TESTING OF DUST LOAD IN DEPARTMENTS OF TEXTILE SPINNING MILL USING A DUST EVALUATOR INSTRUMENT

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ABSTRACT

Textile industry is the second largest industry in the world next to agriculture. This shows the important of a textile industry in a country especially in India, the textile industry contributes substantially to the foreign exchange earned by the country. The textile industry is providing employment to numerous people in the country. The emphasis on awareness about the environmental concern such as air, water and noise pollution during the processing from fibre to fabric is essential in the present circumstances. Pollution is the introduction of contaminants into the natural environment that causes adverse change.

Keyword : *Textile industry, pollution, noise pollution, fabric, contaminants*

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1. INTRODUCTION

The environmental litigation has increased over the last several decades. Claims against not only polluters, but the agencies involved in the control and regulation of pollution have been proposed. Air pollution is the most difficult type of pollution to sample, test and quantify in an audit[1]. Continued collection of air emissions data from textile operations will result in better definitions of industry norms. Efforts are now underway to establish a reliable set of emissions factors for textiles; however, no set is currently available that can be recommended for audit purposes. Most processes performed in textile mills produce atmospheric emissions. Gaseous emissions have been identified as the second greatest pollution problem for the textile industry. Speculation concerning the amounts and types of air pollutants emitted from textile operations has been widespread but, generally air emissions data for textile manufacturing operations are not readily available[2]. Most published data are based on mass-balance calculations, not direct measurements. Textile industry being the largest sector providing employment to the workers needs to be focused in pollution management. Workers exposed to cotton dust laden environment generally become patients of byssinosis. It is a breathing disorder that occurs in some individuals with exposure to raw cotton dust. Characteristically, workers exhibit shortness of breath and/or the feeling of chest tightness when returning to work after being in the mill for a day or more. There may be increased cough and phlegm production. Information regarding cotton dust exposure impacts on workers and its control strategies is missing among textile employers, management, and employees.

Cotton dust is defined as dust present in the air during the handling or processing of cotton, which may contain a mixture of many substances including ground up plant matter, fibre, bacteria, fungi, soil, pesticides, non-cotton plant matter and other contaminants which may have accumulated with the cotton during the growing, harvesting and subsequent processing or storage periods[3]. The evaluation of cotton dust is carried out by instrument by direct or indirect means. The information obtained from the instrument will help to grade the various departments of the mill. The poorly graded department will be taken for analysis and improvement process to control the dust liberation[4]. This will prevent the workers suffering from health hazards associated with the cotton dust. Table.1 shows the concentration limits of dust in air stream in Textile processes.

Table -1: Concentration Limits of Dust in Air Stream in Textile Processes

Process	Limit (mg/m^3)
Blow room to speed frame	0.5
Spinning	0.2
Doubling	0.2
Winding	0.2
Warping	0.2
Sizing	0.75
Weaving	0.75

Dust consists of small and microscopic particles (Table 2) of various substances, which are present as suspended particles in gases and sink only slowly, so that they can be transported in air over substantial distances[5,6]. In accordance with a classification system established by the International Committee for Cotton Testing Methods (ITMF), the following types are to be distinguished.

Table -2: Type of dust and its particle size

Type	Particle size(μm)
Trash	Above 500
Dust	50 - 500
Micro dust	15 - 50
Breathable dust	Below 15

The Micro-dust comprises 50-80% fibre fragments, leaf and husk fragments, 10-25 % sand and earth and water-soluble materials 10-25 %. [7,8]. The high proportion of fibre fragments indicates that a large part of the micro-dust arises while processing. Nearly about 40 % of the micro dust is free between the fibres and flocks, 20-30 % is loosely bound, and the remaining 20-30 % bound to the fibres.

1.1 Types of Dust

1. *Inhalable Dust:* It is a term used to describe dust that is hazardous when deposited anywhere in the respiratory tree including the mouth and nose[9].
2. *Thoracic Dust:* It is defined as those materials that are hazardous when deposited anywhere within the lung airways and the gas exchange region.
3. *Respirable Dust:* Respirable dust is defined as that fraction of the dust reaching alveolar region of the lungs.

Problems created by Dust

- Dust is unpleasant, it can induce allergies.
- It can induce respiratory disease (byssinosis).
- Contamination of the air conditioning.
- Quality deterioration directly.
- Dust accumulations leading to operating disturbances such as jamming and running out of true.
- Increased yarn unevenness; more end breaks.
- Rapid wear of machine components.

2. COTTON DUST

2.1 Generation of Cotton Dust during Manufacturing

- Ginning factories discharge large amounts of cotton dusts. Cotton ginning and pressing have been identified as traditional industries under the unorganized sector which functions on a seasonal basis.
- Major problem of cotton dust exists in the blow room and carding section of spinning mill whereas exposure level in other areas is comparatively not much.
- Poor Relative Humidity follow-up in the department.
- Blow-down, or blow-off, is the cleaning of equipment and surfaces with compressed air.
- Cleaning of clothing or floors with compressed air.
- Improper handling of waste during transportation.
- Insufficient ventilation system.
- Improper suction system in the key areas such as blow room and carding and wherever there is a chance of dust generation.
- When materials such as laps, sliver cans and roving bobbins are delayed in process or stored for an extended period in an area where there is a likelihood of significant dust or lint accumulation.
- Usage of spring-loaded cans and carts as waste receptacles creating dust dispersion during compression of the spring loaded bottoms.
- Poor working procedures and cleaning methods.

2.2 Health Hazards Associated with Cotton Dust Exposure

Workers exposed to cotton dust laden environment generally become patients of byssinosis. Byssinosis is a breathing disorder that occurs in some individuals with exposure to raw cotton dust. Characteristically, workers exhibit shortness of breath and/or the feeling of chest tightness when returning to work after being in the mill for a day or more. There may be increased cough and phlegm production.

Change in the levels of Histamine may be used as indicators to assess pulmonary dysfunction in the workers those are exposed to cotton dust. It was suggested that the low hemoglobin and poor immunity against diseases may also predispose the outcome pulmonary dysfunction at an earlier stage. Cotton dust extract induces the release of histamine from samples of human lung tissue in vitro. Therefore, it is believed that histamine release is responsible for the major symptoms of byssinosis, "chest tightness".

It is believed that the degree or severity of response for individuals with symptoms of byssinosis is related to the dust level in the workplace. The beginning steps in yarn preparation generally produce more dust. Therefore, the closer to the beginning of the process, the higher will be the dust level and the more likely the pulmonary reaction or response for some workers.

2.3 Permissible Exposure Limits of Cotton Dust

The table 3 gives the information about the permissible exposure limit of cotton dust for various departments in the textile mill (i.e.) amount of dust permissible expressed in micrograms per cubic meter.

Table -3: Dust particle size at various departments in spinning mill

Department	PEL (micrograms per cubic meter)
Opening	200
Picking	200
Carding	200
Combing	200
Roving	200
Spinning	200
Winding	200
Weaving and knitting	750
Waste house	750

The need to develop dust-sampling methodology for application to cotton-dust emissions can be summarized as follows:
(a) The collection of particulates in the reparable range is dependent on their size distribution. This is the major factor governing successful application of control equipment.
(b) No single technique has yet been accepted by the National Institute for Occupational Safety and Health and Environmental Protection Agency as best suited for sampling mixtures of fibrous materials and dust.
(c) The particle sizes reported to date by various sampling techniques are not comparable. Particles of different sizes are collected with different efficiencies depending upon the design of the collector.
(d) The R-dust (aerodynamic diameter below 15 microns) causes lower airway response. It is of critical importance to distinguish between the effects of these two classes of dust. This is not possible without appropriate technology for both T- and R-dust.
(e) No single particle-sizing device has been found suitable for all sampling circumstances in stationary emission sources. As stated by Hatch, dust sampling should be able to assess the dust exposure and determine the characteristics of the dust source and the patterns of dust production. It helps to assess the biological consequences of such an exposure so that the exposure limits can be established.

3. DUST EVALUATION INSTRUMENT

The three-dimensional model of a cotton dust evaluation instrument was shown in figure 1. The suction was created by making use of a blower or a vacuum cleaner and filter fabric cloth was mounted to it by supporting frame. The sensor was placed at the top of the supporting frame in order to measure the pressure drop if there was an accumulation of dust in the filter fabric cloth.

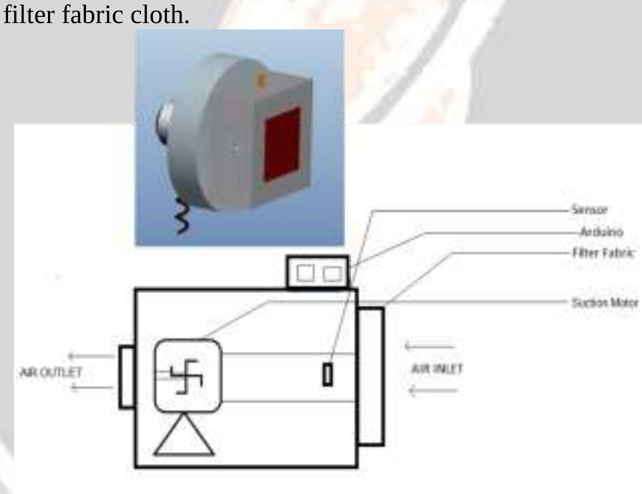

Fig -1: Dust Evaluation Instrument

The instrument consists of a centrifugal pump to create a suction effect thereby the ambient dust particles are absorbed to the instrument. The suction process was carried at the axis of the pump and the delivery was carried out tangentially to the centrifugal pump. The pump gets the motion from the A.C motor coupled to it. single phase motor is used to give rotary motion to the blades of the centrifugal pump. The fabrication for the housing of the pump, filter and sensor is made by using mild steel casing which holds the sensor towards its centre position in order to measure the pressure drop. The filter fabric cloth was supported in the casing by temporary fasteners. The filter cloth was selected considering the particulate size of the impurities present in the ambient condition of the industry. The properties of the filter cloth which was engaged with the cotton dust evaluation instrument was shown in the below table 4.

Table -4: Specification of the filter fabric

Particulars	**Filter Fabric**
Warp Count (Denier)	19.75
Weft Count (Denier)	20.46
Ends per Inch	110
Picks per Inch	116

Cover Factor	12.6

3.1 Operating principle of the instrument:

The centrifugal pump in the instrument sucks the air through the filter fabric. The pores of the filter fabric are blocked by the cotton dust which is present in the mill atmosphere. The filter fabric gets plugged with dust offer greater resistance which in turn pressure drop was generated behind the filter fabric. This is due to the fact that the total surface area will be greater and hence the drag on the air flowing past will be more. If the environment contains less dust, then the filter fabric needs more time to get plugged with dust particles so that time required for achieving pressure drop behind the filter fabric increases. If the environment contains more dust, then the filter fabric needs less time to get plugged with dust particles so that time required for achieving pressure drop behind the filter fabric decreases.

The pressure drop in the casing was directly proportional to the amount of dust accumulated in the instrument. The change in pressure was measured with the help of pressure sensor attached to the casing. The measured value was interpreted in order to obtain the quantity of the dust accumulated. Since the pressure sensor was used instead of using pressure gauges we have various advantages and even small amount of dust accumulation can be measured.

3.2 Operation of Dust Evaluation Instrument

1.Take the instrument to the concerned department and position the instrument in a relevant place.
2. Give electrical connection to the instrument.
3. Clean the dust on the filter fabric if any and switch on the instrument.
4. Note down the initial readings of the pressure sensor with the help of computer connected to the sensor (programmed with Arduino software to display the result in digital form).
5. Wait until the filter fabric gets blocked by cotton dust, as a result pressure drop was generated in the casing.
6. Note down the value given out by the pressure sensor.
7. Interpret the initial value and the final values of the pressure sensor over a period of time.
8. Switch off the instrument and clean the filter.
9. Repeat the above steps and do two more trials.

3.3 Field trial at spinning mill

Fig -2: Investigation dust load at blow room department of a spinning mill

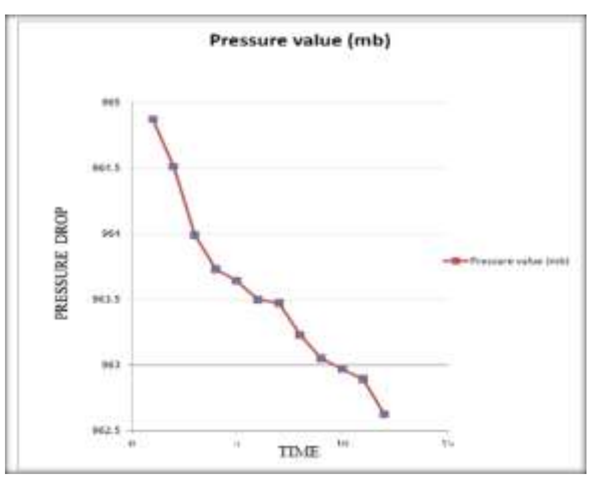

Fig -3: Investigation dust load at blow room department of a spinning mill

Fig -4: Investigation dust load at rinframe, simplex department of a spinning mill

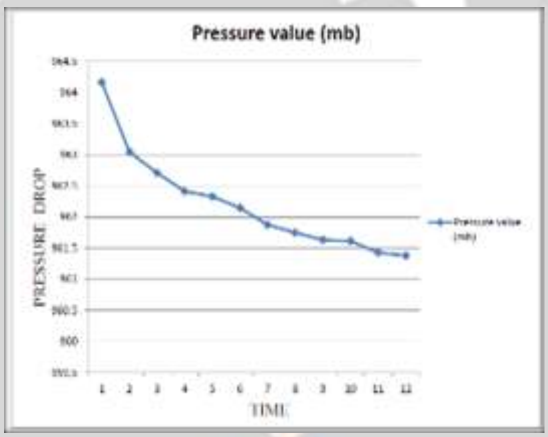

Fig -5: Dust measurement at ring frame and simplex department

Investigation dust load at blow room and ring frame department of a spinning mill are shown in figure 2 and 4. From the figure 3,5 it can be clearly understood that the blow room department will have high dust load compared to ring frame and simplex department of a spinning mill. Cotton dust evaluation instrument based on fan speed have certain mechanical constraints which found difficulty in practical operation. We aborted the idea of fabricating the instrument by using pressure sensor. We tried to design and develop an instrument based on air flow principle. The design and development of the instrument facilitates the evaluation of mill's internal working environment by quick and economic way. Grading of Department or Mill can be done by using the information obtained from the instrument. The time and pressure drop are displayed as digital is the key value used to grade the department or mill.

4.CONCLUSION:

The instrument is very much useful to evaluate the duat load in spinning mills. The contamination level in spinning mill can be easily assessed by using this instrument. This instrument can be taken to the respective department to analyze the pollution load. From the data obtained from the test results the standard of operational efficiency of humidification plant and it performance in controlling the duat and flies in the partment can be easily evaluated.

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