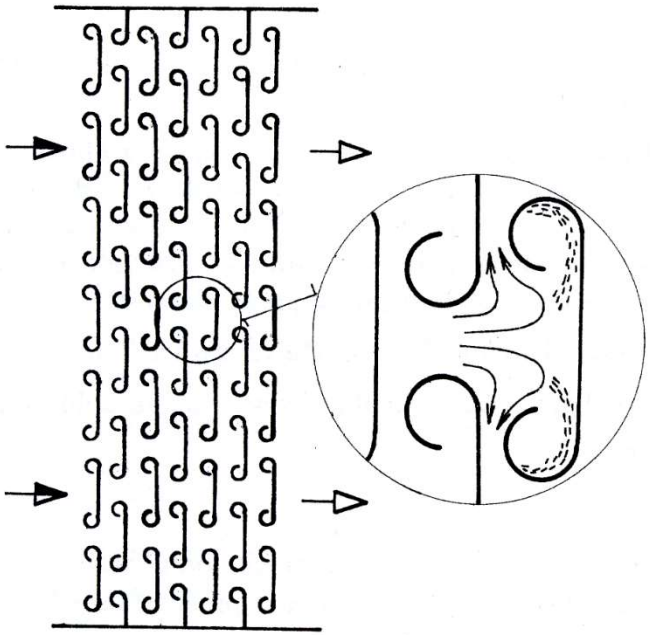


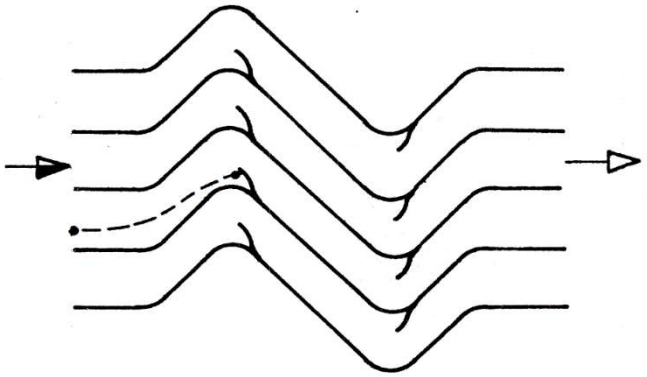


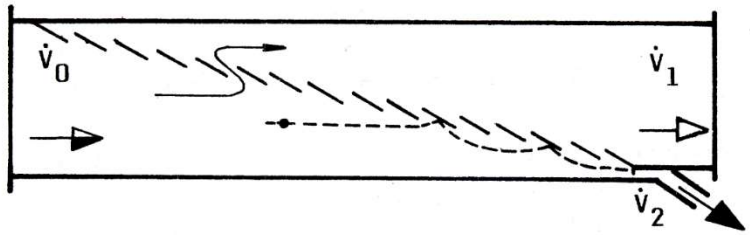
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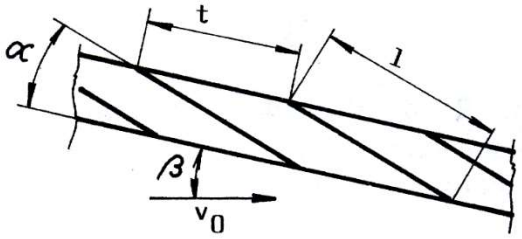
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Inertial separators





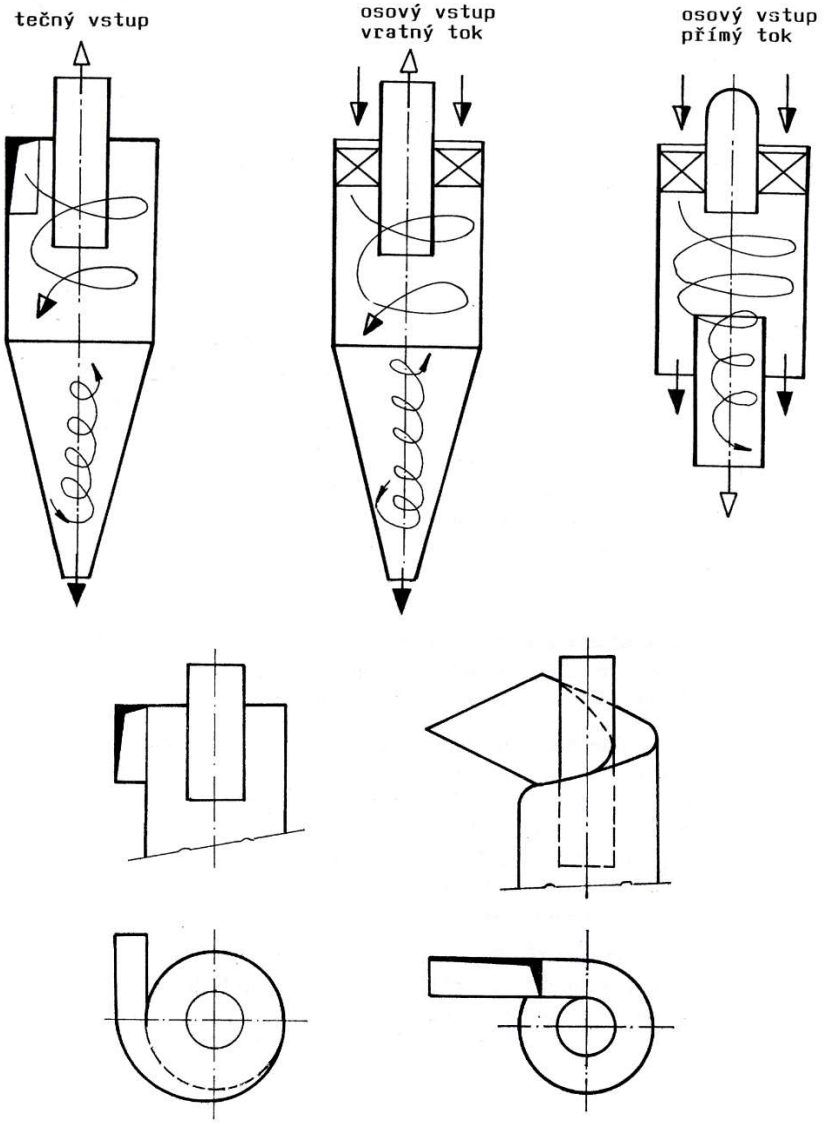


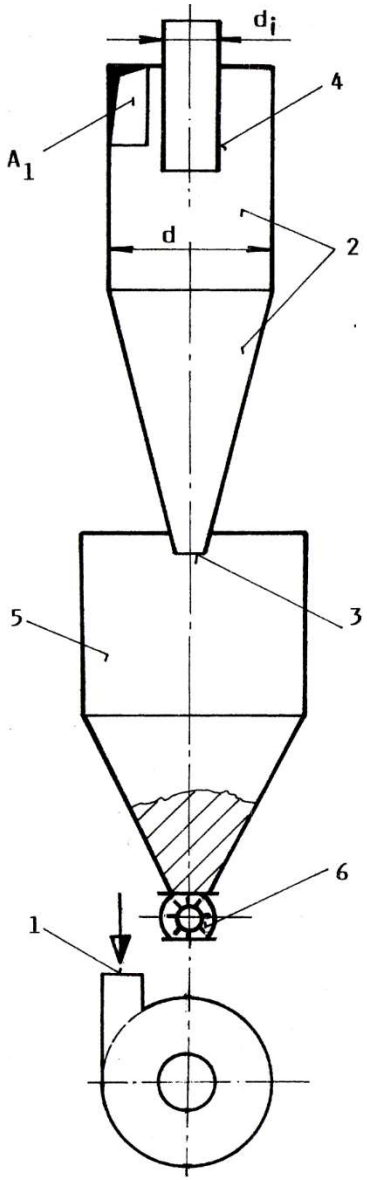


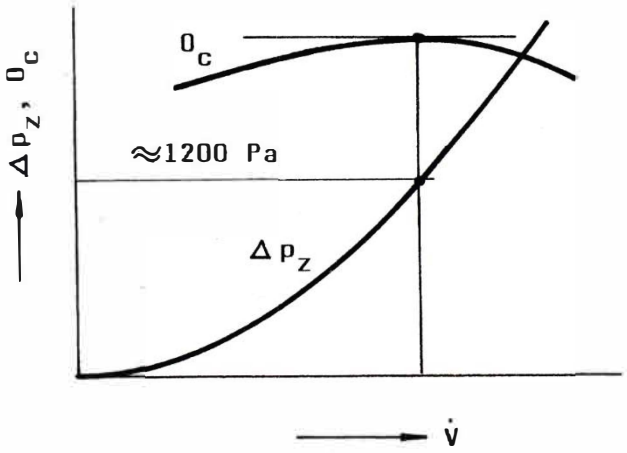
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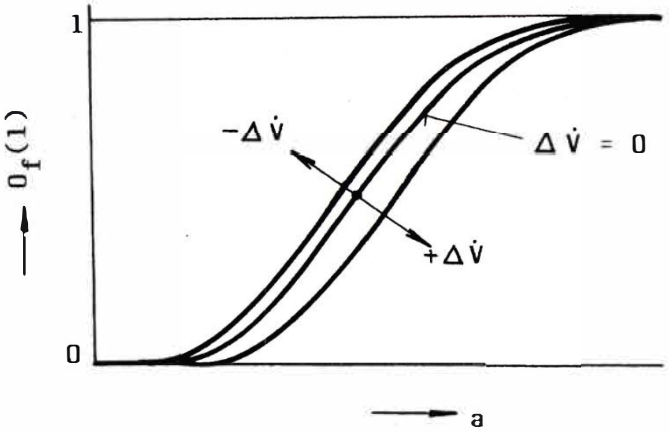
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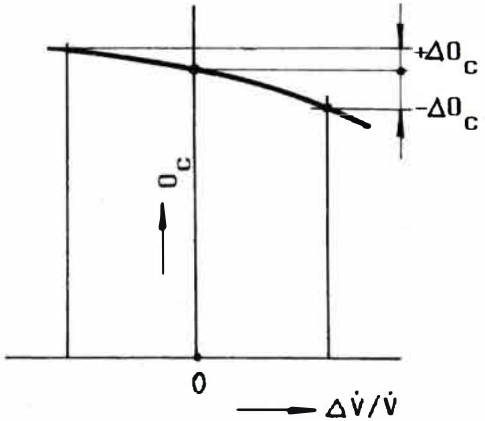
Centripetal separators







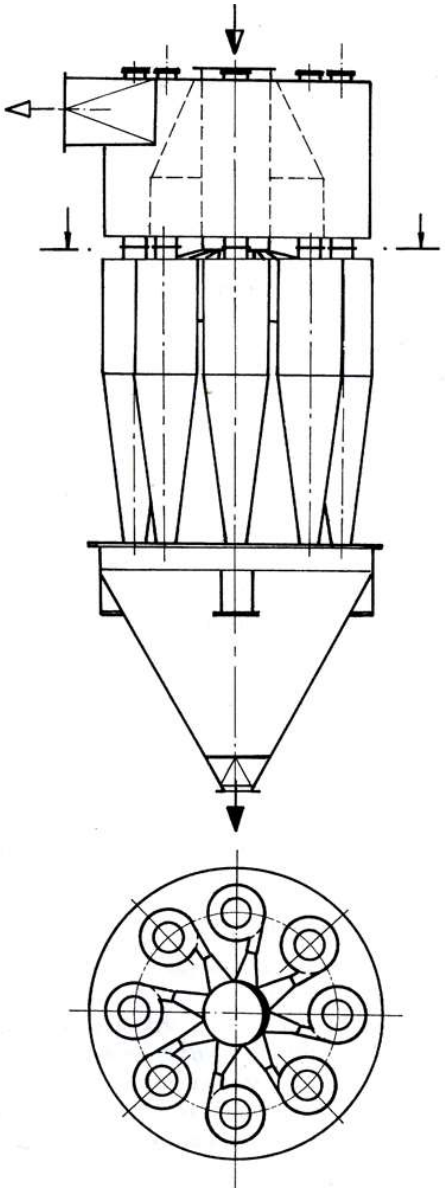


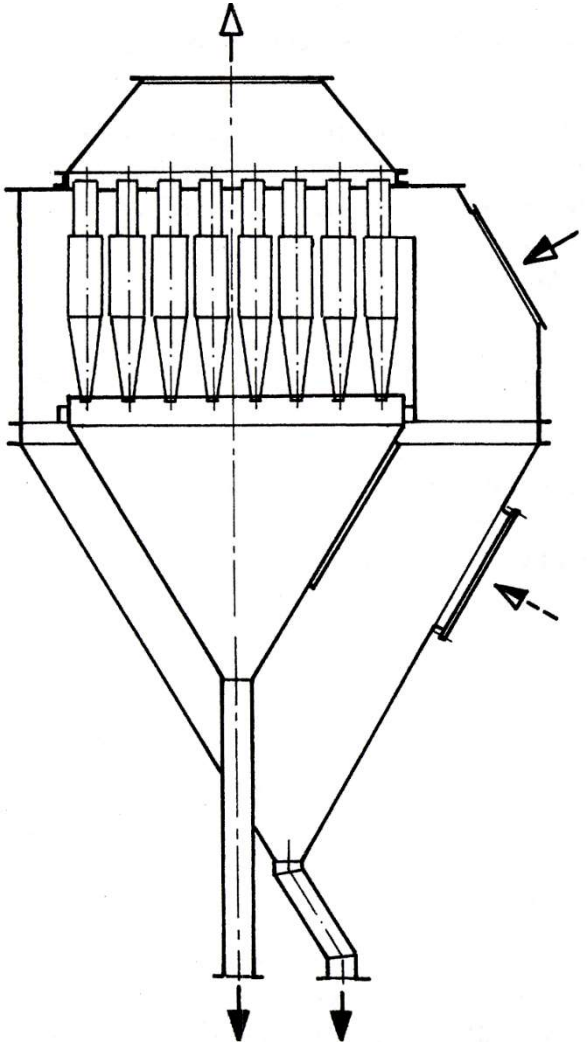


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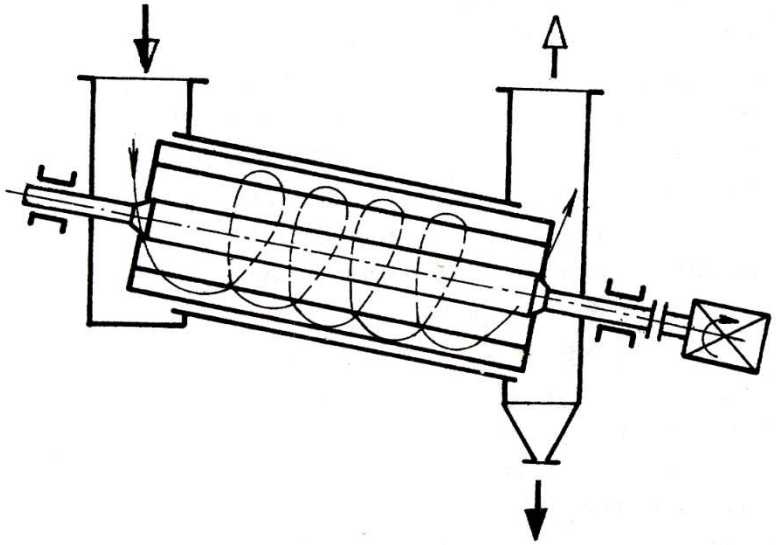
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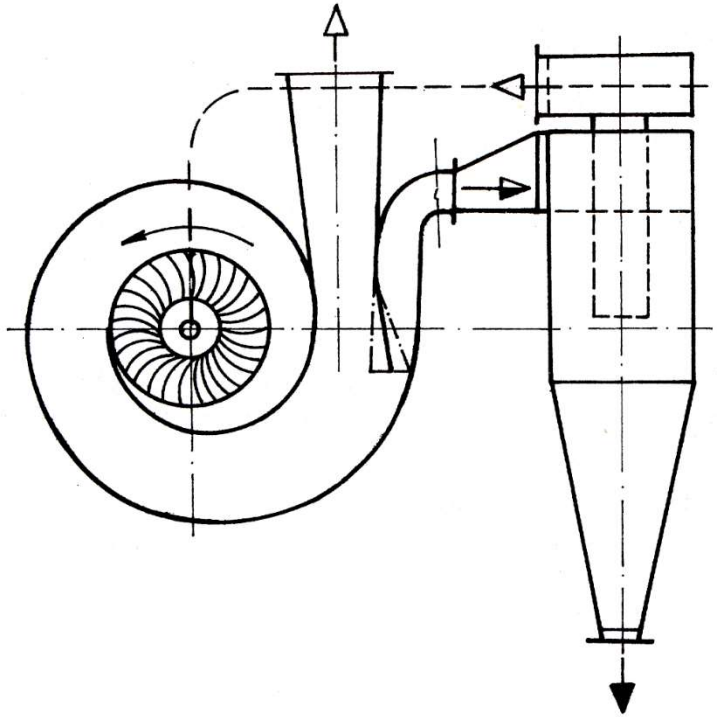
Group x battery separators





Rotational separators





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