EXPERIMENTAL INVESTIGATION ON THE EFFECT OF PLUNGING PIPE DIAMETER CHANGE IN CYCLONES TO THE PERFORMANCE OF CYCLONES

by

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Original scientific paper
https://doi.org/10.2298/TSCI221107116B

In this study, in the cyclone designed according to the high-efficiency Stairmand model, three different immersion pipe diameters, four different flow rates, and two different samples were used to examine the pressure loss and dust holding efficiency that affect the cyclone performance. Cyclone separators are fixed-part devices used in the process of separating particles from the gas by forming vortexes with a gas stream containing solid particles. In cyclone separators, the parameters that have the most significant impact on their performance are dust collection efficiency and pressure loss. In this study, temperature measurement with thermocouple and pressure measurement with digital pressure measurement device were made at the inlet and outlet parts of the cyclone. Dust retention efficiency was calculated by the ratio of the weight of the dust entering the cyclone to the weight of the dust accumulated in the dust collection chamber at the end of the experiment. In addition, the obtained data were analyzed by means of SOLIDWORKS FLOW simulation program and compared with the experimental study. The best result in dust retention efficiency in the coal sample was obtained with 374.85 m³ per hours flow rate and Ø114.3 mm plunge pipe diameter. In the biomass sample, the best dust holding efficiency was obtained with an Ø88.9 mm plunge pipe diameter at a flow rate of 374.85 m³ per hours.

Key words: *cyclone, plunge pipe diameter, pressure loss, efficiency*

Introduction

Cyclone separators are one-piece devices that provide separation of solid particles from the gas by the centrifugal force of the solid-gas mixed phase. Today, cyclones are generally used in fields such as engineering, chemistry, textiles, sample separation and recycling. It provides fluid, tangential entry in the cyclone and the vortex provides movement formation. The fluid in the cyclone forms a relative path in the radial direction with different inertial force thanks to the vortex. With this centrifugal force created, a large part of the dense phase is removed from the fluid. Two different vortices form within the cyclone. The gas-solid phase, which is sent through the first vortex fan, passes through the inlet cross-section. The phase hits the cylindrical inner surface, creating a helical motion. Thanks to the centrifugal force, the solid-gas phase is separated from each other. Heavy particles that cannot attach to the air go down, and small particles leave the cyclone through the outlet pipe with gas.

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Numerous studies have been conducted to increase the cyclone yield. Xiang *et al.* [1] in this study, the effect of cyclone cone size on performance was examined. The collection efficiency, particle size and flow rate of cyclones with three different cone base diameters were measured. When the cyclone cone diameter is greater than the gas outlet diameter, it allows higher collection efficiency to be achieved without increasing the pressure drop. Hsiao *et al.* [2] in this study, systematic experimental investigations were conducted to investigate the different effects of a cyclone on the cyclone performance of geometric configurations and optimal ranges for geometric aspect ratios were proposed. Analysis was performed for the cyclone body, cyclone cone and vortex length as per the four cyclone geometric components. A cyclone with a short and wide cone has a steeper cutting curve than one with a long and sharp cone. Although a cone cyclone results in higher collection efficiency, the slope of the efficiency curve is less steep than the cone less one. Brar, *et al.* [3] in their study, the effect of the cyclone model change in cylinder and cone lengths on cyclone performance was examined. In addition, two geometric variables were compared in ten different data according to the performance and speed area. As the cylinder length increased relative to the cyclone diameter, an increase in pressure loss and an increase in collection efficiency were observed. As the cone length increases relative to the cyclone diameter, the pressure loss decreases, and the collection efficiency increases. The pressure and collection efficiency parameters affecting the performance of Elsayed and Lacor [4] cyclone separators were examined. As a result of the experiment, it was determined that cyclone performance was superior in design analysis. Fu *et al.* [5] is an efficient gas-flow path and a connected vortex-inertia separation mechanism used in cyclone separators to reduce the rotating density by adding vortex locator and minimize flow instability in the separator. In their studies, the effects of vortex finders on the improvement of flow fields and the corresponding performance in cyclone separators were examined. El-Batsh [6] this study aimed to optimize the dimensions of the plunge outlet pipe to improve cyclone performance. Calculations were made and numerical results were compared with experimental measurements. Martignoni *et al.* [7] in this study, the effect of cyclone geometry was examined by creating a symmetrical input and output section in an experimental cyclone and comparing it with tangential input. The results showed that the new designs significantly influenced cyclone performance parameters and found different details in cyclone fluid dynamics properties using RSM-LES. Dirgo and Leith [8] conducted experimental work using the highly efficient cyclone Stairmand [9] had developed. In line with the results obtained, it was determined that the data obtained with particles larger than 10 μm were more suitable for the theoretical approach. Bhaskar *et al.* [10] in the first study, different turbulence models, and experimental and simulated plunge pipe outlets were designed to suit. The increase in cyclone inlet pressure also increased tangential velocities and reduced the cyclone cut size. Using the particle injection technique, the distribution values were found to be consistent with the experimental results while obtaining between 4.9 μm and 14.0 μm. Farias *et al.* [11] in this study, the effect of geometric parameters (vortex locator diameter) and solid concentration on the separation process from the input phase is examined numerically. A numerical solution of the main equations is compared with the ANSYS program. Current lines, pressure drop and separation efficiency parameters in the cyclone were analyzed. It has been observed that particle concentration and cyclone geometry affect separation efficiency. Hosseini *et al.* [12] in this study, the effects of inlet flow rate, sample volume rate and sample droplet diameter on separation yield and pressure drop rate along the cyclone body were investigated. The CFD technique was used using simulations, Eulerian multiphase model, and Reynolds stress turbulence model. The results of the simulations were compared with the experimental data.

However, the sample volume fraction showed little effect on the hydrodynamic flow behavior in the cyclone body compared to the other parameters investigated. Li and Chen [13] to test the effect of operating temperatures on cyclone performance, an experimental study was conducted in the tangential inlet cyclone with particle separation in reverse flow, 300 mm diameter and heated air up to 973 K. The optimum inlet velocity of the cyclone, which has the highest separation efficiency, increases with the increase in temperature.

In this study, the cyclone was designed according to the high-efficiency Stairmand model. Experiments were carried out using three different immersion pipe diameters in the cyclone. A total of twenty-four different data were obtained with two different samples and four flows in diameter of each plunge pipe. The pressure loss affecting the cyclone and the dust collection efficiency were examined by using pulverized coal and biomass (corn stalk).

Materials and methods

The general test equipment manufactured consists of sheets and pipes. The schematic view of the experimental set-up is shown in fig. 1.

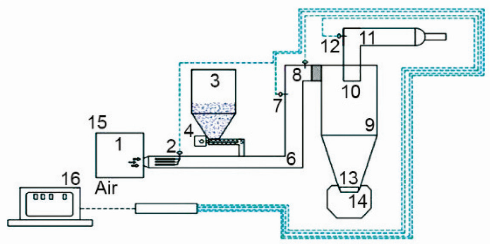


Figure 1. Schematic set-up of experimental study; *1 – fan, 2 – temperature, 3 – pattern bunker, 4 – reducer, 5 – helix pipe, 6 – pipe, 7 – temperature probe, 8 – pressure measurement station, 9 – cyclone, 10 – plunge pipe, 11 – plunge outlet pipe, 12 – klape, 13 – ash collection chamber, 14 – frequency inverter, and 15 – automation system*

The list of equipment included in the experimental set is given in tab. 1.

Table 1. Test Assembly Material List

Component		Specification – value
Plunge pipe	3 Pieces	Ø88.9 mm, Ø114.3 mm, Ø139.7 mm
Inlet-outlet pipe	1 Piece	Ø114.3 mm
Concentric reduction	2 Pieces	4" × 3" mm
Patent elbow	3 Pieces	Ø114.3 mm 90°
Fan (inverter)	1 Piece	Maximum flow: 450 m³ per hours. Engine power: 3 kW, 2850 d/dk
Pressure Transmitter	1 Piece	Measurement differential pressure: –5000...+5000 Pa
Resistance	3 Pieces	30 °C (4 kW)
Reducer	1 Piece	0.37 kW, 220 V 50 Hz
Screw shaft	1 Piece	Ø28 mm L:820 mm
Control panel	1 Piece	
Temperature probe	1 Piece	30 °C, 4 kW
Bunker	1 Piece	0.75 m³

The prepared test set is shown in fig. 2. Information about the elements used in the experiment set is given further in the text..

Figure 2. Test assembly and control panel image

Biomass (corn straw) and coal samples with plunge pipes are given in fig. 3.

Figure 3. Three different plunge pipes and two different samples

Due to the direction of departure of the pipes, they were manufactured as straight and patent elbows. The bunker with a volume of 0.75 m^3 is designed to be connected to the screw shaft. The reducer, which provides rotational movement at a motor power of 0.37 kW connected to the screw shaft, ensures that the sample is transferred to the channel with the leaf blades of the shaft. In the experiment established to separate solid particles in cyclone separators, air is sent to the channel with four different flow rates thanks to a 2850 rpm 3 kW fan with frequency inverter. In order to prevent the air tightness of the flanges, a seal was placed between them, and a bolt-nut connection was made. The layout design of the resistors was made to heat the air inside the channel. Three resistance channels with a temperature of 30 °C with a power of 4 kW connected to the fan are placed in the channel. The resistance cables are connected to the control panel thanks to a zone opened from the channel. Reduction opening plate was manufactured and boiled to the cyclone. Biomass (corn stalk) and coal samples were used in the cyclone experimental set with a high efficiency Stairmand model. Before the test, the weights of two different samples were measured on the balance. The samples are transferred to the bunker respectively. In this way, the air entering the channel reaches the desired temperature and provides a mixture with solid particles. A probe cable is inserted into the cyclone inlet pipe so that the temperature can be detected from the control panel. Measuring probes are installed in the cyclone inlet section and outlet pipe areas. With the digital pressure measuring device, the input-output values of pressure and temperature were measured.

Solidworks flow simulation analysis

Cyclones are designed using appropriate theoretical relations based on dimensionless efficiency curves and pressure loss coefficients. The most important geometric dimensions in cyclones are the inlet and outlet sections, and they can be listed as cyclone length, cone tip diameter and plunge pipe diameter. Cyclone sizing for different uses is given in tab. 2.

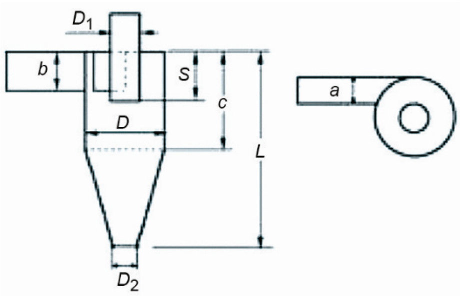
Table 2. Standard cyclone design sizing

Cyclone type	Purpose of use	D_1	b/D_1	a/D_1	D_2/D_1	S/D_1	c/D_1	L/D_1	D_3/D_1
Stairmand	High performance	1	0.5	0.2	0.5	0.5	1.5	4.0	0.37
Swift	High performance	1	0.44	0.21	0.4	0.5	1.4	3.9	0.4
Lapple	General purpose	1	0.5	0.25	0.5	0.62	2.0	4.0	0.25
Swift	General purpose	1	0.5	0.25	0.5	0.6	1.75	3.75	0.4
Stairmand	High flow	1	0.75	0.37	0.75	0.87	1.5	4.0	0.37
Swift	High flow	1	0.8	0.35	0.75	0.85	1.7	3.7	0.4
Leith-Mehta	General purpose	1	0.43	0.17	0.68	1.2	3.0	5.0	0.37

The cyclone model designed in accordance with the geometric features of the high-efficiency Stairmand model is given in fig. 4.

The appropriate dimensions are given in fig. 5 by taking the coefficients according to the high-efficiency Stairmand model.

Flow analysis was performed in the SOLIDWORKS FLOW SIMULATION program to examine the pressure loss and dust retention efficiency that affect performance in cyclone separators. As can be seen in fig. 6, modeling was made according to the chimney fan. The cyclone model with a diameter of 300 mm and a length of 1200 mm was designed. Four different flow rates are heated at 30 °C, respectively, from the fan and sent to the channel. At the same time, the particles sent from the bunker are mixed with the air in the channel and transmitted to the cyclone. For dust retention efficiency, six different micron sizing particles are formed, and vortex movement is created from the inlet section with an area of 150 mm × 80 mm to the cyclone diameter. As a result of the vortex movement, heavy particles are separated from the cone end and small non-adherent particles are sent to the chimney fan with air.



b/D_1	a/D_1	D_2/D_1	C/D_1	$L\text{-}c/D_1$	S/D_1	D_d/D_1
0.5	0.2	0.5	1.5	2.5	0.5	0.375

Figure 4. Cyclone design modeling

Experimental study

In the experimental set, three different plunge pipe diameters were applied as a geometric design. The pipes were welded to the flanges. Capacity differences were observed

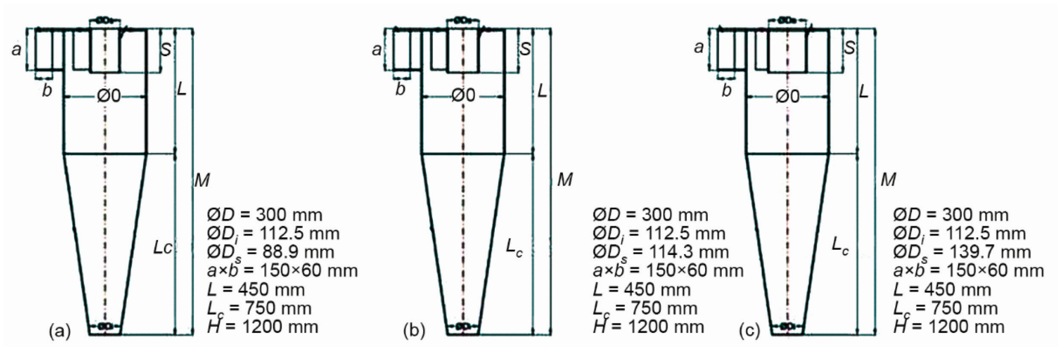
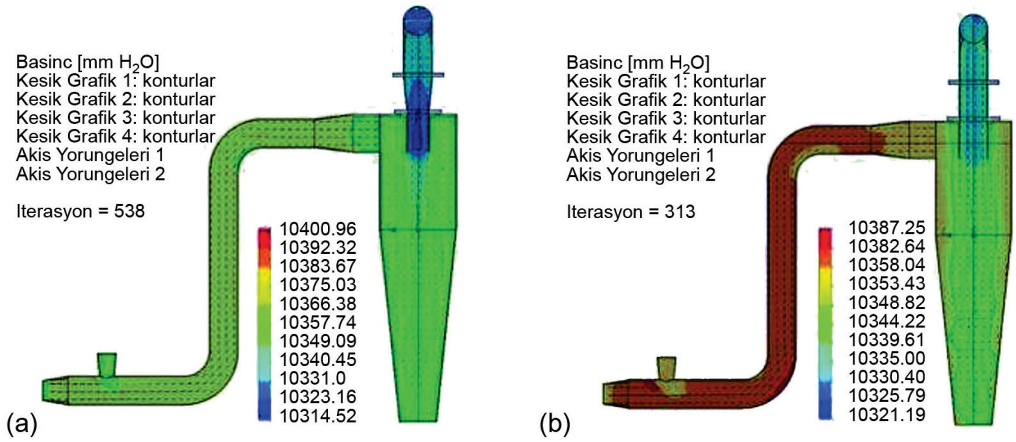


Figure 5. Cyclone plunge pipe diameter features



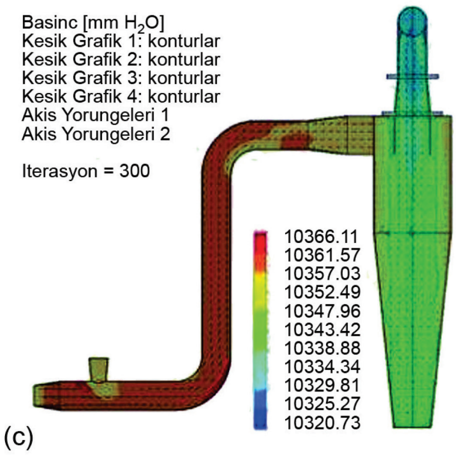


Figure 6. Cyclone flow analysis with diameters of 88.9 mm, 114.3 mm, and 139 mm plunge pipe

using four different flow rates in the experiment. The values of the flow rates were given as 450 m³ per hours, 374.85 m³ per hours, 299.7 m³ per hours, and 225 m³ per hours, respectively. The solid-gas mixture entering the cyclone is gradually sent to the vortex at a certain speed with the air sent and heavy particles accumulate in the ash collection chamber at the cone end. The total efficiency rate was determined by measuring the weight of the particles deposited in the ash collection chamber. Small particles that attach to the air leave the cyclone through the outlet pipe with the diameter of the plunge pipe. In the experiment, geometric variability was created by using three different plunge pipe diameters 88.9 mm, 114.3 mm, and 139.7 mm. In the study, a cyclone with three different immersion pipe diameters, two different samples and four different flow rates were used. Sieve analysis was created for two different samples. In the analysis, five different sieves were used. The screens with dimensions –35 μm, 38-45 μm, 45-75 μm, 75-500 μm, 500-850 μm, +850 μm are stacked on top of each other. In the top of the lined sieves, 286.35 g of coal and 215.91 g of biomass are placed, respectively. After the samples passed through each sieve, their weight was calculated by making a size classification.

Conclusions and discussion

Flow analysis was performed in SOLIDWORKS FLOW simulation to examine pressure loss and dust retention efficiency parameters in cyclone separators. The analysis table for four different flow rates and three different plunge pipe diameters for coal and biomass fuel is given in tab. 3.

Table 3. Biomass and coal pressure loss data of SOLIDWORKS FLOW analysis

Pattern	Value	Flow [m^3h^{-1}]	Plunge pipe diameter		
			139.7 mm	114.3 mm	88.9 mm
Coal	Pressure loss [mmSS]	450	83.71	85.8	109.92
		374.85	59.9	71.7	72.75
		299.7	34.73	36.66	51.88
		255	26.1	26.41	36.83
Biomass	Pressure loss [mmSS]	450	69.51	83.99	104.1
		374.85	59.95	60.48	74.65
		299.7	39.69	36.75 m	49.9
		255	27.38	27.61	36.4

The pressure loss analysis graph by changing the plunge pipe diameter of coal and biomass samples is given in fig. 7.

In the study carried out with coal and biomass samples, it is seen in fig. 7 that the pressure loss decreases as the diameter of the plunge pipe increases. In the dust retention efficiency analysis, 100 particles were sent from the cyclone cross section inlet with sizes between –5 μm and +30 μm. The result data of the number of particles coming out of the chimney were taken in the flow rate, sample and immersion pipe diameter changes. A dust retention efficiency analysis of four different flow rates and three different plunge pipe diameters for biomass is given in tab. 4. The particles accumulated in the cyclone conical part give the dust retention efficiency.

Depending on the table, the pressure loss analysis graph by changing the plunge tube diameter of the biomass sample is given in fig. 8.

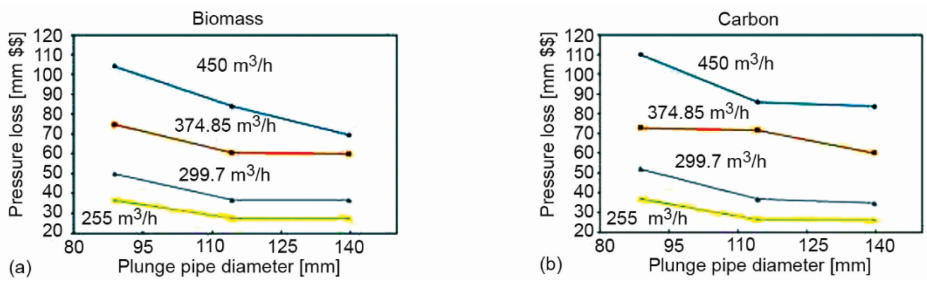
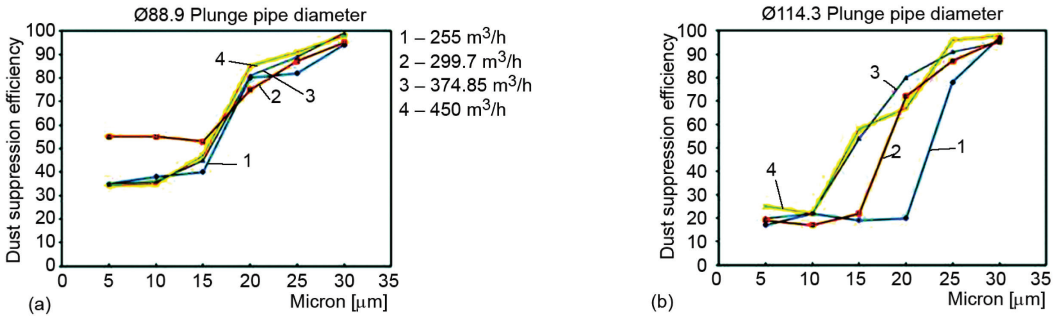


Figure 7. Biomass and coal pressure loss diameter [mmSS]

Table 4. The SOLIDWORKS FLOW analysis dust retention efficiency of biomass sample

Biomass											
Plunge pipe diameter	Flow [m^3h^{-1}]	Micron [μm]	Dust suppression efficiency	Plunge pipe diameter	Flow [m^3h^{-1}]	Micron [μm]	Dust suppression Efficiency	Plunge pipe diameter	Flow [m^3h^{-1}]	Micron [μm]	Dust suppression efficiency
DN80	450	5	5	DN100	450	5	2	DN125	450	5	2
		10	20			10	6			10	5
		15	21			15	6			15	13
		20	76			20	52			20	77
		25	90			25	76			25	88
		30	97			30	94			30	93
	374.85	5	15		374.85	5	1		374.85	5	2
		10	17			10	2			10	4
		15	19			15	6			15	12
		20	89			20	58			20	40
		25	94			25	83			25	75
		30	98			30	96			30	91
	299.7	5	3		299.7	5	3		299.7	4	34
		10	19			10	5			10	35
		15	33			15	14			15	52
		20	95			20	68			20	94
		25	96			25	97			25	95
		30	98			30	99			30	96
	255	5	35		255	5	1		255	5	2
		10	44			10	10			10	9
		15	52			15	9			15	26
		20	88			20	93			20	67
		25	94			25	97			25	78
		30	96			30	99			30	93



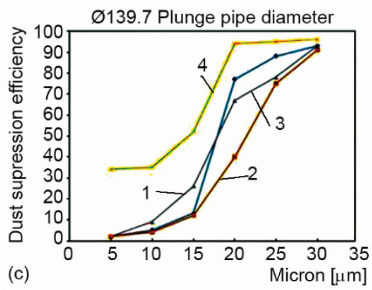


Figure 8. Biomass dust suppression efficiency

In the biomass analysis, three different plunge pipe diameters and dust retention efficiency at four different flow rates were examined. It has been determined that as the micron size increases, the yield increases in general. When the best dust retention efficiency is reached, the diameter of the immersion pipe is 88.9 mm, the flow rate is 450 m³ per hours, the diameter is 114.3 mm, the flow is 450 m³ per hours, and the 139.7 mm flow rate is 255 m³ per hours. The best efficiency in three different immersion pipe diameters is the data where the immersion pipe diameter is 114.3 mm and the flow rate is 450 m³/h. Dust retention efficiency analysis for four different flow rates and three different plunge pipe diameters for coal is given in tab. 5.

Depending on the table, the pressure loss analysis graph by changing the plunge pipe diameter of the coal sample is given in fig. 9.

In the coal analysis, three different plunge pipe diameters and dust retention efficiency at four different flow rates were examined. It has been determined that as the micron size increases, the yield increases in general. In the best dust retention efficiencies, the immersion pipe diameter is happening at 88.9 mm flow rate 450 m³ per hours, 114.3 mm flow rate 374.5 m³ per hours and 139.7 mm flow rate 374.5 m³ per hours. The best efficiency in three different immersion pipe diameters has been achieved with values of 88.9 mm and flow rate of 450 m³ per hours.

Results of the experimental study

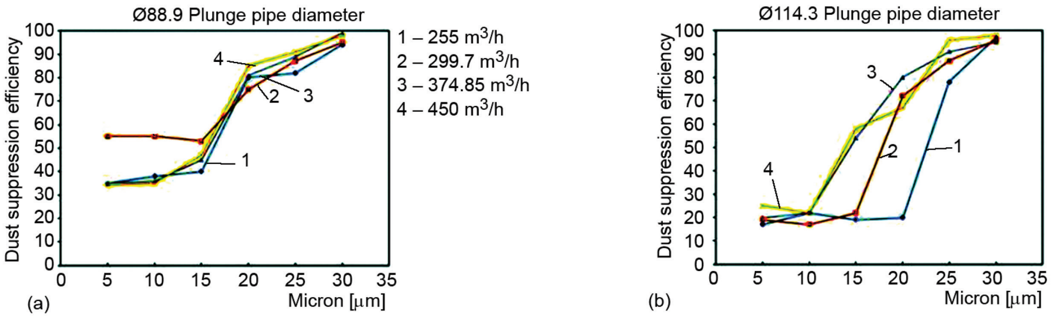
An experimental study was carried out after the analysis according to the parameters of pressure loss and dust retention efficiency affecting the performance of cyclone separators. The values of biomass and coal dust retention efficiency as a result of experimental study are given in tab. 6.

As a result of the experimental study, the graphical document of the dust retention efficiency the table is given in fig. 10.

Flow rates have been changed considering dust retention efficiency. Highest dust retention efficiencyis achieved when the diameter of the plunge pipe is 114.3 mm, and the flow rate is 374.5 m³ per hours in coal and when the diameter of the plunger pipe is 88.9 mm, and the flow rate is 374.5 m³ per hours in biomass._As a result of the experimental study, the pressure drop values of biomass and coal are given in tab. 7.

Table 5. SOLIDWORKS FLOW analysis dust retention efficiency of coal sample

Coal											
Plunge pipe diameter	Flow [m^3h^{-1}]	Micron [μm]	Dust suppression efficiency	Plunge pipe diameter	Flow [m^3h^{-1}]	Micron [μm]	Dust suppression Efficiency	Plunge pipe diameter	Flow [m^3h^{-1}]	Micron [μm]	Dust suppression efficiency
DN80	450	5	95	DN100	450	5	98	DN125	450	5	98
		10	80			10	94			10	95
		15	79			15	92			15	87
		20	24			20	48			20	23
		25	10			25	24			25	12
		30	3			30	6			30	7
	374.85	5	85		374.85	5	99		374.85	5	98
		10	83			10	98			10	96
		15	81			15	94			15	88
		20	11			20	42			20	60
		25	6			25	17			25	25
		30	2			30	4			30	9
	299.7	5	97		299.7	5	97		299.7	4	66
		10	81			10	95			10	65
		15	67			15	86			15	48
		20	5			20	32			20	6
		25	4			25	1			25	5
		30	2			30	1			30	4
	255	5	64		255	5	99		255	5	98
		10	56			10	90			10	81
		15	48			15	91			15	84
		20	12			20	7			20	33
		25	6			25	3			25	22
		30	4			30	1			30	7



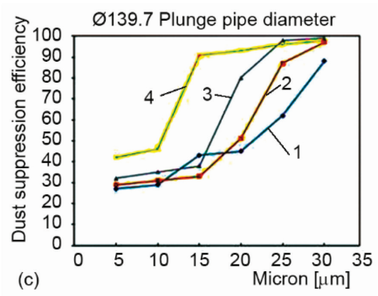


Figure 9. Coal dust suppression efficiency

Table 6. Dust Retention Efficiency of Biomass and Coal in Experimental Study

Pattern	Value	Flow [m^3h^{-1}]	Plunge pipe diameter		
			139.7 mm	114.3 mm	88.9 mm
Biomass	Dust suppression efficiency [kg]	450	0.85	0.74	0.89
		374.85	0.82	0.8	0.97
		299.7	0.78	0.68	0.75
		255	0.86	0.96	0.84
Coal	Dust suppression efficiency [kg]	450	0.67	0.81	0.73
		374.85	0.85	0.95	0.74
		299.7	0.61	0.72	0.93
		255	0.47	0.59	0.94

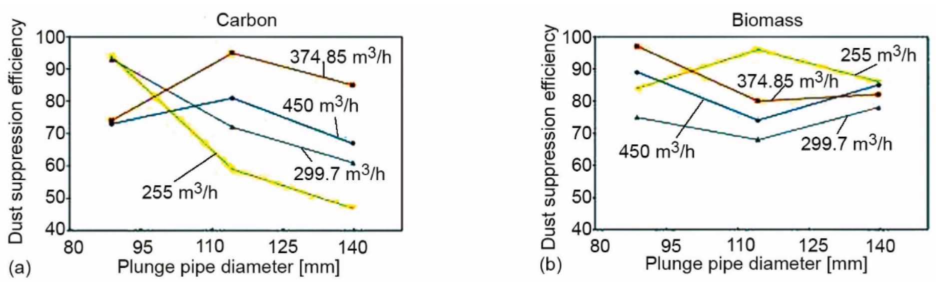


Figure 10. Biomass and coal dust suppression efficiency in experimental study

Table 7. Pressure loss of biomass and coal in experimental study

Pattern	Value	Flow [m³h⁻¹]	Plunge pipe diameter		
			139.7 mm	114.3 mm	88.9 mm
Coal	Pressure loss [bar]	450	22.4	24.34	27.97
		374.85	14.02	27.28	19.8
		299.7	8.17	11.1	12.5
		255	4.19	5.81	6.03
Biomass	Pressure loss [bar]	450	26.6	26.49	36.17
		374.85	15.36	19.56	24.74
		299.7	10.84	10.88	15.14
		255	6.15	6.49	7.35

As a result of the experimental study, the graphical document of the pressure drop according to the table is given in fig. 11.

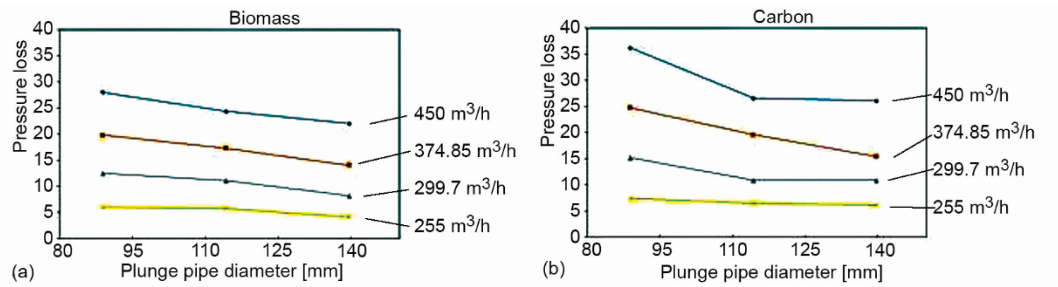


Figure 11. Biomass and coal pressure loss

In fig. 11, for coal and biomass samples, the pressure loss decreases as the diameter of the plunge tube increases. Sieve analysis of two different samples was performed in cyclone separators. The weights of the samples were calculated using five different sieves and precision balances. The calculations, the micron weight in biomass and coal fuels is given in tab. 8.

Table 8. Coal and Biomass Sieve Analysis Values

Coal		Biomass	
Micron [µm]	Heft [g]	Micron [µm]	Heft [g]
–38 µm	12.10	–38 µm	3.01
38-45 µm	5.16	38-45 µm	9.87
45-75 µm	17.01	45-75 µm	50.42
75-500 µm	249.49	75-500 µm	151.69
500-850 µm	0.97	500-850 µm	0.46
+850 µm	0.089	+850 µm	0.075

After sieve analysis of coal and biomass samples, particle size analysis was performed in the Mastersizer device. The analysis data is given in figs. 12 and 13. In biomass analysis data, the concentration percentage was given as 0.0116, the surface area as 546.5 m^2/kg, and the analysis time as 1.092 second. The weights of each micron are given according to the volume density-dimension class graph data.

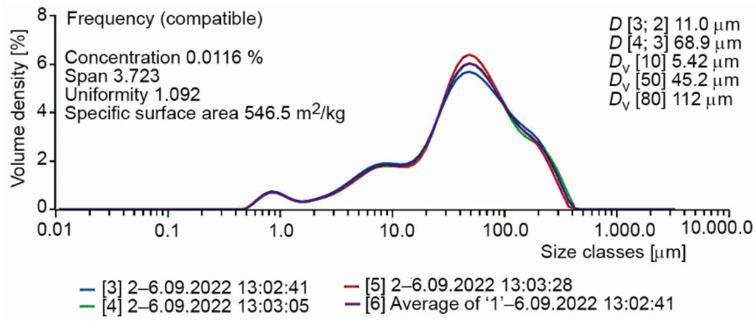


Figure 12. Biomass Mastersizer 3000 laser solid particle analysis

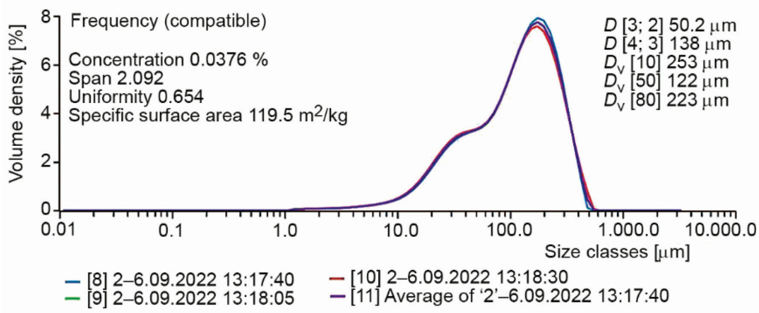


Figure 13. Coal Mastersizer 3000 Laser solid particle analysis

Based on the mass analysis data, the concentration percentage is 0.0116, the surface area is 546.5 m^2/kg, and the analysis time is 1.092 seconds. The *K* factor values of three different immersion pipe diameters are given in fig. 14 in the pressure loss calculation.

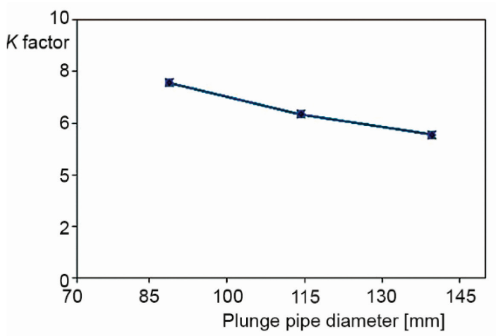


Figure 14. Pressure loss factor calculation

Conclusions

In cyclones, the effect of subduction pipe diameter and flow rate, which affect pressure loss and dust collection efficiency, was both numerically analyzed and experimentally examined using two different samples. Flow analysis is performed in SOLIDWORKS FLOW simulation. In the flow analysis, it was observed that the pressure loss in coal and biomass decreased as the diameter of the plunge pipe increased. In the study, dust retention efficiency in six different micron ranges was investigated. The dust retention efficiency increased as the micron size increased in three different immersion tube diameters for both samples. Moreover, the best dust retention efficiency was obtained with 88.9 mm immersion pipe diameter and 374.5 m³ per hours flow rate in coal and biomass samples. While biomass with a diameter of 114.3 mm has a flow rate of 299.7 m³ per hours and 255 m³ per hours, coal has a flow rate of 299.7 m³ per hours. If tube diameter is 139.7 mm, the biomass flow rate is 255 m³ per hours, while the higher efficiency is obtained in coal with 299.7 m³ per hours. In the experimental study, the pressure loss decreases as the diameter of the plunge pipe increases in biomass and coal. In the study conducted with coal, as the dipped pipe diameter increased at 450 m³ per hours and 374.85 m³ per hours flow rates, first an increase in efficiency and then a decrease occurred. However, yield decreases were observed at 299.7 m³ per hours and 255 m³ per hours flow rates. The best value of dust retention efficiency compared to the coal sample was achieved at a flow rate of 374.85 m³ per hours and a plunge pipe diameter of 114.3 mm.

Based on the biomass sample, variability in the dust retention efficiency parameter was observed. As the plunge pipe diameter increased at flows of 450 m³ per hours, 374.85 m³ per hours and 255 m³ per hours, first a decrease and then an increase in yield was observed. At a flow rate of 299.7 m³ per hours, it was observed that the yield first increased and then decreased. The highest value of dust retention efficiency was achieved at a flow rate of 374.85 m³ per hours and a plunge pipe diameter of 88.9 mm. In both coal and biomass samples, the best yield was 374.5 m³ per hours flow rate. In the sieve analysis, the most abundant micron range in coal and biomass samples passing through five different stages is between 75-500 μm. From the results the diameters of the plunge pipes increased, a decrease in the K factor occurred.

In the study, two different samples were used. For three different plunge pipe diameters, air was sent to the cyclone from the highest flow rate to the lowest flow rate. Thus, the plunge pipe diameter, which affects the cyclone performance, was determined. Based on the flow analysis performed for the pressure loss parameter, the experimental study and the K factor calculation, the pressure loss decreased as the plunging pipe diameter increased. In the dust retention efficiency, there is variability in experimental and flow analysis. Although the dust retention efficiency of flow analysis is increased in general, it has been observed that there is variability based on flow rate and plunge pipe diameter in the experimental study. The large plunge pipe diameter prevented the eddy formed in the cyclone, thus reducing the efficiency. For this reason, the diameter of the immersion pipe should be selected in accordance with the flow rate in order to obtain a good efficiency.

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Paper submitted: November 7, 2022
Paper revised: December 24, 2022
Paper accepted: January 9, 2023