



Low-emission furnaces

Using waste heat to reduce emissions

Effective particle separators are needed to reduce harmful fine dust emissions from furnaces. Fraunhofer IPM offers a self-powered system that uses the waste heat from the plant.

Burning wood or biomass releases fine dust, carbon monoxide (CO), nitrogen oxides (NO_x) and organic pollutants (OGC), all of which are damaging to health. Particulate matter with a particle size of less than 1 µm is particularly hazardous. Innovative electrical exhaust gas treatment systems effectively reduce emissions from furnaces and keep them within legal limits.

Emissions from wood furnaces

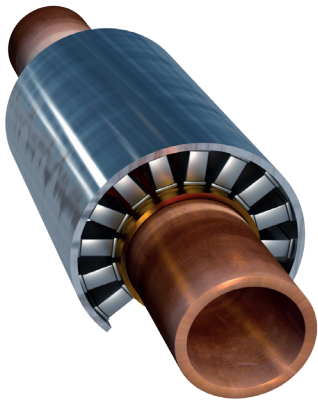
As local, carbon-neutral raw materials, wood and biomass play an important role in climate protection. However, burning biomass emits large quantities of fine dust, including particles of less than 1 µm in size, which are particularly damaging to health. That is why countries like Germany are imposing increasingly strict limits on how much particulate matter can be emitted. In addition to mass-related regulations on particulate matter emissions, CO, NO_x and OGC emissions are also regulated at European level by the European Ecodesign Regulations. As of 2024, some environmental certificates (e.g. the »Blue Angel«) will also require compliance with limits based on the number of particles – this is already standard for combustion engines today. Therefore, new technologies and effective methods of combustion control are needed to reduce fine dust emissions and optimize combustion at every stage of the process.

Innovative particle separation concepts

Separators that contain filters can cause pressure loss, become clogged with particles and require maintenance due to the need to periodically replace the filters. Fraunhofer IPM offers innovative concepts for particle separation based on electric separators. Electric separators do not contain any filters. Nevertheless, they still provide a very high level of separation efficiency – over 90 percent of the particle count – even for particles down to the nanometer range.

Our particle separator systems can be retrofitted into existing installations, or can be integrated into a new installation from the start. They are equipped with specially designed self-cleaning devices, which autonomously remove deposits of separated particles from the system.

99 %
of particulate
matter is
separated by
using our low-
energy plasma
technology.



Left: Tube-shaped thermoelectric generator

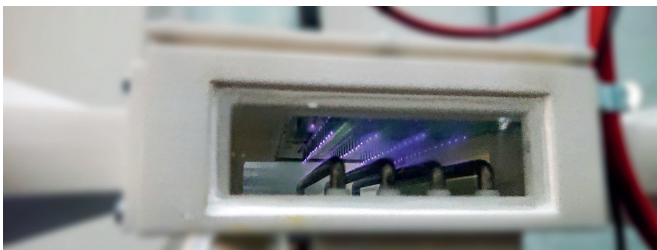
Right: Pellet stove (Palazzetti Ecofire Bianca) equipped with electrostatic separator

Integrated electrical power supply via thermoelectric generators

Thermoelectric generators (TEGs) use heat flows to generate their own electricity. They are durable and reliable and can be used even in very small spaces. Integrating a TEG into the flue gas train can generate enough electrical energy to operate a particle separator and a combustion control system. This means that the entire exhaust gas treatment system operates without the need to connect it to the grid.

Novel separation processes for superior separation efficiency

As standard, we use commercially available electrostatic separators as the core element of our separator solutions. By using low-energy plasma separators, we achieve an even higher fractional separation efficiency of over 99 percent, even for ultrafine particles of less than $0.1 \mu\text{m}$ in size. These separators provide higher power density and ion concentration in the separation zone than conventional separators because the system operates above breakdown voltage. Fraunhofer IPM designs plasma separators for various applications, including plasma separators that can be integrated into separation systems for biomass furnaces. Initial feasibility studies in a commercial pellet stove achieved separation efficiencies of over 99 percent.



Low-energy plasma separator in a flow channel

Our exhaust gas treatment services

Fraunhofer IPM has the expertise and the industrial manufacturing technology required to develop customized emission reduction solutions. We offer all of the following services, directly from us:

- Advice on designing exhaust gas treatment systems – both as a retrofit solution and as a solution integrated into new installations from the beginning
- Design and construction of the system
- Integration of a self-cleaning system to remove the separated particles
- Integration of thermoelectric generators to provide an off-grid power supply for the exhaust gas treatment system
- Development of low-energy plasma separators to achieve superior separation efficiencies
- Measurement of the system's fractional separation efficiency
- Acceptance of the complete system in cooperation with accredited testing bodies
- Referral of suppliers for separator components for series production

Contact

Dr. Olaf Schäfer-Welsen
Head of Department Thermal Energy Converters
Phone +49 761 8857-173
olaf.schaefer-welsen@ipm.fraunhofer.de

Fraunhofer Institute for Physical Measurement Techniques IPM
Georges-Köhler-Allee 301
79110 Freiburg, Germany
www.ipm.fraunhofer.de/en