

**REVERSE FLOW CYCLONES FOR  
COLLECTION OF TEA DUST**

**M.Sc (Chemical and Process Engineering)**

**I.M.B.M. De Silva**



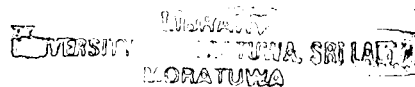
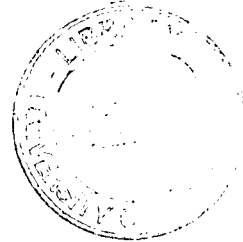
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# REVERSE FLOW CYCLONES FOR COLLECTION OF TEA DUST

By

**I.M.B.M. De Silva**



This Thesis was submitted to the Department of Chemical and Process Engineering of the University of Moratuwa in partial fulfillment of the Degree of Master of Science in Chemical and Process Engineering

**Department of Chemical and Process Engineering  
University of Moratuwa  
Sri Lanka**

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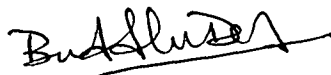
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## DECLARATION

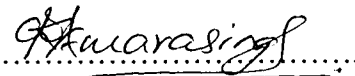
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.....  
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To the best of my knowledge, the above particulars are correct





.....  
Supervisor  
(Dr. B.M.W.P.K. Amarasinghe)

## ABSTRACT

Reverse flow cyclones are used most extensively in the chemical process industries for gas – solid separation. Cyclones are often employed to collect large particles ( $>5\mu\text{m}$ ) that can be used not only as an air pollution control device, but also for recover particulate matter and size separation of particles. Common features found in locally designed cyclones are ineffective and crudely designed. Design of cyclone is more towards realizing a shape of the cyclone than the performance. Customized design approach gives a cyclone with greater collection efficiency, smaller in size or with lower pressure drop that would be found for a conventional standard design. Since the customized design procedure requires trial and error calculations, this research focused on the importance of the development of a computer package: “CycDesign”.

Using this package, a pilot scale reverse flow cyclone is designed and fabricated. This unit was used to examine the suitability of abating the air pollution caused due to dust generated from the fluidized bed dryers in tea industries. Trials were also done for sawdust, cement, quarry dust, talc powder and silica sand. Inlet and outlet particle size distributions were measured. Above 90% Overall collection efficiencies were attained for all the types of dust tested. For tea dust 99.2% collected experimentally which was predicted as 100% by the computer package. Also the computer package can be used to predict performance and dimensionless parameters for a cyclone design. It predicts that a continual decrease of Stokes number based on cut diameter, with increasing Reynolds number  $Re$ , for cyclones having different height to diameter ratio  $H/D$ . According to predictions, collection efficiency increases with  $H/D$  ratio of the cyclone. The declining patterns of fractional efficiency can be visualized with decreasing pressure drop across the cyclone and particle density. A decrease in fractional efficiency can be observed with the increasing of gas flow rate, gas temperature, and gas density.

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## NOMENCLATURE

$\Delta H$	Pressure drop expressed as number of inlet velocity heads
$\Delta P$	Pressure drop
$\mu$	Gas viscosity
$\psi$	Cyclone inertia parameter
$\eta$	Efficiency Captured fraction
$\rho_G$	Gas density
$\rho_p$	Particle density
$Stk_{50}$	Stokes number based on cut diameter
$\bar{v}$	Escaped fraction
$\eta_{fractional}$	Fractional efficiency
$\eta_{overall}$	Overall efficiency
$a$	Gas entry height
$A_c$	Interior collecting surface of the cyclone
$b$	Gas entry width
$B$	Dust outlet diameter
$C$	Cyclone geometry factor
$C_a$	Allowable outlet dust concentration
$C_i$	Inlet dust concentration
$C_o$	Outlet dust concentration
$D$	Cyclone cylinder diameter
$D_e$	Gas outlet diameter
$d$	Particle diameter
$d_{100}$	Critical particle diameter
$d_{50}$	Cut particle diameter
$F_c$	Centrifugal force acting on particle
$F_d$	Drag force acting on particle
$H$	Cyclone overall height
$h$	Cyclone cylinder height
$n$	Vortex exponent

$N$	Number of turns gas makes within cyclone
$n_1$	Vortex exponent at gas temperature at $T_1$ ( usually 283 K)
$n_2$	Vortex exponent at gas temperature at $T_2$ K
$P$	Pressure drop factor
$Q$	Volumetric gas flow rate
$r$	Radial distance from cyclone axis
$Re$	Reynolds number
$r_w$	Radial distance from cyclone axis to cyclone wall
$S$	Gas outlet height
$t$	Time
$T_1$	Gas temperature corresponding to vortex exponent, $n_1$
$T_2$	Gas temperature corresponding to vortex exponent, $n_2$
$u_r$	Radial component of particle velocity
$u_t$	Tangential component of particle velocity
$v$	Gas velocity
$v_i$	Gas inlet velocity
$v_r$	Radial component of gas velocity
$v_t$	Tangential component of gas velocity
$v_{tw}$	Gas tangential velocity at cyclone outer wall
$w$	Migration velocity of the particle
$Z$	Natural vortex length

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