Research Inventy: International Journal Of Engineering And Science
Vol.5, Issue 5 (May 2015), PP 29-35
Issn (e): 2278-4721, Issn (p):2319-6483, www.researchinventy.com,

Energy Efficiency and Performance Analysis of Industrial (Textile Sector) Fans based on the Associated Systems

Aftab KHAN, Shazia SHABBIR, Hammad ALTAF, Usman HAFEEZ, Wasi ULLAH and Faisal SHABBIR
National Productivity Organization, Ministry of Industries & Production, 2nd floor software technology park constitution avenue, F-5/1 Islamabad, Pakistan.

ABSTRACT - *A detailed analysis of fan system is done in this paper to analyze efficiency of industrial fan systems. Energy Audits of textile Industries of Pakistan were conducted during which it was observed that the air flow of supply and return fans was mostly lower as compared to that showed in case studies. The case studies done during audits indicate that the system is not supporting the fans performance i.e. generation of air flow, due to which more fans were added to get required air changes which lead to higher energy input. Hence, to increase the performance of fan and to reduce energy losses there is a need to develop a proper fan system.*

Keywords – *Energy Consumption, Energy Efficiency,Industrial Fan, Performance of Fans, Textile Sector*

I. INTRODUCTION

Most industrial equipment forms part of a wider electric motor driven system used in manufacturing. Key equipment includes pumps, fans, air compressors, process chillers and gas fired boilers. Fans are extensively used in commercial and industrial applications. Most manufacturing plants use fans for industrial processes that need air change. Fan systems consist of a fan, a drive system, ducts, trenches, electric motor and air conditioning equipments (i.e. filters, heat exchangers, cooling coils, etc) which are essential to keep manufacturing processes smooth. In manufacturing processes, fan reliability is significant and its failure or low performance can lead to energy and production losses. Fan performance is typically defined by a plot of developed pressure and power required over a range of fan-generated airflow. The actual efficiency of a fan depends on the power requirement. Its efficiency is the ratio between the power transferred to the air stream and the power delivered by the motor to the fan. The power of the airflow is the product of the pressure and the flow, corrected for unit consistency.

For the industrial buildings one of the main barriers for investments in high efficiency fans is the competition with investments in production technologies. A common problem is that companies purchase large and oversized fans for their service requirements. Large fans typically cost more than small ones, and large fans also require larger and more costly motors. Oversized fans increase system operating costs both in terms of energy and maintenance requirements. Oversized fans tend to operate with one or more of the indications of poor performance including noisy, inefficient, or unstable fan operation. High airflow noise often results from the excess flow energy imparted to the airstream. Unusually high operating costs are often caused by inefficient fan operation that, in turn, can be the result of improper fan selection or poor system design. Improper fan selection can often result in a fan that is too large, or a fan that is running at a higher speed than necessary for the application. The result of this is high energy costs, excessive airflow noise and increased maintenance requirements. Flawed system design can lead to high operating costs as a result of poor fan inlet or outlet airflow conditions, which can cause significant efficiency and airflow losses.Most of the case studies show that room for improvement of the efficiency of fans exists and is economical. The largest potential savings can be achieved through optimizing the overall fan system, with savings of up to 30% possible. Proper cleaning, servicing and regular maintenance of fans is important to maintain their performance levels as efficiency of fan and motor will both deteriorate if this is not carried out.

Keeping in view the importance of industrial fan system's efficiency, we consider for energy audit to identify the gaps, solutions, best practices and saving opportunities, for this over 250 units have been audited.

II. BACKGROUND

The sector wise energy consumption of Pakistan is:

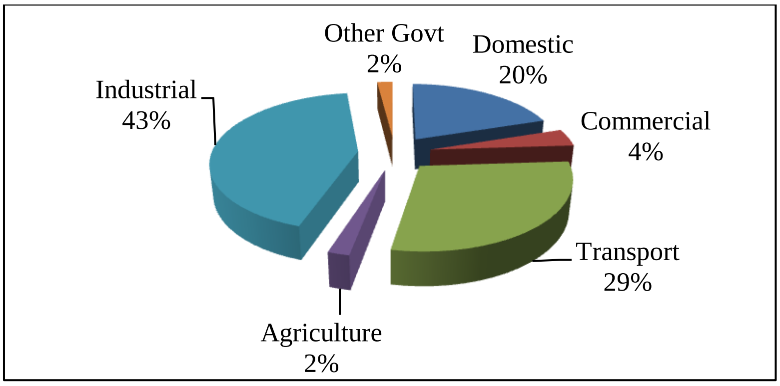

Fig. 1. Sector wise Energy Consumption.

Industrial Sector

The industrial sector is the major economic contributor in Pakistan after agriculture.

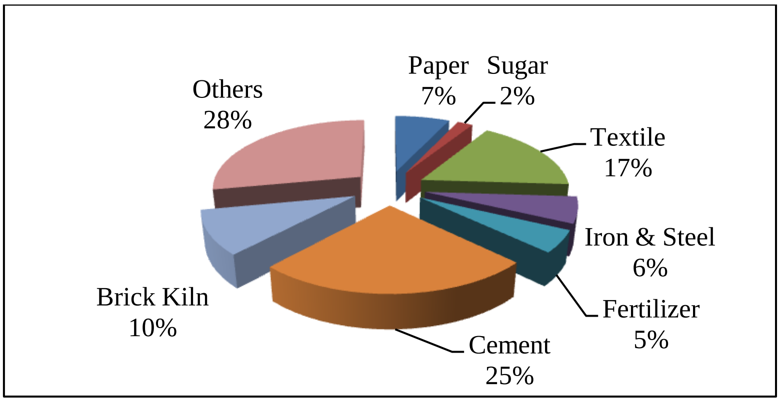

Fig. 2. Industrial Energy Consumption.

Textile sector, second largest energy consumer, adds up to 57% of GDP in Pakistan, it contains following sub sectors: Ginning, Spinning, Weaving, Processing, Knitting, Stitching, Garments.

Spinning sector

Spinning sector is an export oriented sub-sector. It works as backbone in textile sector. During Energy Audits data was collected and analyzed of the entire Spinning unit.

Average electricity consumption per day in a Textile Spinning sector is as under:

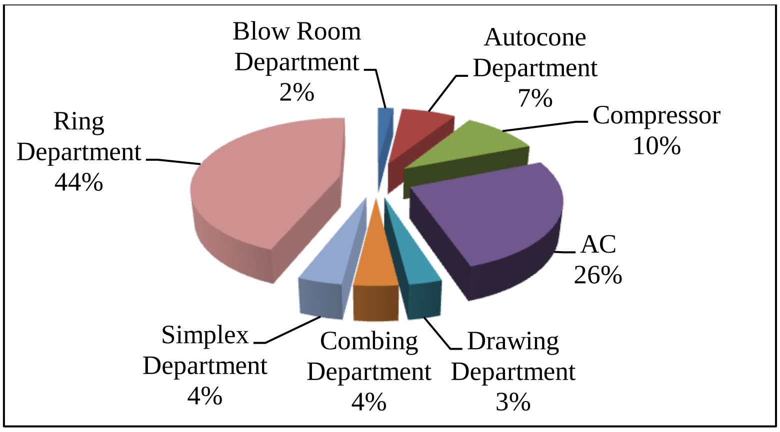

Fig. 3. Energy Consumption in spinning sector

According to the figure 3, air conditioning system is the second largest energy consumer and an important part of the mill. As per observations ACs is being running through conventional methods, which mostly results in low process performance. Therefore, in order to find out opportunities for improvements it was selected for further research studies.

There are three elements of Air Conditioning unit which plays important role. Average running load of return fan, water pump and supply fan is shown in figure 4.

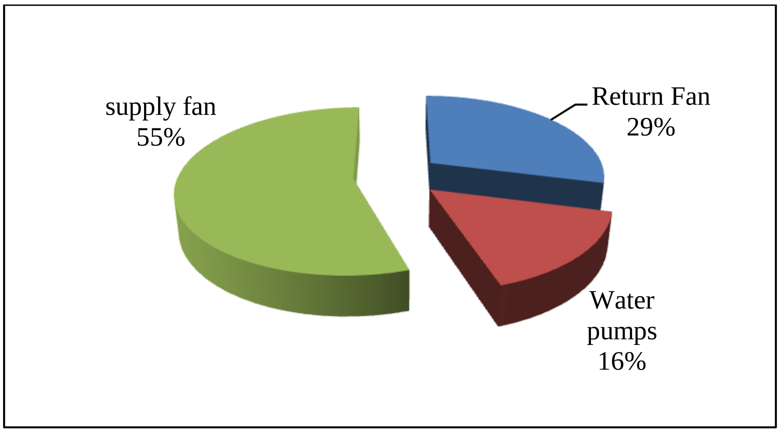

Fig. 4 AC-Running Load

These are the main energy consumers and responsible for maintaining the desired environment for production process. Fans are installed in parallel as shown in figure 5 and used for the circulation of air and pumps are used for water showering to cool and clean the air, therefore, no other equipment is being used.

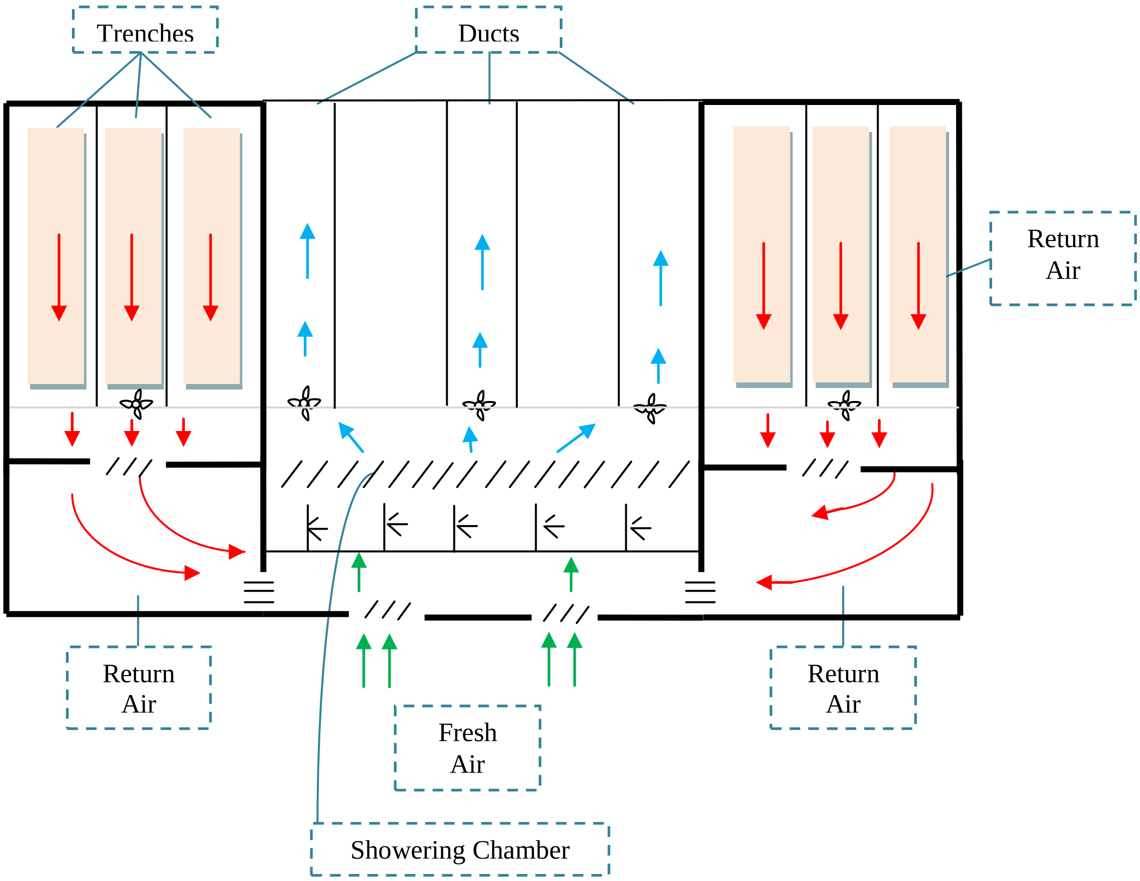

Fig. 5 Return and Supply Fan System

III. DATA COLLECTION & OBSERVATION

Specific energy consumption of supply and return fan were observed.

Supply Fans:

It transfers the reconditioned air to production hall as per need of the process. Its major elements are: electric fan motors, blades, ducts (through which air travels) and louvers (which equal distributes the air). Clean and humid air is necessary for production process, if it is disturbed then production losses increases, human irritation increases which may lead to high turnover and low productivity.

The figures below shows the specific energy consumption of different supply fans in different departments.

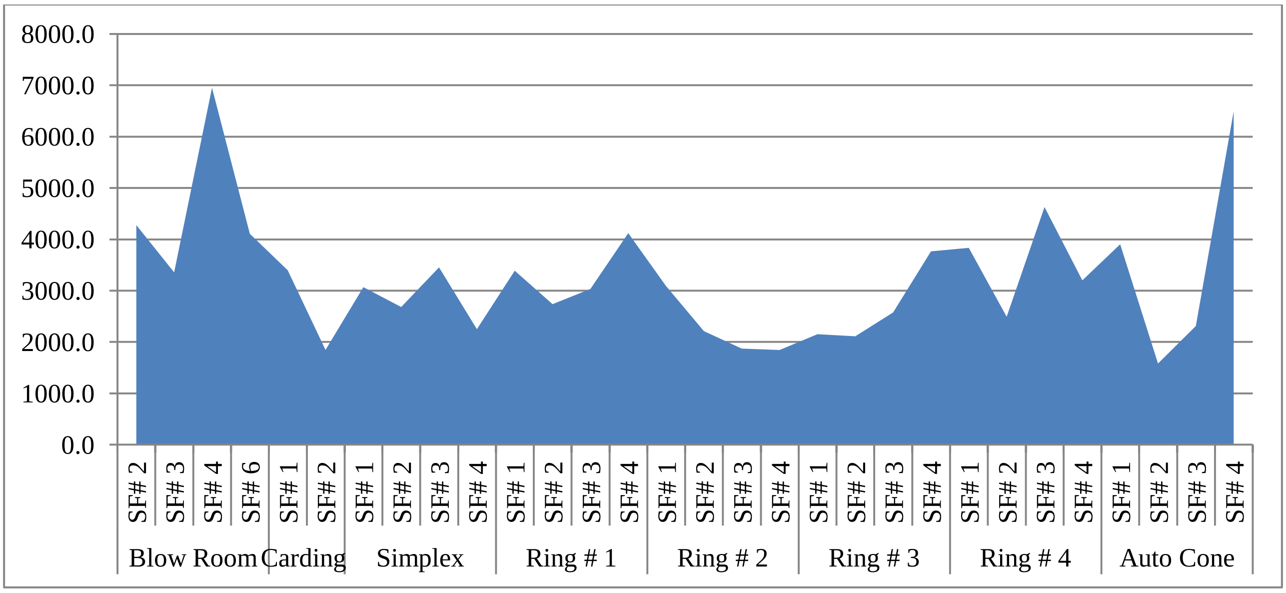

Figure 6: Specific Consumption (m^3/hr/kW) of Supply Fan Factory-1

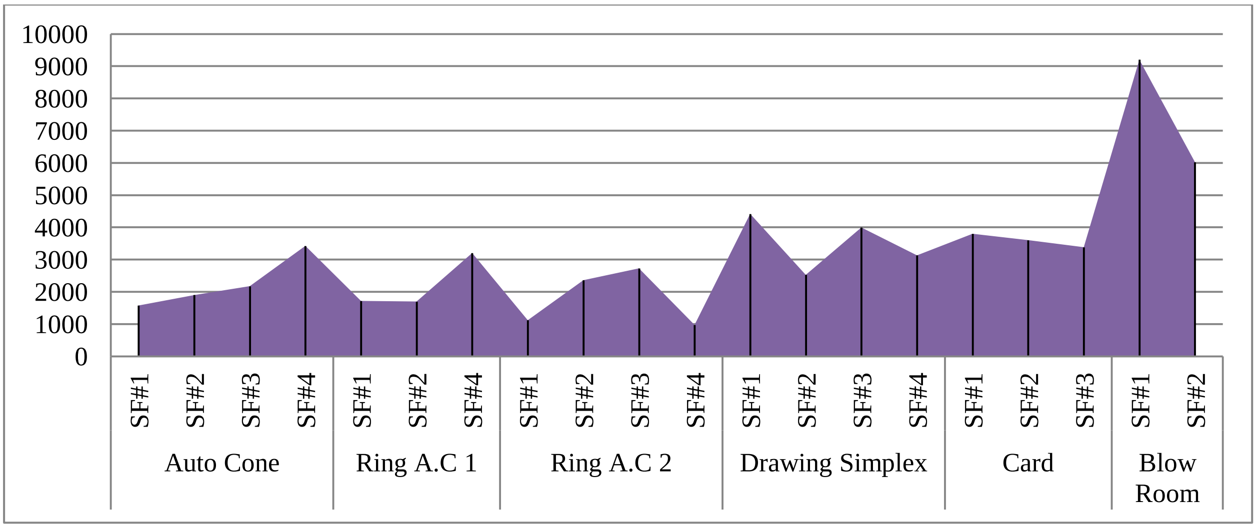

Figure 7: Specific Consumption (m^3/hr/kW) of Supply Fan Factory-2

The peaks in the graphs show the performance that is air generated against the Kilowatt consumed.

Return Fans:
It exhausts dirty and fluffy air from production hall which is then filtered, exhausted or reticulated after humidification. If it is not maintained properly than it does not exhaust dust air, due to which internal dust increases that results in low production and quality.

Layout of return fan:

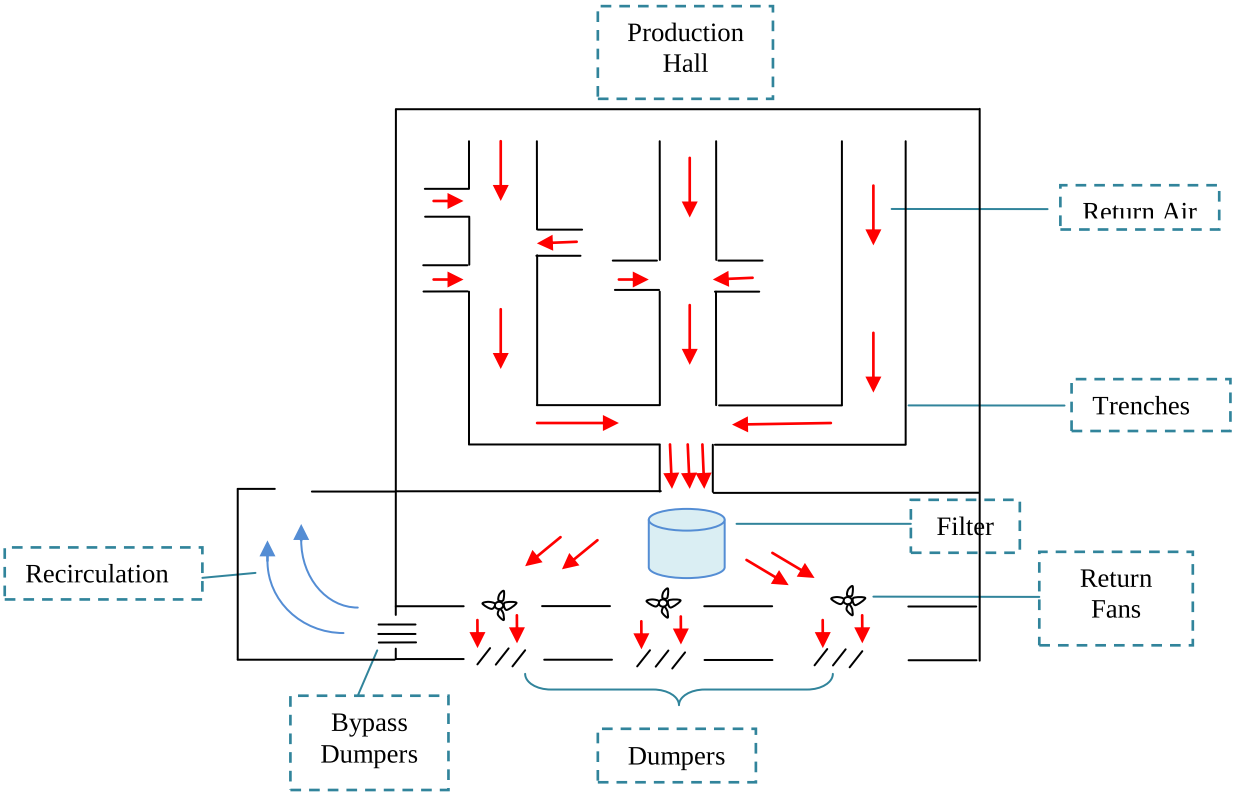

Figure 8: Layout of Return Fan

Specific energy consumption of return fans:

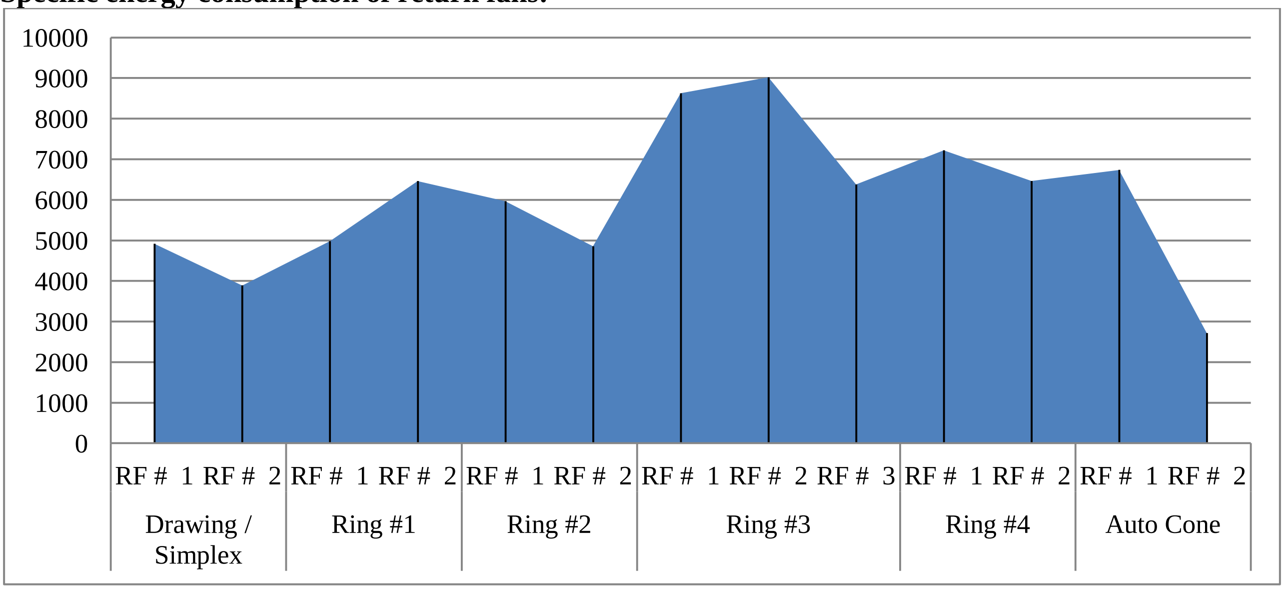

Figure 9: Specific Consumption (m^3/hr/kW) of Return Fan Factory-1

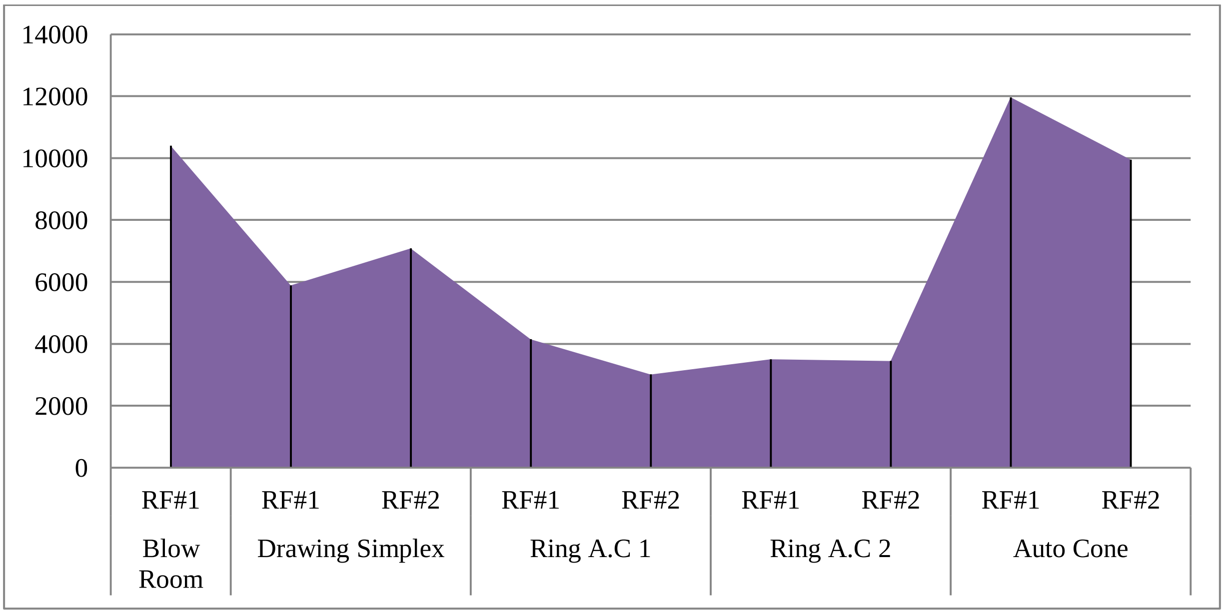

Figure 10: Specific Consumption (m^3/hr/kW) of Return Fan Factory-2

Variations in the performance affect the environment stability and hence, lead to energy wastages and production losses. These variations are of high concern and to be solved through proper fan designing and equipment installed.

IV. CASE STUDY

A detailed analysis was done to find out ways and means to save energy through best practices or any new interventions. If we study the above graphs as a whole for the mill and for individual departments there is huge difference between the specific energy consumptions of the fans. The size and capacity of the fans are same then what are the reasons for this behavior of the fans even in one department, to sort out this question we made a case study. The case study shows the performance of three return fans (RF # 1, #2, #3) of same capacity, size and department and used for same purpose.

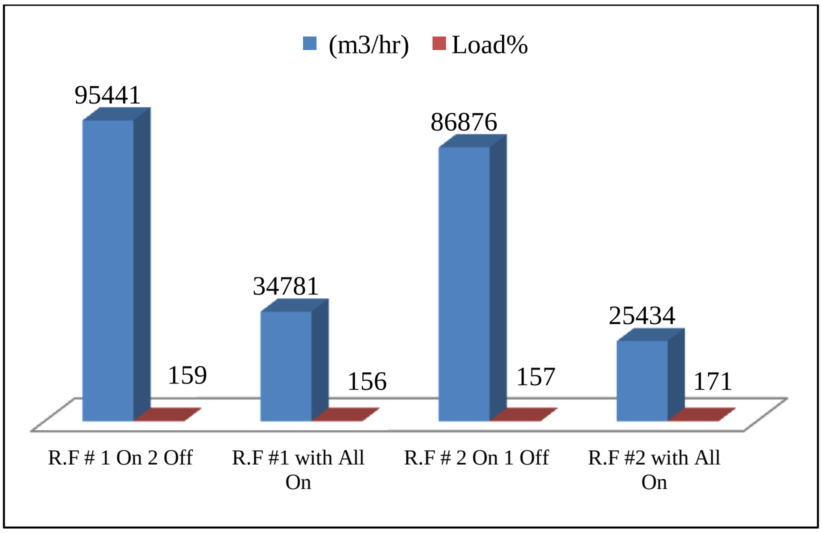

Fig. 11. Return Fan Case Study Vs Load % (Running KW/Rated KW)

The figure shows that the performance of the fan # 3 when all the fans are in running position while some are off. When all other fans are off, there is more availability of air to draw hence the performance of the fan increases and specific consumption decreases.

This shows that the system (trenches, ducts, louvers) and its networking not supporting the fan capacity, as fans are underutilized which increases energy consumption increases. Therefore, it is needed to standardize the infrastructure, design, layout and size of system.

V. CONCLUSION

The graphs of return and supply fan shows variation in the performance even fans of same department installed parallel to each other, which leads us to know that the infrastructure of humidification plant is undersize, not as per capacity of the installed fans, hence result in less output to input per fan. The case study shows that when one or two fans in parallel to it get off then performance of fans is improved, which to some extent justify that the infrastructure is undersize and not up to benchmark. Therefore, it can be concluded that a detailed work / study may be done to develop standardized design and size of the system. It will lead to save energy, initial cost in the form of investment in purchasing fan and production losses.

REFERENCES

[1] Radgen, Dr.P., Oberschmidt, J. (Frauenhofer Institute, Germany), Cory, W.T.W. (ind. consultant, UK) - *EuP Lot 11: Fans for ventilation in non-residential buildings / Final Report*, April 2008

[2] Lawrence Berkeley National Laboratory Washington, DC, Resource Dynamics Corporation Vienna, VA – *Improving fan system performance, a source book for industry*, U.S. Department of Energy, 2003

[3] Productive Energy Solutions - *The Fan System Assessment Tool User Manual Version 1.0*, U.S. Department of Energy, 2004

[4] United Nations Environment Programme - *Energy Efficiency Guide for Industry in Aisa - Electrical Energy Equipment: Fans and Blouvers*,2006

[5] Dr.-Ing. Peter Radgen – *Market Study for Improving Energy Efficiency for Fans*, Final Report, 2001

[6] Tobias Fleiter - *Cost effective industrial energyefficient technologies: Options for electric motor systems and the pulp and paper industry*, Berlin, February 19th 2010

[7] Discussion Paper - *Improving the Energy Efficiency of Industrial Equipment*, 2010

[8] Aftab Khan Masood, Sher Muhammad, Shazia Iftikhar, Hammad Altaf, Wasi Ullah, and Faisal Shabbir - *Energy Efficiency in Textile Sector of Pakistan: Analysis of Energy Consumption of Air-Conditioning Unit*, International Journal of Environmental Science and Development vol. 6, no. 7, pp. 498-503, 2015.

[9] *Pakistan Energy Year Book,* FY 2011-2012

[10] *Pakistan Economic Survey*, FY 2012-13