An EA Revision Sheet has been prepared for this Environmental Assessment – See the FONSI for this Food Contact Notification

Environmental Assessment

1. Date: February 14, 2017

2. Name of Submitter: Bulk Chemical Services, LLC

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4. Description of proposed action:

a. Requested action:

The action requested in this notification is to permit the use of polymers made from 2-propenoic acid sodium salt, CAS No. 9003-04-7, commonly known as sodium polyacrylate polymer. This polymer is used as a mineral pigment dispersant for calcium carbonate or kaolin pigments in the manufacture of food-contact paper and paperboard in contact with all food types, except for use in contact with infant formula and human milk.

The FCS may be used in coatings at a level not to exceed 1.25 weight percent of solid pigment and in mineral fillers at a level not to exceed 0.6 weight percent of solid pigment.

The maximum use level of the FCS in mineral filler will be 0.6% by weight, and the maximum use level of the filler in paper will be 10% by weight, giving a maximum use level of sodium polyacrylate in paper of 0.06%.

The maximum use level of sodium polyacrylate in coatings will be 1.25% by weight, and the maximum use level of the coating on paper will be 30% by weight, giving a maximum use level of sodium acrylate in paper of 0.38%. The coating use is a dry-end application, and therefore the coating use does not result in the FCS entering wastewater. Because the use in mineral fillers will result in higher levels of the FCS in both the final food-contact article and in wastewater as compared to the use in coatings, this environmental assessment will focus on the potential environmental impact resulting from the use in mineral fillers.

b. Need for action:

The FCS described in this notification will be used as a rheology aid in coatings, as well as an aid in grinding and dispersing mineral fillers for food-contact paper or paperboard materials. Raw material clays for these coatings and mineral fillers vary in composition and may require a higher dosage of dispersant to reach desired viscosities and/or be ground to the right fineness and provide stable mineral suspensions (slurries) for use in the automated processes of paper mills.

c. Location of use/disposal:

Sodium polyacrylate polymer will be used as a dispersant to manufacture mineral filler slurries, preferably by the mineral filler producer, for subsequent delivery to paper mills or directly in paper mills.

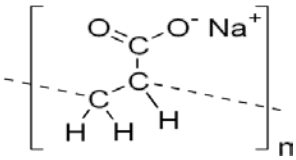
Disposal of paper or paperboard material containing bound mineral filler, and with it the major part of sodium polyacrylate dispersant, is expected to occur nationwide when the corresponding packaging material is disposed of in municipal solid waste landfills, or is burned or recycled.

Disposal of the minor part of sodium polyacrylate, which is precipitated from paper mill wastewater effluent and/or adsorbed on wastewater treatment sewage sludge, is normally as follows:

- Thermal disposal in incinerator plants
- Land disposal in a suitable landfill
- Use as agricultural fertilizer

5. Identification of substance that is the subject of the proposed action:

General information concerning the chemical identity of the FCS sodium polyacrylate is provided below.

- Complete nomenclature:
  - The food-contact substance consists of the sodium salt of a straight-chain polyacrylic acid. The Chemical Abstracts name is 2-Propenoic acid, homopolymer, sodium salt.
- CAS registration number:
  - 9003-04-7
- Molecular weight:
  - The average molecular weight by weight, M_w, is 4500 g/mol.
- Molecular formula:
  - $(C_3H_3NaO_2)_n$
- Proposed structural formula:
  - 
- Physical description:
  - The FCS will be produced and used as a viscous, light-colored, aqueous solution at 43% solids by weight in water, with a specific gravity of about 1.3 g/cm³ at 20°C.

6. Introduction of substances into the environment

a. Introduction of substances into the environment as a result of manufacture

No extraordinary circumstances apply to the manufacture of the processing aid sodium polyacrylate.

b. Introduction of substances into the environment as a result of use/disposal

Use

The below worst-case value is based on estimated dispersant consumption for mineral filler to be used in food-contact material in the US market.

During the wet-end phase of the papermaking process, the aqueous concentration of solids (fibers and fillers) typically varies between 0.5% and 1% by weight [11]. In the following calculation, we use the 2% concentration for a worst-case assessment purposes.

In general the findings published in the literature cited below for sodium polyacrylate refer to sodium polyacrylate of the molecular weight Mw = 4,500 D.

Of these 2% of solids, the typical proportion of mineral filler is assumed to be 10% by weight and, of that 10%, a maximum proportion of 0.6% of sodium polyacrylate dispersant is needed. Therefore, the overall maximum concentration of sodium poly- acrylate in wet- end process water (also called "white water") is:

$$0.02 \times 0.10 \times 0.006 = 0.0012\ \%$$

As described by Gliese [1], at least 80% of sodium polyacrylate filler dispersant exits the papermaking process inside the paper material, firmly bonded to the constituent mineral particles, and thereby releasing no more than 20% to the white water.

Therefore, a maximum concentration of:

$$0.0012\% \times 0.2 = 0.00024\% = 2.4 \text{ ppm sodium polyacrylate}$$

would be retrievable as "free" dispersant in solution in white water.

Since the paper-making process is a continuous one, the wastewater effluent treatment process is also continuous, and therefore release to the environment is continuous.

The 2.4 ppm free dispersant most likely consists of the lowest molecular weight fractions of sodium polyacrylate, those which are the least adsorbed at the surface of mineral fillers. The 2.4 ppm concentration is a conservative and worst-case calculation, which does not take in account the coagulation and precipitation of the sodium polyacrylate by cationic retention aids and coagulants, which are always present to facilitate both paper sheet formation and filler retention.

We assume that the concentration of FCS in the white water is the concentration expected to be introduced into a water body via disposal of wastewater, even though further dilution is expected. While there is an aquatic ecotoxicity endpoint lower than this worst-case concentration, it is a level at which no adverse effects were identified (No Observed Effect Concentration (NOEC)), and the toxicity observed in the studies are likely an artifact of test conditions, not of the FCS. As Langbein, 1997 succinctly explains, the toxicity observed in tests are due to the “precipitation of calcium polymer salt, not on typically toxic properties of the polycarboxylate,” and this is “confirmed by the fact that no negative effects were found over the entire concentration range up to 400 mg/liter when the test solutions, after allowing them to stand for 24 h, were filtered before introducing the daphiae.” The next lowest chronic aquatic toxicity endpoint was 6 mg/liter, a NOEC from reproduction tests in daphia (both the 4500 Da homopolymer and the 70,000 copolymer), which is about two-fold higher than the worst-case concentration in white water. The lowest acute aquatic ecotoxicity endpoint at which effects were estimated is an EC_{10} for algae at 32 mg/liter (Langbein, 1997), which is over ten-fold higher than the worst-case concentration in white water. The concentration that reaches the environment is expected to be much lower due to adsorption and dilution.

As described by Soap and Detergents Association [4] and by Freeman and Bender [3], Mw 4500 sodium polyacrylate polymer does not adversely impact the operation of a sewage treatment plant (sludge sedimentation, treatment capacity, sludge dewatering) and is efficiently removed from water with a high yield (Freeman and Bender [3], Hamilton et al. [5]), e.g., 98% when ferric chloride is used as a precipitant in a continuous activated sludge waste water treatment plant. Therefore, once precipitated and adsorbed to the sewage sludge of the paper mill water treatment plant, sodium polyacrylate stays strongly bound to this sludge and is disposed of along with the sludge either by thermal disposal in incinerator plants, by placement in a suitable landfill, or by use as agricultural fertilizer.

Papermaking solids contain 10% filler. The filler contains 0.6% sodium polyacrylate. Therefore, paper-making solids contain:

0.1 x 0.6% = 0.06% sodium polyacrylate

Of this 0.06% of solids, it is assumed that > 80% (or 0.05 % of solids) remains with the paper and < 20 % (< 0.01% of solids) is released to the treatment plant.

Thus, the manufacture of 1 metric ton of paper results in the release of <0.01% of 1 ton of sodium polyacrylate to the treatment plant, at least 98% of which (approximately 98 g) will be captured and disposed of in the treatment sludge.

However, we cannot assume all paper mills utilize specific wastewater treatment methods, therefore, we assume that 100% of the FCS in the white water is the same concentration, approximately 2.4 ppm as determined above, introduced onto land via application of sludge. This level is far below the 225 mg/kg growth inhibition in corn, wheat, soybean NOEC noted in Hamilton [5], Freeman [3], and Langbein [6].

In addition, Hamilton [5] cites an acute toxicity (96 HR, LC_{50}) of greater than 1,000 mg/kg soil for earthworms and again the level of FCS (2.4 ppm) is far below this terrestrial endpoint. Acute oral toxicity in rats is also generally very low, Langbein [6].

Disposal in landfills

Disposal by the ultimate consumer of food-contact paper or paperboard containing the subject FCS will be primarily by recycling or incineration. Recycling will not be impacted by the use of the FCS, as the presence of sodium polyacrylate in recycled paper materials does not impact its fitness for use as a non-virgin fiber source for the paper making process. The FCS' presence does not negatively affect the standard unit operations typically employed by paper mills utilizing recycled fiber. Only extremely small amounts, if any, of sodium polyacrylate polymer constituents are expected to enter the environment as a result of the landfill disposal of paper or paperboard materials, in light of the Environmental Protection Agency's (EPA) regulations (40 CFR 258) governing municipal solid waste landfills.

Disposal by combustion

The organic part of sodium polyacrylate consists of carbon, oxygen, and hydrogen. No toxic combustion products are expected as a result of the proper incineration of this polymer. Due to the nature of the combustion products and their low levels compared to the amounts currently generated by municipal waste combustors, the additional combustion products from incineration of the polyacrylic acid sodium salt will not cause any violation of applicable emissions regulations. The emissions regulations of 40 CFR 60 will not be violated and no significant impact on the environment is expected from combustion of the FCS.

According to EPA data for 2014, 33.14 million tons of municipal solid waste (MSW) was disposed of through combustion. This is an average of 12.82% of all MSW [10]. According to industry data (FisherSolve industry data (2010)), only 13 million metric tons of the paper produced in the US annually is used for food contact. Therefore, assuming that all mills in the US that produce food contact paper use the FCS in their mineral filler at the maximum level of 0.6% – a very unrealistic assumption:

$$\text{13MM metric tons} * 0.6\% = \text{78,000 metric tons FCS used annually}$$

To determine what GHG may be released upon combustion of the FCS, the percent carbon dioxide produced from the combustion is calculated as follows. Based on the molecular formula for sodium polyacrylate, $(C_3H_3NaO_2)_n$, there is 38% C in the FCS. The amount of C combusted annually as a result of the proposed use of the FCS is calculated by: (annual market volume of the FCS)*(14.3% combusted paper and paperboard [10])*(percent C in the FCS).

$$\text{78,000 metric tons FCS} * \frac{\text{14.3 metric tons FCS combusted}}{\text{100 metric tons FCS total}} * \frac{\text{38 metric tons C combusted}}{\text{100 metric tons FCS combusted}}$$

$$= \text{4,239 metric tons C combusted annually}$$

Converting this amount of C to CO_2 as follows:

$$\text{4,239 metric tons C} * \frac{10^6\text{g C}}{\text{metric ton C}} * \frac{\text{mol C}}{\text{12.0107 g C}} * \frac{\text{1 mol } CO_2}{\text{1 mol C}} * \frac{\text{44.0095 g } CO_2}{\text{mol } CO_2} * \frac{\text{metric ton } CO_2}{10^6\text{g } CO_2}$$

$$= \text{15,533 metric tons } CO_2$$

Based on this very conservative assumption of the projected market volume for the FCS, we do not expect annual CO_2-e emissions resulting from combustion of the FCS to exceed the EPA GHGRP threshold of 25,000 metric tons of CO_2-e emissions.

On August 1, 2016, the Council on Environmental Quality (CEQ) issued final guidance [12] to agencies regarding addressing GHG emissions and climate change impacts in NEPA documents. This guidance is "intended to help Federal agencies ensure their analysis of potential GHG emissions and effects of climate change in an EA or EIS is commensurate with the extent of the effects of the proposed action" (CEQ, 2016 p. 3). The GHG emissions resulting from the use and disposal of the FCS relate to the incineration of articles containing the FCS in municipal solid waste (MSW) combustion facilities. Such facilities are regulated by the U.S. Environmental Protection Agency (U.S. EPA) under 40 CFR 98, which "establishes mandatory GHG reporting requirements for owners and operators of certain facilities that directly emit GHG." Part two of this regulation (40 CFR 98.2), describes the facilities that must report GHG emissions and sets an annual 25,000 metric ton carbon dioxide equivalents (CO_2-e) emission threshold for required reporting.

To evaluate the significance of the environmental impact of these GHG emissions, we refer to CEQ regulations under 40 CFR 1508.27, which defines "significantly" as it relates to assessing the intensity of an environmental impact in NEPA documents. 40 CFR 1508.27(b)(10) states, that when evaluating intensity of an impact, one should consider "whether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment." GHG emissions from MSW combustion facilities are regulated under 40 CFR 98.2. Based on the total market volume, the expected CO_2-e emissions, as shown in the above calculations, are below 25,000 metric tons on an annual basis. As the estimated GHG emissions are well below the threshold for mandatory reporting, no significant environmental impacts are anticipated resulting from combustion of the FCS in MSW combustion facilities.

7. Fate of substances released into the environment

a. Physical/chemical properties

Sodium polyacrylate is fully soluble in water but it will become insoluble by exchanging its sodium counter-ions with multivalent ones such as alkaline- earth metal ions (calcium or magnesium) or trivalent cations (iron or aluminum). The pH of a concentrated solution of the FCS is about 7.8. The FCS is typically an aqueous product with approximately 40% active polymer solids by weight, and a specific gravity of about 1.3.

Sodium polyacrylate stays firmly adsorbed at the surface of mineral particles except for low molecular weight fractions (below 1500 g/mol), which can desorb because they have fewer anchor groups. However, even these low molecular weight fractions can be precipitated if the majority of the pending carboxylate groups are bound to multivalent cations.

b. Environmental depletion mechanisms

As worst-case EICs are lower than levels that show ecotoxicity (see Item 8), the fate of the FCS in the environment is not discussed. Any degradation or dilution will only decrease the concentration of the FCS in the environment. No significant effect on the concentration of any substances in the atmosphere is anticipated due to the proposed use of sodium polyacrylate. The polymer is solid and does not volatilize. Thus, no significant quantities of polyacrylate or any substances originating from it will be released upon the use and disposal of food-contact paper or paperboard manufactured with sodium polyacrylate.

The environmental fate of 4500 Mw sodium polyacrylate homopolymers has been extensively studied because huge quantities of the polymer are used as co-builders in house hold detergents. Studies by Chiaudani referenced in [4], Langbein [6] and Hamilton [5] show that the environmental fate of 4500 Mw sodium polyacrylate is to be precipitated in the form of divalent or trivalent salts and thus removed from water systems and to stay adsorbed on sewage sludge, sediment or soil. Particularly, Chiaudani studied the environmental fate of sodium polyacrylate in soil using C^{14} - labeled 4500 Mw sodium polyacrylate polymers and lysimetric testing. These studies showed that the highest Mw fractions of 4500 Mw sodium polyacrylate (around 90%) accumulate in the first 15 mm of the ground and are not further removed or biodegraded, and thus cannot percolate to aquifers, whereas the lowest Mw fractions of sodium polyacrylate (around 10%) stay mobile, and are more difficult to precipitate or to adsorb onto soil particles. The same study states that the lowest molecular weight fractions of sodium polyacrylate (fractions with Mw below 1000 g/mol) are the only ones to show significant, though not complete, biodegradation (measured by rate of release of C14 - labeled carbon dioxide). Further studies by Kawai [7] and Larson [8] show that sodium polyacrylate oligomers start to be metabolized by micro-organisms below 7 monomer units (Mw in the range 500-700) but that the cutoff for complete biodegradation is even lower.

Low molecular weight fractions of sodium polyacrylate will not stay in surface waters but will react with water hardness (calcium and magnesium ions) and will precipitate in the sediments of aquatic environments (Chiaudani referenced in [4]).

8. Environmental Effects of Released Substances

As discussed under Item 6b, release to the environment is continuous, and therefore, both acute and chronic exposure is possible, thus, both acute and chronic endpoints are relevant to compare to exposure. Toxicity data for Mw 4500 sodium polyacrylate (Freeman and Bender [3]) show that this polymer does not present any significant acute toxicity to aquatic test species under USEPA toxicity classification guidelines. Indeed, Mw 4500 sodium polyacrylate has lethal concentrations for 50% of the test population (LC50 or EC50) of >100 $mg*L^{-1}$ in all acute toxicity tests: Bacteria, Algae, Daphnia, and Fish. Additionally, Mw 4500 sodium polyacrylate shows a chronic No-Observed Effect Concentration (NOEC) of approximately 6 $mg*L^{-1}$ in Daphnia and much higher in fish (56 $mg*L^{-1}$). In comparison, the estimated worst-case sodium polyacrylate concentration at the outfall of paper mills' on-site sewage treatment plants is below 40 ppb (see Item 6b), i.e. <0.04 $mg*L^{-1}$. There is therefore a considerable margin of safety (greater than 150x) between the NOEC of the most sensitive species tested and the estimated concentration of sodium polyacrylate in natural waters (6 $mg*L^{-1}$ vs. 0.04 $mg*L^{-1}$).

Sludge containing adsorbed or precipitated sodium polyacrylate may be landfilled or used as agricultural fertilizer. In this case, the concentration of sludge-amended soils can be estimated to be 0.6 $mg*kg^{-1}$ soil at the time of application (see Item 6c). Additionally Mw 4500 sodium polyacrylate shows chronic No-Observed Effect Concentration (NOEC) in plants of 225 $mg.kg^{-1}$ soil. Plants tested were corn, wheat, soybean (Freeman and Bender [3]).

9. Use of Resources and Energy

As is the case with other food packaging materials, the production, use and disposal of sodium polyacrylate involves the use of natural resources such as petroleum products, coal, and the like. However, the use of the sodium polyacrylate as mineral filler dispersant will mainly substitute for the use of other polymer mineral dispersants and will be used in the same food-contact applications. The formulation change will therefore have no net impact on the use of resources and energy.

10. Mitigation Measures

As shown above, no significant adverse environmental impacts are expected to result from the manufacture, use and disposal of food-contact paper or paperboard containing sodium polyacrylate. This is primarily due to the low and acceptable environmental exposure of sodium polyacrylate in surface waters or in soils, the insignificant impact on environmental concentrations of combustion products of the polymers, and the similar use of resources and energy in making the subject polymers and the materials they are intended to replace in food-contact paper or paperboard. Thus, the use of sodium polyacrylate as proposed is not reasonably expect to result in any new environmental problem requiring mitigation measures of any kind.

11. Alternatives to the Proposed Action

No potential adverse environmental effects are identified herein that would necessitate alternative actions to the proposed in this Notification. The alternative of not approving the action proposed herein would simply result in the continued use of the material that the FCS would otherwise replace; such action would have no significant environmental impact

12. List of Preparers

Certification

The undersigned officials certify that the information is true, accurate, and complete to the best of the knowledge of Bulk Chemical Services, LLC.

[redacted] Date 02/14/17

Harry Colley
Chemical Engineer: Georgia Institute of Technology
Director of Sales & Marketing at Bulk Chemical Services, LLC

[redacted] Date 02/14/17

Melissa McWilliams
Chemical and Biomolecular Engineer: Georgia Institute of Technology
Product Manager at Bulk Chemical Services, LLC

14. References

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