Using waste heat to generate electrical power

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A new study contributes to "increasing the energy efficiency of industrial processes and cutting the emission of gases that pollute the atmosphere."

When tackling the challenge of meeting energy demand while being environmentally friendly, "it is very important not only to use fossil fuels more rationally but also to seek alternative energy sources," says Patricia Aranguren, who has focused on thermoelectricity. Thermoelectrical generation is a technology with the capacity to produce electrical power from sources of waste heat, so it offers an opportunity for energy recovery in large industrial systems as well as in blocks of flats. Only 35 to 40 percent of energy is used for this purpose and the rest is released into the atmosphere in the form of waste heat.

"The capacity of thermoelectricity to convert waste heat into electrical power positions this technology within the intelligent use of energy because of the better use of fossil fuels," says Aranguren.

Thermoelectricity has been successfully applied across a range of sectors, such as the automotive sector and even in highly demanding fields such as space technology (for example, in the NASA rover Curiosity sent to Mars).

Simulations and experiments

While working on her thesis, Aranguren carried out computer simulations and experimented on real scenarios. "In both cases, highly

promising values were obtained for generating electricity by using waste gases," she said.

Specifically, she developed a computer model that simulates thermoelectric generation by predicting the behaviour of generators so that they can be optimised. Furthermore, the computer model was enriched with the variables obtained in experiments and through the tests conducted on various heat-exchange devices.

With this prior experience, Aranguren studied an electrical power generator in experimental conditions designed and built by the research group she belongs to, Thermal Engineering and Fluids, led by David Astrain-Ulibarrena, lecturer in the Department of Mechanical, Energy and Materials Engineering and the supervisor of the thesis. "The generator was fitted to the flue outlet of a boiler used to heat water. It comprises 48 thermoelectric modules, two heat exchange systems and other devices. The net optimum generation of electricity amounts to an output of 100 W/m2", says Aranguren.

After that, she chose a ceramic tile kiln to optimise the heat exchange systems. "Net maximum electrical power of 136.77 MWh/year was obtained and is the equivalent of the energy used every year by 40 homes; thermosyphons free of moving parts were used on the outside of the kiln flue, thus forming highly robust, quiet systems", said Aranguren. She used thermoelectric devices based on the Seebeck effect; the advantage of this is that they require a minimum of maintenance and have a long service life since no moving parts are used. What is more, they are suited to the recovery of low temperature waste heat (lower than 250º C) that makes up 70% of the heat that is wasted.

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