



Inventory of and Technical/Socio-Economic Background Study for 2-Butoxyethanol and 2-Methoxyethanol

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Executive Summary

Introduction:

Environment and Health Canada have assessed 2-ethoxyethanol, 2-butoxyethanol and 2-methoxyethanol. It has been proposed that 2-ethoxyethanol not be considered "toxic" as defined in Section 64 of the *Canadian Environmental Protection Act, 1999* (CEPA 1999). In contrast, the Ministers of the Environment and Health have recommended that 2-butoxyethanol and 2-methoxyethanol be added to the List of Toxic Substances under *CEPA 1999 Schedule 1* (as published in *Canada Gazette* I, August 19, 2000). As a consequence, Environment Canada requires an inventory of, and technical and socio-economic background information on 2-butoxyethanol and 2-methoxyethanol - this report provides the required background information on these aspects.

Glycol Ethers:

2-Butoxyethanol (2-BE) and 2-Methoxyethanol (2-ME) are volatile organic compounds (VOCs), and both are highly water-soluble colourless viscous liquids. They are members of a class of chemicals commonly referred to as "glycol ethers". Glycol ethers are categorised as E-series glycol ethers (based on ethylene oxide) or P-series glycol ethers (based on propylene oxide) - both 2-BE and 2-ME are E-series glycol ethers. The main uses for glycol ethers are as solvents for formulations such as paints, inks and cleaning fluids. Glycol ethers combine the solubility characteristics of both ethers and alcohols, as both functional groups (ether and hydroxyl [or carboxyl]) are present in the molecule. Non-solvent applications for glycol ethers include use as anti-icing agents in jet fuel, as fluids for hydraulic systems and as chemical intermediates for plasticizers, and other compounds.

There is no domestic production of either 2-BE or 2-ME in Canada currently and over 99% of the imports into Canada are from the United States.

Uses:

2-Butoxyethanol - In 1998-2000, it is estimated that an annual average total of ~6000 tonnes of 2-BE was available for use in Canada. Over 85% of the 2-BE used in North America is used in paints and coatings, with ~70% of this use being concentrated in water-borne coatings. Of the remaining 2-BE, ~7% is used in cleaning products, ~5% is used in printing inks, and ~2% is used in other markets including textile/pulp and paper processing, pesticides, hydraulic fluids etc. This North American pattern of uses is expected to be highly reflective of 2-BE uses in Canada. The distribution of 2-BE uses between coatings and cleaning products changes significantly when consumer products are examined alone. Of the total amount of 2-BE used in consumer products - the majority is used in cleaning products, consumer-use solvents and polishes, with only ~30% being used in consumer paints.

2-Methoxyethanol - In recent years, it is estimated that an annual average total of ~500 tonnes of 2-ME was available for use in Canada. Conflicting data on the current market for 2-ME was received. It appears that use patterns for this chemical differ significantly between the US and Canada. It is estimated, based on currently available information, that the primary use of 2-ME is as an anti-icing agent in jet fuel (~80% of the 2-ME market), ~15% is used as a chemical intermediate, and ~5% in other markets including electronics manufacturing, hydraulic fluids and pharmaceutical manufacturing. There appears to be no current uses of 2-ME in consumer products in Canada.

The industries involved:

2-Butoxyethanol - The total value of 2-BE imports (as a commodity chemical) into Canada were \$4.9 million in 1999 and \$5.7 million for the first 10 months of 2000, up from \$1.9 million in 1990. This increase in the total value of 2-BE imports into Canada reflects the increased tonnages of 2-BE entering Canada from the US coupled with a relatively stable price per kg over this time frame.

2-Methoxyethanol - The total value of 2-ME imports (as a commodity chemical) into Canada in the early 1990's were, on average ~\$1.5 million. During the mid 1990's the total value of 2-ME imports dropped to an average of \$0.5 million per annum as the quantity of 2-ME imports declined during this period. In 1998, the value of 2-ME imports increased sharply to \$1.2 million in 1999, but appears to have returned to a more typical \$0.7 million in 2000.

The Canadian industries that are involved with 2-BE are diverse and include the Paints and Coatings Industry (SIC 3751), the Printing Ink Industry (SIC 3791), the Soap & Cleaning Compounds Industry (SIC 3761), Other Chemical Products n.e.c. Industry (SIC 3799), the Plastics and Synthetic Resins Industry (SIC 3731), the Other Agricultural Chemicals Industry including pesticide manufacturing (SIC 3729), amongst others. The 6 industry groups named above had combined shipments of \$14.6 billion in 1998, <2% of GDP.

The Canadian industries associated with 2-ME are primarily companies that import 2-ME as an anti-icing additive for fuels. The 2-ME imported for this purpose is primarily imported into Canada by the US producers of 2-ME (<50% of imports), with the majority of the remainder being imported by Canadian chemical distributors, and producers of fuel anti-icing products. The 2-ME is sold to petrochemical companies that produce jet fuel according to military aircraft specifications, or directly to military airforce bases for mixing with fuels. There is also some use of 2-ME as a chemical intermediate to produce additives for hydraulic fluids, adhesives, coatings, chemical processing, and general industry use solvents etc. The primary industry group that would use 2-ME as a chemical intermediate would be the Other Chemical Products n.e.c. Industry (SIC 3799) - and it is estimated that this industry uses ~15% of the 2-ME imported into Canada for this purpose. The remaining 5% of imported 2-ME would be utilized by a variety of industries including electronics manufacturing, reprographic chemicals manufacturing, and pharmaceutical processing. Small uses of 2-ME occur in some specialist coating products.

Production and consumption trends and forecasts:

There has been a significant increase in the global demand for glycol ethers over the past decade. This trend is largely due to the growth of the coatings industry and the technical importance of glycol ethers in a wide range of coatings formulations. In 1990, global glycol ether production was 450kt annually but by 1999 global glycol ether production had reached over 1030kt per annum. In 1990, approximately 85% of the glycol ethers produced globally were E-series glycol ethers (based on ethylene oxide). In the last decade, however, P-series glycol ethers (propylene oxide-based) have gained an increasing share of the glycol ethers market and represented ~35% of the glycol ethers market in 1999. Hence, although the demand for glycol ethers, particularly in paints and coatings has continued to grow, the demand for E-series glycol ethers for these products has declined. This trend is expected to continue into the next decade for two main reasons; (1) E-series glycol ethers will continue to be increasingly replaced with P-series glycol ethers, and other alternative solvents, and (2) paints and coatings products, and other product types, will continue to trend towards lower VOC and zero-VOC formulations.

Total uses of E-series glycol ethers declined between 1989 and 1998 and this trend is expected to continue to 2008 in North America. The decline in use is observed in all product categories in which E-series glycol ethers are used indicating that replacement of E-series glycol ethers can be achieved in all product categories. Hence, total industry uses of E-series glycols ethers by 2008 are expected to be only ~35% of what they were in 1989.

It is predicted that uses of E-series glycol ethers in paints and coatings will decline by over 25% between 1998 and 2008. The current uses of 2-BE in Canada are concentrated in the paints and coatings market and this is the industry sector responsible for the majority of emissions of 2-BE into the Canadian environment. It is estimated that ~5000 tonnes of 2-BE were used in paints and coatings in Canada in 1999/2000. Based on industry forecasts for E-series glycol ethers demand it is expected that uses of 2-BE by this industry will decline to ~3750 tonnes by 2008. Based on these forecasts and current industry trends, any current minor uses of 2-ME in coatings are expected to be phased out during the same time period.

Similarly, uses of E-series glycol ethers in cleaning/household products are expected to decline by over 50% between 1998 and 2008. Importantly, the largest use of 2-BE in **consumer** products is in cleaning. In North America, over 50% of the total amount of the 2-BE used in consumer products is used in cleaning products, with an additional ~18% used in consumer polishes and related products. In contrast, only ~30% of the 2-BE used in consumer products is used in consumer paints and coatings. Since it is estimated that ~1000 tonnes of 2-BE is used in products that may be used by consumers in Canada it is estimated that ~700 tonnes is used annually in consumer cleaning and related products and

~300 tonnes is used in consumer paints. This market is a critical one when assessing the expected future patterns of consumer exposure to 2-BE. It is forecasted that use of 2-BE in consumer cleaning products will decrease to <210 tonnes by 2008. Similar rates of decline in demand in the other markets in which 2-BE and 2-ME are used are expected over the same time frame.

Declining use of E-series glycol ethers, including 2-BE and 2-ME, is expected to occur in the US and Canada in the absence of any regulations specifically targeted towards 2-BE and 2-ME. Reduced use of 2-BE and 2-ME in Canada would therefore not be expected to adversely affect the competitiveness of the Canadian industry versus its US counterpart, or have any adverse effects on trade, - since the same trends in chemical use are expected to occur in both countries. Depending on the alternatives that are used to replace them, there may be reduced costs, no increase in raw material cost, or there may be increased costs. The replacement of 2-ME with diethylene glycol monomethyl ether (DEGME) results in cost savings since DEGME is generally sold at a lower price and used at the same concentration. Additionally, DEGME has technical advantages (higher flash point) over 2-ME in its main application (jet fuel anti-icing). Although generally carrying a higher price tag, P-series glycol ethers have been demonstrated to be cost-effective replacements for 2-BE in coatings, cleaning products, and inks - which combined comprise over 95% of 2-BE uses. For example, some formulations of cleaning products with P-series glycol ethers (e.g. Propylene glycol n-butyl ether (PGnBE) and/or Dipropylene glycol n-butyl ether (DPGnBE)) can be less expensive than 2-BE-containing formulations at the same performance level, and, at cost parity, blends of P-series glycol ethers with alcohols have been shown to outperform 2-BE as coupling agents in waterborne coating applications. These facts, coupled with the fact that the US producers of 2-BE and 2-ME and their Canadian subsidiaries, are also actively involved with the chemicals most likely to replace them, indicates that the decline in 2-BE and 2-ME use is unlikely to adversely impact solvent market dynamics, or the output, profitability, or employment of the producers of these chemicals, their Canadian operations, or the primary industries formulating with these chemicals. However, industries involved with pesticide products and disinfectants/sanitizers currently containing 2-BE may face significant costs since re-registration is often necessary following re-formulation of these types of products. It should be noted that these products represent a relatively small fraction of the market for 2-BE in Canada currently and are not a significant source of 2-BE emissions.

Inventory:

A survey by ToxEcology on current uses of 2-BE in products available to consumers in Canada identified 274 products containing 2-BE, and indicated that the majority of consumer products that contain 2-BE are hard surface cleaners, particularly window/glass cleaners and general purpose/all-purpose cleaners. There are also some paints and coatings products available to consumers that contain 2-BE. It is estimated that ~280 tonnes of 2-BE are used in general-purpose cleaners, ~160 tonnes in window/glass cleaners, ~95 tonnes in floor/baseboard strippers, and ~160 tonnes in other cleaner categories combined. Consumer paints are estimated to be responsible for ~300 tonnes of 2-BE uses.

Emissions during the lifecycle:

A annual average total of ~6 kilotonnes of 2-BE is currently used in Canada, at least 5000 tonnes (>80%) of this is used in products where significant amounts of the glycol ether is expected to evaporate following application of the product (e.g. application of a paint/coating, ink, or cleaning fluid), hence resulting in atmospheric emissions of a significant portion of the 5000 tonnes used in these applications. An average of ~400 tonnes is used in products that would typically be disposed of 'down the drain' following use. This includes use in household, industrial & institutional cleaning products, and industry processing e.g. pulp & paper/textile processing.

The industries involved with 2-BE in Canada reported total releases of ~390 tonnes of 2-BE per annum in 1996 (Environment Canada PSL II survey for 2-BE, 1995/1996). In 1999, the industries involved with 2-BE released a total of ~1568 tonnes (based on NPRI 1999 data).

The majority of industries involved with 2-BE are located in Ontario, and the majority of 2-BE emissions occur in Ontario. Taking into account the common use of 2-BE in automotive and other OEM (original equipment manufacture) coatings, and the concentration of the Canadian automotive, and OEM, manufacturing industry in Ontario, it is not surprising that the highest emissions of 2-BE are in this province. It is important to note that over 90% (~1400 tonnes) of the emissions cited above are associated with the use of paints and coatings, with over 50% (~800 tonnes) of total 2-BE emissions being associated with the use of automotive coatings in 1999. In contrast, the producers of paints and coatings were responsible for only ~1% of reported emissions of 2-BE in 1999.

The vast majority of 2-BE emissions that occur during the lifecycle are atmospheric emissions resulting from the industrial use of paints and coatings.

Environmental releases reported to Environment Canada as part of the PSL II assessment of 2-ME indicated that a total of 8.7 tonnes were released in 1996. Recent data from the NPRI indicates that total environmental releases of 2-ME totalled ~8.2 tonnes in 1999. There are no quantitative data available on environmental emissions of 2-ME through use as

an anti-icing agent in jet fuel although the 2-ME formulated into fuel would be burned during fuel combustion, resulting in little, if any, 2-ME releases during normal aircraft operation. Environmental emissions of 2-ME associated from its use in jet fuel would occur primarily during the formulation of fuel with 2-ME, and the transfer of fuel containing 2-ME for transportation and during refuelling operations. Reported environmental emissions of 2-ME in the US, as reported to the US Toxics Release Inventory, were primarily from 3 manufacturing facilities (a plastics and paper processing facility, a pigment producing facility, and a minerals processing/chemical production plant) in the US (responsible for ~70% of reported 2-ME emissions). The emissions of 2-ME in Canada, as reported to the NPRI in 1999, were associated with 2 facilities - a furniture manufacturing facility using 2-ME in metal/wood coatings (~99% of reported emissions), and a coatings manufacturing company (~1% of reported emissions). When considering data on reported environmental emissions of 2-ME, it is important to note that these US TRI reported emissions and Canadian NPRI reported emissions do not capture emissions of 2-ME through its use as an anti-icing agent in jet fuel.

Voluntary agreements on reducing 2-BE and 2-ME emissions:

It is important to note that a MOU on reducing VOC emissions between CCPA and the Government of Canada (signed by Environment Canada and Industry Canada), which included 2-ME, expired at the end of 1998 and, although an updated MOU has been developed (which includes both 2-BE and 2-ME), this currently awaits final agreement by the Government (to be signed by Environment Canada, Health Canada, Industry Canada, the Ontario Minister of the Environment, and the Alberta Minister of the Environment). Hence, in 1999, the year in which the above emissions were reported, there was no MOU on VOC emissions in place between CCPA and the Government of Canada. However, it is important to realise that CCPA member companies have been operating throughout 1999 and 2000 as if the MOU on VOC emissions was in place. In addition, industrial users of coatings containing 2-BE, including the automotive industry, are not members of CCPA and hence are not bound by this MOU on reducing VOC emissions. The CCPA represents the chemical manufacturing industry whereas the industrial users of coatings, e.g. the automotive manufacturing industry, are the end users of products of the chemical and coatings manufacturing industry.