

1. Record Nr.	UNINA9910806195203321
Autore	Niu Steve S
Titolo	Process Control for Pumps and Compressors
Pubbl/distr/stampa	Cham : , : Springer International Publishing AG, , 2024 ©2023
ISBN	3-031-43122-7
Edizione	[1st ed.]
Descrizione fisica	1 online resource (292 pages)
Collana	Advances in Industrial Control Series
Disciplina	621.69
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Nota di contenuto	Intro -- Series Editor's Foreword -- Foreword -- Preface -- Contents -- Symbols and Abbreviations -- Symbols -- Constants -- Functions -- Subscripts -- Fonts -- Abbreviations -- List of Figures -- List of Tables -- 1 Introduction to Pumps and Compressors -- 1.1 Type of Pumps and Compressors -- 1.1.1 Rotating Equipment -- 1.1.2 Pumps and Compressors -- 1.1.3 Centrifugal and Reciprocating Machines -- 1.1.4 Fans and Blowers -- 1.2 Applications of Pumps and Compressors -- 1.2.1 Liquid Pumping -- 1.2.2 Gas Compression -- 1.3 Operation and Control of Pumps and Compressors -- 1.3.1 Operating Requirements and Control Objectives -- 1.3.2 Overall Control Strategy -- 1.3.3 Process Control Technologies -- 1.3.4 Monitoring and Safeguarding -- 1.4 Practical Considerations -- 1.4.1 Process-Centric Versus Equipment-Centric Solutions -- 1.4.2 In-House Versus Third-Party Solutions -- 1.5 Summary -- References -- 2 Characteristics of Pumps and Compressors -- 2.1 Basic Properties of Fluids -- 2.1.1 Basic Principles of Fluid Dynamics -- 2.1.2 Basic Principles of Thermodynamics -- 2.1.3 Gas Compression Process -- 2.1.4 Liquid Transport Process -- 2.2 Description of Pumps and Compressors -- 2.2.1 Three Variables: Speed, Head, and Flow -- 2.2.2 Two Curves: Performance and Resistance Curves -- 2.2.3 One Point: Operating Point -- 2.2.4 † Other Variables and Curves -- 2.3 Behaviors of Dynamic Machines -- 2.3.1 Relationship Among Head, Flow, and Speed -- 2.3.2 † Suction and Discharge Relationship -- 2.3.3 ‡ Euler's Equation and Slope of Performance Curve -- 2.3.4 ‡ System Resistance and Slope of

Resistance Curve -- 2.4 Surge and Choke Phenomena -- 2.4.1 Surge and Choke Points -- 2.4.2 Surge Line and Choke Line -- 2.5 Summary -- References -- 3 Operating Requirements and Control Objectives -- 3.1 Operating Objectives and Requirements -- 3.2 Maintaining the Operating Point. 3.2.1 Operating with Single Control Handle -- 3.2.2 Operation with Multiple Control Handles -- 3.2.3 $\uparrow$ Capacity Turndown -- 3.3 Protecting the Operating Envelope -- 3.3.1 Operation Under Abnormal Operating Conditions -- 3.3.2 $\pm$ Flow in System Resistance Components -- 3.4 Transitioning Between Operating Modes -- 3.4.1 Startup of Centrifugal Machines -- 3.4.2 Shutdown of Centrifugal Machines -- 3.4.3 $\uparrow$ Crippled Operation -- 3.5 Summary -- References -- 4 Overall Control Strategy -- 4.1 Overall Control Strategy -- 4.1.1 General Control Philosophy -- 4.1.2 Overall Control Objectives -- 4.1.3 Layered and Integrated Design -- 4.1.4 Migration from Proprietary to Open-Platform Solutions -- 4.2 Regulatory Control: Capacity Control -- 4.2.1 Capacity Control Objectives -- 4.2.2 Process Dynamics and Cause-and-Effect Relationships -- 4.2.3 Process Measurements and Controlled Variables -- 4.2.4 Final Control Elements and Manipulated Variables -- 4.2.5 Capacity Control Algorithms -- 4.3 Protective Control: Anti-surge Control -- 4.3.1 Protective Control Objectives -- 4.3.2 Process Dynamics for Operating Envelope -- 4.3.3 Measurements and Controlled Variables -- 4.3.4 Recycle Valve and Manipulated Variables -- 4.3.5 Protective Control Algorithms -- 4.4 Control Integration and Optimization -- 4.4.1 Sequential Control: Mode Transition -- 4.4.2 Instrumented Safeguarding Against Failures -- 4.4.3 Online Performance Monitoring -- 4.4.4 $\uparrow$ Integration of Capacity and Anti-surge Control -- 4.4.5 $\pm$ Load Balancing and Optimization -- 4.5 Summary -- References -- 5 Invariant Coordinates and Surge Indicators -- 5.1 Inlet Conditions and Invariant Coordinate Systems -- 5.1.1 API Datasheet for Compressor -- 5.1.2 $\uparrow$ Impact of Inlet Conditions -- 5.1.3 Invariant Coordinate -- 5.2 Equivalent Coordinates -- 5.2.1 $\uparrow$ Alternative Variables for Polytropic Head. 5.2.2 $\uparrow$ Alternative Variables for Volumetric Flow -- 5.2.3 $\uparrow$ Equivalent Coordinate Systems -- 5.3 Surge Reference Line and Surge Indicators -- 5.3.1 Surge Reference Line -- 5.3.2 Surge Indicators -- 5.4 Calculation of Anti-surge Parameters -- 5.5 Summary -- References -- 6 Basic Control Schemes -- 6.1 Centrifugal Pumps -- 6.1.1 Capacity Control -- 6.1.2 Minimum and Maximum Flow Control -- 6.1.3 A Complete Control Design -- 6.2 Centrifugal Compressors -- 6.2.1 Capacity Control -- 6.2.2 Anti-surge Control -- 6.2.3 Anti-surge Parameter Calculation -- 6.2.4 $\uparrow$ Flowmeter Design -- 6.2.5 Instrumented Safeguarding -- 6.2.6 A Complete Control Design -- 6.3 Reciprocating Pumps and Compressors -- 6.3.1 Capacity Control for Reciprocating Machines -- 6.3.2 Protective Control for Reciprocating Machines -- 6.4 Practical Considerations -- 6.4.1 Speed of Response -- 6.4.2 $\uparrow$ Sensitivity Analysis -- 6.5 Summary -- References -- 7 Advanced Control Solutions -- 7.1 Integration Between Capacity and Anti-surge Control -- 7.1.1 Capacity Control Revisited -- 7.1.2 An Unintegrated Design -- 7.1.3 Integrated Design of Capacity and Anti-surge Control -- 7.1.4 $\uparrow$ Integrated Design with Feedforward Compensation -- 7.2 Load-Balancing Control -- 7.2.1 $\uparrow$ Load Balancing Among Compressor Trains -- 7.2.2 $\pm$ Load Balancing Among Stages -- 7.3 A Fully Integrated Control Design -- 7.3.1 A Complete Solution for Compressor Control -- 7.3.2 $\uparrow$ Integration Between Control and Safeguarding -- 7.3.3 A Real-World Example -- 7.4 Multi-machine Optimization -- 7.4.1 $\uparrow$ Pumps and Compressors in Parallel -- 7.4.2 $\uparrow$ Pumps and Compressors in Series -- 7.5 Implementation

Considerations -- 7.5.1 Naming Convention -- 7.5.2 Manual Versus Automatic Operation -- 7.5.3 † Controller Configurations -- 7.6 Summary -- References -- 8 Commissioning, Startup, and Monitoring -- 8.1 Application Life Cycle. 8.2 Commissioning -- 8.2.1 Factory Acceptance Test (FAT) -- 8.2.2 Site-Acceptance Test (SAT) -- 8.3 Plant Startup -- 8.3.1 Incipient Surge Test -- 8.3.2 Pre-startup -- 8.3.3 During Startup -- 8.3.4 Post-startup -- 8.4 Performance Monitoring -- 8.4.1 Performance Indicators -- 8.4.2 Performance Visualization -- 8.5 Troubleshooting and Problem-Solving -- 8.5.1 † Surge Detection -- 8.5.2 † Troubleshooting of Surge Control Scheme -- 8.6 Summary -- References -- Appendix A Performance Analysis and Control Design with Software Tool -- A.1 Introduction -- A.1.1 Data Requirements -- A.1.2 The Work Process -- A.1.3 The CPACS Software Tool -- A.2 Data Preparation and Management -- A.2.1 Data Format -- A.2.2 Source of Design Data -- A.2.3 Engineering Units -- A.3 Data Visualization and Validation -- A.3.1 Automatic Error Detection -- A.3.2 Visual Inspection -- A.4 Surge Parameter Calculation -- A.4.1 Anti-surge Parameters Calculation -- A.4.2 Data Selection -- A.4.3 ASP Formula -- A.4.4 Real-Time Data -- A.5 Summary -- References -- Appendix Glossary -- Index.
