

# The Testing for Harmful Substance from Static-electricity Equipment Exhausted in the Operation Process

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**Abstract** The office equipments, like electrostatic photography copier, laser printer and PPC-Fax etc. bringing fast, conveniently, efficiently, and many advantages of etc, but at the time also bring some of the environment pollution problems that is neglected for harm human body usually, especially the machines are operated for a long time in narrow and bad ventilated office continuously. The paranormal quantity of the harmful substances exhausted, for example ozone, styrene, dust and noise etc. could harm to human health probably. This text study of testing methods and principles for ozone, dust and styrene etc. exhausted from electrostatic photographic process.

**Keywords:** testing, harmful substance, electrostatic photographic process, ozone, styrene

## 1. Introduction

The electrostatic photography technique already catholically applied in copier, laser printer, PPC-Fax, multi-function peripherals (integral gather copy, print, fax and network to one equipment), electrostatic photographic plate-making machine (used for offset lithograph system), high-speed document system, name card machine, label machine etc., electrostatic photography technique has brought revolutionary development in office and related realm, caused variety of the quality.

The electrostatic photography equipments at the time of bringing the people the convenience, fast, efficient, many advantages of etc., also bring some of the environments pollution problems that allow of no to neglect for harm human health usually, especially the machine has been operating for a long time in narrow and bad ventilated office continuously. The paranormal harmful substances were exhausted, for example ozone, styrene, dust and noise etc. to harm human health probably.

## 2 The testing procedure and conditions

### 2.1 The environment of the testing room

The capacity of the testing room must be 50 m<sup>3</sup> and airtight. Four walls and ceilings of the testing room are built in glass material or fiberboard of inside wall had coated polyfluorotetraethylene materials or stick to polyfluorotetraethylene film. The ozone is not adsorbed by polyfluorotetraethylene. The anti-electrostatic floor board is paved over the ground. There are well ventilated bore and the fans upside the four walls. The ventilated bore and the fans should keep the closeness off.

### 2.2 Requests for temperature and degree of humidity

The temperature of the testing room was set down in 25°C±2°C. The degree of humidity of the testing room was set not over 50% down. In measure process wholly, the temperature and the degree of humidity did not need to control specially, but it

shouldn't appear to dew.

### 2.3 Testing procedure

First, not than less 1 hour to air the room before testing beginning; Second, the concentration of the background is measured; Then, exhausted harmful substance by equipment is measured in operating continuously; Last, deal with measured data..

### 2.4 The machine and consumable material measured

The machine for measuring sample is put on the workbench which was in the central position of the room. The height of the workbench is 0.8 m. The sample instrument that used to measure is placed in positive front of the machine for measuring sample. It is level distance and height from the ground, see the table 1.

Item	Height	Level distance
Dust	165cm	10cm
Ozone	120cm	30cm
styrene	120cm	30cm

Table 1. The sample instrument position

It should keep ample consumable materials (toner or paper) possibly when the machine was been measured. To make sure that it must work 120 minutes uninterruptedly. In consideration of some trouble with the machine, like complement paper, abrupt paperboard or other failures etc., the output sum of the machine should be guaranteed to attain certain settled sum. (the output sum of the machine  $\geq$  the most rating speed of the machine  $\times$  consecution output time  $\times$  80%).

### 2.5 The result correction for nonstandard capacity testing room

It is called nonstandard capacity testing room when the capacity of testing room can't satisfy 50 m<sup>3</sup> standard. The value measured can be corrected by the formula below:

$$C' = CV / V_0 \quad (1)$$

In the formula:

C: Measured value (mg/ m<sup>3</sup>)

C': The value after revises (mg/m<sup>3</sup>)

V: The capacity of the testing room (m<sup>3</sup>)

V<sub>0</sub>: Standard volume 50(m<sup>3</sup>)

## 3 Measure for the harmful substances

### 3.1 The ozone generated and measure

#### 3.1.1 The ozone generated

Electric equipments with high frequency and high voltage often generate ozone while it is working. In the

electrostatic-photographic process, it will generate high electric voltage of several thousand while the drum surface was charging by corona charge device. The corona charge also is called high electric voltage charge. The corona will make oxygen molecule ( $O_2$ ) of air surrounding to form atomic oxygen ( $O$ ) in the charging process. The atomic oxygen unsteady will combine with oxygen molecule surrounding again, and change to ozone ( $O_3$ ).

### 3.1.2 Measure ozone

The instrument for ozone testing is a special monochrome light spectrophotometer absorbing ultraviolet ray. It can measure ozone concentration direct through to measure attenuation ratio of the ultraviolet ray in the sample of the gas, for example, air, oxygen, nitrogen, to analyze ozone concentration.

The instrument for ozone testing measures the ozone concentration of the air with the "A pair of measure data" technique. The "A pair of measure data" is a set of the background gas (zero gas) and the sample gas. The background gas is as reference gas which ozone of the environment air has been eliminated. The sample gas is collected from the machine working environment. The sample gas has never yet been any processed, the ozone exists still. The zero gas of certain quantity and the sample gas as the same quantity were extracted from the environment of sample machine to the optical platform of the instrument alternately through the pump and the sample store system. The radiation strength of ultraviolet ray was measured alternately and continuously in

the period of the background gas (be called the reference period) and the period of the sample gases (be called the testing period) by the special monochrome light spectrophotometer. Then, to get data measured in the reference period and the testing period. This pair of the data is called "A pair of measure value". The ozone concentration continuously can be obtained through contrasting a set of samplings. The radiation attenuation ratio of ultraviolet ray depends on length of the optical platform, the ozone absorption ratio and the ozone concentration.

$$I/I_0 = e^{-(ALC)} \dots\dots\dots (2)$$

In the formula:

I: The radiation strength of ultraviolet ray in the measured period

$I_0$ : The radiation strength of ultraviolet ray in the reference period

A: The ozone absorption coefficient (the wave-length 253.7 nm, STP 308.3/ cm<sup>3</sup>,atm )

L: The path length of optical platform (cm)

C: The ozone concentration

### 3.1.3 Sampling example

An example below, a set of copying machine with speed of 16 c/pm was measured by the instrument for ozone testing in 120 minutes (x-coordinate) continuously under the condition of 3.1.2-mentioned. The ozone concentration is expressed by Y-coordinate. See the figure 1.

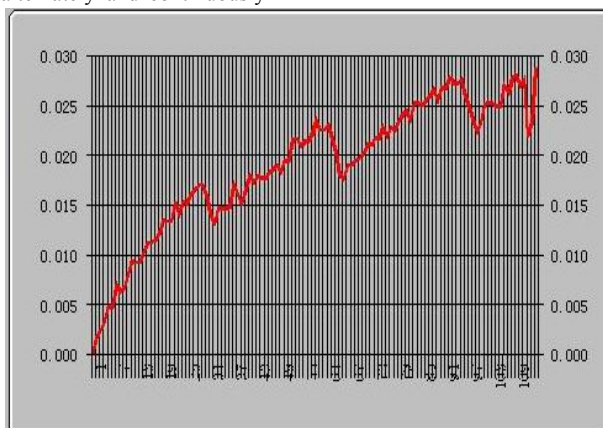


Figure1. The trend diagram of ozone concentration of sample measure result

## 3.2 The dusts generated and measure

### 3.2.1 The dusts generated

The dust was generated by some powders of toner and wastepaper which would be flying from the copying machine when it has been operated in the high speed.

### 3.2.2 The principle

The dust was measured by the constant flux inhalant sampling instrument. It includes the fan of dust collector, flux sensor, constant flux techniques etc., the flux is steady. The dust can immediately be inhaled and obtain two pieces of the data which are inhalational dust and total dust once.

It is weighed to a filtrate film of standard aperture with the analytical balance. The weight of the film is expressed by  $W_{01}$ . Put the filtrate film into the sampling instrument to the dust sampling. Then take off the film after sampling over. It is weighed by analytical balance again. The weight is expressed by  $W_{02}$ . The dust concentration was calculated by below:

$$C = (W_{02} - W_{01}) / V_0 \dots\dots\dots (3)$$

In the formula:

$V_0$ : Standard volume 50(m<sup>3</sup>)

## 3.3 The styrene generated and measure

### 3.3.1 The styrene generated

The main composition of electrostatic photography developer is resin, like polyethylene and polystyrene etc., but the molecular weight is smaller than it used for plastic resin. The copying machine will produce some styrene monomer and other organic compound which could be harmful to human body, especially in the development process and fix process of the copy machine.

### 3.3.2 The principle

The gas chromatogram analysis instrument is used to measure styrene monomer. The hydrogen flame ion detector of the

instrument is a kind of high sensitive and widespread used. It attains 10 ~ 12g/s detective ability for carbon organic compound, and for a trace element of ppb class. There are many excellences in the instrument, such as the structure is simple, the sensitive degree is high, the physical volume is small, the line scope is wide, the respond speed is quick etc. It is connected with the capillary tube to make a trace element analysis and fast analysis usually. But some substance can't be ionized in the flames, that means these can't be generated ion flow or the few ion flow, so they can't be direct detected, such as rare air, O<sub>2</sub>, N<sub>2</sub>, CO, CO<sub>2</sub>, SO<sub>2</sub>, NH<sub>3</sub>, H<sub>2</sub>O, SiF<sub>4</sub> and inorganic acid etc. It is mixed together to the carrier gas of the flame ion detector and compound separated by chromatogram table pillars with hydrogen gas, they were transmitted to the ion room and were sprayed from the mouth jet. The hydrogen was burnt with the combustion-supporting in the air. The organic substances were decomposed to ion and electricity as the energy taking from heat flames. The electricity forming by the moving of positive and the negative ion is measured. The electricity is direct proportion to quantity of carbon atom. The

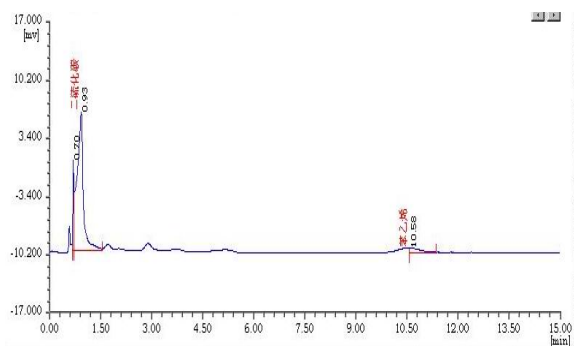


Figure2. Colors diagram of styrene sample

Table2. Measure result

ID No.	1	2	7
Compound	—	Carbon bisulfide	Styrene
Retain time (min)	0.700	0.933	10.583
Peak height (microvolt)	10597	16220	601
Peak area (microvolt×sec)	14220.0	213769.0	14397.0
Peak value	W	W	W
Content(%)	0.000	0.000	0.004

positive ion generated by ionized is collected with the collection pole (negative electrode or cathode), the negative ion (electronics) was succeed in catching by the project pole (positive electrode). As a result, electric current is created in action of the electric field of putting the electric voltage of 220V on two poles. Electric current is enlarged through micro-electric current enlarger to become as the signal of electric voltage. The signal output was connecting to a record instrument or the gas chromatography instrument to process and calculation.

### 3.3.3 Sampling example

An example below, a copying machine with speed of 16 c/pm was measured by the gas chromatography analysis instrument in 120 minutes (x-coordinate) continuously under the condition of 3.1.2-mentioned. Then the gas sample in active carbon tube was parsed in an hour. After this, turn on the work station of the gas chromatography instrument, and enter to "real time analytical interface", the data is transmitted to the chromatogram chart until the data processing completed.

## 4. Conclusion

It is important to study of test the harmful substances quantity exhausted by working process of some office equipments in working environment simulated, like ozone, dust, styrene etc. which can estimate the design of the equipments whether satisfying to requests of the international standard or not. And can help people to select regular office equipment.