Reducing non conformance quality of yarn using pareto principles and fishbone diagram in textile industry

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Abstract. Non Conformance quality of yarn in the Ring Spinning machine is high unevenness (U%) on the yarn. Unevenness is a measure of yarn quality which states the amount of mass deviation per length, whose existence cannot be avoided. This paper focuses on improving quality, by using pareto and fishbone analysis to solve problems. Through the loepfe sensor on the winding machine, it can be observed that there are Yarn with high unevenness that cannot pass through the sensor and cannot winding. After test using Uster Tester 5, it can be seen that the yarn has an unevenness percentage 10.74% compare with a standard is 9.92%, which means that the quality of unevenness is high and quality deviations occur. It can be seen in the Spectrogram mass that the area of unevenness occurs in the area of 10 cm-1 m with the source of information received from the quality control (QC) and maintenance of the area occurs in the technical or machine parts, namely on the top roll in the Ring Spinning machine. Through technical observations it was found that the top roll surface was uneven and this was the cause of the high level of unevenness in the P / V 30's Yarn. The solution to solve this case is a technical solution by grinding the top roll. Through this settlement, the quality improvement of the unevenness of the Yarn can be seen again from the Uster Tester 5, where the unevenness rate has decreased to 9.28% and the figure is included in the classification of yarn uneven quality standards.

1. Introduction

The fishbone analyse is a tool for analyzing business process. It is also commonly referred as “Ishikawa Diagram” because it was invented and incorporated by Mr. Kaoru Ishikawa, a Japanese quality control statistician. It is defined as a fishbone because of its structural outlook and appearance. [1] have been studied about ishikawa diagrams and he have observed in St James Hospital and Lucas Engineering system. He use two scheme of making the fishbone analysis, first of all the fishbone analysis will be done with six classic variables as usuall (Equipment, People, Proccess, Material, Environment, and Management) and in the second analysis those will be further analyzed with more causes or bones to solve the problem. Same idea with [1], [2] tell that Ishikawa diagram can help to analysis the probabilities and the impact which allow determining the risk score for each category of causes, but also, of the global risk.
Pareto diagram principle, one of statistical quality control tool is applied to identify and analyse the key sources of waste within the production line. In order to detect possible underlying reasons/factors, a fishbone diagram is applied [3].

Different with (Bose, 2012) and (A.A.A.H.E. Perera, 2016), [4] combine six sigma technique and cause and-effect diagram is used to demonstrate how to relate potential causes of a major presenting problem in Sepahan Oil Company. For this purpose, the four liter production line of the company has been selected for investigation. The paper findings imply that the application of cause-and-effect diagram has reduced the scraps from 50000 to 5000 ppm and has resulted in a 0.92% decrease of the oil waste.

[5] has been made to implement the some statistical process control (SPC) techniques in the industry that is offering its customers the widest and latest range of sealing solutions for various applications in the automotive industry. He use only two main techniques i.e. cause and effect diagram and control charts are implemented in this industry out of seven SPC techniques. But that’s work, after implementing the SPC tools to remove the root causes, the percentage rejection is reduced from 9.1% to 5% and process capability of 0.953 is achieved.

Following [6] Ishikawa diagram is very useful to identify the probable causes of error or problem from different prospective, problem with quality Management includes quality assurance and control, Ishikawa Diagram can improve quality, reduce rejection, and very well known and widely used.

Thilak Vadicherla on the paper talk about quality yarn with combined between polyester and cotton, the paper said increasing the recycled polyester content increases the tenacity, elongation at break and hairiness and decreases unevenness, thin places, thick places and neps, while a decrease in linear density increases the tenacity, elongation at break, unevenness, thin places, thick places, neps and hairiness [7]. In the different case improvement quality used HOQ to determine the quality of yarn or products should be designed to reflect customers desires and taste [8].

Spinning is one of the fields of textiles that produce products in the form of yarn. The production capacity for the spinning division in one textile company in Central Java is 566 thousand bales / year. The production figure is fairly high, and each year the target is always fulfilled. The need for yarn, either through orders or orders or for further processing in the weaving or weaving department, encourages operators to be able to pursue planned production targets. In the spinning process, whether or not a production target is achieved is determined by the final stage of the process, namely the winding machine. However, in its implementation it is inseparable from various problems caused by various factors.

On the winding machine, there are many yarn that cannot roll. The ring spinning yarn cannot pass through the loepfe sensor in the winding machine, which indicates that there is a deviation in the yarn. The deviation that occurs is the quality of the ring spinning machine's yarn.

The quality of the yarn is classified according to the test equipment. Yarn quality includes, yarn unevenness (U%), yarn strength (elongation), Ne or yarn number and TPI or twist per inch. Of the several qualities mentioned above, unevenness of yarn (U%) is of particular concern. Because, from observations in the field there are yarn that cannot pass through the sensor on the winding machine and the yarn has high (U%) unevenness[9] [10].

Yarn unevenness is a measure of yarn quality which states the amount of mass deviation at a certain length, whose existence cannot be avoided. Unevenness (U%) of ring spinning yarn can be one of the causes of the decline in the quality of the yarn itself and can also have an impact on the next process, namely rolling the yarn on the winding machine[11].

2. Method and Materials

2.1. Method and Materials

The results of the unevenness test on the Uster Tester 5 with an Imperfection Indicator (IPI) ratio of -50% / + 50% / + 200% with an understanding of -50% states thin, + 50% states thick and + 200% states
that neps shows that U% is high and exceeded standards. The company provides a standard reference of U% for the P / V 30's process is 9.92%, but the results of the tests that have been carried out on the P / V 30's yarn point to 10.74%. This can certainly have an impact on the next process. So that an analysis of ring spinning yarn unevenness test is carried out through the Uster Tester 5 test equipment, which will be a reference for improving yarn quality.

In addition to the data analysis through the Uster Tester 5 test equipment, the search for the cause of the appearance of yarn unevenness that exceeds the standard is also carried out in the technical or machine parts. The results of the data on the Uster Tester 5 test showed that the high unevenness was seen on the spectrogram that occurred in the area of 10 cm-1 m and according to information from the mechanical part and the quality control in the spinning department the most common part was on the top roll. The results of the analysis on the technical part found that there was a top roll with an uneven surface.

3. Results and Discussion

3.1. Result Test

Thus, from the two data retrieval analyzes, the quality improvement of the P / V 30S yarn inequality on the ring spinning machine can be solved by reviewing it through the Uster Tester 5 testing equipment.

| Daily Quality Check P/V 30'S |
|-----------------------------|
| Quality       | Test 1 | Test 2 | Test 3 | Test 4 | Test 5 | Test 6 | Standard | Frequency |
| Ne            | 29,7   | 29,8   | 29,9   | 30,5   | 30     | 30     | 30-31    | 0         |
| Elongation    | 11,10  | 10,97  | 10,46  | 10,51  | 11,10  | 10,51  | 11,22    | 0         |
| Strength      | 535,0  | 537,4  | 529,4  | 520,8  | 467,0  | 490,2  | 527,8    | 3         |
| TPI           | 19,12  | 18,62  | 18,82  | 18,60  | 18,48  | 18,47  | 18,51    | 4         |
| U%            | 10,74  | 13,34  | 13,32  | 10,20  | 9,95   | 9,93   | 9,92     | 6         |

Source : Daily Check Uster Tester 5 Spinning Department

From table 1 above, we can describe the non conformance product with Pareto Diagram to analyse the main problem which should be reduce first.

Figure 1 Diagram Yarn Quality Check P/V 30'S

From the Pareto diagram above, it can be seen that there are three types of high frequency quality, but what will be discussed and resolved in this chapter is U% because of the highest U% frequency and the most priority. Data taken from daily check yarn quality in spinning department III.
It has been explained above that inequality that there is a quality deviation, so that it will be the subject of discussion. To find out that the quality of unevenness deviates, then the yarn is tested through the leopfe sensor on the winding and quality tests on the yarn in the uster tester are carried out. The following are the test results.

This case is found in the winding machine, which is through observation during the production process and through supervision of the winding supervisor, there are many yarn from the ring spinning which supply winding material cannot pass through the leopfe sensor and the yarn cannot roll on the winding machine.

The cause of the uneven (U%) result is high, it can be known through the Mass Spectrogram contained in the Uster Tester 5 test equipment, which will indicate which part the problem occurred. Here is a Mass Spectrogram chart.

| No | U%   | CVm (%) | Thin -50% | Thick +50% | Neps +200% | H  |
|----|------|---------|-----------|------------|------------|----|
| 1  | 9,65 | 12,25   | 0,0       | 0,0        | 120,0      | 6,90|
| 2  | 9,11 | 11,60   | 0,0       | 0,0        | 0,0        | 6,61|
| 3  | 9,51 | 11,99   | 0,0       | 0,0        | 80,0       | 6,08|
| 4  | 9,48 | 11,85   | 0,0       | 0,0        | 0,0        | 6,19|
| 5  | 13,34| 16,41   | 0,0       | 0,0        | 0,0        | 4,42|
| 6  | 13,32| 16,54   | 40,0      | 40,0       | 40,0       | 4,41|
| Mean | 10,74| 13,44   | 6,7       | 6,7        | 40,0       | 5,77|
| CV  | 18,8 | 17,6    | 244,9     | 244,9      | 126,5      | 18,9|

Source: Uster Tester 5

From the Mass Spectrogram above, the location of the area causing high unevenness occurs in the area of 10 cm-1m. Through analysis of test data, and information from the QC and maintenance departments, the area shows that the occurrence of the problem is the technical part of the ring spinning machine. Through the diagram, fish bone will be found for the causes of unevenness. The fishbone will be find the main problem to solve, here is the fishbone diagram:
3.2. Improvement Process

The following is the information obtained and obtained from the possible results of a high U% cause:

1. Environmental Factor
   The temperature and RH of the room are still in standard conditions, namely $T = 360^\circ C$ and RH $= 61\%$. This condition is said to be quite conducive. The results of temperature and RH measurements can be seen in Appendix 12. Cleanliness in the production process area, especially on ring spinning-winding machines, the picketing schedule is enough to run smoothly and always announced every morning.

2. Material Factor
   According to information from the preparatory part of the raw material, trash on the material has never been a big problem, because the material being processed synthetically and the trash has been detected in the blowroom, especially in the metal detector.

3. Method Factor
   From the information on the roller covering section, top roll grinding has been done correctly according to the grinding standard which is $\pm 0.05$ mm per two months, top roll maintenance has been carried out according to the SOP made and the replacement schedule has been carried out according to the procedure.

4. Man Factor
   From the observations made, the ring spinning operator is a senior operator, whose skills have been trained and yarn misplacement is almost never done, and has their respective responsibilities, because each operator has been placed in their respective parts.

5. Machine Factor
   It is known from the mass spectrogram peak that problems occur in the technical part, namely on the top roll. From the observations made, the top roll surface conditions are uneven, so it has to be grinding on the top roll.

3.3. Result Test (After Improvement)

After going through the top roll grinding process, the yarn quality test was carried out again to find out the results of the unevenness (U%) there were still irregularities or not. By taking the test sample through the Loepe sensor on the winding machine, there is a change in the quality of the yarn through the same test equipment, namely the Uster Tester 5. The following is the result of the P/V 30's yarn unevenness test.
From the two test results above, there is a difference in the quality of the unevenness (U%) of the P/V 30's yarn from the L/R 6/A ring spinning machine before and after the top roll grinding. The test results show the level of unevenness has decreased from 10.74% to 9.28%. This shows that the use of top roll that is in accordance with the standards and in good condition is very influential on yarn quality. After the test is complete, the yarn test through the loepfe sensor on the winding machine is carried out again, and it is proven that the yarn can pass through the sensor and can roll.

4. Conclusion
From the data analysis that has been done, namely through testing and through daily check data in the form of pareto diagrams, it appears that the unevenness is always increasing. Unevenness has the highest frequency of occurrence so that it becomes a priority for completion.

From the technical analysis that has been found and done, the factors causing the high P/V 30's yarn inequality are in the technical part of the ring spinning machine, namely on the top roll of the Ring Spinning machine L/R 6/A and the specific factor is the top roll surface unevenness.

To solve the factors causing the problem of high inequality in the yarn, namely by grinding on the uneven top roll, and grinding done in accordance with the standards that have been reviewed in the discussion chapter. Through top roll grinding the unevenness rate decreased from 10.74% to 9.28%, the figure decreased by 1.46%.

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Table 3.3.1 Result of Unevenness yarn after improvement P/V 30'S

| No | U%  | CVm (%) | Thin -50% | Thick +50% | Nep's +200% | H  |
|----|-----|---------|-----------|-----------|-------------|----|
| 1  | 8.67| 10.95   | 0         | 0         | 0           | 4.62|
| 2  | 8.84| 11.13   | 0         | 0         | 0           | 4.65|
| 3  | 8.92| 11.88   | 0         | 0         | 0           | 4.80|
| 4  | 9.18| 11.73   | 0         | 40.0      | 0           | 4.61|
| 5  | 9.88| 12.46   | 0         | 0         | 0           | 4.26|
| 6  | 10.20| 12.60  | 0         | 0         | 0           | 4.23|

Mean 9.28 11.79 0.0 6.7 0.0 4.53
CV 6.7 11.79 0.0 244.9 5.1

Source: Uster Tester 5
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