TSCA and the Regulation of Renewable Chemicals

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The dual national goals of reducing America's dependence on foreign oil and greening the economy converge in biobased chemicals, the promising and rapidly evolving field of technology that produces commercial chemicals from renewable feedstocks. Although biobased chemicals have a long history, increasing sensitivity to reliance on nonrenewable feedstocks and the environmental impact of petroleum-derived chemicals have hastened the commercialization of biobased chemicals, and today they are in production as never before. According to one estimate, biobased chemicals' share of the global chemical industry is expected to grow from 2% in 2008 to 22% by 2025.[1] Lux Research reports that biobased chemicals capacity will double in market potential to $19.7 billion in 2016.[2]

The enthusiasm that supports the rapid commercialization of biobased chemicals has eclipsed the necessary discussion on how the Toxic Substances Control Act (TSCA) might apply and the potential commercial consequences of TSCA's premanufacture review requirements on biobased chemicals deemed ''new'' chemicals. While there is no doubt TSCA is relevant, a lack of awareness as to how TSCA applies and any potential commercial and regulatory impact it may have is inviting business disruption and other unpleasant commercial consequences. This article provides background on biobased chemicals, explains TSCA's application to these commercial products, discusses some of the anomalies that may arise when applying TSCA to biobased chemicals, and suggests strategies for industrial stakeholders to ensure the successful introduction and marketing of biobased chemical products.

The Biobased Chemicals Market

For TSCA purposes, biobased products can be placed into two broad groups: biobased chemical products and biofuels. While biofuels may be more prominent, biobased chemicals are the primary focus of this article as they represent the product area in which TSCA has its greatest potential application.

While there is no formal definition of biobased chemicals, the term ''biobased product'' is defined in the Farm Security and Rural Investment Act of 2002 as ''a commercial or industrial product (other than food or feed) that is composed, in whole or in significant part, of biological products or renewable domestic agricultural materials (including plant, animal, and marine materials) or forestry materials.''[3] While biobased chemical products are enjoying increasingly broad commercial popularity, they are not new—a multi-billion pound chemical business based on animal fats, vegetable oils, tall oil, tall oil fatty acids, and naval stores (e.g., turpentine and rosin) already exists. While certain solvents—namely, acetone, butanol, and ethanol—and acids such as citric, lactic, itaconic, gluconic, and related organic acids were produced principally by fermentation until the middle of the 20th century, the emergence of low-cost petrochemical feedstocks by the 1950s made fermentation processes commercially unattractive. By 1952, most fermentation facilities were closed. Today, chemical industry feedstock accounts for approximately 10% of the petroleum consumed in the US.[4]

The large environmental footprint of petroleum-based chemical feedstocks has incentivized the search for more environmentally friendly and renewable raw materials, however.[5] Rampant volatility in the cost of petroleum has also fueled efforts to find cheaper, more stable feedstocks. In the US, corn, soybeans, tallow, lard, and naval stores are the primary feedstocks for biobased production. It is widely recognized, however, that for biobased production to achieve its full market potential, it will be necessary to develop a broader range of plant and animal material and plant waste sources (collectively referred to as biomass).

Domestic Policy Support for Biobased Products

There is significant federal government support for biobased products. Federal legislation, Executive Orders, and regulations have long and consistently expressed national support for these innovations, spurring development over the past two decades. Executive Order 13134, Developing and Promoting Biobased Products and Bioenergy, is perhaps the most prominent example of the federal government's enthusiastic support for biobased products.[6] Issued in 2009, it made the development of a strategy to stimulate the creation and adoption of technologies needed to make US biobased products globally competitive a national priority.[7]

Several equally relevant legislative acts have helped to fuel a surge in the growth of biobased products. The BioMass Research and Development Act of 2000 established the Biomass Research and Development Board, an interagency board composed of representatives from the White House, US Department of Agriculture (USDA), and US Department of Energy.[8] Among other functions, the Board implements the Biomass Research and Development Initiative, which provides grants to stimulate the development of bioenergy technologies. The 2002 Farm Security and Rural Energy Act created the BioPreferred® Program, a USDA-administered program that has been very successful in increasing the purchase of biobased products by the

DOI: 10.1089/ind.2012.1539

federal government by awarding federal procurement preference status to qualifying products.[9] The Program was expanded significantly in 2008 under the Food, Conservation, and Energy Act.[10] The 2005 Energy Policy Act established renewable fuel standards and the first renewable fuel volume mandate in the US.[11] The standards, which are implemented by the US Environmental Protection Agency (EPA), ensure that transportation fuel sold in the US contains a minimum volume of renewable fuel. Most recently, the Obama Administration renewed its commitment to strengthening and growing bioscience through the issuance of the National Bioeconomy Blueprint.[12] The Blueprint ''outlines steps that agencies will take to drive the bioeconomy—economic activity powered by research and innovation in the biosciences—and details ongoing efforts across the Federal government to realize this goal.'' The Blueprint specifically outlines strategic objectives for a bioeconomy with the potential to generate economic growth and address societal needs.

One federal law with potential relevance to biobased chemicals is the Pollution Prevention Act (PPA), which served as a foundation for EPA's Green Chemistry Program.[13,14] The Act focuses the attention of stakeholders—be they from industry, government, or the public sector—on reducing pollution at its sources through cost-effective changes in production operations, shifts to less toxic chemical intermediates or products, recycling of materials to keep them out of waste streams, and related manufacturing and processing changes. Using the PPA as a springboard, EPA developed the Green Chemistry Program, which encourages efforts to design and develop processes and chemical products that reduce or eliminate the use of hazardous intermediates or the generation of hazardous chemicals, contribute to reduced use of energy or resources, and produce safer products. Through its annual Presidential Green Chemistry Challenge Awards, EPA recognizes innovative technologies that promote green chemistry.[15] The PPA and EPA's Green Chemistry Program provide federal policy support and important recognition opportunities, respectively, for biobased chemicals and are among a number of legislative and federal policy initiatives paving the way for a thriving and growing biobased products market.

TSCA

As with most innovations, the quest for global competitiveness and commercial acceptance has outpaced any rigorous review of the governance and regulatory implications of the production of biobased chemicals. The perception that anything biobased is inherently more benign and sustainable has enhanced this halo effect. While this perception may be accurate in many cases, the fact of the matter is biobased chemicals are still chemicals, and as such, subject to TSCA—the federal law that comprehensively governs new and existing chemical substances throughout their production, distribution, use, and disposal.[16]

TSCA authorizes EPA to regulate chemical substances, defined broadly to include ''any organic or inorganic substance of a particular molecular identity.''[17,18] As defined, the term chemical substance does not include pesticides, drugs, or food, all of which are regulated under other federal laws.[19] Biobased chemicals, however, are plainly subject to TSCA as they include substances of a particular molecular identity; that these substances may be derived from renewable feedstocks does not preclude application of regulation under TSCA.

TSCA is a complicated law with many interesting provisions and fascinating policy implications. We focus here on aspects of three TSCA sections, Section 2, Section 8(b)(1), and Section 5, as an understanding of these provisions is critical to understanding how TSCA applies to biobased chemicals.

TSCA SECTION 2

TSCA Section 2(b) discusses the policy of the US regarding actions under TSCA. TSCA Sections 2(b)(1) and (2), respectively, discuss the need for adequate test data to be developed by industry on the effects of chemicals and that adequate regulatory authority should exist to control chemicals presenting unreasonable risks to health and the environment. Section 2(b)(3) makes clear that this authority ''should be exercised in such a manner as not to impede unduly or create unnecessary economic barriers to technological innovation while fulfilling the primary purpose of this Act to assure that such innovation and commerce in such chemical substances and mixtures do not present an unreasonable risk of injury to health or the environment.''[20]

TSCA Section 2(c) states that it is the intent of Congress that, in implementing TSCA, EPA ''shall consider the environmental, economic, and social impact'' of any actions taken.[21] Read in combination, TSCA Sections 2(b) and (c) make clear that in taking action to control unreasonable risks under TSCA, EPA is to consider and balance the risks, costs, and benefits presented. TSCA, like its federal counterpart law that regulates agricultural chemicals, is a ''risk–benefit'' statute, meaning that EPA is required to balance the regulatory costs versus the likely benefits of a chemical regulation. More traditional environmental statutes such as the Clean Air Act and Clean Water Act do not require such balancing.

TSCA SECTION 8(b)(1)

TSCA Section 8(b)(1) directs EPA to compile and keep current a list, commonly referred to as the TSCA Chemical Substance Inventory, of each chemical substance that is domestically manufactured or imported into the US.[22] The initial Inventory developed from 1978 to 1979 used input from the chemical industry and allowed existing chemical substances already in commerce to be grandfathered in. These chemicals were included in the TSCA Inventory automatically, side-stepping any EPA review at the time of the listing. Thus, under TSCA, EPA has less authority over existing (as opposed to new) chemical substances.

Because the TSCA Inventory was created in the late 1970s, the organic chemicals listed reflect the fact that commercial chemistry at that time was largely petroleum-based. A large number of petroleum-based feedstocks are listed on the original Inventory. For example, EPA has identified almost 600 petroleum process streams for purposes of partially exempting these substances from reporting under TSCA Section 8 Chemical Data Reporting rule obligations. Many of these chemicals are named in ways that make their petroleum sourcing explicit (i.e., the term petroleum is included in many of the names). Certain naturally occurring chemical substancs are also already included on the TSCA Inventory, and are likewise exempt from

regulatory review.[23] EPA provides examples of such substances including raw agricultural commodities such as corn and soy; water, air, natural gas, and crude oil; and rocks, ores, and minerals. While biobased chemicals were certainly present on the original TSCA Inventory, their number and variety were limited in comparison to petroleum-based substances. As such, many of the biobased chemicals entering the market will be considered ''new chemicals'' subject to TSCA Section 5 notification.[24]

TSCA SECTION 5

Because biobased chemicals can be considered new chemical substances, it is critically important for biobased chemical manufacturers and their downstream customers to understand the regulatory implications of the TSCA status of their biobased chemicals. TSCA Section 5 governs the manufacture in and import into the US of chemical substances considered new. Manufacturers of such chemical substances—which under TSCA includes importers—must notify EPA of the new chemical substance through the submission of a Premanufacture Notification (PMN).[25] Unless a PMN exemption applies, a company must submit a completed PMN form to EPA at least 90 days before commencing the manufacture or import of a new chemical substance.[26] Although the EPA review process by statute is supposed to take no more than 90 days, in reality it can take considerably longer. As a result, the chemical review process must be carefully factored into a company's business plan to avoid disruptive and costly operational delays.

EPA under TSCA Section 5 is required to assess the information provided by industry in a PMN to determine the potential for ''unreasonable risk'' of a new chemical, chemicals that are produced in high volumes and may have substantial exposure potential, and/or chemicals that may have ''significant new uses.'' TSCA Section 5(d)(1) requires that certain information be provided in the notice, including a description of the new chemical substance, estimated annual production volume, intended uses, worker exposure information, and any test data in the possession of the notifier on health and environmental effects.[27]

Although most new chemicals submitted for EPA review are not ultimately regulated under TSCA Section 5 after the PMN is submitted, when EPA targets a chemical for regulation this will at a minimum result in unplanned delays that could last for months to years as the regulatory process proceeds and, in the worst case scenario, could result in a regulatory barrier to commercialization. Following review of the PMN, EPA can take a variety of regulatory actions under TSCA Section 5(e) if certain determinations can be supported. Under TSCA Section 5(e)(1)(A)(ii)(I), EPA may determine that the new chemical ''may present an unreasonable risk'' to health or the environment.[28] A determination of unreasonable risk involves consideration of cost-benefit and relative risk factors including the cost or performance-based benefits of the new chemical, the economic impact of testing or regulation, and the relative risks in comparison to existing chemical alternatives. Under TSCA Section 5(e)(1)(A)(ii)(II), EPA may determine that, because production of the new chemical is substantial, it has the potential for significant exposure or release.[29] Applying Section 5(e) authority, EPA can prohibit or limit manufacture, processing, use, or disposal of the new chemical pending development of test data needed to support a reasoned evaluation of the risks.

Chemical Naming Conventions

Before discussing the PMN administrative review process and the regulatory actions EPA is authorized to take regarding the manufacture and distribution of new chemicals, it is important to review a few points about biobased chemicals nomenclature. Since biobased chemicals can be structurally similar to petroleum-based chemicals already listed on the TSCA Inventory, the PMN review process may be avoided in some cases. Biobased chemicals may be named differently than their petroleum-based counterparts however, and determining whether a biobased chemical is listed on the Inventory can be tricky.

Several chemical naming conventions are used globally. The Chemical Abstracts Service (CAS) Chemical Abstract (CA) Index Names and Registry Numbers (CASRNs), which is used under TSCA, is widely accepted throughout the world as a consistent and valid method of identifying chemicals. To assist in the development of the initial TSCA Inventory, the Soap and Detergent Association (now the American Cleaning Institute) and EPA jointly developed a system for naming chemical substances derived from natural fats and oils and their synthetic substitutes. This system, referred to as the SDA Nomenclature system, may be of special relevance to biobased chemical substances derived from natural fats and oils. (The SDA Nomenclature System is described in detail in Section 1 and in Appendix A, Volume 1 of the 1985 printed version of the TSCA Chemical Substance Inventory.) International Union of Pure and Applied Chemistry (IUPAC), the official naming convention of the European Union (EU) under the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) regulation (European Parliament and Council Regulation (EC) 1907/2006), is intended to allow the naming of a structure by following a set of rules. IUPAC names are not acceptable for TSCA Inventory purposes.

NAMING AND IDENTIFYING BIOBASED CHEMICALS

EPA applies CAS nomenclature in naming TSCA Inventory chemicals, although the agency also follows a number of naming conventions that are or can be distinct from a strict CAS approach. These may be based on the way that EPA approached the naming of a particular chemical (and will use a similar approach for naming other new chemicals of that type) or are derivative of approaches outlined in EPA documents that provide guidance in the naming and identification of TSCA-regulated chemicals. One such guide, the Toxic Substances Control Act Inventory Representation For Certain Chemical Substances Containing Varying Carbon Chain Lengths (Alkyl Ranges Using the CX-Y Notation), is particularly relevant since many biobased chemicals are derived from fats and oils containing fatty acids ranging from C8 to C22 in even carbon increments, with no significant quantities of fatty acids with an odd number of carbon atoms.[30]

EPA's guidance documents, however, also indicate that ''[f]undamental to the Inventory as a whole is the principle that

entries on the Inventory are identified as precisely as possible for the commercial chemical substance, as reported by the submitter.''[31] A chemical substance may therefore be listed on the Inventory with a general description, but depending on the circumstances and the knowledge of a more specific chemical identity, it may be the case that a company cannot ''fit'' its biobased chemical into an Inventory-listed nomenclature and must instead consider its chemical as new for Inventory-listing purposes. If that is the case, a CA Index Name must be provided in the PMN. Submitters may obtain the correct chemical identity of the PMN substance either through the CAS Registry Services Inventory Expert Service (IES)—Method 1—or from any other source, dubbed Method 2.[32] For Method 1, a copy of the IES report must be attached to the PMN. Submitters who choose Method 2 and develop their own chemical identity are cautioned that, if a source other than IES is used and any chemical identity information is determined by EPA to be incorrect, the notice will be declared incomplete and the submitter will be responsible for correcting the chemical name prior to the start of the review period. If Method 1 has been used, however, EPA will work with IES to agree on a name, and the review period will not be affected. Use of CAS services other than the IES, including the CAS Registry, also falls under Method 2.

Naming rules for biobased chemicals can be complex, but there is some flexibility in applying these conventions. When a new biobased chemical intended for use as a chemical intermediate is introduced, downstream derivatives based on that chemical, depending on how they are named and identified, can also be considered new chemicals. An example is the use of 9-octadecenoic acid (9z)-, homopolymer, isomerized to form fatty acids, C8–18 and C18-unsaturated, reaction products with isomerized oleic acid homopolymer. Note the change in nomenclature for the starting material from the 9-octadecenoic acid (9z)-, homopolymer, isomerized to isomerized oleic acid homopolymer in the product. In the case of a new biobased chemical used as a monomer, all polymers based on that new monomer would trigger new chemical requirements. Given how young the biobased industry is, new chemical requirements for biobased feedstocks and their derivatives are likely to be a long-term challenge for the industry and its downstream customers.

Substances on the TSCA Inventory are divided into two classes for ease of identification. A Class 1 chemical substance is a substance whose composition, except for impurities, can be represented by a definite chemical structural diagram. A Class 2 chemical substance is an ''unknown or variable composition, complex reaction products, and biological materials'' (UVCB) substance whose composition cannot be easily represented by a definite chemical structural diagram. Such a substance is generally derived from natural sources or complex reactions. Its composition may be complex, difficult to characterize, and variable. Various nomenclature schemes for Class 2 substances are discussed below:

Source-Named Chemicals. A source-named substance is derived from a single animal or plant source. Unlike SDA nomenclature, a source-based name implies a typical percent composition of individual carbon chain lengths. If a natural source material is processed to increase or decrease the relative amounts of the various chain lengths, the substance obtained must be named using the CX-Y type of notation.

SDA Nomenclature. The SDA system describes long-chain alkyl derivatives based on an alkyl descriptor; a functionality descriptor to identify the functional group(s) associated with an alkyl group; and a salt descriptor that identifies cations associated with the functional groups. These rules provide flexibility in the botanical source of a substance, while still accurately noting the chemical composition of a substance and providing the opportunity to describe UVCB in a convenient and relevant way for regulatory purposes. SDA nomenclature presents a relatively simple procedure for identifying multi-component Class 2 chemical substances derived from natural fats and oils, and can be quite useful for similar substances derived from different natural sources. For example, Fatty acids, C16-18, C18 unsaturated (CASRN 67701-08-0), can be sourced from canola, corn, cottonseed, linseed, palm, rapeseed, safflower, and soybean oils. SDA nomenclature could also encompass fatty acids and derivatives derived from new oils such as high oleic acid soybean oil.

Use of SDA nomenclature can provide feedstock flexibility when producing derivatives, as there is no source requirement. An example of this can be found in two substances recently subject to PMNs: Fatty acids, C8–18 and C18-unsaturated, reaction products with isomerized oleic acid homopolymer iso-butyl ester; and fatty acids, coco, reaction products with isomerized oleic acid homopolymer, iso-butyl ester. In the first instance, which applies SDA nomenclature to the fatty acid reactant, there is flexibility in the fatty acid source and the concentrations of the various constituent fatty acids, while in the second, source-named nomenclature, the fatty acid source must be coconut oil and no change in the quantities of the various constituent fatty acids typically present in coconut fatty acids is allowed under this name.

Alkyl Chain Ranges CX-Y. As noted above, EPA has developed a guidance document on the application of alkyl chain ranges in the naming of TSCA chemicals. Alkyl chain ranges CX-Y is restricted to substances using the general alkyl range notation of the type CX-Y. If the range of X-Y is given with both X and Y being even numbers, the range between the X and Y values may include either all of the even and odd numbers of carbon atoms or all of the even numbers of carbon atoms. The choice depends on a manufacturer's commercial intent and must be consistent with the carbon numbers that are available from the source or process used. If a range of X-Y is given with either or both of the X and Y values being odd numbers, the range X-Y is interpreted by EPA to include all even and odd carbon numbers between and including X and Y. If a range of X-Y is given with both of the X and Y values being even numbers, there is no indication in the name of whether it is all the even numbers of carbon atoms or all the even and odd carbon numbers, thus either of these circumstances can be accommodated within the name. Note, however, that if the ''all'' requirement concerning presence of carbon numbers cannot be satisfied, the CX-Y nomenclature cannot be used.

If two or more substances with alkyl ranges are blended without chemical reaction, the product is simply a mixture of the

two substances. A product produced by chemical reaction from such a blended starting material can, however, use the combined CX-Y range. The substances described by CX-Y notation may be derived from a source not described in SDA nomenclature, be purified to enhance one or more of the alkyl chains from a natural source, or be derived from two or more interchangeable sources. Such changes would not trigger the need for different chemical names or affect the regulatory status of the substances. An example of CX-Y nomenclature is the name given to biodiesel produced from the hydrotreating of fats or vegetable oils: Alkanes, C10-20-branched and linear. Another example is Fatty acids, C10-20, where, because of the distribution and concentration of the fatty acids, SDA nomenclature is not applicable.

Polymers. Most polymers are represented on the Inventory in terms of the starting materials from which they are manufactured. This so-called monomer-based representation is used when a polymeric substance cannot be identified by a single definite structural diagram and a polymer contains more than one type of constituent monomer in no particular sequence, regardless of the degree of polymerization. A simple example of a biobased polymer is Propanoic acid, 2-hydroxy-, homopolymer or more commonly, polylactic acid. An example of a polymer with a Class 1 biobased monomer is Nonanedioic acid, polymer with 1,6-hexanediamine (Nylon 6, 9). The nonanedioic acid (azelaic acid) is biobased, as it is derived from oleic acid. As noted above, a consequence of the monomer-based approach to naming polymers is that all of the monomers for a domestically produced polymer must be on the Inventory or the PMN requirement is triggered.

EMERGING NOMENCLATURE CHALLENGES

As new sources of biobased feedstocks and chemicals are developed, such as transgenic plants and algae, interesting challenges with chemical nomenclature will emerge. Soybean oil, for example, has been modified to contain calendric acid and algae oil. If these oils are chemically processed, as most oils typically are, PMNs will be required. If these oils are further chemically reacted, care will be needed to determine the TSCA Inventory status of the products and whether additional PMNs may be needed. Interestingly, EPA does not require sourcing from genetically modified plants to be part of the chemical name of an oil derived from that plant. There is a point at which such oil sources need to be distinguished, however. An example is soybean oil, oleic acid-high (high oleic acid soybean oil or HOS), in which ''oleic acid-high'' indicates the difference from normal soybean oil. The definition that accompanies the CA Index name, however, does not indicate that HOS is from a transgenic plant.

Other oils with modified fatty acid distributions are the result of hybridization. An example is Sunflower oil, oleic acid-high. It is not clear how different these new oils must be from existing oils before requiring a new CA Index name and a PMN. In both the soybean oil and sunflower oil examples the change is from approximately 20% oleic acid to more than 80% oleic acid. Another example is Canola oil, oleic acid-high, in which the change is from a typical oleic acid content of 62% to an oleic acid content of 70–80%. Consultation with IES or EPA is advisable if there is doubt whether a slightly modified new oil requires a new name and the concomitant PMN.

Other new areas include the use of petroleum refinery processing technologies, such as catalytic cracking and hydrotreating, on biobased feedstocks, or the use metathesis chemistry on fats and oils. Though these processes will produce chemicals that closely resemble or are indistinguishable from existing Inventory chemicals, in most cases a PMN will need to be filed. As noted above, many petroleum-based feedstock chemicals include the term petroleum as part of the Inventory name, and such nomenclature cannot be used to describe a substance made from a biobased feedstock even if the chemical makeup is indistinguishable from a substance produced from a petroleum feedstock (e.g., Naphtha (petroleum), light alkylate).

A final consideration is whether the process yields by-products, which EPA defines as substances produced without separate commercial intent during the manufacture or processing of another chemical substance. According to TSCA Inventory regulations, by-products that are solely burned as a fuel, disposed of as waste (including disposal in a landfill or for enriching soil), or have component chemical substances extracted for commercial purposes, are exempt from new chemical notification.[33] If a by-product is not already on the Inventory and there is intent to process it chemically into a commercial product, the by-product is considered to be a new chemical subject to TSCA Section 5 notification.

EPA Review of PMNs

EPA's review begins with consideration of the information provided in the PMN. This includes evaluation of:

- The new chemical's name and chemical identity information (structural diagram, molecular formula) to determine their adequacy; ensure that they match each other; and ensure that the name is consistent with CAS nomenclature policies and EPA's naming approach for similar chemicals on the Inventory. EPA also determines whether the chemical is not listed on the Inventory and thus is a new chemical subject to notification.
- Information on by-products and impurities, production volume, intended uses, production process, exposures and releases, use of engineering controls or protective equipment, and related factors.
- Any submitted health and environmental test data.
- Any information or explanation provided in the optional Pollution Prevention section (e.g., information on expected net benefits such as reductions in risk or releases associated with the new chemical, energy or product efficiency, use of less toxic intermediates, and related factors).

EPA applies a staged assessment process to evaluate the potential risks presented by new chemicals. This includes both an initial review, which involves a screening level assessment of the new chemical and, when needed, a standard review that examines the issues identified in more detail. EPA also considers information on similar PMNs, including regulatory history; test data available on structurally analogous chemicals; the results of quantitative structure activity relationships (QSAR) analysis to estimate physical-chemical properties and assess

potential health and environmental toxicity and environmental fate; and modeling for quantitative assessment of potential exposures to workers, consumers, and the general population, and releases to the environment.[34]

Initial review goes through approximately day 20 of the 90-day PMN review period, at which point EPA makes risk-based decisions to drop about 80% of new chemicals from further review. Standard review is applied to the remaining 20% of new chemicals, including any voluntary suspensions in the review period (which can extend from weeks to years in duration) needed for EPA to complete its assessments and take regulatory action. Since test data are frequently not provided on new chemicals, EPA relies on QSAR analysis to estimate physical-chemical properties and assess potential health and environmental toxicity and environmental fate. Exposure assessment applies the information provided in the PMN, measured or estimated values for key physical-chemical properties (e.g., vapor pressure, water solubility, log octanol-water partitioning coefficient, and related factors), and considers process flows and unit operations to identify potential releases and exposures associated with manufacture, processing, and use of the new chemical. EPA also uses models to estimate potential exposures and releases; this can involve application of ''reasonable worst case'' assumptions for exposures and releases.[35] Hazard and exposure information are combined and ideally provide a quantitative or semi-quantitative assessment of potential risks. If the risk assessment shows potentially unacceptable risks, EPA will consider the need for regulatory controls and/or testing.[36]

POTENTIAL OUTCOMES OF PMN REVIEW

EPA applies several policy drivers in its oversight of new chemicals, including differentiated approaches based on some 56 categories of new chemicals (e.g., anionic surfactants, ethylene glycol ethers, esters), whether the chemical is ''Persistent, Bioaccumulative, and Toxic'' (PBT), and exposure-based testing. EPA has developed the categories based on its prior experience with new chemicals assessment and regulation, and will typically approach new chemicals that meet a PMN category definition using a consistent approach to assessment, control measures, and testing as described in a guidance document available from EPA.[37] Under the PBT policy, EPA has developed criteria for persistence, bioaccumulation, and toxicity and identifies new chemicals that meet all three criteria as PBTs. Such chemicals are then subjected to tighter controls or bans as appropriate if environmental releases are expected.[38] Finally, using its ''exposure-based authority'' under TSCA Section 5(e)(1)(A)(ii)(II), EPA can require testing on new chemicals it determines are produced at substantial quantities and have substantial or significant exposure or release.[39] EPA has developed guidance in the form of specific criteria that, if exceeded, can trigger exposure-based requirements. The new chemical production volume trigger is 100,000 kilograms per year (kg/yr) and the worker exposure criterion is 1,000 workers.[40]

For certain substances, if EPA's review reveals potential risk concerns with a new chemical based on effects to human health, environmental concerns, or both, TSCA Section 5(e) authorizes EPA to issue consent orders to the manufacturer allowing it to market the chemical only in conformance with certain enforceable conditions.[41] In such a consent order, which EPA must implement prior to the expiration of the 90-day PMN review period, EPA has considerable discretion to limit the manufacture, processing, distribution, use, or disposal of the chemical.[42] EPA can also impose testing requirements on the new chemical, which, consistent with TSCA Section 2(b)(1), are the responsibility of the notifier to complete. Consent orders are initially developed by EPA and considered final after being discussed with the notifier and executed in final. This process invariably requires a voluntary suspension of the 90-day notice review period, although EPA can also act unilaterally under Section 5(c) to extend the review for up to an additional 90 days.[43]

Once the chemical is commercialized subject to a consent order and added to the TSCA Inventory, the notifier is legally required to observe the terms and conditions in the consent order. Once on the Inventory, it is no longer considered new and other manufacturers may produce the chemical without submitting a PMN. TSCA Section 5(a)(2) gives EPA authority, however, to regulate and require notifications on significant new uses of existing chemicals; in promulgating a Significant New Use Rule (SNUR), EPA is required to consider all relevant factors, including, for example, the projected volume and the extent to which a new use increases the magnitude or changes the type of exposure.[44]

For cases in which a TSCA Section 5(e) consent order has been issued, to avoid the competitive imbalance that would otherwise ensue if follow-on manufacturers were free to manufacture and use the chemical without the commercial restrictions imposed on the original PMN submitter, EPA can issue a SNUR imposing the consent order's requirements on subsequent chemical manufacturers. These are known as Section 5(e) SNURs. For other substances, EPA may determine that although the manufacture, processing, and/or use of the chemical substance as described in a PMN does not present health and/or environmental risks requiring EPA action, there are other potential uses not described by the PMN submitter that EPA determines represent significant new uses such that a SNUR is needed. EPA can use its SNUR authority to regulate such potential uses; these are referred to as non-5(e) SNURs to reflect the fact that no Section 5(e) consent order was issued to the original PMN submitter.[45]

EPA must identify the uses it considers significant new uses in the specific SNUR for that substance. In developing a chemical-specific SNUR, EPA may incorporate provisions identified in its generic SNUR regulations at 40 CFR Part 721, Subpart B. These generic SNUR regulations set forth five categories of general significant new uses: protection in the workplace; hazard communication program; industrial, commercial, and consumer activities; disposal; and release to water. The generic SNUR regulations also contain various regulatory requirements applicable to significant new uses that EPA may select based on the known or suspected risks of the chemical and the conditions of manufacturing and processing. For example, EPA's generic SNUR regulations designate as a standardized, significant new use any manner of manufacture, import, or processing in which the manufacturer, importer, or processor has not established a worker protection program that includes certain requirements.[46]

Other significant, generic new uses would include any uses in the absence of a hazard communication program and various uses in connection with certain industrial, commercial, and consumer activities.[47,48] These requirements can be quite narrow or broad; examples include use of a certain type of respirator; use in a consumer product; any release to water; and release to water that exceeds a specified stream concentration.

To issue a SNUR, EPA may elect to engage in full notice-and-comment rulemaking, but generally prefers instead to utilize its ''expedited'' process whenever possible. EPA has issued regulations establishing expedited procedures for Section 5(e) SNURs and non-5(e) SNURs.[49] The 5(e) SNURs must be ''based on and be consistent with'' the Section 5(e) consent order issued for that substance.[50] Non-5(e) SNURs must satisfy certain concern criteria set forth in the regulations.[51] The conditions also apply to any additional uses EPA designates as significant that are not specified in the Section 5(e) consent order. Under an expedited rulemaking process, EPA is authorized to publish a ''direct final rule'' that will become final unless EPA receives adverse comment during the comment period.[52] If adverse comment is received, EPA will withdraw the portion of the direct final rule implicated by the adverse comment and issue a proposed SNUR. EPA has stated that it tries to use its expedited procedure ''in cases where it does not think comment is likely (e.g., SNURs that put in place restrictions already agreed on between EPA and a PMN filer).''[53]

When EPA promulgates a SNUR designating a significant new use for a particular chemical substance, manufacturers, importers, and processors of that chemical substance must provide to EPA a significant new use notice (SNUN) at least 90 days before any manufacture, import, or processing for that use.[54] For all practical purposes, a SNUN requires the same information be submitted to EPA as a PMN. Upon review of a SNUN, EPA can exercise the same authority it may take with respect to a newly filed PMN. Specifically, EPA can obtain health or environmental test data, take action to protect against risks EPA believes to be unreasonable (including regulating the manufacture, processing, distribution, use, or disposal of the substance as it relates to the significant new use), or take action to protect against imminent hazards as provided under TSCA Sections 5(e), 5(f), 6, or 7.[55] If EPA takes no such action in response to the SNUN, it must publish a notice in the *Federal Register* explaining its reasons for failing to take such action.[56]

EPA's decision to pursue a SNUR can affect the PMN submitter before the SNUR is issued in final. Examples include the uncertainty that results when the PMN submitter is aware of EPA's intention to develop a SNUR, but those new uses are not yet issued in final and can take years to realize, or for those subject to a Section 5(e) consent order, a requirement that the PMN submitter ensure that customers meet the control requirements specified in the order, which can be difficult to realize and can represent a commercial constraint on the product.

Table 1 presents summary statistics for PMNs received and regulatory outcomes during the period 1979–2006.[57] Most new chemicals are not regulated by EPA under TSCA Section 5 once the PMN has been filed. At the same time, however, only a fraction of new chemicals are ever commercialized.

Table 1. PMN and New Chemical Statistics[a]

PMNs submitted[b]	36,600
§5(e) Consent orders	1,320
5(e) SNURs	734
Non-5(e) SNURs	575
PMNs withdrawn[c]	1,705
New chemicals added to Inventory[b]	18,100 (~50% of PMNs)

[a]Through September 2006, unless noted.

[b]October 2003.

[c]Often in the face of action.

Source: EPA. Overview: Office of Pollution Prevention and Toxics Laws and Programs. (2008) Available at: www.epa.gov/oppt/pubs/oppt101-032008.pdf (Last accessed July 2012)

Points to Consider in Developing and Commercializing New Biobased Chemicals

KNOW HOW TSCA APPLIES TO YOUR OPERATIONS

Biobased chemicals under TSCA's jurisdiction are required either to be listed on the TSCA Inventory or be submitted for review by EPA as a new chemical. Which category a specific chemical belongs to needs to be known well in advance of any plans for commercial activities such as manufacture, import, or processing of the chemical, including each member of a series of chemicals used as intermediates to make a final commercial product. If TSCA Chemical Inventory listing for the chemical(s) can be established, the PMN hurdle can be avoided entirely. If, on the other hand, one or more of the chemicals is subject to TSCA new chemical notification, this point needs to be recognized and addressed early as part of a company's business development plan for the product or process. Although most new chemicals submitted for EPA review are not ultimately regulated under TSCA Section 5 after the PMN is submitted, when EPA targets a chemical for regulation this will, at a minimum, result in unplanned delays or potentially introduce a regulatory barrier to commercialization. Once EPA targets a new chemical for regulatory controls, there is a greater likelihood that other new chemicals similar in chemical structure and in use and potential exposure will encounter a similar fate. The bottom line is, given the potential scale of biobased chemical introductions over the coming years, new chemical notification requirements could represent a significant and continuing regulatory challenge and impediment to commercial development.

WHEN "GREEN" MAY NOT BE GOOD ENOUGH

While the US government recognizes the issues associated with chemicals based on nonrenewable feedstocks such as petroleum and enacts policies to encourage the development of biobased products, TSCA requirements must be satisfied as part of the commercialization process. Given the historical prevalence of petroleum-based sources on the TSCA Chemical Inventory, a number of anomalous situations arise. While EPA is generally supportive of new chemistries that can replace older,

petroleum-based chemistries, it takes its new chemical review responsibilities seriously; biobased chemical introductions are and will continue to be the subject of regulatory scrutiny by EPA as new chemicals. This can lead to a disproportionate amount of regulatory scrutiny at the point of commercial introduction when these new, presumptively greener chemicals are attempting to break into the market and compete with established nonrenewable chemicals that, as Inventory-listed substances, escape such rigorous review.

This situation can lead to a well-intentioned but nonetheless significant barrier to the introduction of new chemistries even as other parts of the federal government generally encourage their development. TSCA as constructed recognizes that chemicals present both risks and benefits, however. The policy guidance at TSCA Section 2(b)(3) indicates that regulatory authority to control unreasonable risks should be exercised in a way that does not ''impede unduly or create unnecessary barriers to technological innovation.'' Thus it is important in new chemical notifications to emphasize the benefits of a biobased new chemical. The PMN form includes on page 11 a section entitled ''Optional Pollution Prevention Information.''[58] This often-underutilized section can and should be used to discuss the benefits of a biobased new chemical, including renewable sourcing; pollution prevention or risk-reduction benefits (e.g., reduced pollution, role in or contribution to recycling, use of safer processes or products, avoidance of toxic intermediates, reduced or less toxic waste generation, energy efficiency, relatively safer or less polluting than competing existing chemicals, and related considerations); and cost or performance benefits.

Conclusions

The business development plan for any biobased chemical should include a thorough understanding of TSCA requirements and regulatory responsibilities. TSCA provisions should not be collateral to the business plan; it must be a core element embedded in the planning process. A good command of TSCA will decrease the likelihood of a major, unanticipated disruption to the commercialization timeline due, for example, to late recognition of the need for a PMN or other significant new chemical issue. A strong compliance program will also help avoid EPA enforcement issues and the significant potential costs (both monetary and reputational) that can result.[59]

It is also critically important to recognize and understand the importance of how a chemical is named and identified, and how that can affect new chemical responsibilities. As discussed above, there is both art and science involved in naming a TSCA chemical. It is important to understand the relevance of naming conventions to the manufacturing process. If this core competency does not exist within the company's staff, competent professionals should be found. As arcane as this point may seem, it could make a critical difference in the timing of the commercialization process. A basic understanding of EPA's review process and regulatory approach is also essential. While EPA works off of the information included in the PMN, it also considers information on related cases, applies QSAR analysis when hazard test data are not available, and, among other factors, will use assumptions about likely exposures and releases if information is not provided in the PMN. EPA also has a number of policy drivers that can affect new chemicals, including its use of categories of PMNs, the PBT policy, and the exposure-based policy for new chemicals.[60] It is useful to understand and be able to anticipate (and where possible avoid) the potential effect of these policy drivers.[61]

If EPA is likely to impose testing requirements on a new biobased chemical, consider the benefits of either doing the testing in advance of the notification (and thus avoiding that issue), or, if future commercialization plans involve additional structurally similar new chemicals, whether it might make sense to develop a testing strategy that would attempt to encompass and account for the range of new chemicals likely to be introduced. While such a strategy could be implemented by a single company, if other firms are known to be active in this area of new chemical development, there might be significant opportunities to share costs and responsibility. EPA is also more likely to be receptive to a consortium's regulatory advocacy as opposed to a single company's efforts to influence new chemicals policy. Regardless of the approach taken, it is always wise to consult with EPA before embarking on chemical-specific testing or developing and implementing a testing strategy to ensure an understanding of EPA's views and determine if the agency is receptive to the proposed approach.

Understanding and advocating the benefits of a new biobased chemical can help ensure that EPA new chemical reviewers are aware of and appropriately consider and value those benefits. This should involve careful preparation of the optional Pollution Prevention section of the PMN notice. Beyond that, there may be value in recognizing and advocating the bigger picture policy benefits of biobased chemicals. While EPA at the higher management levels is likely aware of US government policy drivers, this may or may not have reached the scientists and other career EPA staff levels that actually handle the review of PMN notifications. As with testing, while individual companies can and should emphasize relevant policy drivers in their interactions with EPA's new chemical reviewers, there may also be considerable value for a consortium to underscore the benefits of a new biobased chemical.

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