An Approach to the Development of Close System Industries through Finned Surface and Improved Exhaust System in order to Reduce Utility & Maintenance Cost include Safety

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Abstract— In rapidly challenging market competition, one of the foremost amendments to be done in the industries is to diminish the overall costs of production. Thus reduction of unusual costs along with unnecessary costs vastly depends on the working environment of the industry. It has been acknowledged that a lot amount of supplementary expenses like utility cost, maintenance cost etc. which causes obstacles to the development without concerning the comfortable working conditions within an industry. This paper deals with reduction of unusual cost and also enhancing the working environment by use of advanced and radical finned surface and better exhaust system. The main upshots of the analysis is to offer better air circulation, humidity control, improved safety and working condition, enhance product quality, using better technologies, improve and mend productivity and also make the maintenance and other utility cost lesser than the customary one relating to various Bangladeshi mills, garments, production shops and industries. In this paper, some suggestions has been provided about how the industrial sector could be benefited as well as promoted like never before by applying these techniques.

Index Terms— Fin, Exhaust system, Product quality, Utility cost, Maintenance cost, Safety, Environment.

1 INTRODUCTION

INDUSTRY is the mainstay upon which the growth of economy of a country prevails. In a growing economy like ours, the finite nature of materials and other resources entails a reappraisal of contemporary methods and implementations of optimal systems. Generally in an industry more focus is given on profit, but most cannot focus on reduction of utility expenses, initial cost of the industries, ensure contended working environment of the industries. These become imminent indestructible impediments. Some simple changes and design can overcome this situation. In order to moderate utility expenses, making better working environment with fin-exhaust system is very effective in almost all kinds of garments and industries.

A fin is a surface that extendes from an object to proliferate the rate of heat transfer to or from the environment by increasing convection. Increasing the temperature difference between the object and the environment, increasing the convection heat transfer coefficient, or increasing the surface area increases heat transfer [1]. Adding fin however, can be economical elucidation to heat transfer problems in close loop exhaust system. There are three goals that are normally considered in the optimal design of heat exchangers like fin: (1) Minimising the pressure droing power), (2) Maximizing the thermal performance and (3) Minimizing the entropy generation [2]. This practice saves a lot of money in industry and there are many examples of it [3]. As the heat supplied to other streams from the heat exchangers would otherwise come from an external source that is more expensive and more harmful to the environment.

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2 LITERATURE REVIEW

In the garment industry, production house, mills, most of it are works in a traditional way to make some products or developed any other certain things. Often we can see the high level authority always try to improve their product by the regular way, but often this seem not much profitable. But they haven't thought differently. Improvement of a product not only depends on the effort behind its improvement but also majorly on environment, safety and aesthetic needs of the workers.

To overall improvement of a close system, mainly improvement of the working zone, Fin and Exhaust system is a very effective method. This improved air circulation system not only improve the working environment but also ensure safety of worker, reduce noise, giving mental satisfaction to the workers and most importantly reduce the utility cost about 7-10% per year.

In a word, Fin is a mechanical device which increases the flow of a substance through several thin plates [4]. In the present world, fin used in many mechanical devices. Fin widely used for cooling purpose and vastly used in Motorcycle, Car, Bus and several other vehicle, and it also used in Computer, Laptop, Refrigerator, air-conditioner etc.

This article will explain how fin geometry and fin density affect the performance of heat exchangers and cold plates. It eill briefly review some basic heat transfer theory and their role in

improving performance, and focus on minimizing thermal resistance as a way to maximize performance.
This basic equation that describes the total heat transfer in a process is given by:

Q = U * A * LMTD

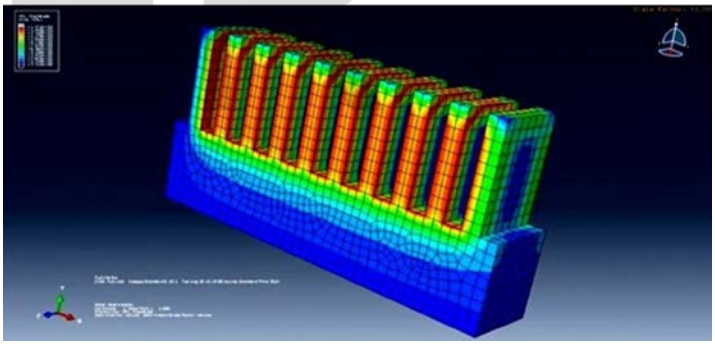
Where,

Q =Amount of heat transferred, BTU/hr. (W)
U =Overall heat transfer coefficient, BTU/hr.-ft²-°F (W/m²-°C)
A =Heat transfer area, ft² (m²)
LMTD =Log Mean Temperature Difference between the two incoming fluids in a heat exchanger or between the local surface and the fluid flowing underneath in case of cold plates, assuming an evenly distributed heat load, °F (°C)

For most heat exchanger and cold plate applications, the overall heat transfer coefficient consists mainly of a combination of conduction and convection terms, where the conduction term tends to be much smaller than the convection term(s). This is important because component designers usually have little control over the materials of construction, which affects conduction, and the coolant to be used. They do, however, wield considerable control over fin geometry and fin density, which affects convection.
Fins improve heat transfer in two ways. One is by creating turbulent flow through fin geometry, which reduces the thermal resistance through the nearly stagnant flim that forms when a fluid flows parallel to a solid surface. A second way is by increasing the fin density, which increases the heat transfer area that comes in contact with the fluid [5].
In this project, our main target is to reduce cost. Cost is again two types, one is fixed cost and another is variable cost. Fixed costs are those cost which are fixed for a certain period of time.Such as Industry setup cost, Generator's setup cost, Deterioration cost, Maintenance cost. Variable costs are those costs which are changed periodically. Such as Wages of worker, Incentives, Overhaul cost, Transportation cost. The total cost mainly depend both Fixed cost and Variable cost.
Here, Total Cost = Fixed Cost + Variable cost [6].
In this project, mainly it has been emphasis on Utility cost and Maintenance & Repair cost. Here, Maintenance & Repair cost is Fixed cost because a certain amount funded for this purposes. And Utility cost is regarded as Variable cost.
In order to improve the working environment, exhaust system always plays an important role. In Traditional system, exhaust fans are normally small insize and placed in the top surface of the wall. Thus because of small size and speed these cannot plays a good form on circulation of air. In order to get better circulation of air, here quite large exhaust fans are used. This type of fans normally increases the air circulation rate about 3-4 times from the Traditional ones. This becomes successful because of advanced finned surface and better exhaust system. Thus because of finned surface air cooling rate and also circulation rate have been increased, also this circulation rate vastly Improve by improved exhaust system. Thus the overall working environment have been improved so much that this techniques bring mental satisfaction to the worker, in order to product improvement.

3 METHODOLOGY

This research work is carried on mainly garment sector. In almost all garment sector want to improve their product quality. But the financial problem is one of the major obstacles, because production's budget is almost fixed. In order to make the production more profitable, reduce the utility and maintenance cost is the most effective one. This research has been developed with the help of four data collectors. These data collectors are recruited with minimum graduation degrees. The data collectors are sent to the field to collect necessary data. Firstly the overall diemension of the building, the working area's diemension, number of celling fan, number of exhaust fan, safety issues, working environment, generators cost, various setup cost and overall monthly &yearly estimated total utility and maintenance cost had been collected from several garments. Various problems had been found in these garment factories' data. Then it has been studied on these problems, and applied necessary steps to found the solutions of these problems. After studied and applying different logical techniques and procedure it has been seen that fin & improved exhaust system is more effective, because in this system, not only the initial overall setup cost is lower but also utility and maintenance cost is lower than the traditional ones.
Here the picture presented the simulation view of a finned surface.
Figure 1: Simulated preview of finned surface



The picture presented the air cooling system, in which hot gas/air mainly pass in front of the finned surface and passes the cool gas/air from the rear side of finned surface. This air cooling system is commonly used in vehicles, computer, laptop etc. In case of excess cooling, such as in air conditioner, air cooler or refrigerator, Freon gas is passed through the tube and it increase the cooling rate.
Conventional finned surface normally faces some problem with its surface. This problem can be overcome by giving a paper coated mixture over the finned surface. The usefulness of this coated mixture is, it raise the area of finned surface which increases the heat transfer rate. And also because of paper coating, this paper absorbs the water when they sprayed over it, also very effective in enhancing of cooling rate, and because of this coating, water spray rate decreases which helps to reduce cost. There is some other problem we found in this research work that, because water flow constant-

ly this type of finned surface become rusty, this is further overcome by use of steel plate insead of iron plate. At the last of this research, it can be crystal clear that why this special type of advance finned surface & improved exhaust system is very much effective for the Garments, Industries, Production shops etc. from the traditional one.

Here's the projected preview of the Traditional system and Fin & Exhaust system. In the traditional system one can easily identify the components required and the other facilities. In the traditional system the required number of electric component is high enough regard to the Fin & Exhaust system. So setup cost, utility & maintenance cost is higher than the other special system.

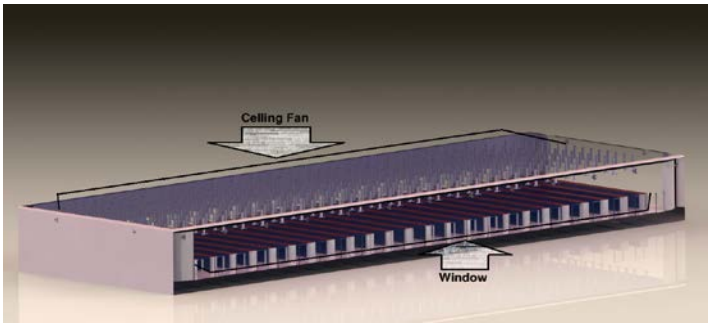


Figure 2: Projected preview of Traditional System

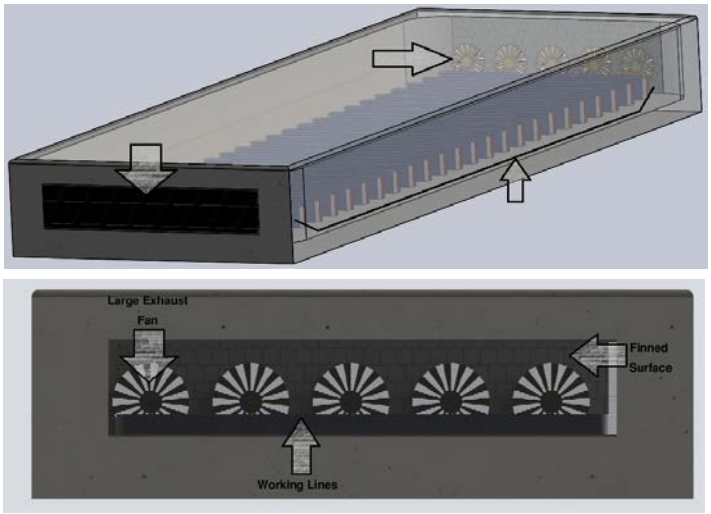


Figure 3: Projected preview of Fin & Exhaust System

From above the figures it has been crystal clear that the number of Electric component is less in Fin & Exhaust system than the Traditional system. So this system can ensure lowering Utility & Maintenance cost and also ensure better safety, better working environment to the customer. Because of lower electric components the accidental probability is less than the Traditional system. In future, the working environment may be further improved by Sunlight roof, inside tree plantation etc., which not only lower the utility cost but also improves the working environment, which also improves the mental satisfaction of the workers.

4 Data Collection and Analysis

In this study Fin & Exhaust system is selected to optimize the Utility and Maintenance cost with a better impact on productivity. Firstly for smoothly run for this Project some necessary data taken. These are the Summarized information of both Traditional system and Fin & Exhaust System.

4.1 Summerized information of both systems

Serial No.	Data	Information
01	Working Room's Length (with clearance 10 feet in each side)	64+ (10*2) = 84 Feet
02	Working Room's Width (with clearance 5 feet in each side)	250 + (5*2) = 260 Feet
03	Working Room's Height	15 Feet
04	Working Lines	25 Lines
05	**Fin:**	
	Fin's Length (4 Finns required)	16*4 = 64 Feet
	Fin's Height	4 Feet
	Fin's Width	7.5 Inch
	Fin Type	Paper type
06	**Big Exhaust Fan (Fin & Exhaust System):**	
	Quantity	5 pcs
	Cost	12000 taka; each
	Power	1hp; 3 phase
07	**Cooling pad :**	
	Motor power(Using for water spraying)	1 Pc; 2hp
08	**Stand Fan: (Both Systems)**	
	Cost	4000 taka; each
	Power	1.5 KW
09	**Celling Fan: (Traditional System)**	
	Quantity (Each line required 10 Celling fan)	25*10 = 250 fans
	Cost	1500 taka; each
	Power	85 Watts
10	**Small Exhaust Fan: (Traditional System)**	
	Quantity (In each length required 2 Fans, and each width required 8 fans)	(2*2) + (8*2) = 20 pcs
	Cost	1200 taka; each
	Power	40 watts

11	Window (With Grill Fence): (Traditional system) Cost Quantity (In each length required 2 Windows, and each width required 8 fans)	 7000 taka; each (2*2) + (8*2) = 20 pcs
12	Grill Fence's Cost	170 taka per Square Feet
13	Generator's Setup Cost: (Both Systems)	Around 1500000 ~ 2000000 taka

These are some relevant data about both Traditional and Fin & Exhaust system. Now some other cost calculation will be provided to make sure about the beneficial side of Finn & Exhaust System. Firstly it will be shown the calculation of number of required components on both systems, and then the estimated initial cost, variable cost, Maintenance & repair cost will be provided.

4.2 Cost Calculation

4.2.1 Fin & Exhaust System

Number of Items Required:

- Fin 4 pcs
- Stand fan 10 pcs
- Big Exhaust Fan 5 pcs
- Water Pump 1 pc

(a) Initial Cost:

Fin's cost: 80000*4 =320000 taka
Stand fan's cost: 4000*10 = 40000 taka
Big exhaust fan's cost: 12000*5 = 60000 taka
Water pump's cost: 1*1000 = 1000 taka
Fin's Grill Fence's cost: (64*4) *170 = 43520 taka cost of per sq. ft. grill= 170 taka
Generator setup cost: 1800000 taka
Total Initial cost: 2264520 taka

(b) Maintenance & Repair cost:

Fin's Cost: 5000 taka per year
Others: 5000 taka per year
(Including stand fan, large exhaust fan and paint of grill)
Generator and water pump's cost: 20000 taka per year
Total Maintenance & Repair cost: 30000 taka per year

(c) Utility Cost: (Estimated cost for one month only)

Here both exhaust fan and stand fan running for 16 hours and water pump is running for 8 hours (with interrupting) in a day. Here's also mentioned that the generators are used for running 5 large exhaust fans & 5 stand fans.

1. Estimated Monthly Electricity Bill:
Large Exhaust fan: (746W *16hrs*5pcs*30days)/1000 = 1790.40 units
Stand fan: 1KW*16hrs*10pcs*30days= 4800.00 units
Water pump: (2*746W*8hrs*30days)/1000 = 358.08 units
Total Consumed Units = 6948.48 units
For over 1000 consumed units the cost is 10 taka per unit (DESCO)
Total estimated monthly electricity bill:
(6948.48*10) = 69484.8 taka
2. Estimated monthly Generator's cost:
For 5 pcs of exhaust fan:
(746W*8hrs*5 pcs*15days) / 1000 = 447.60 units
For 5 pcs of stand fan:
(1kW* 8hours*5pcs*15days) = 600.00 units
Total Consumed Units = 1047.6 units
For per consumed units the generator's cost is 15 taka per unit.
Total Estimated Monthly Generator's cost:
(1047.6*15) = 15714 taka

Total Utility Cost: around 85200 taka per month

So, Overall Maintenance & Utility Cost will be for Fin & Exhaust system will be around
30000 + (85200*12) = **1052400 taka per year (without initial cost)**

4.2.2 Traditional System

Number of Items Required:

- Windows 20 pcs
- Stand fan 5 pcs
- Small Exhaust Fan 20 pcs
- Celling fans 250 pcs

(a) Initial Cost:

Window cost: 7000*20=140000 taka
Stand fan's cost: 4000*5 = 20000 taka
Small exhaust fan's cost: 1200*20 = 24000 taka
Celling fan's cost: 250*1500 = 375000 taka
Generator setup cost: 1800000 taka
Total Initial cost: 2359000 taka

(b) Maintenance & Repair cost:

Celling Fan's Cost: 10000 taka per year
Others: 5000 taka per year
(Including stand fan, small exhaust fan and paint of grill of window)
Generator and window repair's cost: 20000 taka per year
Total Maintenance & Repair cost: 35000 taka per year

(c) Utility Cost: (Estimated cost for one month only)

Here celling fan and stand fan running for 16 hours in a day and small exhaust fan running for 10 hours in a day. Here's also mentioned that the generators are used for running 100 celling fans.

1. Estimated Monthly Electricity Bill:
Small Exhaust fan: (40W *8hrs*20pcs*30days)/1000 = 192.00 units
Stand fan: 1KW*16hrs*5pcs*30days= 2400.00 units
Celling Fan: (85W*16hrs*250pcs*30days)/1000 = 10200.00 units
Total Consumed Units = 12792 units
For over 1000 consumed units the cost is 10 taka per unit (DESCO)
Total estimated monthly electricity bill:

(12792*10) = 127920 taka
2. Estimated monthly Generator's cost:
For 100 pcs of celling fan:
(85W*8hrs*100 pcs*15days) / 1000 = 1020 units
Total Consumed Units = 1020 unit
For per consumed units the generator's cost is 15 taka per unit.
Total Estimated Monthly Generator's cost:
(1020*15) = 15300 taka

Total Utility Cost: 143220 taka per month
So, Overall Maintenance & Utility Cost will be for Traditional system will be around
35000 + (143220*12) = **1753640 taka per year (without initial cost)**

From above calculation it is very clear that Finn & Exhaust System is very much cheaper than the Traditional system. It is not only cheaper from the initial cost but also very much cheaper in overall yearly total cost.
This Fin & Exhaust System is not only benefitted by cost, in this system there is less electric component which ensure safety of the workers. From [7] it can be known that, in every 15 seconds, a worker dies from a work-related accident or diseases. And every 15 seconds, 160 workers have a work-related accident. Thus this system ensures safety not only by reducing electric instrument/part but also giving additional protection to avoid this kind of accidents.

5 Conclusion

In this paper we described a novel approach of using a developed Fin and exhaust system to optimize the cost of close system such as garments, industry in respect of Bangladeshi industries. Our simulation results indicate the improvement in reduction of utility expenses, Improve product quality, generating better working environment, and ensure safety alongside the traditional garments or industry. Therefore, we safely assume that, this Finn and advance exhaust system is a better approach to cost optimization as compared to former traditional exhaust techniques. Since fins are used to improve heat transfer in exhaust system, so it is imperative to consent open spaces toward optimization. In many industrial processes there is waste of energy that is being exhausted. This method can be used to preclude wastage of heat and to reduce superfluous costs effectively as well as guide to be a solution for most of the apparel industries of Bangladesh that are slanted towards exports.

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