

Analysis of Causes on High False Rejection Rate of Dark Tipping Paper Connector of ZJ118 Cigarette Machine

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Abstract. ZJ118 cigarette making and tipping machine combination is widely promoted in the industry because of its fast speed of production and stable operation. However, with the development of process requirements and the diversification of cigarette types, when producing cigarettes using dark tipping paper, the false rejection rate of tipping paper joint detection system is higher than the normal level. Given this situation, taking Black Middle cigarettes of a tobacco company as an example, the engineer spent 3 months to analyze its causes according to the characteristics of the detection system through on-site statistical investigation progressively, and finally concluded that the problem lay in the mismatch between the transmittance of tipping paper and the detection system. Dark tipping paper due to its low light transmittance, caused high false rejection rate. This article elaborates this in detail.

Keywords: Dark Tipping Paper; ZJ118 Cigarette Machine; Joint Detection; High False Rejection Rate.

1. Introduction

ZJ118 cigarette making and tipping machine combination is a new type of high-speed coiling unit independently. After repeated demonstration, ZJ112 cigarette making and tipping machine combination is selected as the technical development platform for the research and development of ZJ118[1]. On the basis of ZJ112, more advanced and stable technical principles are adopted, such as clumping and loosening technology of cigarette, separation of cigarette, cigarette weight control, cigarette rod forming, cigarette transmission, cigarette rubbing and splicing, and main transmission of filter tip splicer[2]; At the same time, considering the visual, practical, durable and modern high-end equipment material selection trend, sheet metal spraying and stainless steel are used as the main materials. The overall style of the machine pursues simplicity, stability and atmosphere, with both fashion and high-tech characteristics. According to the technical progress trend of the coiling equipment and the actual needs of users, various new and original functional modules of the combination have been carefully arranged, so that the combination has better performance, more comprehensive function, more convenient operation, and more beautiful appearance. With its rated production velocity of 8000 pieces per minute, the combination is composed of YJ118 feeding and forming machine, YJ118 coiling and forming machine, and YJ218 filter tip assembling machine[3].

The ZJ118 cigarette machine has three specifications, namely, the production of regular cigarettes, middle cigarettes and slim cigarettes. The tipping paper joint detection system of cigarette machine adopts photoelectric detection sensors. When using the middle ZJ118 cigarette machine to produce dark tipping paper cigarettes, it is founded that its false rejection rate is extremely high, resulting in a large number of qualified cigarettes being kicked off, high loss and low efficiency of equipment operating.

With deep colors, mainly black and silver, Black Middle cigarettes' caffeine paper of a tobacco company is very representative, so we take this as an example to analyze.

2. Analysis of the Current Situation

2.1 Terminology

Inspection principle of the water-loose paper joint inspection system

The tipping paper joint detection system of ZJ118 cigarette machine consists of a photoelectric detection sensor B2M, a paper scraper, a signal amplifier, a signal processing module A100-A5, a Ejecting valve Y5M, etc. Its rejection principle is that when tipping paper with a connector passes through the photoelectric detection sensor, the photoelectric detection sensor converts the optical signal into an electrical signal and transmits it to the signal amplifier[4]. Meanwhile, the paper scraper lifts to let the tipping paper connector partially passed. The amplifier sends the amplified signal to the signal processing module for processing, giving a rejection signal to the Ejecting valve. The unqualified cigarettes with connectors are rejected at the Ejecting valve[5]. The process is shown in Figure 1:

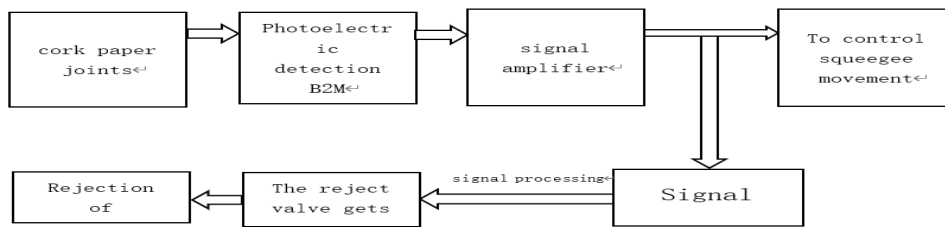


Fig 1. Rejection flowchart of unqualified cigarettes

The circuit diagram of the part of the joint detection system for cork paper is shown in Figures 2 to 4. Among them, Figure 2 is the detection circuit diagram, Figure 3 is the signal processing circuit diagram, and Figure 4 is the rejection circuit diagram.

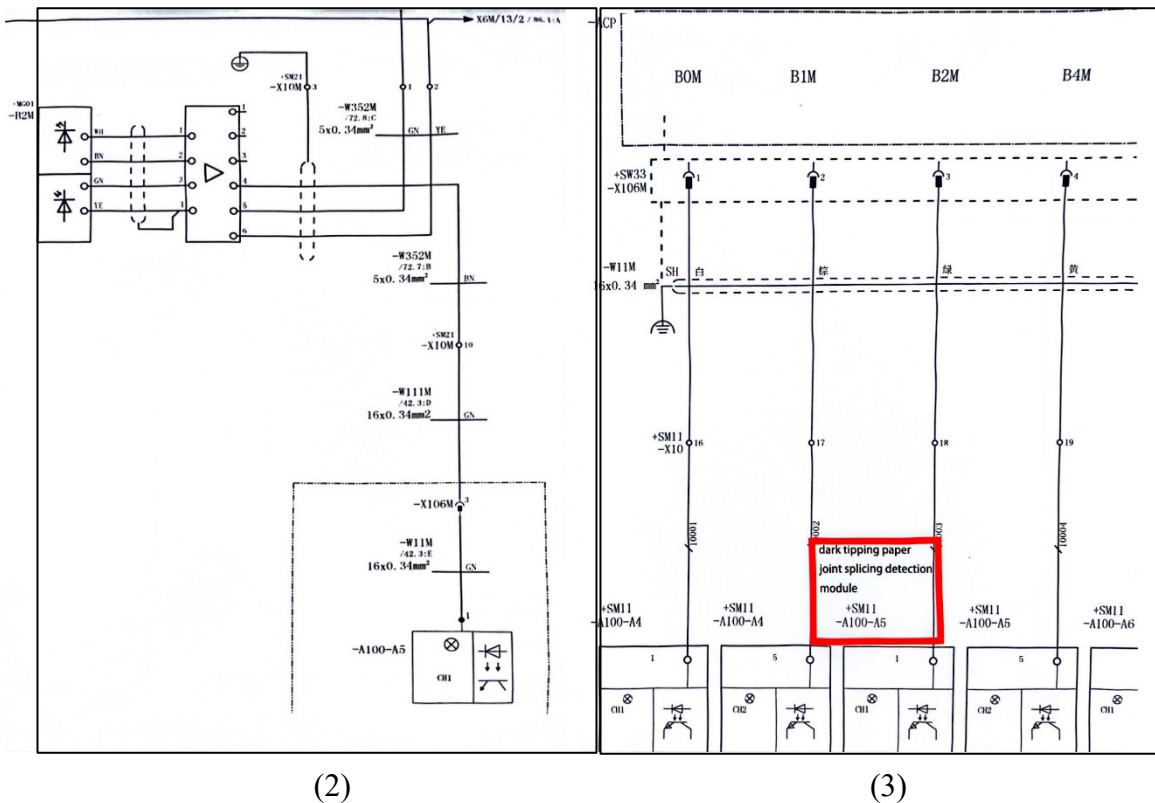


Fig 2. Circuit diagram of the joint detection section of cork paper

Fig 3. Circuit diagram of the signal processing section

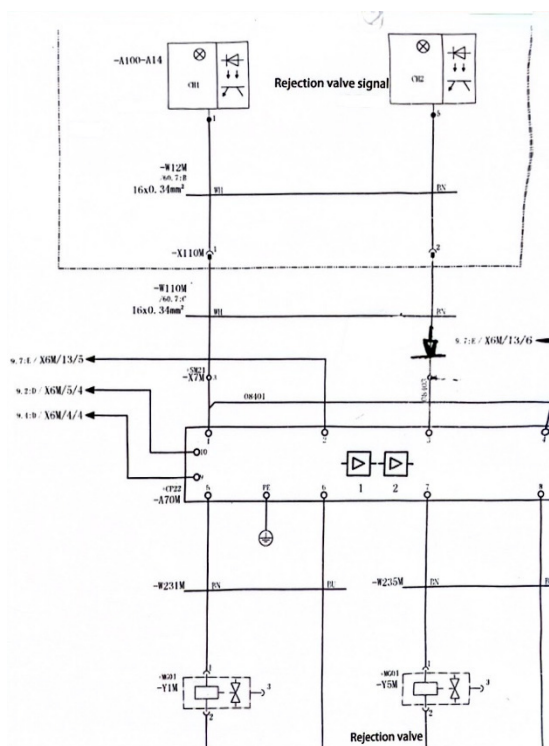


Fig 4. Circuit diagram of the reject section

The role of photoelectric sensors in the detection system

When the tipping paper passes through the photoelectric detection sensor B2M, the transmitter of the sensor light source sends incoming light to the tipping paper. Passing through the tipping paper, the incoming light is received by the receiver, and then the receiver converts the transmitted light into a voltage signal to send it to the signal amplifier for processing.

When the tipping paper with connector passes through the sensor B2M, the incident light from the transmitter of the detector changes obviously when it passes through the tipping paper and enters the receiver. The LED flashes once, and the changed signal is sent to the signal amplifier for amplification. Figure 5 shows the photoelectric sensor of tipping paper joint detection system.



Fig 5. Photoelectric sensors of the tipping paper joint detection system

False Rejection of tipping paper joints

The joint inspection system misjudges the jointless joints, which leads to the rejection of qualified cigarettes. Whenever the joint detection system for joints rejected cigarettes, the scraper will have obvious lifting action[6], the number of scraper action is observed to record the total number of joints rejected. Each joint tray labels the number of joints and marks the joints position at the joints, thus the number of correctly rejected joints is obtained, apart from which are part of the tipping paper without joints. If this part causes the scraper to move and causes the cigarettes to be rejected, then it is a false rejection of the joints, and the number of false rejections can be recorded. Figure 6 is a diagram of cigarettes with tipping paper joints.

The formula for calculating the false rejection rate of tipping paper joints

$$\text{False reject rate for tipping paper joints} = \frac{\text{Number of false ticks}}{\text{the total number of rejections}}$$



Fig 6. Diagram of a cigarette with a watered-down paper joint

2.2 Statistics of the survey on the false rejection rate of the joints of the cork paper of Black Middle Cigarettes

By sorting out the production records of Black Middle cigarettes produced by the ZJ118 cigarette machine in January 2024, the team members learned that the false rejection rate of tipping paper joints of the ZJ118 cigarette machine was shown in Table 1:

Table 1. ZJ118 cigarette machine tipping paper joint error rate

machine type	Brands	Statistics Date	1.2	1.3	1.4	1.5	1.8	1.9	1.10	1.11	1.12	1.15	1.16	
ZJ118	Black Middle	Number of normal rejections (times)	66	58	68	64	68	70	65	54	59	53	58	
		Number of false rejections (times)	41	38	43	35	42	43	39	31	36	42	48	
		Total rejections (times)	107	96	111	99	110	113	104	85	95	96	106	
		False reject rate %	38.32%	39.58%	38.74%	35.35%	38.19%	38.05%	37.5%	36.47%	37.89%	43.75%	45.28%	
machine type	Brands	Statistics Date	1.17	1.18	1.19	1.22	1.23	1.24	1.25	1.26	1.29	1.30	1.31	
ZJ118	Black Middle	Number of normal rejections (times)	62	56	43	41	48	52	61	54	51	49	57	
		Number of false rejections (times)	49	39	29	29	31	39	39	39	39	39	31	37
		Total rejections (times)	111	95	72	70	79	91	100	93	90	80	94	
		False reject rate %	44.14%	41.05%	40.28%	41.43%	39.24%	42.86%	39.0%	41.94%	43.33%	38.75%	39.36%	

The statistical chart was shown in Figure 7.

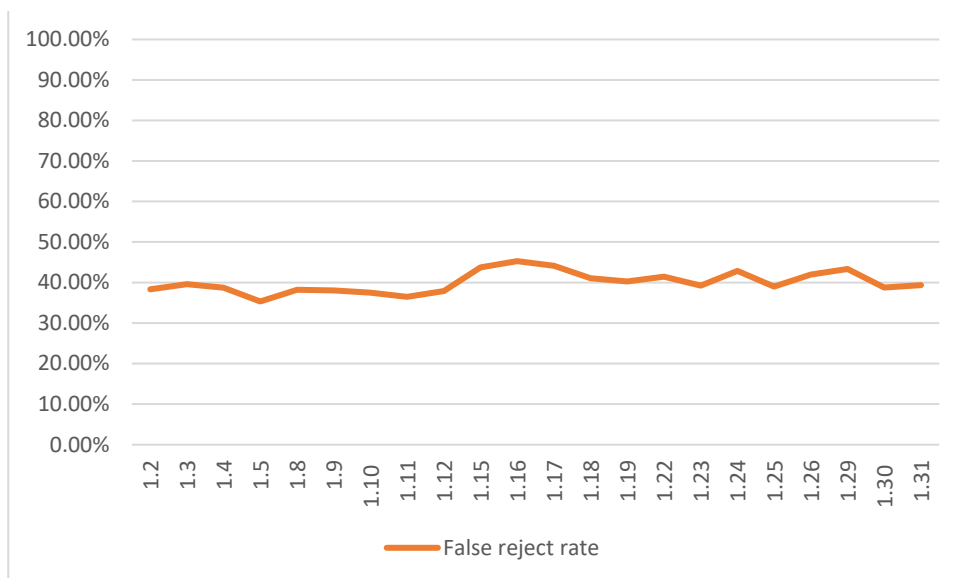


Fig 7. Statistical chart of incorrect pick rate of dark tipping paper joint in January 2024

3. chapter 3. Analysis of Causes

In response to the dark-colored cork paper joint detection of the high false rejection rate, at the same time, according to the specific circumstances of the equipment, we will carry out specific analysis from the following three aspects.

3.1 Analysis on Untied Tipping Paper Installation of ZJ118 Cigarette Machine

Purpose of the survey

Investigate the influence of misplacing of tipping paper joint detection when tipping paper of ZJ118 cigarette machine is not installed in place.

Principles

When the cigarette machine MAX tipping paper is not installed in place, the tipping paper is not transported according to the original route, so in the production process, the tipping paper joint detection may be triggered by mistake and results in the action of the paper scraper, leading to a large number of cigarettes with normal quality being picked.

Methods

Check the installation of cigarette machine MAX tipping paper threading on site to see if the installation is not in place.

The process of investigation

Table 2. Frequency of incomplete installation of tipping paper in March 2024

Statistics on the frequency of occurrence of unavailability of tipping paper installation for the month of March, 2024 (Unit: times)							
machine number	03.01	03.04	03.05	03.06	03.07	03.08	03.11
1#	0	0	0	0	0	0	0
2#	0	0	0	0	0	0	0
machine number	03.12	03.13	03.14	03.15	03.18	03.19	03.20
1#	0	0	0	0	0	0	0
2#	0	0	0	0	0	0	0
machine number	03.21	03.22	03.25	03.26	03.27	03.28	03.29
1#	0	0	0	0	0	0	0
2#	0	0	0	0	0	0	0

Two team members recorded the frequency of the tipping paper of 1 # and 2 # ZJ118 cigarette machines not installed in place in 21 working days in March 2024. The results were shown in Table 2.

Analysis of the results

Cigarette machine stoppers in the workshop were all professionally trained, experienced, and they operated at a high level, so that in the actual production process, there will not be a situation where the installation of the cork paper is not in place.

Conclusion

Inadequate installation of tipping paper will not occur in the actual production process, which is not the reason that affects the low detection accuracy of the joint of the Black Middle tipping paper produced by ZJ118 cigarette machine.

3.2 Analysis Of Sundries Such As Paper Chips In The Tipping Paper Joint Of ZJ118 Cigarette Machine

Purpose of the survey

Investigate the influence of paper scraps and other sundries in the tipping paper joint detection of ZJ118 cigarette machine on the false rejection of tipping paper joint detection.

Methods

(1) Confirmation process I: 1. Observe the signal triggering of the detection system by placing pieces of paper and other debris in the detection.

2. By controlling the sensitivity of photoelectric detection and other conditions remain unchanged, obtain the false rejection data of cork paper joints.

(2) Confirmation process II: check the passage through tipping paper during the detection of cigarette machine MAX tipping paper joint on site to see if there is any residual paper.

The process of investigation

(1) Confirmation process 1: The team members put small pieces of shredded paper inside the detection to observe the false rejection of different grades of cigarette cork paper by the cork joint detection. Through on-site detection, it can be observed that in the detection of paper and other debris into the higher frequency of false rejects, the number of cigarette rejects increased sharply. Table 3 is a statistical table of the incorrect cleaning of the tipping paper joints of different unit brands containing debris

Table 3. Detection of different units containing debris tipping paper error rate

Crews	Grades	Total rejections (times)	False classification (times)	False reject rate
1#	Black Middle Branch	72	29	40.28%
	Xiaoqinzhi	43	12	27.9%
Crews	Grades	Total rejections (times)	False classification (times)	False reject rate
2#	Black Middle Branch	46	18	39.13%
	Xiaoqinzhi	50	15	30%

(2) Confirmation process II: 2 team members investigated and recorded the frequency of sundries in the channel through tipping paper during the tipping paper joint detection of 1 # and 2 # ZJ118 cigarette machines on 21 working days in March 2024. The results were shown in Table 4.

Analysis of results

Putting paper and other debris into the detection channel under the experimental conditions led to false triggering of cork joint detection and false rejection of cigarettes, which greatly affected the false rejection rate of cork joint detection.

However, in normal production, with experienced workshop cigarette machine blocker, high level of operation and daily maintenance in place, the detection of debris in this case can be avoided.

Table 4. Frequency of debris contained in the tipping paper channel in March 2024

Statistical table showing the frequency of occurrence of debris in the channel passing through the water-joints in the test of water-joints in March, 2024 (unit: times)							
machine number	03.01	03.04	03.05	03.06	03.07	03.08	03.11
1#	0	0	0	0	0	0	0
2#	0	0	0	0	0	0	0
machine number	03.12	03.13	03.14	03.15	03.18	03.19	03.20
1#	0	0	0	0	0	0	0
2#	0	0	0	0	0	0	0
machine number	03.21	03.22	03.25	03.26	03.27	03.28	03.29
1#	0	0	0	0	0	0	0
2#	0	0	0	0	0	0	0

Conclusion

The occurrence frequency of paper scraps and sundries in tipping paper joint detection is extremely low, a low probability event, which is not the main reason that affects the high false rejection rate of tipping paper joint of ZJ118 cigarette machine for a long time.

3.3 Defect Analysis of Tipping Paper Joint Detection System of ZJ118 Cigarette Machine

Purpose of the survey

Investigate whether the tipping paper joint detection system of ZJ118 cigarette machine has design defects.

Principles of investigation

Different materials will lead to different transmittance. The photoelectric sensor of tipping paper joint detection system of ZJ118 cigarette machine detects different types of tipping paper and counts their respective false rejection rates.

Methods of investigation

The respective rejects are recorded through the use of different types of cork paper materials.

The process of investigation

Table 5. Different grades of tipping paper joint false pick rate

Total rejections and false reject rates for different grades of cork paper joints				
Grades	Black Middle	Feitian Huajing	Xiaoqinzhi	Feitianmeng Middle
Colors	Black & Silver	Light blue	Dark blue	Yellow
Transmittance (%)	10	45	50	60
Total rejections (times)	58	35	41	37
Number of false rejections (times)	26	12	11	7
False reject rate (%)	44.83	34.29	26.83	18.92

The following table shows the record of production rejection of Lanzhou Black Middle cigarette, Lanzhou Feitian Huajing cigarette, Lanzhou Xiaoqinzhi cigarette and Lanzhou Feitianmeng Middle

cigarette in the single shift (8 hours) production of 1 # ZJ118 cigarette machine recorded in the second half of 2023. By analyzing the color and transmittance of tipping paper of four brands using the transmittance meter, the false rejection rate of tipping paper joint detection was obtained, as shown in the following Table 5.

Analysis of results

Experimentally, the transmittance of the Black Middle cigarettes' cork paper material was lower than that of the other three brands.

When the ZJ118 cigarette machine produced four brands of cigarettes, the false pick rate of tipping paper joint detection in single shift production varied according to the different transmittance of tipping paper. Especially for Black Middle-sized cigarettes, the false rejection rate was as high as 44.83%, which was far higher than other brands of cigarettes. The reason was that the color of the tipping paper of Black Middle Cigarette was dark, which was black and silver, resulting in poor transmittance of tipping paper.

Conclusion

The joint detection of middle ZJ118 cigarette machine is based on the principle of photoemission, which detects the existence of the joint by the size of the transmittance. The poor transmittance of tipping paper seriously affects the removal accuracy of the tipping paper joint detection system. The lower the transmittance, the higher the false rejection rate of the detection system. In normal production, a large number of qualified cigarettes will be picked by mistake, resulting in serious waste of raw materials such as tipping paper, filter tip, reel paper, tobacco, etc.

4. Findings

This paper explored and investigated the reasons for the high false rejection rate of tipping paper joint detection system of ZJ118 cigarette machine. Combined with the conditions of the equipment, the engineer conducted on-site statistical investigation from the following three aspects: inadequate installation of tipping paper, the impurities in the detection system channel and the design defects of the system. Through long-term production data analysis, as the machine operators are experienced and properly trained, the first two cases do not occur. The result shows that that the diversity of materials is the main reason why the detection system cannot be perfectly matched and adapted. Therefore, when using dark tipping paper, due to its low transmission rate, the detection system of the tipping paper joint misjudged, resulting in a large number of qualified cigarettes being kicked out, making the false pick rate high.

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