American Chemistry Council | Plastics Division

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Nabanita Modak Fischer
Fuels and Incineration Group
Sector Policies and Programs Division
Environmental Protection Agency
Research Triangle Park
North Carolina 27711

U.S. Environmental Protection Agency
Docket ID No. EPA-HQ-OAR-2021-0382

Re: ACC Comments on EPA's ANPRM – Potential Future Regulation Addressing Pyrolysis and Gasification

The American Chemistry Council ("ACC") appreciates the opportunity to submit these comments on the U.S. Environmental Protection Agency's ("EPA" or the "Agency") advanced notice of proposed rulemaking entitled "Potential Future Regulation Addressing Pyrolysis and Gasification Units" published in the Federal Register at 86 Fed. Reg. 50296 (Sept. 8, 2021) ("ANPRM"). ACC, acting on behalf of its members and including its self-funded groups and their members, represents a diverse set of companies engaged in all aspects of the U.S. business of chemistry. The business of chemistry is a $553 billion enterprise that provides approximately 542,000 high-paying jobs, drives innovations enabling a more sustainable future, and is helping to solve the biggest challenges facing our country and the world. ACC and its participating companies have been cornerstones of the global effort to address marine debris and plastic waste and their initiatives include helping develop, launch, and support the Alliance to End Plastic Waste; Circulate Initiative; the Declaration of the Global Plastics Associations for Solutions on Marine Litter; the Wrap Recycling Action Program; and the Materials Recovery for the Future project. ACC's Plastics Division and its members are working toward a goal of making all U.S. plastic packaging recyclable or recoverable by 2030, and reused, recycled, or recovered by 2040.

ACC strongly supports policies that recognize the products of "advanced recycling," which refers to processes like pyrolysis and gasification that turn plastic polymers back into feedstocks for new plastics or individual monomers, allowing materials to be reused in a variety of ways. These technologies can produce new virgin equivalent plastics and chemicals converted from post-use materials that would otherwise be landfilled or incinerated. Advanced recycling is an important complement to mechanical recycling methods currently in use and is necessary to achieving the United States' plastics reuse and recovery goals.

ACC welcomes EPA's efforts to develop a consistent approach to the regulation of pyrolysis and gasification. However, for the reasons set forth below, EPA should not regulate pyrolysis or gasification under the Clean Air Act ("CAA") Section 129 as "other solid waste incineration units" ("OSWI"). Instead, ACC supports the approach EPA took in its August 31, 2020 proposed rule in which the Agency determined that pyrolysis units should not be regulated

as OSWI because those units do not involve combustion of a solid waste.[1] Similarly, gasification also does not involve combustion of a solid waste and should not be regulated as OSWI. Put simply, as shown below, combustion/incineration involves burning hydrocarbons in the presence of excess oxygen to produce energy. Pyrolysis can *only* occur in the absence of oxygen – the pyrolysis process takes great pains to keep oxygen out of the reaction and produces raw materials for other manufactured products. Likewise, the amount of oxygen used in a gasification process is minimal and certainly not enough to be considered combustion. Both EPA and chemical handbooks define pyrolysis and combustion separately, and to argue they are the same, as some commenters did with regard to the August 31, 2020 proposal, violates the laws of thermodynamics. Gasification, in turn, is also not combustion. It is a chemical conversion process that converts hydrocarbon feedstocks into a synthetic natural gas product ("syngas") under oxygen starved conditions. While gasification uses a small amount of oxygen, it is well under the amount needed for combustion. Like pyrolysis, the syngas produced by gasification can be used as a chemical feedstock to produce other materials. We respectfully request that EPA consider the following points, each of which is discussed in detail below:

- Pyrolysis and gasification are not "combustion" of a "solid waste." Therefore, EPA should finalize the August 31, 2020 proposal and reject scientifically unsupported comments arguing that these processes should be regulated under the OSWI regulations or any other Section 129 regulations.

- There is no legal or technical support to regulate pyrolysis or gasification as incineration of a solid waste.

- Pyrolysis and gasification facilities can be properly regulated and permitted as manufacturing facilities and as such, are properly regulated under the CAA.

- Regulating pyrolysis and gasification facilities as "incineration" under Section 129 is inconsistent with a strong trend in state regulations.

- EPA has not provided, and there is no justification for reversing course and now regulating pyrolysis or gasification facilities as incinerators under Section 129**.**

- Regulating pyrolysis or gasification facilities under Section 129 would discourage the use of innovative technology, which is critical to the circular economy and the efforts to meet accelerating EPA recycling targets.

I. EPA's Conclusion That Pyrolysis Is Not "Combustion" of a "Solid Waste" and Therefore Should Not Be Regulated Under CAA Section 129 Is Correct

In the August 31, 2020 proposed rule, EPA concluded that pyrolysis is not combustion of a "solid waste" under OSWI.[2] EPA reasoned that pyrolysis can be readily distinguished from combustion because it is "endothermic and does not require the addition of oxygen (i.e. the

[1] 85 Fed. Reg. 54187 (Aug. 31, 2020).

[2] 85 Fed. Reg. 54187 (Aug. 31, 2020).

partial pressure of oxygen during a pyrolysis process is maintained close to zero)."[3] EPA concluded that "Based on this understanding, we recognize that the pyrolysis process, by itself, is not combustion." *Id.*[4]

The lack of combustion in pyrolysis (and, as later explained, gasification) should be enough to distinguish these processes from incineration. EPA's original analysis was correct as there is no scientific basis on which to conclude that the endothermic process here is combustion.

Moreover, while solid waste includes solid, liquid, and semisolid material, as well as gases in a container when the container is combusted, the combustion of *uncontained* gases in pyrolysis units is inconsistent with the definition of solid waste. In the August 2020 proposal, EPA noted that pyrolysis gas remains outside of a container and is therefore not "contained gaseous material."[5] This is an accurate description of the way in which gas is used in the process. As described more fully below, there is substantial support to show that both pyrolysis and gasification do not process solid waste. Therefore EPA should not regulate pyrolysis or gasification through Section 129.[6]

II. EPA Should Reject Any Arguments That Pyrolysis and Gasification Are Incineration of a Solid Waste Because Those Claims Are Wrong From Technical and Legal Perspectives

A. Pyrolysis is not incineration

Any argument that pyrolysis or gasification should be regulated as incineration is not legally or scientifically defensible. It is undisputed that combustion involves burning hydrocarbons in the presence of excess oxygen to produce energy and carbon dioxide. Pyrolysis is quite different since the goal in this process is to keep oxygen out of the process. In fact, the lack of oxygen is necessary for the technology to successfully produce raw materials that can be used for other processes. Additionally, emissions from pyrolysis are not the same as incineration because an endothermic oxygen free reaction will not produce the same emissions as an exothermic reaction. It is inconsistent with the laws of thermodynamics to treat these processes as the same. As discussed in detail below, neither pyrolysis nor gasification "combust" a "solid waste" and can therefore be easily distinguished from incineration.

[3] 85 Fed. Reg. 54187 (Aug. 31, 2020).

[4] In the ANPRM, EPA acknowledged these conclusions from the August 31, 2020 proposal – "the combustion of uncontained gases in pyrolysis/combustion units is inconsistent with [the definition of solid waste]," and "the Agency recognizes that the pyrolysis process, by itself, is not combustion." 86 Fed. Reg. at 50300-301 (Sept. 8, 2021).

[5] *Id.*

[6] The August 31, 2020 proposal never uses the term "gasification." The ANPRM calls gasification a "process of converting feed materials (primarily carbonaceous) into syngas (carbon monoxide and hydrogen) and carbon dioxide." 86 Fed. Reg. at 50300 (Sept. 8, 2021). EPA notes that a small amount of oxygen is added, but much less than the stoichiometric ratio needed for complete combustion of the feed material. *Id.*

1. Pyrolysis is not incineration under the Resource Conservation and Recovery Act because it does not use combustion

The Resource Conservation and Recovery Act ("RCRA") regulations define incinerator as "any enclosed device that ... [u]ses *controlled flame combustion* and neither meets the criteria for classification as a boiler, sludge dryer, or carbon regeneration unit, nor is listed as an industrial furnace." *See* 40 C.F.R. § 260.10 (emphasis added). While the regulations do not define "controlled flame combustion," combustion is clearly a type of oxidation reaction. *See, e.g.*, Hawley's Condensed Chemical Dictionary (12th Edition, 1993) ("Hawley's") at 302 (defining combustion as "[a]n exothermic *oxidation* reaction" (emphasis added)); *see also* Memorandum from Elizabeth A. Cotsworth, Acting Director, Office of Solid Waste, EPA, to Julie Anderson, Director, Waste Management Division, EPA Region 9 (July 30, 1997) (RCRA Online #14238) ("Combustion is an exothermic chemical reaction involving the rapid thermal *oxidation* of a substance" (emphasis added)). Moreover, not just any oxidation/combustion process will do. Rather, for a unit to qualify as an incinerator, it must produce a flame, and the combustion/flame must be "controlled," indicating that it must be intended and subject to active adjustment (*e.g.*, to achieve a desired level or rate of combustion). *Id.* ("Controlled flame combustion refers to a steady-state, or near steady-state, process wherein fuel and/or oxidizer feed rates are controlled"); *see also* Encyclopedia Britannica, "Combustion" (defining combustion as "a chemical reaction between substances, usually including oxygen and usually accompanied by the generation of heat and light in the form of a flame…").

Pyrolysis is altogether different. It is explicitly defined as a *non*-oxidative reaction. *See, e.g.*, Hawley's at 982 (defining pyrolysis as "[t]ransformation of a compound into one or more other substances by heat alone, *i.e., without oxidation*" (emphasis added)); U.S. Department of Agriculture, Agricultural Research Service, "Biomass Pyrolysis Research" ("Pyrolysis is the heating of an organic material ... in the absence of oxygen. ... Because no oxygen is present *combustion does not occur*" (emphasis added)); EPA, "Engineering Bulletin: Pyrolysis Treatment" (October 1992) ("Pyrolysis is formally defined as chemical decomposition induced in organic materials by heat *in the absence of oxygen*" (emphasis added)); Encyclopedia Britannica ("Pyrolysis") (defining pyrolysis as "the chemical decomposition of organic (carbon-based) materials through the application of heat" and explaining that "[p]yrolysis ... occurs in the *absence or near absence of oxygen*, and it is thus *distinct from combustion* (burning), which can take place only if sufficient oxygen is present" (emphasis added).

EPA has stated that, "[i]n practice, it is not possible to achieve a completely oxygen-free atmosphere" and thus "nominal oxidation" will occur. EPA, "Engineering Bulletin: Pyrolysis Treatment" (October 1992). However, any such irreducible amount of oxidation that may occur, because of practical limitations in trying to "completely" remove oxygen from the system, does not convert the pyrolysis unit into a controlled flame combustion device that might qualify as an incinerator. As an initial matter, "nominal" oxidation is, by definition, oxidation that is trifling or insignificant. *See* Webster's Online (definition of "nominal"). The classification of a unit should not be dictated by an insignificant reaction that may take place inside. Further, as noted above, it is not enough for oxidation/combustion to take place in a unit. Instead, for the unit to be an incinerator, the oxidation/combustion must be intentional and controlled. In pyrolysis, oxidation is not intentional; the goal is to transform the input material *without* oxidation (*e.g.*, because oxidation would result in altogether different and less desirable products). Considerable efforts

are made to exclude oxygen, for example, by purging the system of oxygen up front, replacing the oxygen with inert gases, and/or designing the system to prevent infiltration of air. In addition, conditions are not "controlled" to achieve a desired level or rate of oxidation. It is also worth noting in this regard that any "nominal oxidation" that may take place would not produce sufficient heat and light to create a "flame," which is yet another requirement for a unit to qualify as a "controlled flame combustion" device, and thus an incinerator.

In light of the above, there is simply no basis to assert that a pyrolysis unit is engaged in controlled flame combustion, such that it might be classified as an incinerator. Indeed, EPA has consistently maintained since the beginning of the RCRA regulatory program that pyrolysis units are non-combustion devices and not incinerators. In the 1980 rule that initiated the RCRA program, EPA drew a clear distinction between incineration and pyrolysis. In particular, the Agency stated that "the final rules contain a separate Subpart specific to thermal treatment processes other than incineration," and it added "a definition of 'thermal treatment' ... to more explicitly define the relationship between incinerators and other thermal treatment devices." *See, e.g.*, 45 Fed. Reg. 33,154, 33,217 (May 19, 1980). Under that definition, codified in 40 C.F.R. § 260.10, pyrolysis is listed separately from incineration, and thus is subject to the "separate Subpart specific to thermal treatment processes other than incineration" (*i.e.*, Subpart P of the interim status standards in 40 C.F.R. Part 265), rather than the subpart for incineration (*i.e.*, Subpart O). *See also* 45 Fed. Reg. 33,228, 33,252 (May 19, 1980) (establishing separate hazardous waste "handling codes" for incineration (T6 – T10) and pyrolysis (T12)).

Similarly, in 1987, when EPA issued the RCRA standards for permitted (rather than interim status) thermal treatment units other than incinerators, as well as for other "miscellaneous units," under Subpart X of 40 C.F.R. Part 264, the Agency explicitly stated that pyrolysis units were among the types of units that it envisioned would be subject to such standards (if not otherwise exempt from regulation). *See* 52 Fed. Reg. 46,946, 49,952 (December 10, 1987) ("*Thermal Treatment Units Other Than Incinerators.* ... A number of different types of thermal treatment units, including ... noncombustion units such as ... pyrolysis ... which are not covered under Part 264 Subpart O regulations [*i.e.*, the RCRA incinerator rules] will be covered under Subpart X"). By stating that pyrolysis units would be subject to the Subpart X rules for miscellaneous units, rather than the Subpart O for incinerators, EPA made clear again that pyrolysis units are not incinerators. *See* 40 C.F.R. § 260.10 ("*Miscellaneous unit* means a hazardous waste management unit ... that is *not* a container, tank, surface impoundment, pile, land treatment unit, landfill, *incinerator* ..." (emphasis added)).

2. Pyrolysis is not incineration under the Resource Conservation and Recovery Act because any gases created during the process are not solid waste

To the extent that some pyrolysis units may be connected to a separate device in which fumes/vapors from the pyrolysis process are combusted, that would not in any way change the regulatory status of the pyrolysis units. Nor would it cause the separate combustion device to be classified as a solid waste incinerator, because the fumes/vapors are not solid wastes. Under RCRA, solid waste is defined as and limited to "solid, liquid, semisolid, or contained gaseous material." *See* RCRA § 1004(27), 42 U.S.C. § 6903(27). Since the earliest days of RCRA, the phrase "contained gaseous material" as used in this definition has been understood to be limited

to containerized or condensed gases. *See, e.g.*, 54 Fed. Reg. 50,968, 50,973 (December 11, 1989) ("EPA ... believes our authority ... under RCRA is limited to containerized or condensed gases (*i.e.*, section 1004(27) of RCRA excludes all other gases from the definition of solid wastes ...)"); EPA, "Hazardous Waste TSDF – Technical Guidance RCRA Air Emission Standards for Process Vents and Equipment Leaks" (EPA-450/3-89-021) (July 1990) ("RCRA Air Emission Guidance") at 2-3 ("the process vent stream (*i.e.*, gases and vapors) from a hazardous waste management unit would not be classified as ... waste. Noncontainerized gases emitted from hazardous wastes are not themselves ... wastes because the RCRA statute implicitly excludes them"). As EPA's Environmental Appeals Board ("EAB") has stated, "a substance in gaseous form is not considered a solid waste under RCRA unless it is containerized." *See In re Chemical Waste Management of Indiana, Inc.*, RCRA Appeal No. 95-4, 6 E.A.D. 144, 160 (EAB, August 23, 1995).

For this reason, EPA has consistently and repeatedly stated that fume incinerators are not solid (or hazardous) waste incinerators under RCRA. For example:

- In 1982, EPA clarified that the RCRA incinerator regulations, which had only recently been promulgated, do not apply to "[f]ume incinerators which are used to destroy gaseous emissions from various industrial processes." *See* 47 Fed. Reg. 27,520, 27,530 (June 24, 1982). The Agency explained that "the RCRA standards do not apply to fume incinerators since the input is not identifiable as a solid waste." *Id*.

- EPA reiterated this conclusion in 1986, saying "a fume incinerator used only to destroy gaseous emissions from an industrial process is not subject to RCRA regulation since the fume input, being an uncontained gas, is not a solid waste." *See* EPA, RCRA Hotline Report (March 1986) (RCRA Online #12568).

- In 1989, EPA put an even sharper point on this conclusion, stating that "RCRA standards do not apply to fume incinerators because the input (an uncontainerized gas) is not a solid waste." *See* 54 Fed. Reg. 50,973, note 5.

- In 2011, EPA confirmed that "the Agency's previous statements and interpretations [regarding fume incinerators] remain effective" citing back specifically to the 1982 Federal Register notice mentioned above, as an example. *See* Letter from Suzanne Rudzinski, Director, Office of Resource Conservation and Recovery, EPA, to Tim Hunt, Senior Director, Air Quality, American Forest and Paper Association (May 13, 2011) (RCRA Online #14819 and #14857). In particular, EPA stated that "burning of gaseous material, such as in fume incinerators ... does not involve treatment or other management of a solid waste (as defined in RCRA section 1004(27))." *Id*.

- In 2012, EPA underscored the point in the 2011 letter, stating that that letter "clarified that EPA was not changing any of its previous positions regarding what constitutes a 'contained gaseous material' for purposes of defining the term 'solid waste' under RCRA" and therefore fume incinerators "do[ ] not involve treatment or other management of a solid waste." *See* Letter from Suzanne Rudzinski, Director, Office of Resource Conservation and Recovery, EPA, to Chris Hornback, Senior Director,

Regulatory Affairs, National Association of Clean Water Agencies (February 15, 2012) (RCRA Online #14830).

Cf. also 56 Fed. Reg. 7134, 7200 (February 21, 1991) (stating that activated carbon units used as air pollution control devices are not subject to RCRA "because the gas ... being treated is not a solid waste (it is an uncontained gas)"); Letter from Matthew Straus, Chief, Waste Characterization Branch, EPA, to Gregory J. Harvey, Occupational Medical Services, Newark Air Force Station (July 15, 1986) (RCRA Online #11166) (discussing solvent vapors from paint spray booths that are captured on activated carbon, and concluding that "[s]ince these solvent vapors are not contained, they are not defined as a solid or hazardous waste"); Memorandum from Matthew Straus, Chief, Waste Characterization Branch, EPA, to Clifford Ng, Engineer, EPA Region 2 (June 17, 1987) (RCRA Online #11255) (stating that methanol vapor from a production process, which is captured in carbon beds, "does not meet the definition of a solid waste under RCRA because it is in vapor form and not confined in a container").

The fact that, in most or all of these cases, the fumes were presumably conveyed from the process to the fume incinerator in closed pipes or ducts did not change the conclusions that the gases were not "contained" within the meaning of the statute and thus that the fume incinerators were not engaged in burning solid waste. In fact, EPA's Environmental Appeals Board (EAB) has explicitly rejected the argument that vapors passing through piping are contained gases, within the meaning of the definition of solid waste under RCRA. *See In re BP Chemicals America Inc., Lima, Ohio*, RCRA Appeal No. 89-4, 3 E.A.D. 667, 670 (EAB, August 20, 1991) (rejecting the argument that vapor qualifies as "contained gas" under RCRA simply because it is confined to "the various process units through which it passes, by associated piping, and by the plant as a whole"). As the EAB noted, such an argument "cannot be reconciled with the Agency's treatment of fume incinerators." *Id*. While the vapors passing through pipes "are contained in the broad sense of being bound or controlled and not being emitted to the atmosphere, ... such vapors [are] outside the scope of the 'solid waste' definition because they are not containerized in the narrower sense of being in an individual container such that the gas is amenable to shipment." *Id*.

One commenter on the August 31, 2020 proposal asserted that "[e]ven if the gases [sent to the separate combustion device] are not 'contained' they are derived from solid waste and are, therefore, solid wastes themselves." *See* Comments of Earthjustice, Docket No. OAR 2003-0156, at 6. However, there is nothing in the RCRA definition of solid waste that extends its coverage to any and everything that is derived from solid waste. Indeed, if that were the case, recycling of solid wastes would be a fool's errand, because products derived from recycling of solid wastes would inevitably remain solid wastes. The statute explicitly limits the definition of solid waste to gases that are "contained," and it matters not whether the gases are derived in some way from other materials that are solid wastes. *See also* RCRA Air Emission Guidance at 2-3 ("the process vent stream (*i.e.*, gases and vapors) *from a hazardous waste management unit* would not be classified as ... waste" (emphasis added)).

3. Pyrolysis is not incineration under the Resource Conservation and Recovery Act because plastic feedstock is not solid waste and gases are not mixed with solid waste

There is another more fundamental reason the commenter's claim here is flawed – the commenter appears to believe that plastics and other inputs to a commercial pyrolysis system are solid wastes. That is false. Under RCRA, solid wastes are defined as "discarded materials." *See* RCRA § 1004(27); 42 U.S.C. § 6903(27). However, the inputs to a pyrolysis process are not being discarded. Instead, they are valuable materials that pyrolysis facilities typically must pay for (unlike wastes that a landfill or incinerator must be paid to take) and that serve as essential feedstocks for a chemical production process designed for the very purpose of producing even more valuable products from such materials. The inputs are not being disposed into the environment (as in the case of landfilled wastes) or processed for purposes of destruction (as in the case of incinerated wastes). Nor are the materials being "reclaimed" or scavenged to recover a small amount of useful components that may happen to be present. Rather, the inputs are carefully selected feedstocks – frequently pre-processed at significant expense to ensure their suitability for the pyrolysis process – and essentially the entirety is converted through a sophisticated chemical process into new chemicals, which are sold for profit for use in a variety of applications. Clearly, the pyrolysis process is a true commercial chemical enterprise. The feedstocks to the process have not been discarded, and thus do not constitute "solid wastes."

The same commenter hypothesized that "the pyrolysis process does not produce just gases but, in reality, a combination of gases, liquids, and solids [such that a] mixture of all of these is sent to the [separate combustion device] which is, therefore, burning solid and liquids as well as ... gases [and thus is a solid waste incinerator]." *See* Comments of Earthjustice at 6. However, the commenter offered no evidence that the gases that exit the pyrolysis unit and make their way to a separate combustion device are, in fact, mixed with solids or liquids. On the contrary, pyrolysis facilities generally take steps to remove any fine solid particulates or aerosolized liquid droplets that might be suspended in the gases prior to burning, for example using "knockout pots" and/or filters. Moreover, even if a minute amount of particulates or liquid droplets might reach the separate combustion device, such materials would not qualify as solid wastes, much less materials whose presence would cause the separate combustion device to qualify as a solid waste incinerator.

Nothing in EPA's extensive guidance on fume incinerators not qualifying as solid waste incinerators (as discussed above) has ever suggested that a different result might obtain if the fumes being burned contained minute amounts of suspended particulates or aerosol droplets. If there were such an exception, EPA's repeated and consistent statements about fume incinerators would have been virtually meaningless – and highly misleading. It is widely recognized that vapors routed to fume incinerators or similar devices such as flares may contain entrained liquid droplets, and efforts are commonly made to reduce the presence of such droplets by using knockout pots prior to burning. *See, e.g.*, RCRA Air Emission Guidance at 5-29 to 5-31 ("Process off-gases ... sent to [a] flare ... can vary widely in volumetric flow rate, moisture content, organic concentration, and heat value. [A] knock-out drum ... removes water or hydrocarbon droplets that could create problems in the flare combustion zone"); EPA, "Air Pollution Control Fact Sheet: Flares" (EPA-452/F-03-019) ("Liquids that may be in the vent stream gas ... are removed by a knock-out drum"). However, such knockout pots are rarely, if

ever, 100% effective. As a result, some nominal burning of liquid droplets (and/or particulates) may be inevitable in many/most cases. If such burning represented an exception to the rule that fume incinerators are not solid waste management units, it would be the exception that swallows the rule. (It also questionable whether any suspended particulates or droplets would qualify as solid wastes. *See, e.g.*, *Center for Community Action and Environmental Justice, et al., v. BNSF Railway Company, et. al*., 764 F.3d 1019, 1020-21 (9th Cir. 2014) (holding that "emission of diesel particulate matter does not constitute 'disposal' of solid waste within the meaning of RCRA").)

In sum, pyrolysis is clearly not incineration under RCRA. To the extent that some pyrolysis units may be connected to a separate device in which fumes/vapors from the pyrolysis process are combusted, that would not in any way change the regulatory status of the pyrolysis units. Nor would it cause the separate combustion device to be classified as solid waste incinerator, because the fumes/vapors are not solid wastes. While some have hypothesized that the fumes/vapors in these instances would contain a minute amount of suspended particulates or liquid droplets, even if that were true, that would not change the fact that the separate combustion device would not constitute a solid waste management unit under RCRA. Accordingly, there is no basis for EPA to regulate pyrolysis units or any associated vapor combustion devices as solid waste incinerators.

4. The purpose and chemistry of pyrolysis is completely different from that of combustion

The purpose of pyrolysis in the case of advanced recycling of plastic is to transform the plastic into smaller molecules and therefore a usable form by thermally breaking the covalent bonds holding the polymer together.[7] This is fundamentally different from the purpose of incineration, in which the combustion mass products are not reused.

The chemistry of pyrolysis is completely different from the chemistry of combustion. In pyrolysis, heat/temperature are used to chemically transform the plastic into different and smaller molecules which can be used as raw materials for production of new products. These cleavage reactions are endothermic. Small amounts of free oxygen may be present by happenstance, but oxygen is not added intentionally nor is it desired that the plastic feed and hydrocarbon products react with any free oxygen that may be present, and every effort is taken to prevent this from happening (e.g., through oxygen freeing and inerting equipment). In combustion oxygen is introduced intentionally in excess to drive the oxygen to react with the hydrocarbons to chemically transform those hydrocarbons into carbon dioxide and water, thereby releasing heat in an exothermic reaction.

[7] The International Union of Pure and Applied Chemistry ("IUPAC") defines pyrolysis generically as "thermolysis usually associated with exposure to high temperature." Thermolysis, in turn, is defined as "the uncatalysed cleavage of one or more covalent bonds resulting from exposure of a compound to a raised temperature." https://goldbook.iupac.org/terms/view/P04961. IUPAC goes on to note that pyrolysis generally refers to reaction in an inert environment.

B. Gasification is not incineration

The analysis for gasification units is similar in many respects to that of pyrolysis, but somewhat different with respect to combustion. In any event, it leads to the same conclusion (*i.e.*, that such units are not incinerators). EPA has previously explained that "gasification systems ... react carbon containing materials and steam at high temperatures under partial oxidation conditions to produce a synthesis gas fuel composed mainly of carbon monoxide and hydrogen." *See* 67 Fed. Reg. 13,684, 13,687 (March 25, 2002). Although "partial oxidation" takes place in a gasification unit, and combustion is defined as a type of oxidation reaction (as discussed above), not all oxidation is combustion (much less "controlled flame combustion," as necessary for a unit to be classified as an incinerator). For example, both rusting of iron and spoilage of food involve oxidation, but nobody could seriously argue that either process constitutes combustion or incineration. *See, e.g.*, Dictionary.com (rust) (defining rust as "the red or orange coating that forms on the surface of iron ... *formed by oxidation*" (emphasis added)); Institute of Agriculture and Natural Resources, University of Nebraska – Lincoln, "How Food Spoils," available at https://food.unl.edu/how-food-spoils ("When fats in foods become rancid, *oxidation is responsible*" (emphasis added)).

Combustion of organics is defined as a process whose "end products ... are carbon dioxide and water." *See* Hawley's Condensed Chemical Dictionary (12th Edition, 1993) at 302. However, the very purpose of a gasification unit is ***not*** to produce these combustion end products. As EPA has stated, "[g]asification processes ... limit and control oxygen levels to ensure the process reactions convert organic material to the synthesis gas product, and *to prevent ... complete (or unwanted) oxidation*." *See* 67 Fed. Reg. at 13,689 (emphasis added); *see also id.* at 13,687 ("Gasification systems ... are all operated in a manner that limits the complete oxidation ... to water and carbon dioxide"). It is this difference (among others discussed below) which distinguishes gasification from combustion/incineration. *See, e.g.*, 63 Fed. Reg. 38,139, 38,141 (July 15, 1998) ("Gasification is a chemical conversion process that converts hydrocarbon feedstocks into a synthetic natural gas product .... This process occurs under oxygen-starved (or reducing) conditions, *which distinguishes gasification from combustion*." (emphasis added)); *see also* Letter from James R. Berlow, Director, Hazardous Waste Minimization and Management Division, EPA, to Douglas E. McKinley, Jr., Director of Administration, Integrated Environmental Technologies, LLC (February 15, 2001) (RCRA Online #14535) (describing a "gasification and vitrification" process that produces syngas and glass from hazardous waste as a "*non-combustive*, oxygen-reduced, thermal treatment process" (emphasis added)).

In light of this fundamental distinction between gasification and combustion, EPA and other regulatory agencies have long stressed that gasification units are not incinerators. For example, in 2000, the U.S. Department of Energy ("DOE") issued a lengthy report entitled "A Comparison of Gasification and Incineration of Hazardous Wastes." *See* DOE Report # DCN 99.803931.02 (March 30, 2000). After a detailed comparison of the two technologies, the DOE report concluded as follows:

> Both gasification and incineration are capable of converting hydrocarbon-based hazardous materials to simple, nonhazardous byproducts. However, the conversion mechanisms and the nature of

> the byproducts *differ considerably, and these factors should justify the separate treatment of these two technologies in the context of environmental protection* and economics. ... All things considered, the ability of gasification technologies to extract useful products from secondary ... materials [is] *unlike hazardous waste incineration*.

Id. at ES-15 to ES-17 (emphasis added). In 2008, EPA explicitly endorsed the DOE conclusion and summarized the basis for the conclusion as follows:

> DOE concluded, and we agree, that *gasification and incineration are distinct processes* that can be distinguished by a number of factors. As discussed in the report, the factors distinguishing the two processes are: (1) Incinerators are designed to maximize the conversion of feedstock to carbon dioxide and water; gasifiers are designed to maximize the conversion of feedstock to carbon monoxide and hydrogen; (2) incinerators utilize large quantities of excess air; gasifiers utilize small quantities of oxygen; (3) incinerators operate in a highly oxidizing environment; gasifiers operate in a reducing environment; (4) incinerators discharge their flue gas to the environment as a waste; gasifiers utilize their synthesis gas for ongoing chemical, fuel production or power production as a product gas.

See 73 Fed. Reg. 57, 61 (January 2, 2008) (emphasis added).[8]

Based on this reasoning, EPA in 2008 explicitly rejected the idea that gasification units are waste combustion devices/incinerators. *Id*. at 63 ("we do not agree with the commenter's suggestion that gasification systems [are] incinerators [and] should be subject to all RCRA/CAA hazardous waste combustion regulations"). Indeed, in a 2002 proposal to exclude certain hazardous secondary materials from the definition of solid waste when handled/stored prior to processing in a gasification unit, the Agency proposed to define "gasification system" as "an enclosed thermal device and associated gas cleaning system or systems that *does not meet the definition of an incinerator* or industrial furnace [and meets certain other requirements including] [l]imit[ing] oxygen concentrations ... to prevent ... full oxidization… [and] [p]roduc[ing] a synthesis gas." *See* 67 Fed. Reg. at 13,700 (proposed to be codified at 40 C.F.R. § 261.10). Although EPA dropped the explicit exclusion of incinerators (and industrial furnaces) from this

[8] We underscore these conclusions by DOE and EPA by noting that while incinerators use far greater than the stoichiometric quantities of oxygen (in the form of air) needed to fully oxidize the materials being burned, gasifiers use only a small fraction of the amount that would be required for (undesired) complete oxidation (commonly in the form of pure/liquefied oxygen). In addition, the environment in a gasifier is based on the hydrogen gas produced in the unit, which is not present in the oxygen-rich environment of an incinerator. As a result, for example, nitrogen bound up in the feedstock is converted primarily into nitrogen (N2) or ammonia (NH3) gases, rather than nitrogen oxides that would be created in an incinerator. Finally, to the extent that some gasification units may produce a small amount of unwanted gases together with the syngas product, the fact that those unwanted gases are separated, filtered, and ultimately flared, would not cause the gasification unit or the separate flare to be classified as solid waste incinerators, for the reasons discussed above in the context of pyrolysis.

definition in the 2008 final rule, the Agency made clear that this was not intended as a substantive change. *See* 73 Fed. Reg. at 62 ("we are persuaded that including the reference to hazardous waste burning incinerators and industrial furnaces in the definition is *unnecessary* and could lead to confusion" (emphasis added)).

Thus, the definition of gasification added to the RCRA regulations in 2008 embodied the understanding that gasification units are not incinerators. *Id*. at 72 (definition of gasification codified at 40 C.F.R. § 260.10). Although the 2008 definition was removed from the RCRA regulations in 2015, in response to a court decision vacating the exclusion from the definition of solid waste for certain materials processed in gasification units, nothing in the court decision or EPA's withdrawal related to, or affected in any way, the Agency's conclusion that gasification units are not incinerators. *See* 80 Fed. Reg. 18,777 (April 8, 2015); *Sierra Club v. EPA*, 755 F.3d 968 (D.C. Cir. 2014). Indeed, nothing in the court decision or EPA's withdrawal changed the fact that gasification units processing hazardous wastes are exempt from RCRA regulation. *See, e.g.,* 67 Fed. Reg. at 13,685 (explaining that "gasification systems ... are exempt from RCRA permitting, as recycling units," but that the then-proposed (and now withdrawn) exclusion from the definition of solid waste for certain materials intended to be processed in such units was designed to address "numerous requirements that still apply to ... storage and handling [prior to processing]").

In sum, gasification is clearly not incineration under RCRA. Although some limited degree of oxidation does take place in gasification units, such partial oxidation does not constitute combustion, which is a *sine qua non* for classification as incineration. As EPA and DOE have long recognized, gasification and incineration are distinctly different technologies, with many completely different attributes. For these reasons, there is simply no basis for the Agency to regulate gasification units as solid waste incinerators.

III. Pyrolysis And Gasification Facilities Can Be Properly Regulated And Permitted As Manufacturing Facilities

Pyrolysis and gasification use a chemical process to recycle plastics, resulting in raw materials that can be used to create new polymers, waxes, lubricants and chemicals. The plastic feedstock used by pyrolysis and gasification facilities is not waste, but instead is a valuable commodity, necessary to the manufacture of new products.[9] Rather than regulation as a solid waste unit, pyrolysis and gasification facilities are more properly regulated in the same manner as other manufacturing facilities since they process raw materials (e.g., post-use polymers and

[9] Two trade associations representing paper interests have filed comments challenging this characterization. They assert that pyrolysis and gasification are simply "energy recovery" and therefore, they argue, should not be characterized as recycling. See American Forest & Paper Association, "Comments on Docket ID No. EPA-HQ-OAR-2021-0382 Potential Future regulation Addressing Pyrolysis and Gasification Units" (November 8, 2021); Paper Recycling Coalition, "Comments on Potential Future Regulation Addressing Pyrolysis and Gasification Units" (November 8, 2021). As demonstrated throughout our comments, this characterization is not accurate. The materials used as feedstock for pyrolysis and gasification are not burned for energy recovery. Rather, they serve as feedstock converted by sophisticated chemical processes into new chemicals and syngas products.

recoverable feedstocks) to make valuable intermediate and final products. In many states, this is already occurring (see Section IV below).

At these facilities, permits must be obtained for both pyrolysis and gasification units. For example, a pyrolysis or gasification source emitting any criteria pollutants or hazardous pollutants would be subject to all relevant CAA requirements including construction and operating permits and/or registrations (depending on the jurisdiction) and applicable air emission standards. Federal air permit requirements are triggered if a facility's potential air emissions exceed certain thresholds. Applicable triggering thresholds for criteria pollutants (particulate, volatile organic compounds, sulfur dioxide, nitrogen oxide, carbon monoxide, and lead) vary between 10 and 250 tons/year depending on the air quality of the area in which the facility is located. For hazardous air pollutants ("HAPs"), federal air permitting requirements are triggered if the facility has the potential to emit 10 tons/year for a single HAP or 25 tons/year for any combination of HAPs under CAA Section 112. Depending on the precise feedstocks, equipment, and operations present at the facility, federal regulations may additionally impose emission limits or other operational requirements on the facility's operations under the New Source Performance Standards ("NSPS") and/or National Emission Standards for Hazardous Air Pollutants ("NESHAP") programs. Therefore, it is not necessary to layer on additional requirements under Section 129 for these facilities. EPA has previously taken a similar approach by exempting fired sources regulated under 40 C.F.R. § 63, subpart DDD (NESHAP for Industrial, Commercial, and Institutional Boilers and Process Heaters) from the usual standards of performance for regulated stationary sources.[10]

Further, even if the facility does not trigger federal permitting requirements, it may still need a state (and in some cases, for example, in California, local) air construction and/or operating permit. It may also be subject to state-imposed emission limits and/or operational requirements. Similarly, any waste would be subject to federal and state disposal laws.

IV. Regulating Pyrolysis or Gasification Facilities as "Incineration" Under Section 129 Is Inconsistent With a Strong Trend in State Regulations

Many states have already taken a hard look at pyrolysis and gasification facilities to determine that they should not be regulated in the same manner as incinerators. Currently, 14 states have passed legislation to regulate pyrolysis or gasification as manufacturing facilities. Arizona, Arkansas, Florida, Georgia, Illinois, Iowa, Ohio, Oklahoma, Louisiana, Pennsylvania, Tennessee, Texas, Virginia, and Wisconsin have all passed a regulatory framework that supports advanced recycling. For example, in Louisiana the most recent state to pass legislation, SB 97 classifies advanced recycling as a manufacturing process rather than a solid waste process and excludes certain plastic feedstock from the definition of solid waste. That same legislation excludes advanced recycling facilities, including those that use pyrolysis or gasification from the definition of a "solid waste disposal facility." In Virginia, SB 1164 is similar, and explicitly states that advanced recycling facilities will not be considered a combustion facility or an incinerator. Recognizing the value that these facilities have in the global fight against plastics pollution, these 14 states are removing unnecessary obstacles to permitting while ensuring regulation and reduction of air emissions. Action by EPA to regulate pyrolysis or gasification as

[10] See 40 C.F.R. § 60.2887(i).

OSWI is inconsistent with the approach taken in these states and will complicate the efforts of these states to attract advanced recycling facilities, spur innovation, and promote plastics recycling. It will also complicate permitting and possibly require these states to amend their current legislation. Such action is unnecessary when these facilities can be effectively regulated in another manner.

V. EPA Has Not Provided, And There Is No Justification For Reversing Course And Now Regulating Pyrolysis Or Gasification Facilities As Incinerators Under CAA Section 129

EPA does not claim in the ANPRM that it is reconsidering any of the engineering or scientific judgments from the August 31, 2020 proposal. EPA also does not claim that that any legal judgments from that proposal were faulty. Accordingly, ACC does not see how EPA can justifiably reverse those judgments. EPA cites several reasons for issuing the ANPRM and reconsidering whether to regulate pyrolysis and gasification units under the OSWI subcategory:

- "Through recent requests for applicability determinations, it appears that pyrolysis and gasification processes are more widely used to convert waste into useful products or energy."

- "As a result of recent market trends, especially with respect to plastics recycling, the EPA has received several inquiries about regulations under CAA section 129 for solid waste incineration units and the applicability of such regulations to pyrolysis and gasification units for a variety of process and feedstock types."

- "Based on these requests and the differences in language pertaining to pyrolysis among CAA section 129 rules, the Agency believes that there is considerable confusion in the regulated community regarding the applicability of CAA section 129 to pyrolysis and gasification units."

- The EPA received adverse comment on the proposed change to the definition of "municipal waste combustion unit" on the basis that pyrolysis should be considered solid waste combustion and regulated under the OSWI rule. In addition, the Agency received a comment that the OSWI category should also cover other combustion technologies not already regulated as municipal waste combustors, medical waste incinerators, or commercial and industrial solid waste incinerators under sections 111 and 129 of the CAA, such as pyrolysis and gasification technologies."

None of these reasons, however, provide a legal basis for EPA to reverse the course set forth in the proposed August 31, 2020 rulemaking. Indeed, as demonstrated below, several of these reasons – e.g., use of pyrolysis in plastics recycling – should cause EPA to step back from any further regulation of pyrolysis or gasification. Rather, EPA should be encouraging such recycling practices, not discouraging them by issuing new regulations unsupported by good science.

VI. Regulating Pyrolysis or Gasification Facilities Under Section 129 Would Discourage the Use of Innovative Technology, Which Is Critical to Plastics Recycling in the Circular Economy

EPA recognizes the value of pyrolysis and gasification in the ANPRM, as it states that:

> Pyrolysis and gasification processes have been touted as potential methods to generate a "circular economy" around plastics use, where a post-consumer plastic product can be recycled to produce a plastic of equal or similar quality again instead of being disposed of or "downcycled" to lesser quality products. Pyrolysis and gasification technologies have been used to convert solid and semi-solid materials . . . to useful products . . . [11]

Advanced recycling using pyrolysis and gasification is a critical tool to reduce plastic waste. Both technologies make it possible to recycle many types of plastic, even plastic that would otherwise not be recyclable using mechanical methods. The U.S. Government Accountability Office has highlighted advanced recycling for its ability to reduce the amount of plastic going to landfills and produce high-quality recycled plastic.[12] Reversing course and regulating pyrolysis and gasification as OSWI would place the investments by ACC member and other companies in advanced recycling at risk and could make it impossible to meet EPA's recycling goals.[13] These investments are substantial. A recent report by the Closed Loop Fund highlights a potential economic opportunity of up to $120 billion in North America when new advanced technologies are utilized to make a versatile mix of new end products, chemicals and plastics.[14]

China's National Sword Policy, which restricts the importation of certain solid waste materials, although disruptive to recycling programs throughout the U.S., has created an opportunity for U.S. investment in advanced recycling technologies. Below are some examples of the types of plastics accepted and outputs generated by advanced recycling technologies:

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[11] EPA comments at 86 Fed. Reg. at 50299. Note also that circularity promotes diversion from a landfill, which on its own, has a high value. Evaluating circularity based only on similar quality and equal or greater value, which typically is understood to mean unit sales price, does not account for diversion and other important values achieved by the circular economy.

[12] U.S. Government Accountability Office, *Can Chemical Recycling Reduce Plastic Pollution?*, available at https://www.gao.gov/blog/can-chemical-recycling-reduce-plastic-pollution.

[13] In its recently published *National Recycling Strategy*, EPA recognizes advanced recycling as a means to help increase the U.S. recycling rate to the National Recycling Goal of 50% by 2030, available at Strategies on Building a Circular Economy for All | US EPA. In addition, EPA's 2018 recycling data suggest increased recycling of plastics offers perhaps the greatest opportunity to help achieve EPA's 2030 goal which reinforces the need and importance of advanced recycling. See, National Overview: Facts and Figures on Materials, Wastes and Recycling | US EPA.

[14] Closed Loop Partners, *Accelerating Circular Supply Chains for Plastics*, available at: https://www.closedlooppartners.com/research/advancing-circular-systems-for-plastics/.

- Polystyrene foam (#6) can be recycled as styrene monomer and used to manufacture food packaging for meat, dairy and bakery products, electronics, automotive components, medical devices, and paper coatings.

- PET (#1) and polyester fiber can be recycled as PET monomer building blocks and used to manufacture new polyester and PET for use in durable food containers, small appliances, consumer electronics, antifreeze, and skin conditioning agents.

- PET (#1)/flexible packaging/plastic films can be recycled as cellulose based thermoplastics and used to manufacture textiles, eyeglass frames, and automotive lens applications and decorative trim.

- Mixed plastics including HDPE (#2), LDPE (#4), /PP (#5), PS (#6), and miscellaneous plastics (#7) can be recycled and used to manufacture waxes, lubricants, ingredients for detergents and cosmetics, and polymer building blocks such as olefins or BTX.

- Mixed plastics (combined with non-compostable materials) can be recycled to create renewable methanol and ethanol used to manufacture plastics, new chemicals, and products such as acetic acid, inks, adhesives and windshield washer fluid.[15]

- Mixed plastics including #3 through #7 can be recycled to recapture hydrochloric acid for water treatment, and hydrocarbon feedstocks for conversion into new chemicals and plastics.

The above list demonstrates the diverse value of advanced recycling and its potential to divert post-use plastics from disposal and to convert plastics to many different types of useful products. Regulated as manufacturing facilities, pyrolysis and gasification units are sufficiently permitted to protect public health and the environment, while promoting the advancement of plastics recycling. Additional requirements regulating these technologies as OSWI are not needed and will stifle use of these innovative technologies.

VII. Conclusion

ACC appreciates the opportunity to share these comments on the ANPRM and ACC urges EPA to make a final decision to exclude pyrolysis and gasification from regulation under Clean Air Act Section 129. For any questions, contact Craig Cookson, Senior Director, Plastics Sustainability at craig_cookson@americanchemistry.com or Ted Waugh, Assistant General Counsel at ted_waugh@americanchemistry.com.

[15] ChemicalSafetyFacts.org, *Methanol*, available at: https://www.chemicalsafetyfacts.org/methanol/.