MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

INTEROFFICE COMMUNICATION

TO: File for Potassium bicarbonate (CAS # 298-14-6)

FROM: Doreen Lehner, Toxics Unit, Air Quality Division

DATE: June 3, 2022

SUBJECT: Screening Level for Potassium bicarbonate (CAS # 298-14-6)

Summary

An initial threshold screening level (ITSL) for potassium bicarbonate will not be set. This compound is a solid at ambient temperature and pressure with a relatively low oral toxicity and therefore, emissions may be evaluated based on the National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$ (footnote #26 of the Michigan Air Toxics System Initial Threshold Screening Level (ITSL) / Initial Risk Screening Level (IRSL) Toxics Screening Level Query Notes).

Potassium bicarbonate [$KHCO_3$] (CAS # 298-14-6) is white, fine crystals with a molecular weight of 100.12 g/mol. Potassium bicarbonate is used: to treat or prevent low potassium (hypokalemia), as an antacid, in farming to control powdery mildew, as a leavening agent in baking processes, in dry chemical fire extinguishers, as a buffering agent in regulating pH, as a fungicide, and to neutralize acidic soils to promote agriculture.

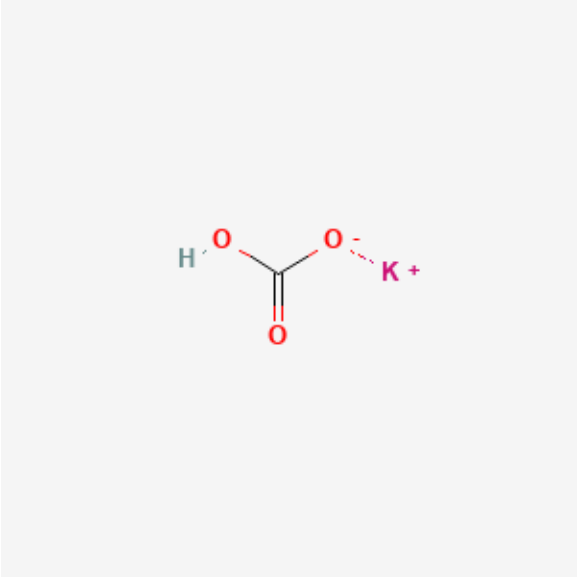

Figure 1. Structure of potassium bicarbonate

A literature review was conducted to determine the screening levels for potassium bicarbonate. The following references and databases were searched. Chemical Criteria Database (CCD), United States Environmental Protection Agency (US EPA) Integrated Risk Information System (IRIS), National Institute for Occupational Safety and Health (NIOSH), American Conference of Government Industrial Hygienist (ACGIH) Threshold Limit Values and Biological Exposure Indices (TLV/BEI) 2019 guide, National Toxicology Program (NTP) Study Database, International Agency for Research on Cancer (IARC), Chemical Abstract Service (CAS) Online (searched 3/19/22), National Library of Medicine (NLM) online, EPA ChemView, EPA CompTox Chemicals Dashboard and the Canadian Centre for Occupational Health and Safety Registry of Toxic Effects of Chemical Substances (RTECS).

No inhalation toxicity data were found which could be used to establish an ITSL. However, potassium bicarbonate does have oral toxicity data. A 30-month oral toxicity study in rats found a LOAEL of 20,000 mg/kg (Lina and Kuijpers, 2004). Groups of 15 rats/sex (control diet) and 50 rats/sex receiving a diet containing either 2% (males: 931.116 mg/kg bw/day; females: 1141.368 mg/kg bw/day) or 4% (males: 1932.316 mg/kg bw/day; females: 2412.892 mg/kg bw/day) $KHCO_3$. Treatment with $KHCO_3$ resulted in increased plasma potassium levels. “The increased potassium levels in the plasma of rats fed $KHCO_3$…were associated with hypertrophy of the adrenal zona glomerulosa and increased potassium excretion. A high rate of potassium directly stimulates the secretion of aldosterone that in turn stimulates potassium excretion in the distal nephron.” (Lina and Kuijpers, 2004). Males and females fed potassium bicarbonate showed an early onset and increased incidence of oncocytic tubules in the kidney. The incidence of oncocytic tubules in both the 2% and 4% potassium bicarbonate dose groups in males exceeded the control group in the incidence of severe nephrosis. Interestingly, a high incidence of oncocytic tubules was also noted in females in both the 2% and 4% potassium bicarbonate dose groups when compared to the control group, which suggests that this lesion is induced by, or aggravated by potassium bicarbonate (Lina and Kuijpers, 2004). “Hyperplastic and neoplastic lesions of the urinary bladder were observed in rats fed $KHCO_3$…It was concluded that $KHCO_3$, a promoter of bladder carcinogenesis, is capable of inducting urinary bladder cancer without prior application of an initiator…” (Lina and Kuijpers, 2004).

Potential ITSL Derivation

If the Lina and Kuijpers (2004) study were to be used to derive an ITSL, Rule 336.1232(1)(b), a proposed ITSL can be derived from an oral reference concentration (RfD). The 30-month study can be used to calculate an RfD using the following equation:

$$RfD = \frac{LOAEL\ (^{mg}/_{kg/day})}{UF_A \times UF_H \times UF_L}$$

Where:

UF_A = Extrapolation from animal data to humans. The uncertainty factor of 10 will be used to account for the quality of data and statistics used in the determination of the critical effect.

UF_H = Extrapolation to account for sensitive human populations. The uncertainty factor of 10 will be used to account for the lack of data to determine the effect in sensitive populations.

UF_L = Uncertainty factor used to account for the extrapolation from a LOAEL to a NOAEL.

The male rat LOAEL of 931.116 mg/kg bw/day from the Lina and Kuijpers (2004) study can be used as an RfD using the above equation:

$$RfD = \frac{931.116\ {}^{mg}/_{kg/day}}{10\ \times 10\ \times 10} = 0.93116\ {}^{mg}/_{kg/day}$$

Rule 232(1)(b) uses an oral RfD to determine a potential ITSL using the following equation:

$$potential\ ITSL = oral\ RfD\ \times \frac{70\ kg}{20\ m^3}$$

Where 70 kg is the default body weight for an average human and 20 m^3 is used to define the minute volume (default ventilation rate) for an average human. Taking the oral RfD, which was determined to be 0.93116 mg/kg/day above, this leads to the following equation:

$$potential\ ITSL = 0.93116\ {}^{mg}/_{kg/day} \times \frac{70\ kg}{20\ m^3} = 3.258906\ {}^{mg}/_{m^3} = 3{,}258.906\ {}^{\mu g}/_{m^3}$$
$$\approx 3{,}300\ {}^{\mu g}/_{m^3}$$

According to Rule 232(2)(b), an annual averaging time period would be used. The potential ITSL would be 3300 µg/m^3 with an annual averaging time. As potassium bicarbonate is considered to be a solid, the ITSL determined above exceeds the NAAQS for $PM_{2.5}$. Therefore, an ITSL will not be determined, and emissions of potassium bicarbonate will be evaluated using the NAAQS standard for $PM_{2.5}$.

References

ACT 451 of 1994. Natural Resources and Environmental Protection Act and Air Pollution Control Rules. Michigan Department of Environmental Quality.

FARAD. 2016. Calculations and Conversions for Drugs, Forage, Feed and Water Consumptions. Food Animal Residue Avoidance & Depletion Species Pages. Available online at: farad_vfd_calculator.pdf

Lina BAR and Kuijpers MHM. 2004. Toxicity and carcinogenicity of acidogenic or alkalogenic diets in rats; effects of feeding NH_4Cl, $KHCO_3$ or KCl. Food and Chemical Toxicology. 42(1):135-153.

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