

Department of Refrigeration and Heat Pump Technology

The activities in the fields of refrigeration and heat pumps are concentrated within TNO Environment, Energy and Process Innovation, Apeldoorn, and specifically within the Department of Refrigeration and Heat Pump Technology. The aim of this Department is to develop, implement and test:

- *systems for generating, distributing and using refrigeration;*
- *heat pumps for heating purposes and industrial processes.*

Areas of expertise

The Department of Refrigeration and Heat Pump Technology has acquired a strong position, both nationally and internationally, in the fields of refrigeration and heat pumps.

In many activities, our Department collaborates, on a project basis, with TNO experts in other fields including environmental technology, energy technology, fluid dynamics, industrial safety, food technology, materials science and product development.

Markets, products and services

The Department of Refrigeration and Heat Pump Technology supplies a large number of products and services to producers, suppliers and end-users of refrigeration equipment and heat pumps.

- **Research, development and commercialization of concepts, systems, processes, and components for heat pumps and for generating and applying refrigeration.**

Examples are: air cycle systems, new heat pump concepts, absorption systems, refrigerated display cabinets, ice slurry secondary refrigerants, air

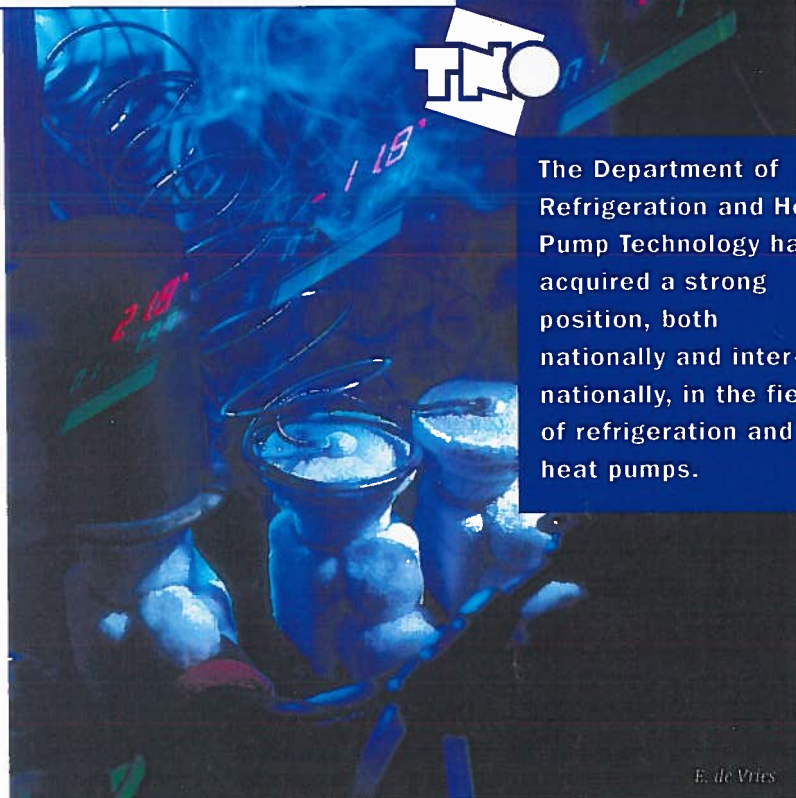
curtains, expansion valves, control systems, compressors, refrigerants.

- **Development, application and marketing of software.**

Examples are: simulation of thermal processes in food products (BERTIX, BAKTIX), simulation of (air) flow in refrigeration equipment and processes (CFD), heat pump databases, simulation of complex heat/cold/power systems and processes (CYCLE-TEMPO).

- **Testing, inspection and certification of heat pumps and refrigerating equipment.**

Examples are: display cabinets, means of refrigerated transport, heat pumps, air conditioning equipment, domestic refrigerators, components, refrigerants; inspection and examination of cooling units as to environmental and safety aspects ((H)(C)FCs, ammonia, hydrocarbons).



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- **Consultancy, policy support and program management in the fields of refrigeration and heat pumps, specifically aimed at process innovation, environment, energy and safety.**

Examples are: techno-economic feasibility studies, energy labeling, quantitative risk analyses (QRA), CFC policy and execution, refrigerant selection, energy-saving agreements.

Facilities

The Department has several databases at its disposal, as well as a whole repertoire of high-quality measurement equipment, several well-equipped laboratories, and various test facilities.

With the measurement equipment, we are able to make accurate determinations of:

- temperature;
- humidity and air velocity;
- sound and light intensities;
- flow rates;
- power;
- insulation coefficients;
- chemical compositions.

The most important facilities are:

- Six climatic rooms in which various climatological conditions can be set; the climatic rooms have various properties with respect to direction of flow (longitudinal flow or transverse flow), permissible floor load, light intensity and adjusting accuracies for stability of temperature and humidity. Some of them are targeted to testing of display cabinets according EN-441,

domestic refrigerators according EN-153, and refrigerated transport equipment according to ATP.

- An atmospheric boundary layer wind-tunnel (suitable for scale models from 1:100 to 1:5000) for research into wind load, wind nuisance, and flow patterns.
- A test facility for cooling systems, to determine thermodynamic and refrigerating properties of refrigerants and to investigate the performance of refrigerating components.
- An air cycle pilot plant using air as refrigerant.
- TNO-MEP Heat Pump Development and Test Centre for stationary and dynamic heat pump testing. The test facilities comprise heat distribution units, heat source units, data processing and control software for simultaneous dynamic simulation of various plant conditions (structure, building, and outdoor environment) for testing a variety of heat pump systems according to EN 255 or conditions specified by the client.
- A heat exchanger test rig (capacity 300 kW and fluid flows up to 20 m³/h) to investigate the thermal and hydraulic behaviour of heat exchangers, as well as pollutant minimization and support in materials selection and construction.
- A test facility for CO₂ refrigerating equipment.

Organization

Recognized both nationally and internationally, the TNO Environment, Energy and Process Innovation is a knowledge and

TNO Environment, Energy and Process Innovation is a recognised contract research institute for industry and government with expertise in sustainable development and environmentally and energy oriented process innovation.

TNO Environment, Energy and Process Innovation

Refrigeration and Heat Pump Technology

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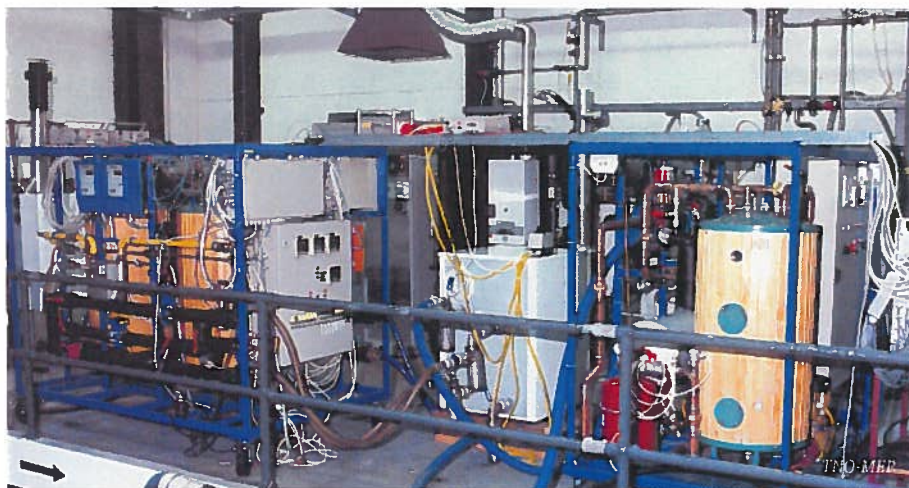
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contract research institute for the corporate sector and government in the fields of sustainable development and environment-targeted process innovation. The department of Refrigeration and Heat Pump Technology has a permanent staff of eighteen scientific employees.

There is a growing collaboration with foreign partners from, e.g., Germany, Great Britain, Ireland, Norway, Belgium, Denmark, Sweden, Canada and France.

We have concluded strategic collaboration agreement with the Forschungszentrum für Kältetechnik und Wärmepumpen (FKW) in Hannover (Germany). Because of this, our product and service supply has shown a considerable increase, specifically in the fields of refrigerants and compressors.

All activities are conducted on a project basis for the external market and for other TNO institutes and meet the standards set in the Model for Quality Assurance EN-ISO 9001.



Part of the TNO-MEP Heat Pump Development and Test Centre