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Case Report

Wood Working Shop Air Dust Collector – A Case Study

Doaa Hanafy[1*], Samir El Gamel[2], Abd El-hay[3], Khaled Tag El din[4]

Abstract

Wood workshops are exposed to a severe ambient of polluted air, and consequently has been associated with increased lung cancer incidences. Current case study proposed a new design for dust collector fan impeller to purify and increase air quality in such harsh working areas. In-House lower cost Centrifugal Blower (CB) was designed, manufactured, and tested for its performance. Such CB mainly consists of one impeller equipped with symmetrical backward - curved centrifugal blower vane, mounted on a rotating shaft and enclosed by a casing. Polluted air is axially drawn to the impeller's eye for energy exchanging along the rotated backward – curved vanes. Experimental measurements were recorded for the flow velocity and pressure at the inlet's eye and the outlet port, at different rotary impeller speeds in the range of 200 to 2,850 rpm. Numerical results and simulations, have shown better performance and 97% correlation between the polluted air pressure with its flow rate of the impeller dust blower fan.

[1]Research and Development Engineer at Engine Factory

[2]Prof. Dr. Dean of Higher Institute for Electronic Engineering at Belbis. and Foreign Faculty Professor at Taxila University

[3]Professor of Mechanical Engineering, Helwan University

[4]Manager in Engine Factory (retired pensioner)

***Corresponding Author's E-mail: doodo.doaa@gmail.com**

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INTRODUCTION

When the air is filled with dirt, dust, debris, chemicals or gasses, it can affect the lungs of anyone who breathes this air in. Not only that, but this particulate can collect on or near equipment, posing a significant fire hazard. With a dust collector, these contaminants are removed from the air, cleaning the air and improving the safety of everyone inside.

As a by-product of the woodworking process, sawdust occurs at practically every phase of the process: when dressing lumber, when cutting out and shaping parts and when smoothing parts. The present study was designed with the latest information needed to choose and implement saw dust control in order to prevent any negative impacts on the environment and human health. Probably the hardest part of dealing with dust is knowing which devices and methods to choose from among the extensive assortment of collection, filtration, and ventilation devices currently available. Different types of operations create different-size chips, from large shavings to fine dust.

Air as one of environmental components is polluted when it contains substances at concentrations that cause harm to human health, as well as when it damages ecosystems and other socially valued materials, such as materials and structures. Figure 1

The present study was able to differentiate the various kinds of dust created in the woodshop because each type of dust is best contained and controlled by a different set of strategies.

centrifugal pumps and blowers are widely used in factories, farm machinery, gasifiers and other buildings.

A centrifugal pump or blower consists essential of one or more impeller equipped with vanes, mounted on a rotating shaft and enclosed by a casing. Fluid enters the impeller axially near the shaft and has energy, both kinetic and potential, imparted to it by the vanes.

With a lowest cost and from the existing material we produced a centrifugal fan for a wood work shop.

wood waste on the environment as well as on human health and the benefits of proper wood waste management practices.

We succeed to design and produced a centrifugal blower system with a lowest cost and existing material, we use Unigraphics nx cad program to design the system

Figure 1. The system blows sawdust from the source

Figure 2. Our system of sawdust control

Figure 3. U-tube manometer

and remove the saw dust from its resource with correlation factor of 80% between velocity and pressure in input and output.

The present study has thus ended with conclusion that Hand operations such as planning a surface with a well-tuned hand plane can remove wide, continuous sheets of wood-not unlike unrolling a roll of paper towels. Figure 2

It was also concluded that a Powerful, well-designed central collection system provides the best means for successfully collecting shavings from woodworking machines. Shop vacuums with small capacity canisters can quickly become overloaded, and long, stringy shavings easily clog the small-diameter (1 -in. to 1X-in.-dia.) hoses found on many models these days.

Procedure to test the backward centrifugal blower

The approach is to make simple measurements, like pressure rise, flow rate, etc. and compare them with the simulation results.

Pressure Measurement

Pressure measurement was done using standard manometers the accuracy and the range of the manometers were selected based on the design requirements. Figure 3

Figure 4. Anemometer

Figure 5. Inverter

Table 1. Measurement Data for Testing the Proposed SSDC-system

Test Run ID	Motor speed N (rpm)	h_{s1} (cm of water)	h_{v1} (cm of water)	h_{s2} (cm of water)	h_{v2} (cm of water)	v_i (m/s)	v_o (m/s)
1.	200	0.5	1	0	0.5	7.6	5.1
2.	1000	2	3.5	3	1	14.3	9.5
3.	1500	4.5	6	1.25	2.5	20	14.6
4.	2100	9	11	3	4.5	27.2	19.5
5.	2200	10	13.5	3	5.5	30.3	20.8
6.	2400	12.5	17	4	7	31.7	21.2
7.	2600	15	19	4	9	34.5	24.7
8.	2850	19	21.5	4	8	36.8	24.8

RPM Measurement

An anemometer was used to measure the blower rpm. These sensors have fast response time and adjustable sensing distance. The rpm value was calculated from the displayed frequency. Figure 4

Velocity inverter

To change the frequency of motor for change the velocity of the bower. Figure 5

Base-Design Simulation and Experimental Data

Pressure values and velocities at various points of motor velocity (Table 2)

Data Reduction

Collected data from experimental runs (Table 1-2) were reduced to air flow rates, and pressures at both the input and output location points. The following Equations and Formulas are used in these data reduction procedures.

Table 2. Experimental Results for the Proposed SSDC-system

Test Run ID	S_{pi} Kg/m^2	V_{pi}	Total pressure (S_p +V_p) At Inlet N/m^2	S_{po}	V_{po}	Total pressure S_p +V_p At Outlet N/m^2	Air flow rate at Inlet (m/s)	Air flow rate at Outlet (m/s)
1.	0.057	0.114	0.171	0	0.057	0.057	7.6	5.1
2.	0.228	0.3998	0.6278	0.343	0.114	0.457	14.3	9.5
3.	0.514	0.685	1.199	0.143	0.286	0.429	20	14.6
4.	1.02	1.257	2.277	0.343	0.514	0.857	27.2	19.5
5.	1.14	1.54	2.97	0.343	0.628	0.971	30.3	20.8
6.	1.43	1.94	3.37	0.457	0.7996	1.2566	31.7	21.2
7.	1.71	2.17	3.88	0.457	1.03	1.487	34.5	24.7
8.	2.17	2.456	4.626	0.457	0.914	1.371	36.8	24.8

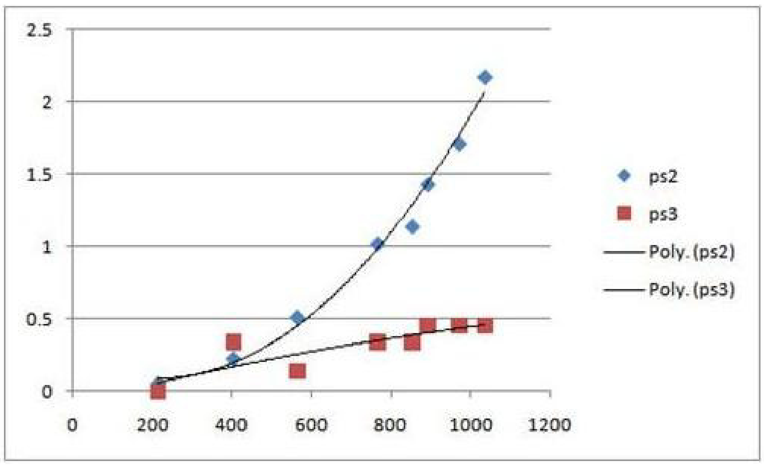

Figure 6. Drive AC-motor Speeds Versus Static Pressures at Blower Inlet (point (2)) and Outlet

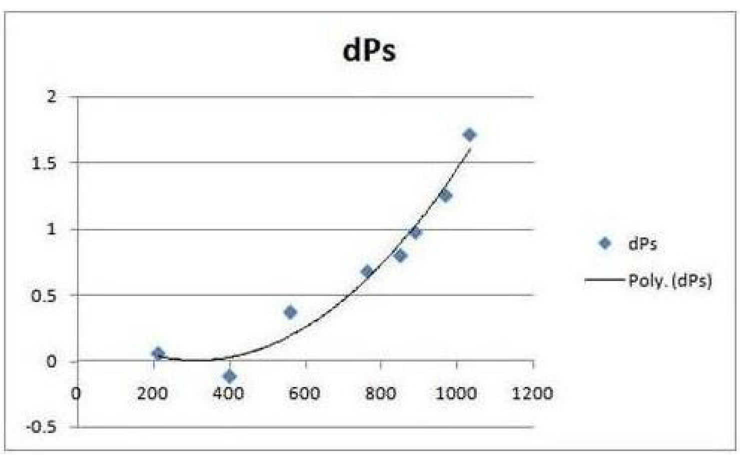

Figure 7. Differential Static Pressure Drop

$P = \rho\, g\, h$
Eq (4-1)

$r.p.m = \frac{Hz \times 60 \times 2}{no.\ of\ poles}$
Eq (4-2)

Volume flow rate = velocity × duct cross sectional area
Eq (4-3)

Total pressure = static pressure + velocity pressure
Eq (4-4)

CONCLUSION

In this study, we produce a dust suction system with a backward-curved centrifugal blowers were practical simulated and analyzed. The results from numerical simulations and measurements were compared to verify the validity of numerical simulation. The numerical simulations of centrifugal blowers are shown to be effective. The system shows a high performance. Figure 6,7 Correlation factor between static pressure, velocity pressured and air flow rate all in inlet and outlet is 0.97 this means that the variables are homogenous with each other. From the plotted results of both of the Static Pressure at the inlet and outlet ports, it is noticed that both are increased with blower's speeds. But, it seems that Inlet static pressure is more sensitive to the increase in blower speeds than at the outlet port. In addition, the outlet static pressure and blower speed are strongly related to each other, with higher correlation factor with the blower speed.

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