EXECUTIVE SUMMARY

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Carbon Emission Study of China's Packaging Printing Industry

Independent Study by Professor Lixin Mo from Beijing Institute of Graphic Communication (BIGC) Highlights Carbon Footprint Advantages and Opportunities for Flexographic Printing Over Gravure

Introduction

In Eastern culture represented by China, product packaging largely determines people's perception of the quality of the product itself. For that reason, East Asia generally has higher requirements for the printing quality of product packaging. Historically, that has meant using gravure printing technology, which continues to represent more than 90% of packaging production in China.

Today, however, China has placed increasing emphasis on sustainability, including the introduction of its "dual carbon" strategy. This refers to China's two climate goals announced by President Xi Jinping at the 75th session of the United Nations General Assembly in September 2020. He noted that China aims to peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060, encompassing a shift towards a low-carbon economy and green transformation across various sectors, including packaging.

When China first decided to acquire packaging printing technology from abroad, flexographic printing was significantly behind gravure – and even offset – in terms of quality. Now, however, the quality and sustainability of flexographic printing has improved

significantly and accounts for more than 70% of the packaging printing market in the United States, and about 50% in European countries.

The purpose of this study conducted by Professor Lixin Mo's group from BIGC was to investigate the development status of flexographic and gravure printing enterprises in China's packaging and printing industry. This was accomplished through surveys and in-person visits to provide a factual basis for clarifying the comparative advantages, shortcomings and development potential of flexographic printing technology. This was especially important in light of China's "dual carbon" goals. By obtaining production data for flexographic and gravure packaging and printing enterprises over a certain period, the carbon emission data of their functional unit printed products was calculated, and a systematic comparative study was conducted. The research results of this paper provide a reference for the carbon emission situation, how the current situation, if continued, can negatively impact the country's sustainability goals, and the value of a potential transformation of the packaging printing industry in China.

Methodology and Data Collection

This study was conducted with a very structured methodology to ensure accurate data collection. From October 1 to December 4, 2023, a total of 32 typical packaging and printing companies were issued questionnaires, and 28 valid questionnaires were collected, including 12 flexographic printing companies and 16 gravure printing companies. The surveyed companies are distributed in developed packaging and printing regions such as North China, East China and South China. The content of the questionnaire survey covers the basic information about printing companies, printing technology, raw materials, environmental governance and other aspects. Site visits were conducted at several locations to validate the accuracy of the survey responses and gather other relevant information.

Company business types surveyed included label printing, paper packaging, and flexible food packaging. The corrugated paper printing business was not included since some 90% is already produced using flexographic printing.

The distribution of companies between gravure and flexographic printing reflected:

- 41.67% of flexographic printing companies and 25.00% of gravure printing companies have label printing businesses.
- 25.00% of flexographic printing companies and 12.50% of gravure printing companies have paper packaging printing businesses.

- 8.33% of flexographic printing companies and 75.00% of gravure printing companies have flexible food packaging businesses.

This distribution is representative of the overall packaging market in China, with labels and paper packaging being the main applications for flexographic printing, while gravure still dominates flexible food packaging.

The carbon emissions per functional unit of printed products were calculated by setting boundary conditions. The main stages included in the carbon emissions calculations considered raw material acquisition (inks and additives), printing production (electricity and natural gas consumption), and waste treatment (energy used by regenerative thermal oxidizer (RTO) equipment to destroy volatile organic compounds (VOCs) and wastewater treatment).

Seventy-five percent (75%) of flexographic companies have obtained various environmental certifications while 31.25% of gravure printing companies have obtained environmental certifications.

Key Findings – Comparative Analysis

The study identified the primary processes being used, to include types of composite and ink. In terms of composite use, there are three types:

- Dry composite,
- Solvent-free composite, and
- Extrusion composite

Dry composite requires the use of a large number of adhesives and diluents resulting in a high level of VOC emissions. The other two do not use organic solvents and are thus more sustainable. In developed countries such as Europe and the United States, solvent-free composite has become the main method to produce flexible packaging composite materials and is the future development direction. Nearly half of the flexographic printing companies do not use composite technology, while 78.57% of gravure printing companies use dry composite technology.

Inks can also be a source of VOCs. Obviously, solvent-based ink has higher VOC emissions, with water-based and UV inks having almost no VOC emissions. The study found that only 8.3% of flexographic companies use solvent inks. Nearly all gravure printers use solvent inks.

The study provides a detailed analysis of emissions at three different printing plants; these calculations support the premise that flexographic printing using water-based inks is significantly more sustainable, and more in line with China's "dual carbon" strategy, than gravure printing, with virtually no compromise in quality.

Conclusions, Recommendations, and Outlook

This study investigates the status of China's flexographic packaging printing industry through a combination of questionnaire surveys and actual visits, and studies the carbon emission levels of flexographic and gravure printing technologies. The survey results show that there are obvious differences between flexographic printing companies and gravure printing companies in China's packaging printing industry in terms of main business, environmental certification, composite process and ink use, and waste gas treatment.

Within the scope of this survey, the carbon emission levels of printed products are ranked from low to high: water-based flexographic printing, solvent flexographic printing, and solvent gravure printing. It can be seen that in the context of China strengthening the implementation of the "dual carbon" policy as a national policy, and with the continuous advancement of flexographic printing technology, it is advocated that, as soon as possible, packaging printing companies actively work to adopt flexographic printing technology for production, minimizing the use of gravure printing, and increasing the use of water-based inks, which will help China's packaging printing industry achieve the country's goal of carbon neutrality before 2060. These actions will deliver improved environmental sustainability in packaging printing production yet still deliver the high-quality packaging that Chinese consumers often use to judge the overall quality of the product the packaging contains.

Not covered within the scope of the survey, but important to consider, is plate/cylinder processing. While the most common process these days for creating gravure cylinders is laser etching, replacing the older and less sustainable chemical etching process, flexo plates, once imaged, are either processed with solvent- or water-wash. Clearly, the latter is more sustainable.

The bottom line is that gravure printing results in significant VOC emissions, while at the other end of the spectrum, flexographic printing using water-based inks and water-wash plate processing emit virtually zero VOCs.

This transition to more sustainable packaging printing, of course, requires investment, which some businesses may resist. However, on the other side of the equation is the regulatory environment which, as enforcement scales up in line with China's "dual carbon" goals, may result in fines and other regulatory penalties. In addition, as the brand and

consumer communities become more dedicated to helping China achieve these goals, a migration from solvent-based gravure to water-based flexography can be a significant competitive advantage in a highly competitive marketplace. Without this transition, the packaging printing industry will basically not only NOT contribute to national goals, but it will also negatively offset progress that may be made in other industries.

Request the full study [**here**].