Numerical Study on Supersonic Flow in the Second Throat Ejector-Diffuser System
이차목 이젝터/디퓨저 시스템을 통하는 초음속 유동에 관한 수치해석적 연구

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The ejector is a device which employs a high-velocity primary motive fluid to entrain and accelerate a slower moving secondary suction fluid. The resulting kinetic energy of the mixture is subsequently used for self-compression to a higher pressure, thus performing the function of a compressor. The outstanding advantages of the ejectors are simplicity and reliability. However the industrial use of ejectors has been confined mainly to very particular cases of operation. The experimental results obtained so far were insufficient to be made use of general cases. Large-sized modern ejectors, mainly driven by high powered air-compressors and designed for very wide ranges of operating conditions, cannot be based on the earlier research results, if we wish to be sure of the final outcome.

For this reason, systematic experimental and theoretical researches have been resumed in many countries on the ejectors with high pressure ratios, in which the primary gas flow is supersonic. The tangential shear action and the turbulent mixing of air jets are one of the most difficult problem of gas dynamics. No correct solution has yet been given for this problem, not thus being able to predict the performance of the ejector operations.

Methods of computational fluid dynamics(CFD) may give help to fully describe the supersonic ejector flow field. They not only model the gross pattern of the flow field, but also details of the complex flow features which experiments cannot readily disclose. None of the investigations to date have produced a clear description of the supersonic ejector flow field.

In the current work, the numerical calculation using mass-averaged explicit Navier-Stokes equations was applied to two-dimensional compressible flow field. A mesh generation code was employed to produce unstructured and structured meshes. The governing equations were discretized in space using a finite volume difference formulation. Adiabatic no-slip conditions were assumed at solid wall boundaries, while the non-reflecting far-field boundary was constructed using the Riemann invariants. The standard k-e turbulence model was employed to close the governing equations. Numerical calculation was carried out for some operation conditions of the supersonic ejector with the design Mach numbers of 1.5 and 5.0 at the primary nozzle exit. The calculated results were used to describe the characteristics of the supersonic ejector with a second throat, as seen in the accompanying figure.