Aalto University
Chemical Engineering

HYDROCYCLONE

___ / ___ 200__
Work done

____
Made by

____
Student number

MARKINGS:

Given in:	___ / ___ 200__	____________________	
Examined:	___ / ___ 200__	____________________	**RET / PASSED**
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Passed:	___ / ___ 200__	____________________	

1. GENERAL

Thickening of a fluid with a hydrocyclone was studied in this laboratory work. Feed flow rate, pressure difference, and the solids concentration of the exiting flows was measured in this work, and the feed flow rate was the altered variable.

Only simple mass and energy balances were are used when calculating the efficiencies and energy losses.

Finally, a rough estimate for cut size of the process is calculated.

2. SOLIDS CONCENTRATIONS

Solids concentrations were determined by weighting the samples before and after evaporation. A summary of calculations of solids concentrations is shown on sheet 13-cycl-en.xls.Concentrations in appendix 1.

Mass fraction of solids is calculated from the measuring data as follows (experiment #______ as an example):

w_F =

3. MASS BALANCE

The following calculations are done by using experiment #_____ as an example.

The volume flow rate of the feed was measured and it is converted to mass flow rate:

F =

Now, the unknown mass flows O and U can be calculated:

O =

U =

A summary of the calculations is shown on sheet 13-cycl-en.xls.Balance-and-Eff in appendix 2.

4. SEPARATION EFFICIENCIES

The following calculations are done by using experiment #_____ as an example.

Hydrocyclone, with which given slurry is handled, can be controlled only by controlling the flow rate. So, the results of the calculations are given as a function of either flow velocity or flow rate.

Diameter of the inlet pipe is D_i =

Then the velocity of feed flow is:

u_i =

Diameter of the piping system is D =

So, the flow rate in the piping system is:

u =

Separation efficiency can be calculated in many ways from the flow rates and concentrations. A summary of calculations is shown on sheet 13-cycl-en.xls.Balance-and-Eff in appendix 2.

In appendix _____ is shown $E_1 = w_O$, in appendix _____ is shown $E_2 = w_U$, and in appendix _____ is shown E_7 = O/U as a function of _____________________________.

Also, in appendix _____ is shown _____, which with the previous describes the best the change of separation efficiency as a function of _____________________________.

5. CUT SIZE

The following calculations are done by using experiment #_____ as an example.

5.1 Residence Time

The cross-sectional area of the flow **is assumed** to be an annulus constrained by diameters D and D_o and the distance which the fluid flows in the cyclone, is the length L of the cyclone.

The cross-sectional area of the flow is

A_A =

The axial velocity is

u_A =

Then the residence time of the fluid in the cyclone is:

τ =

5.2 Sinking Time of a particle through the Whole Flow Layer

The depth of the whole flow layer is:

S =

The sinking speed of a particle, which diameter is d_p = _____________ m, obtained from the Stokes law is:

u_p =

Sinking time of the particle through the whole flow layer is:

t_n =

Since the sinking time of the particle is greater/smaller than the residence time of the fluid in the cyclone, the particle has time/does not have time to sink through the whole layer.

5.3 Sinking Speed of Cut Size

Next, the cut size d_{50} is considered. If a particle has time to sink 50 % of the depth of the flow layer during the residence time τ, it has a 50 % probability to end up in the underflow. In such case, the velocity of the particle has to be:

u_p =

5.4 Cut Size

Normal acceleration based on the inlet velocity in the top of the hydrocyclone is

a =

Assuming that particle sinks with a constant speed obtained from the Stokes law, can the cut size d_{50} be calculated as follows:

d_{50} =

A summary of the cut size calculations is shown on sheet 13-cyclo-en.xls.Cut-size in appendix 3. In appendix ____ are shown cut sizes d_1, d_{50}, and d_{100} as a function of _________.

6. ENERGY LOSSES

The following calculations are done by using experiment #_____ as an example.

6.1 Losses in Cyclone

Loss of mechanical energy in the cyclone is (assumed that flow is turbulent, so α=1):

P_h =

6.2 Losses in Piping System

Flow velocity in the piping is u =

Reynolds number (for water) Re =

Friction factor inside pipe (smooth pipe) ξ =

Length of piping system L =

Diameter of piping system D =

Sum of friction factors due to fittings and valves $\sum \zeta_i$ =

Loss of mechanical energy in the piping system is:

P_h =

6.3 Losses in Pump

Electrical power of motor of the pump P_E =

Efficiency of the motor η_E =

Brake power P_B =

Mechanical efficiency η_p =

Loss of mechanical energy in the pump is

P_h =

6.4 Total Losses and Temperature Rise

Total rate of loss of mechanical energy in the system is:

P_h =

Generation power of heat energy is:

$P_{H,GEN}$ =

Rate of temperature rise in the system is

$$\frac{dT}{dt} =$$

Due to this temperature rise rate, the temperature of the system would increase

ΔT =

in 10 minutes.

A summary of losses and temperature rise is on sheet 13-cycl-en.xls.Losses is shown in appendix 4.

7. INCORRECT ESTIMATE AND CONCLUSIONS

8. APPENDICES