

Real Cases of UV Curing Application and Inspection

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1. Introduction

With the creative development of new materials as well as UV curing technology, the UV curing technology has been applied in more amplitude fields, in which the UV curing related facilities and procedures present the characteristics of high running speed, automatization and unmanned operation. Just because of these features, huge troubles and loss would be resulted as abnormal operations are happened even transient fault. More strict and practical requirements are presented for the reliability, stability and automaticity of UV resources and equipments. It is getting more and more necessary to improve and ensure the efficiency of UV curing, to reduce or even eliminate the operation troubles and loss, to have measurement, monitoring and recording to the effective radiation of UV application systems.

Based on the information acquired from some of customers, there are still plenty of misunderstandings in the some workshops, e.g. it is okay enough if the UV lamp can be lighten up. It has been well known that the UV light is invisible for human's naked eyes. For the effective UV radiation with short wavelength, it is greatly difficult to discern by human's sense organs. The hidden troubles would be brought to the producers if simply depending on the unreliable organism sense and experience. It would be inefficient to find out the true causes once production troubles happen. Some of producers perhaps do not concern the possible problems in UV equipments, but hasty to complain the materials. On the viewpoint of UV equipment manufacturers, some of countermeasures to deal with the aforementioned problems are introduced and discussed herein through integrating with real UV curing projects.

2. Measurement for UV curing systems

2.1. Measuring with portable meters

The emission of UV resource at effective band must be measured and recorded with the portable or other type of UV radiometer. After analyzing the recorded data, the UV equipments should be adjusted as soon as any abnormality emerges.

2.1.1 UV energy meter

With the UV energy meter, the total radiation energy, in the unit of mJ/cm^2 , could be recorded and output through integrating the radiation intensity at designated wave band to irradiation time. As shown in Figure 1, the portable UV energy meters, which are sensitive to the wave band of 250~410 nm, are the general types of employed in UV application workshop.



Figure 1. Portable UV energy meters generally employed in industry

2.1.2 UV radiometer

It is an instrument to measure the radiation intensity at designated wave band. The corresponding output is UV radiation power in the unit of mW/cm^2 . As shown in Figure 2, the portable UV radiometers, which are sensitive to the wave band of 250~410 nm, are general type of employed in UV application workshop



Figure 2. Portable UV radiometers

The characteristics of the above measuring instruments include reasonable cost, pretty generality, some professional requirement on the operators and greater random error.

2.2. Install of on-line UV monitor

With the on-line UV monitor, the UV radiation intensity in the production cabinet could be measured, displayed and recorded in real time. Multi-points alternative monitoring could be realized with moderate design. The alarm function, on/off output and association with production line could be acquired if upper and lower radiation limits are set beforehand. The effective control of production quality could be thus reached. The on-line UV monitoring system could be easily post-installed into the traditional and simple UV curing equipments. The on-line UV monitor system is shown as Figure 3.

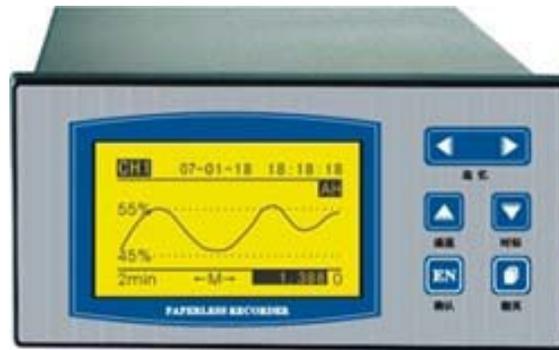


Figure 3. The on-line UV monitor (display and control panel)

2.3. Install of on-line UV monitor and control system

With the intelligent system, the UV radiation intensity in the production cabinet could be measured, displayed, recorded and controlled in real time. The alarm function, on/off output and association with production line could be acquired if upper and lower radiation limits are set beforehand. The constant PID control is obtained by combining the radiation measurement with radiation form. According to the output of digital or analog, the UV radiation system can be controlled independently with the intelligent adjustment of input power. Therefore, the emission of UV system could be kept at a stable level. The intelligent system is suitable for the application fields in which high coherence, great difference between fast and slow running, automation and unmanned operation are required. It could be adapted to traditional UV curing equipments and can actualize multi-points alternative monitoring. The operation interface of the system is shown in Figure 4.



Figure 4. operation interface of intelligent on-line UV monitoring system

The intelligent on-line UV monitoring system realizes monitor and control usually by compare of 100% relative quantity. The recorded historical data could be retrieved easily. To extend the working life of the detector, gap shutter was designed to acquire interval data.

3. Application cases analysis of Runwing UV curing and monitoring systems

Case I (as Figure 5): Monitoring system plus recorder for the UV curing encapsulation of main PCB, established in a large-scaled communication equipments plant of China. The characteristics include unmanned operation, expensive workpieces, accurate irradiation and recording retrievable.



Figure 5. Photography for the case I

Case II (Figure 6): UV monitoring system plus recorder for the UV curing of lamp cup coating in a automobile lamp plant of France. The characteristics include unmanned operation, high speed running, accurate irradiation, recording retrievable and low defective index of production.



Figure 6. Photography for the case II

Case III (Figure 7): UV monitoring system for the UV curing production of IC card. The characteristics include high speed production, PID radiation intensity control, recording retrievable and low defective index of production.



Figure 7. Photography for the case III

It is an important aspect to consider the procedure characters and select matching measuring instruments and monitoring systems carefully. Facile operation, real benefit, low cost, high efficiency and good quality would be reached if the technique parameters match up.

1) Effectively utilize the emission of UV lamp to save energy

It is very important in the field of printing due to the requirement of high running speed. According to the relationship between the light intensity and space distance, the distance from the lamp to the articles could be instantly adjusted through the radiation determination feedback system. Sufficient UV radiation could be achieved for the curing of printing articles. It is one of the mode utilizing UV energy which is reached with the intelligent monitoring system.

2) Evaluate the UV curing factors

Many operators may use electric parameters to evaluate the UV curing factors before the application of radiation measurements. However, on the viewpoint of practice, the UV radiation dosage can not be really reflected by the electric parameters despite the relationship between both of them. The electric parameters are seldom employed to evaluate the UV radiation intensity in practice because the emission efficiency is greatly influenced by the lamp manufacture process, reflection mode of UV light and working environment. The effective radiation intensity is usually determined with professional instrument.

3) The reliability of the UV curing system is improved by impersonal measurement. The measurement can be finished by general operators due to low technique requirement. It can be easily decided whether the lamps should be changed or not simply according to the measurement results.

4) It can be applied to evaluate whether the UV curing reach the requirement of coherence and avoid unfavorable consequence.

5) It is very easy to follow the product quality requiring long shelf-life and distance weathering transportation. The UV curing conditions of these products can retrieved from the database recorded historically so that it is favorable for analysis and finding out the hidden reasons.

6) It can be used to integrate many UV curing systems in different brand and configurations, and provide technical guide to operate in standard process.

It can be predicted that the UV radiation monitoring will advance with development of UV technology. The application of UV monitoring technique is believed to make greater progress and bring much more benefit to the manufacturers.