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Euro Green Chemistry-2018-Characteristics of Chemicals and Trade Secrets Used in the Semiconductor Manufacturing Industry- Chungsik Yoon-Seoul National University

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Introduction:

The semiconductor industry, which is characterized by high levels of technological combination, has changed quickly. A diversity of chemical substances is used in the semiconductor development process. The number and amount of chemicals are increasing because of drastic technological developments in the industry. Although the majority chemical substances used in a semiconductor manufacturing factory are known to be dangerous, it is not easy to get hazard information for all chemicals because of the use of trade secrets. In particular, it is not easy to get information on the chemical content, chemical abstract service number, ingredients, and hazards of these chemicals because of patents and trade secrets. Workers in a semiconductor factory are to be exposed to carcinogens and reproductive materials. In the 1980s, studies of carcinogens and chemicals used in the semiconductor industry that are danger to workers' reproductive health were undertaken in the US and some European countries. Health and safety issues in the semiconductor manufacturing industry have emerged since 2007 because of the onset of cancers that is leukemia, in employees who work in semiconductor manufacturing factories in Korea.

It is tough to get information on the number and volume of chemicals used in an actual semiconductor factory. Although there are various review papers and books documenting possible exposure to chemicals according to the processes used in the semiconductor industry, this information is normally considered to be basic and is not based on real data collected in situ. In respective of safety, health, and environmental issues, it is necessary to understand the actual chemical usage in the semiconductor industry. The objective of this study was to examine the chemical characteristics and chemical inventory in a large semiconductor manufacturing facility in Korea, by using a database based on safety data sheets.

Methods:

This research was conducted by using a chemical information DB provided directly by a company that has a huge market share of the worldwide semiconductor industry. This company has two semiconductor manufacturing factories (called A and B in this study) in Korea .The usage of chemical substances is managed independently in each factory. The DB includes chemical information such as phase, product number, factory, product name, ingredients, CAS number, chemical content, processes used, number of units, and pattern of usage in 2014. The DB was checked using SDSs provided by the company, which also kept SDSs provided by each chemical manufacturer or supplier.

As per the DB provided by the company, the phase indicates to the physical status of the products supplied. Product number is the number assigned to each product at the company. The product name is the name of the real chemical product, which sometimes contains some tricks regarding its chemical identity. From the ingredient and CAS number column, the number of chemical ingredients and trade secrets per product, and whether a product contains any dangerous any chemicals, can be inferred. The amount of each ingredient in a product is expressed as a relative mass percentage, with a range of values provided.

In this study, when the quantity of a certain ingredient used had to be calculated, the most value of the ingredient over the range of amounts present in a product was used. Therefore, the amounts calculated for certain ingredients could have been over estimations.

Information on health hazards, physicochemical properties, toxicity, and the Korean occupational exposure limit (OEL) was added to, or updated in the DB according to SDSs recently published by the Korea Government as an integrated system for managing chemical information (as part of the Korean Occupational Safety and Health Act [Korean OSH Act], which was revised in 2015) Carcinogens were classified according to the International Agency for Research on Cancer (IARC) classification and the Korean OSH Act.

Discussion:

found that around 150 pure chemical substances were used in about 430 chemical products in a semiconductor company; about 40% of these chemical products contain trade secret ingredients. In photolithography, one of the most extensively used processes in semiconductor manufacturing, nearly all products (about 98%) contained trade secret ingredients, with an average number of approximately two per product.

SDSs enable workers to evaluate the health and safety conditions in their workplace, but the huge amount of trade secret ingredients used in the semiconductor manufacturing industry makes it difficult to get accurate health and safety information. These trade secret ingredients could easily be deleted during airborne chemical monitoring and related risk assessments, even though they may be risky.

We noticed that 40% of all products in both factories contained at least one trade secret ingredient. In 2011, a report was published claiming that 45% of chemical products in

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Korean chemical manufacturing plants contained at least one trade secret ingredient. As shown in more than 97% of chemicals used in the photolithography process contained trade secret ingredients, with the average number of trade secret ingredients per product being.

Conclusions:

This study evaluates chemical usage in two factories operated by one of the major semiconductor manufacturing companies in the world. More than 420 chemical products, which contained more than 150 pure chemical ingredients, were used, with 40% of them containing trade secret ingredients. More than 97% of the chemical products used in the photolithography process, one of the majority widely applied chemical processes, contained trade secret ingredients. Less than 30% of the chemical ingredients had OELs. Because of the high percentage of trade secret ingredients, inadequate number of regulated chemicals, and a typical chemical use compared to other industries, it is hard to assess health hazards in the semiconductor industry. In 2014, more than 45,000 tons of chemicals were used in each factory and sulfuric acid, classified as a group 1 carcinogen by the IARC, accounted for about 30% of the total amount.

The company will phase out chemical components that should not be entered at the time of purchase of chemical products and establish a system to review SDS and other safety and health information to comply with laws and rules.