Technology Offer

Innovative nozzle design with homogeneous flow profile usable as divergent long-range nozzle with high penetration depth

Background

Convergent nozzles are used in industry in a multitude of applications, for example as long-range nozzles for the drying of parts placed at large distances (car body painting, glass fabrication) as well as in the field of air-conditioning. The technical challenge of the long-range nozzle is to dry a distant object effectively, precisely and above all uniformly.

Problem

Convergent nozzles achieve the long range by accelerating the fluid to a high speed but require high pumping power. Using a conventional divergent nozzle it is possible to widen the area covered by the flow, however, it is not possible to improve the reach of the jet. This is due to the fact that the divergence induces a separation of the flow from the diffuser which leads to inhomogeneous flow and temperature distribution at the distant part.

Solution

This problem is overcome in the present invention by a central body which influences the flow profile already in the diffuser (Fig. 1). Thus it becomes possible to achieve equal range combined with a broader coverage at lower pumping power when compared with conventional convergent long-range nozzles.

A novel divergent nozzle design was developed at the Institute for Aerospace Thermodynamics at the University of Stuttgart which provides for a homogeneous flow profile even at long distances from the nozzle exit. The flow profile is optimized by a central body shaped and placed in the flow channel in such a manner as to achieve an uniform flow and temperature distribution at the target object. In this way, the flow behavior is signifycantly improved in the far field. Based on these characteristics, the invention is particularly suited to be used as a long range nozzle for large penetration distances in drying and ventilation applications.

It is possible to determine optimal design geometries for the nozzle and the central body to suit different applications through numerical optimization. A methodology (see Fig. 2) for a numerical design process was developed that allows the flow and temperature profiles to be adjusted optimally to the specific requirements.

TLB

Technologie-Lizenz-Büro
der Baden-Württembergischen
Hochschulen GmbH

Contact

Dr. Dirk Windisch
TLB GmbH
Ettlinger Straße 25
76137 Karlsruhe | Germany
Phone (49) 0721 / 79004-58
windisch@tlb.de | www.tlb.de

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Proof of concept / TRL3

Patent Situation

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Service

Technologie-Lizenz-Büro GmbH is responsible for the exploitation of this technology and assists companies in obtaining licences.

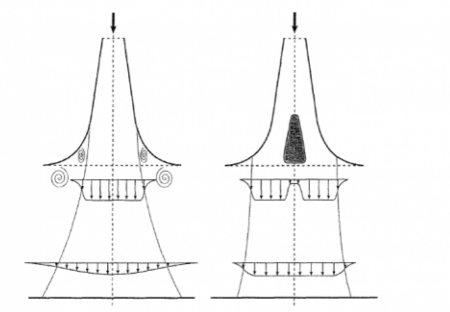
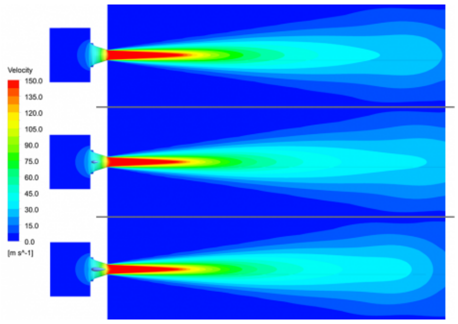


Illustration of the effect of a central body in the nozzle outlet (right) compared with a conventional nozzle. (Source: Institute for Aerospace Thermodynamics, University of Stuttgart)



Simulation examples for different central bodies - reference (top), small central body (middle) and large central body (bottom) [Pictures: Tplus Engineering GmbH].

Advantages

- Homogeneous flow profile in the far field
- Homogeneous temperature profile in the far field
- No flow separation from the nozzle cone
- Increased penetration range
- Reduced pressure loss of fluid
- Uniform drying of target
- Elimination of thermal stresses
- Reduced pumping power
- Reduced drying time
- The numerical optimization of the geometry, including the central body to achieve an optimal flow profile

Application

Divergent nozzle for automotive industry, process engineering, heating, ventilation and air conditioning (HVAC), drying, tempering and cooling.