Cangnan printing & packaging industry renovation and VOCs governance experience

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Abstract. The total content of volatile components emitted by ink accounts for 70%-80% during the process of drying. Various approaches, such as forcing law enforcement, stricting standards, improving governance efficiency, have been used to reduce the VOCs pollution. All these approaches not only improved the environment of workshop and regional air quality, but also promoted the standardized development of the industry.

1. Introduction
Volatile organic compounds (VOCs) are important precursors for the formation of PM$_{2.5}$ and ozone[1]. As ozone is an important characterization of atmospheric oxidation capacity, the enhancement of atmospheric oxidation capacity intensifies the formation of secondary particles[2-4]. According to the research, the contribution rate from PM$_{2.5}$ formed by VOCs to haze reached 17%. Key VOCs emission industries mainly include petrochemical, automobile spraying, industrial coating, printing, etc. Different production processes and different procedures will produce VOCs to varying degrees. In 2013, the survey results organized by the Ministry of Environmental Protection showed that the VOCs generated by the use of solvents in the printing industry reached 6% of China’s total VOCs emissions[5]. The solvent-based ink used in the printing and packaging industry usually contains 50%-60% of volatile components. 30%-70% of the thinner need to be added into the ink to adjust the ink viscosity. The composition of the thinner is generally the same as the solvent composition used in ink or other raw and auxiliary materials, which increases the emission of organic waste gas[6]. The total content of the volatile components emitted by the ink accounts for 70%-80% [7] during the drying process. Therefore the industry remediation of the packaging and printing industry is of great significance to the VOCs governance.

2. Status of the printing industry in cangnan
2.1. Distribution and Main Process of Printing Industry in Cangnan
According to statistics, gravure printing enterprises accounted for just 5 percent of whole printing industry in Zhejiang, but the VOCs emissions account for 80 percent of whole printing industry...
emissions. In Cangnan, there are 300 gravure printing enterprises, accounting for about 30% of the total number of printing enterprises. Therefore, the VOCs emission control in the gravure printing industry of Cangnan is significantly beneficial to the reduction of VOCs pollution around.

Packaging printing is a pillar industry of Cangnan County, Longgang Town is known as “printing city in China”. Longgang printing enterprises accounts for 80% of the total number of the county, and the rest are mainly distributed in Lingxi, Qianku, Jinxiang and other towns. Cangnan packaging printing industry can be divided into: gravure printing, lithography printing, relief printing, hole printing. According to the research, mostly of enterprises are taking gravure printing and lithography printing process.

![Figure 1. Distribution of printing& packaging industries in Cangnan](image)

![Table 1. Classification of printing& packaging technology in Cangnan](table)

### 2.2. Existing problems in Cangnan printing industry

#### 2.2.1 Lack of modern management concept

Most printing enterprises begin at family factories, they have obvious characteristics. Enterprise managers do not have professional managers ability, focus on short-term interests, macro-direction
grasp is insufficient. All these shortages to some extent weakened the overall competitiveness of Cangnan printing industry.

2.2.2 Weak legal consciousness
Driven by various reform measures of the government, enterprises are getting more and more convenient services. But the legal consciousness of enterprises is still weak, and illegal acts such as "building before approval", "excessive discharge" and "abnormal operation of management facilities" still exist. Some standard-sized enterprises do not actively install environmental treatment equipment. They have not assumed the responsibility of environmental protection while enjoying government benefits.

2.2.3 a serious mixture of industry and city
For the development of the times, most of the printing and packaging enterprises (self-employed) are mixed in the residential areas, and the waste gas and noise control facilities all fall behind, the contradiction caused by pollution is quite prominent. Just for Longgang town, there are hundreds of environmental complaints involving printing and packaging every year. At the same time, due to the nature of the land does not meet the examination and approval conditions, a considerable number of enterprises (self-employed) can not approve.

3. Remediation measures

3.1. Come up with a plan by tripartite participation
According to "government led, association led and enterprise main body promoted", Cangnan County Government established a leading group of packaging and printing industry renovation, issued the implementation plan of Cangnan County printing and packaging industry renovation and promotion work, the rectification special working group settled in the enterprise with guidance and assistance, and departments and towns implemented responsibility binding. Longgang as the center of the packaging and printing industry, held a mobilization meeting for thousands of people to rectify the packaging and printing industry. Four groups of leaders were responsible for the work in different areas, and 15 key attack groups were set up to publicize door-to-door in order to supervise and guide the rapid promotion of the industry renovation.

3.2. Improving governance efficiency
Gas treatment expert participated in the treatment process discussion, and help to issue "Guiding Opinions on Pollution Treatment in Cangnan County Packaging and Printing Industry". Five different printing processes such as offset printing, relief printing, gravure printing and screen printing have been specified governance methods, Some efficient governance processes like RCO and RTO must be used to gravure printing. In order to dispel the doubts that the business owners in the industry park do not dare to invest in the treatment of waste gas, the ecological and environmental department takes the reform of the administrative license of industrial enterprises as an opportunity to solve the problem of EIA approval for old industrial parks in the residential security area. Through the filing procedures of the current environmental assessment, the pilot project carries out the environmental assessment and approval in the transitional period, so as to solve the legal problems of enterprises. At the same time, the ecological and environmental department take the lead in organizing training and exchange meetings for printing enterprises to explain the requirements of industry regulation standards, and encourage enterprises to "try first".

3.3. Strengthening the experimental unit demonstration and popularize
According to the 21 standards of Wenzhou printing industry renovation and upgrading, the requirements of "production line sealing, waste gas efficient collection and treatment, and hazardous waste centralized transfer" are implemented, and "large, medium and small" printing enterprises with
different scales are selected to create a rectification model of "learning, seeing and promoting". There are 109 printing enterprises in Longgang packaging and printing industrial park, all have completed EIA approval, 37 gravure printing enterprises have installed efficient waste gas treatment facilities Zhejiang Chengde technical Co., Ltd. and other leading enterprises invested more than 6 million to upgrade waste gas treatment facilities At the same time, the government entrusts a third party to carry out rectification verification and evaluation to ensure that the rectification requirements are effectively implemented.

3.4. Strict law enforcement
Cangnan County comprehensively uses the means of power failure, case filing and investigation, forcing enterprises to speed up the renovation progress. Through the special action of "cutting pollution with sharp sword and tackling key problems in two months", 112 illegal cases of packaging and printing enterprises were investigated and dealt with in the whole county in 2019, with a penalty amount of 10.53 million yuan.

3.5. Speed up gathering in the industry park
In accordance with the working idea of "total volume reduction, centralized entry into the park, and shutdown outside the park", we have vigorously guided enterprises to gather in the industry park. Up to now, 7 printing and packaging industry park have completed construction, and more than 1000 printing enterprises have settled in the park.

Table 2. The selection of different printing & packaging treatment technology in Cangnan

| Type                        | Method                                                                 |
|-----------------------------|------------------------------------------------------------------------|
| Gravure printing (soft packaging, color printing) | Combustion process Adsorption Concentration Combustion Recycling Coating: Combustion, compounding: activated carbon adsorption |
| Coating/composite lithography printing | Coating: Adsorption Concentration Combustion Compound: Water Spray Coating: Recycling |
| letterpress                 | UV Ink: Pretreatment of activated carbon Solvent based Ink: Pretreatment activated carbon, pretreatment photocatalytic activated carbon Waterborne Ink: Water spray activated carbon |
| Porous printing             | Solvent based Ink (Plastic printing): Pretreatment adsorption concentrated combustion Solvent Ink (Paper products, flexo labels): Pretreatment photocatalytic activated carbon Waterborne Ink or UV Ink: Activated carbon adsorption Solvent based Ink: zeolite adsorption concentration combustion method |

4. Results
4.1 Results of industry remediation
According to the guidance of the government, about 1056 printing companies were shut down. 723 companies have upgraded their standards. 144 enterprises have entered the park. After remediation, among the companies listed in the "upgrade group" list (as shown in Figure 2), 95.5% of gravure printing companies choose to use the combustion method, 85.2% of lithographic printing companies use the UV photocatalytic oxidation method, and others use activated carbon adsorption and plasma. After the treatment process, the organic waste gas generated in the printing process has been effectively treated, and the printing industry has achieved remarkable results.
4.2 Results of environmental quality improvement

Through remediation, the urban environment of Cangnan County has been significantly improved. Monitoring data show that in 2019 (as shown in Figure 3), Cangnan County has an excellent ambient air rate of 98.1%, with a PM$_{2.5}$ concentration of 26μg/m$^3$, and an average PM$_{10}$ concentration of 47μg/m$^3$. The air quality has reached the best level of historical monitoring. The air quality rate in Longgang Town was 98%, and PM$_{2.5}$ dropped by 5μg/m$^3$ compared with the same period last year, reaching 27μg/m$^3$. The number of environmental complaints in the printing industry dropped from 450 in 2017 to 243 in 2019.

5. Conclusion

The rectifications of the printing and packaging industry in Cangnan help to improve the urban environment, essentially the air quality. The pollution issues can be solved through the efforts of the
government, the market and the enterprises, by the means of strengthened efficient governance, strict law enforcement and crack down on illegal construction, etc. In the next step, Cangnan will actively explore the governance reform of small and medium-sized enterprises in the park, and comprehensively adopt the forms of "combined production, unified management", "concentrated production, shared pollution control" and "joint investment, group development" to solve the problem of "investment and inability to use" of environmental protection governance by small and medium-sized enterprises.

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