

Contents

| | |
|--|-----------|
| Foreword | III |
| CHAPTER 1 | |
| <u>Study on Elastic-Plastic Mechanical Stresses in Cylindrical Pressure Vessels</u> | <u>1</u> |
| 1.1 Introduction | 1 |
| 1.2 Studies of Elastic Stresses | 2 |
| 1.3 Analysis of Elastic-Plastic Stresses | 7 |
| 1.4 Chapter Summary | 17 |
| References | 20 |
| CHAPTER 2 | |
| <u>Mechanical Autofrettage Technology Based on Tresca Yield Criterion</u> | <u>21</u> |
| 2.1 General Study on Mechanical Autofrettage Technology | 21 |
| 2.1.1 In General Forms | 22 |
| 2.1.2 The Critical Radius Ratio | 33 |
| 2.1.3 The Optimum Plastic Depth k_j^* (k_j is Written as k_j^*) | 34 |
| 2.1.4 The Results When $k_j = k_j^*$ | 35 |
| 2.2 Mechanical Autofrettage Technology Under Entire Yield State | 41 |
| 2.3 Mechanical Autofrettage Technology with Radius of Elastic-Plastic Juncture Being Arithmetic Mean Radius of Inside Radius and Outside Radius | 46 |
| 2.4 Mechanical Autofrettage Technology with Radius of Elastic-Plastic Juncture Being Geometrical Mean Radius of Inside Radius and Outside Radius | 52 |
| 2.5 Mechanical Autofrettage Technology with Minimum Equivalent Total Stress on Elastic-Plastic Juncture | 56 |
| 2.6 Comparison Between Three Cases | 70 |
| 2.7 Chapter Summary | 77 |
| References | 81 |
| CHAPTER 3 | |
| <u>Mechanical Autofrettage Technology Based on Mises Yield Criterion</u> | <u>83</u> |
| 3.1 General Study on Mechanical Autofrettage Technology | 83 |
| 3.1.1 In General Forms | 83 |

| | | |
|-------|---|-----|
| 3.1.2 | The Critical Radius Ratio | 98 |
| 3.1.3 | The Optimum Plastic Depth k_{j^*} (k_j is Written as k_{j^*}) | 99 |
| 3.1.4 | The Results When $k_j = k_{j^*}$ or $k^2 \ln k_{j^*}^2 - k^2 - k_{j^*}^2 + 2 = 0$ | 100 |
| 3.2 | Mechanical Autofrettage Technology Under Entire Yield State | 109 |
| 3.2.1 | The Residual Stresses | 109 |
| 3.2.2 | The Total Stresses | 111 |
| 3.3 | Mechanical Autofrettage Technology with Radius of Elastic-Plastic Juncture Being Arithmetic Mean Radius of Inside Radius and Outside Radius | 117 |
| 3.4 | The Solutions with Radius of Elastic-Plastic Juncture Being Geometrical Mean Radius of Inside Radius and Outside Radius | 127 |
| 3.5 | The Solutions with Minimum Equivalent Total Stress on Elastic-Plastic Juncture | 133 |
| 3.6 | Comparison Between the Three Cases | 146 |
| 3.6.1 | $k = 2.5 > k_c$ | 147 |
| 3.6.2 | $k = 2 < k_c$ | 150 |
| 3.7 | Chapter Summary | 153 |
| | References | 157 |

CHAPTER 4

| | | |
|-------|---|-----|
| | Mechanical Autofrettage Technology by Limiting Circumferential Residual Stress Based on Mises Yield Criterion | 159 |
| 4.1 | The Optimum Plastic Depth When Circumferential Residual Stress on the Inside Surface Controlled | 159 |
| 4.2 | The Distribution of Residual Stresses When Circumferential Residual Stress on the Inside Surface Controlled | 166 |
| 4.2.1 | General Discussion | 166 |
| 4.2.2 | The Residual Stresses for Entire Yield | 176 |
| 4.2.3 | The Residual Stresses with Radius of Elastic-Plastic Juncture Being Arithmetic Mean Radius of Inside Radius and Outside Radius | 177 |
| 4.2.4 | The Residual Stresses with Radius of Elastic-Plastic Juncture Being Geometrical Mean Radius of Inside Radius and Outside Radius | 179 |
| 4.2.5 | The Residual Stresses When Equivalent Total Stress on Elastic-Plastic Juncture is the Minimum | 180 |
| 4.3 | The Total Stresses and the Load-Bearing Capacity When Circumferential Residual Stress on the Inside Surface Controlled | 186 |
| 4.4 | Control Circumferential Total Stress Directly | 196 |
| 4.5 | Chapter Summary | 198 |
| | References | 202 |

| | |
|---|-----|
| CHAPTER 5 | |
| Mechanical Autofrettage Technology Under Low Load | 203 |
| <hr/> | |
| 5.1 Introduction | 203 |
| 5.2 The Optimum Plastic Depth | 204 |
| 5.3 Analysis of Residual Stresses Under the Optimum Plastic Depth | 208 |
| 5.4 Analysis of the Stresses Caused by Internal Pressure and Total Stresses | 219 |
| 5.5 Analysis of the Effect of Load Ratio (λ) and Plastic Depth (k_{λ}) | 228 |
| 5.6 Analysis of Load-Bearing Capacity | 234 |
| 5.6.1 Based on Tresca Criterion | 234 |
| 5.6.2 Based on Mises Criterion | 237 |
| 5.7 Chapter Summary | 240 |
| References | 244 |
| | |
| CHAPTER 6 | |
| Summary of Implement Methods and Their Characteristics of Mechanical and Thermal Autofrettage Technology | 245 |
| <hr/> | |
| 6.1 Implement Methods and Characteristics of Mechanical Autofrettage Technology | 245 |
| 6.2 Implement Methods and Characteristics of Thermal Autofrettage Technology | 248 |
| References | 255 |
| | |
| CHAPTER 7 | |
| Thermal Autofrettage Technology Based on Tresca Yield Criterion | 257 |
| <hr/> | |
| 7.1 Introduction | 257 |
| 7.2 Derivation of Thermal Stresses | 258 |
| 7.3 The Characteristics of the Thermal Stresses | 265 |
| 7.4 The Analysis of Total Stresses and Investigation of Optimum Operation Conditions | 273 |
| 7.5 Examples | 284 |
| 7.6 The Total Stresses Under Optimum Operation Conditions | 296 |
| 7.7 Chapter Summary | 302 |
| References | 306 |
| | |
| CHAPTER 8 | |
| Thermal Autofrettage Technology Based on Mises Yield Criterion | 307 |
| <hr/> | |
| 8.1 The Analysis of Thermal Stresses | 307 |
| 8.2 The Analysis of Total Stresses and Investigation of Optimum Operation Conditions | 309 |
| 8.3 Examples | 331 |
| 8.4 Chapter Summary | 345 |
| References | 348 |
| | |
| Nomenclature | 349 |