

Contents

1. Introduction	1
2. Basic Principles of the Separation Nozzle Method	5
3. Characteristic Parameters of the Separation Element and Specific Expenditure .	8
4. Analysis of Separation Processes in the Separation Nozzle.....	14
4.1 Equilibrium Separation.....	14
4.1.1 Distribution of Molecular Species in a Steady-State Cylindrical Flow.....	14
4.1.2 Bifractional Splitting.....	17
4.2 Uranium Isotope Separation in the Auxiliary Gas.....	21
4.2.1 Ternary Diffusion Processes.....	22
4.2.2 Isotope Separation in Highly Dilute UF_6	25
4.2.3 Influence on Diffusion Processes of the Knudsen Number and the Speed Ratio.....	28
4.2.4 Influence on Isotope Separation of the Spatial Structure of the Flow Field.....	30
4.2.5 Experimental Verification of the Transient Enhancement in Iso- tope Separation.....	31
5. Analysis of Flow Processes in the Separation Nozzle	34
5.1 General Characteristics and Flow Parameters.....	34
5.2 Calculating the Flow Field for Uniform Gases.....	36
5.3 Experimental Studies of the Separation Nozzle Flow.....	38
5.3.1 Methods of Measurement.....	38
5.3.2 Flow Field and Spatial Development of Separation.....	43
5.3.3 Non-Equilibrium Effects.....	50
5.4 Entropy Generation in the Separation Nozzle Flow.....	55

6. Influence of the Operating Conditions on Isotope Separation and Specific Expenditure	60
6.1 Inlet Pressure and Expansion Ratio.....	61
6.2 Stagnation of the Heavy Fraction.....	66
6.3 UF_6 Cut.....	71
6.4 UF_6 Molar Fraction.....	73
6.5 Operating Temperature.....	76
6.6 Type of Light Auxiliary Gas.....	80
7. Measuring Technique and Experimental Strategy Applied in Optimizing Separation Nozzle Systems	86
8. Separation Nozzle Designs.....	91
8.1 Systems with Single Mechanical Flow Deflection.....	92
8.1.1 Criteria for Optimizing Nozzle Geometries.....	93
8.1.2 Influence of the Nozzle Geometry upon the Separation Characteristics and the Specific Expenditure.....	96
8.2 Systems with Double Mechanical Flow Deflection.....	98
8.2.1 Design and Mode of Operation.....	98
8.2.2 Influence of Operating Conditions on Isotope Separation.....	100
8.2.3 Separative Work Output, Specific Process Parameters and Number of Separation Stages.....	104
8.3 Systems with Dynamic Flow Deflection.....	107
8.3.1 Basic Principles and Designs of Separation Systems.....	107
8.3.2 Interaction of Opposed Jets at Medium Knudsen Numbers.....	109
8.3.3 Acceleration of Disparate Mass Mixtures in Convergent Nozzles..	113
8.3.4 Flow Stability of Opposed Jets.....	116
8.3.5 Separation of Uranium Isotopes in an Opposed Jet Separation Nozzle.....	119
8.3.6 Separation of Uranium Isotopes in an Annular Separation Nozzle.	122
9. Conclusions.....	125
References	129
Subject Index.....	135