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Comment On “Patented Blunderings, Efficiency Awareness, And Self-Sustainability Claims in The Pyrolysis Energy from Waste Sector”

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The main focus of the paper, Patented blunderings, efficiency awareness, and self-sustainability claims in the [pyrolysis](#) energy from waste sector, by [Rollinson and Oladejo \(2019\)](#) was pyrolysis of [municipal solid](#)

[waste](#) (MSW) ([Rollinson and Oladejo, 2019](#)). However, the authors of the paper discuss an article that was written by the authors of this commentary on pyrolysis of wastewater [biosolids](#). In the paper by Rollinson and Oladejo, it was noted that “consideration will also be given to [sewage sludge](#), by definition a municipal solid waste, although invariably collected and managed separately.” However, by definition, MSW is essentially “mixed household waste... (and) commercial waste...,” and does not include [sewage](#) sludge ([Vesilind et al., 2002](#)). In fact, sewage is specifically excluded from the definition of solid waste in the US by the [Resource Conservation](#) and Recovery Act.

The context of our publication was [municipal wastewater biosolids](#) (treated sewage sludge), and we did not extrapolate our findings to MSW ([McNamara et al., 2016](#)). [Rollinson and Oladejo \(2019\)](#) recommend that [pyrolysis](#) should not be used for MSW because it is a net [energy loss](#) process and studies that claim otherwise ignored drying ([Rollinson and Oladejo, 2019](#)). In our 2016 publication, we stated “The [enthalpy](#) of pyrolysis is not a substantial energy cost compared to the [energy requirements](#) of biosolids drying.” ([McNamara et al., 2016](#)). We note here that we should have used the phrase “enthalpy for pyrolysis” instead of “enthalpy of pyrolysis” since the energy required to raise [biomass](#) temperature as well as convert biomass into gas, liquid, and solid products was considered ([Daugaard and Brown, 2003](#)). Still, the enthalpy for pyrolysis is insignificant compared to the sensible and latent enthalpy of drying, which has implications for an industry that already dries biosolids for the reasons described below ([McNamara et al., 2016](#)).

We chose to exclude drying energy in our analysis of [enthalpy](#) for [pyrolysis](#) because we deemed it important to distinguish the energy cost of drying from the energy cost of pyrolysis for the wastewater industry for the following reasons. The Milwaukee Metropolitan Sewerage District (MMSD) and some other sanitary districts in the US have processed [biosolids](#) by heat-drying for as long as 100 years. The MMSD [dried product](#), Milorganite[®], is employed across the US as a [fertilizer](#) and [soil conditioner](#). There are energy costs associated with drying to produce Milorganite[®], and more Milorganite[®] is produced than is sold. Unsold Milorganite[®] is often given away or land applied. Unused Milorganite[®] is rich in [organic matter](#) that has already been dried. The reason we conducted our pyrolysis energy balance on the dried biosolids was that the feedstock used for pyrolysis was biosolids that were already dried. For the wastewater utility, drying energy is often required whether or not the unused biosolids are subsequently pyrolyzed. We compared the energy required for pyrolysis to the energy required for drying. Therefore, our study was conducted to determine if pyrolysis for dried biosolids is a viable alternative to land application or landfilling. For the wastewater industry, it is practical to consider the energy balance of pyrolysis with drying energy outside the system boundary. We do agree with the authors that we made multiple assumptions for estimating the enthalpy for pyrolysis which resulted in large error bars for this value. Nevertheless, the energy costs of drying are far higher than the energy input for pyrolysis, indicating that, for an industry that already dries biosolids, pyrolysis could be used to recover energy from the dried biosolids in the form of pyrolysis gas (py-gas). As described in more detail in our publication, py-gas could be used to help offset energy costs associated with drying that has already taken place ([McNamara et al., 2016](#)). Pyrolysis of dried wastewater biosolids pertains to the wastewater industry, and may not be as relevant to [municipal solid waste](#). The conclusion presented by Rollinson and Oladejo (2018) that, in many cases, pyrolysis may not be practical, is more reasonable for cases in which waste products do not need to be dried.

We agree that tar production, co-combustion, and other practical issues need to be addressed during the scale-up of [biosolids pyrolysis](#). While it is important to handle practical engineering issues and to provide fundamental theory, it is equally important to consider economic considerations such as revenue from products, provisions for public health, [environmental protection](#) and overall treatment costs. It is expensive to haul unused biosolids. Often [dewatering processes](#) are employed even though they require energy. In the case of wastewater in which i) solids continue to be produced by the public and need to be managed and ii) we already employ energy-intensive processes such as [activated sludge](#) or dewatering, pyrolysis is one process to be considered as part of a

utility's [management plan](#) to further protect public health and the environment. Biosolids pyrolysis also removes biological [contaminants](#) (Kimbell et al., 2018), destroys or removes [micropollutants](#) such as triclosan and triclocarban from solids (Ross et al., 2016; Hoffman et al., 2016), reduces dried solid mass for transport by approximately 60%, and may concurrently result in some [energy recovery](#) from dried biosolids that may otherwise be wasted (McNamara et al., 2014; Liu et al., 2018). Moreover, [biochar](#) is a possible [value-added product](#) (Carey et al., 2015), and the value of biochar may offset some production costs. In addition, new autocatalytic pyrolysis processes have been developed to reduce tar production and increase py-gas production (Liu et al., 2016a, b; Liu et al., 2017). Therefore, wastewater pyrolysis should continue to be investigated for biosolids management.

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