Empowering Waste-to-Energy Solutions with Steam Turbines

Sustainable municipal waste management solutions often involve waste-to-energy plants that can produce electricity while also providing steam to district heating systems. Efficient steam turbines are important in these applications.

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As urban populations expand rapidly, the demand for efficient waste management systems intensifies. Conventional systems have been extensively utilized due to their ease of implementation and relatively modest upfront costs. Nonetheless, these methods carry notable drawbacks that are becoming progressively harder to overlook.

Waste-to-energy (WtE) technology is a groundbreaking solution that repurposes waste destined for landfills into valuable assets. One of the most impressive features of WtE is its ability to transform waste into ash, reducing landfill volumes by as much as 90%.

Benefits of WTE Plants

The advantages of WtE go beyond simply diverting waste. It provides a cleaner, environmentally friendly solution by averting CO_2 emissions for every ton of waste incinerated. Additionally, the heat produced in WtE facilities can be utilized for electricity generation and district heating, increasing profitability while reducing harm to the environment.

The heat produced from burning waste can be efficiently harnessed to generate electricity (Figure 1) for the power grid and heating for homes and business environments. This twofold functionality reduces the amount of waste transported to landfills and creates fresh revenue opportunities for operators of WtE facilities. The dependable performance of WtE systems is particularly valuable in areas where energy demand is high and resources are scarce. By integrating WtE into current energy networks, the overall efficiency and resilience of the energy system are enhanced. This determines WtE as a crucial strategy for addressing the challenges of waste management and energy production.

1. Waste-to-energy (WtE) power plants burn garbage to produce steam for use in turbines, such as the one shown here, to generate electricity and also to supply district heating systems in some communities. Courtesy: Triveni Turbines

With efficiency rates often surpassing 40%, steam turbines play a pivotal role in scenarios where the heat energy from waste is limited.

Steam turbines play a prominent role in WtE facilities, providing outstanding reliability and lower operational expenses, all while reducing greenhouse gas emissions. The heat produced from waste combustion produces steam, which propels the steam turbines to transform thermal energy into electrical power. Incorporating thermal renewable energy sources, energy-efficient machinery, and intelligent grid systems lays the foundation for eco-friendly, sustainable energy solutions. Triveni Turbines, renowned for its expertise in steam turbine design up to 100 MW, is enabling efficient energy conversion in WtE facilities.

Modern Facilities Operate High-Tech Equipment

Simultaneously, connecting internet of things (IoT) devices with steam turbines unlocks data-driven understandings of power generation and consumption trends, empowering utilities to make informed choices. This method minimizes environmental repercussions and guarantees a steady, dependable energy provision, strengthening resilience against energy deficits and power fluctuations.

The inclusion of steam turbines in WtE systems is essential for multiple reasons. With efficiency rates often surpassing 40%, steam turbines play a pivotal role in scenarios where the heat energy from waste is limited. Their capability to maintain consistent, dependable operation ensures a steady flow of electricity to the grid. Additionally, steam turbines seamlessly blend into current energy frameworks, providing a flexible solution for WtE implementations.

German Case Study

Triveni Turbines Limited (TTL), a global market leader in the up to 100 MW power range, has played a pivotal role in this transition, showcasing the importance of steam turbines in converting waste (municipality, commercial, and industrial) into electricity. One example involves a power plant in Germany. Triveni Turbines played a crucial role in a waste-to-energy project utilizing refuse-derived fuel (RDF) at a leading paper manufacturer in Deutschland.

Triveni's steam turbine generator (STG) unit was successfully installed and commissioned in a biomass-based plant in Germany, in August 2021. Despite the challenges posed by the global pandemic, Triveni's service engineers provided continuous support, enabling the paper mill's power plant to efficiently use the heat and electricity generated from the RDF-based WtE plant.

Since 2008, the customer has supplied thermal energy for paper drying by sourcing local waste materials to fuel its operations. The RDF power plant, pow-

2. State-of-the-art WtE power plants utilize steam turbine generators to produce electricity. Courtesy: Triveni Turbines

ered by Triveni's 15.6-MWe condensing steam turbine, operates with an inlet steam pressure of 27 Bar and an inlet temperature of 320C.

The paper production process requires significant amounts of thermal and electrical energy, leading the client to invest in an RDF power plant to efficiently meet these demands. Triveni Turbines provided the steam turbine generator unit and associated equipment (Figure 2), which processes 300,000 tonnes of waste annually to generate energy for the paper plant and neighboring communities. This project greatly enhances sustainability by incinerating waste in an environmentally friendly way, supplying a substantial portion of the paper mill's steam needs. Additionally, excess heat from the paper drying process is used to warm the outdoor swimming pool, demonstrating a comprehensive approach to energy efficiency and resource utilization.

Energy Savings and Emission Reduction

The RDF power plant achieves remarkable annual savings of 32 million cubic meters of natural gas and primary energy, reducing CO_2 emissions by 55,000 tonnes each year. This case study exemplifies the environmental benefits of a sustainable energy initiative.

There is an urgent need to transition from conventional fossil fuels to renewable, carbon-neutral options. Biomass-derived fuels play a vital role as they offer recent carbon emissions while emitting fewer particulates, sulfur dioxide, and air pollutants than fossil fuels.

Integrating steam turbines into WtE plants aligns with the core principles of the circular economy (CE), which aims to reduce, reuse, recycle, and recover materials, thus minimizing waste and maximizing the service life of resources. This integration plays a significant role in supporting CE goals by turning waste into a thermal renewable energy source, thereby minimizing reliance on primary natural resources.

The future of WtE solutions looks promising as numerous countries actively promote the adoption of these technologies. The synergistic application of steam turbines in WtE plants is a significant stride toward a greener economy. Advanced technologies empower WtE facilities to capture and reduce CO_2 emissions. Harnessing the power of steam turbines in WtE plants optimizes energy generation. The captured CO_2 can be utilized or stored, reducing the carbon footprint of these facilities. Energy generated by WtE plants equipped with steam turbines can aid decarbonization across various industries, including heating applications. ■

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