Professional Development Courses from SigmaTech

NATIONAL AERONAUTICAL & SPACE ADMISISTRATION (NASA)
MARSHAL SPACE FLIGHT CENTER (MSFC), HUNTSVILLE, AL
October 16-18, 2006

1. COURSE TITLE

Valves & Actuators: Design Principles & Applications

2. COURSE DESCRIPTION

Valves and their actuators have been called the "work horses" or "muscles" of any fluid control system. And, with the rapid changes occurring in the process industries, there is a constant need for the design, development, and testing of new and better valves. Defining a need, identifying a new application, designing new valves, improving valve design, replacing old designs, and offering less expensive options are all part of the valve designer's environment.

A methodology of valve design is presented with an in-depth look at the design of various valve codes and standards, valve components, actuators selection and their valve interface, materials of construction, as well as the latest machining practices & manufacturing processes. A close look at prototyping, industry standards, and testing requirements is also included. The instructors use multiple examples of various valve types to present a systematic design methodology, which the valve designer will find very useful for designing any type of valve.

3. COURSE TOPICS

- Overview of Industrial Valve types & Actuators
- Pressure Temperature Ratings, Flow Coefficients, Cv
- Valve Leakage Rates
- Defining a need
- Establishing basic parameters
- Review of Industry Standards
- Materials of Construction
- Design of Valve Body
- Valve Seat and Closure
- Valve Trim
- Flow Calculations
- Valve sizing and selection of optimum valve type
- Actuator Selection
- Valve Actuator Interface
- Coatings and Platings
- Valve Assembly and Testing
- Developing Prototype
- Developing Catalog Information
- Machining Practices and Manufacturing Processes

You will learn to apply these techniques to design, prototype, test, and manufacture valves for your application at the optimum cost. Discussing actual problems from your job experience is encouraged.

4. SPECIAL FEATURES AND BENEFITS

Participants will receive comprehensive notes based on the course presentation.

5. WHO SHOULD ATTEND?

This course was developed for engineers and other individuals involved with the design, specification, and maintenance of industrial valves & actuators. Valve specialists and those with some valve experience will come away with valuable information from this course. Participants should have some technical background and job related experience. Please bring calculators to the class.

6. COURSE OUTLINE

DAY 1 AM: Module Description

- Course Introduction
    - A. Course Overview
        1. Course objectives
        2. Use of course materials
        3. Organization and sequence
    - B. Introduction of Course Participants

- Prelude to the Control Valve Design
    - A. Defining Valve Needs/Applications
        1. Satisfying a new application
        2. Improving existing valve performance
        3. Cost reduction of existing valve
    - B. Establishing basic design parameters (Phase 1)

    1. Line medium
    2. Pressure-temperature of medium
    3. Type of valve-rising stem, rotary, etc.
    4. End connections
    5. Valve sizes
    6. Mode of valve operation
    7. Cost
    8. Write Phase 1.
  C. Investigation of competitive Designs
    1. Investigating similar valves on market
    2. Conducting patent search
      a. Where to find the information
      b. Things to watch out for
    3. Defining applicable industry & regulatory codes
  D. Writing Project Description
    1. Involvement of applicable company departments
    2. Seeking top management's commitment
    3. To go ahead or not?
    4. Writing Phase 2
    5. Establishing schedules and milestones
      a. Design time
      b. Prototype manufacture
      c. Prototype testing
      d. Production release
      e. Follow-up

- Review of applicable valve industry standards/codes
  A. ANSI B16.5
  B. ANSI B16.34
  C. MSS Standards
  D. API Standards
  E. NACE Standards

- Nuclear and Military Requirements
  A. Military specs and standards
  B. ASME standards and code cases

- The Design of Valves
  A. Where to start?
    1. Establish a conceptual design
    2. Filing patent of proposed innovation
    3. Understanding three basic valve elements:
      a. Body
      b. Trim and seat
    4. Interdependency of one element on another
  B. Establish priorities among elements
  C. Criterion for materials selection
    1. Corrosion
    2. Strength
    3. Wear, galling
    4. Ambient, high, low temperature service
    5. Materials for seat
    6. Materials for gaskets and stem packing
    7. Materials for bolting
    8. Radiation tolerance for nuclear applications

- Material Selection
    - A. Material selection for corrosion
    - B. Material selection for strength
    - C. Material selection for high temperature
    - D. Material selection for low temperature
    - E. Material selection for radiation/nuclear
    - F. Material selection for weldability
    - G. Material selection for NACE requirements

- Types of On-Off and Control Valves: Gate, Globe, Ball, Plug, Butterfly, and Diaphragm valves
- Types of valve Actuators
  - Manual, pneumatic, hydraulic, and electrical operated actuators
- Valve design and selection philosophy
  - Applicable standards, specifications and codes
    - Milspecs and Industry standards
    - End connections, Pressure classes, Pressure-Temperature ratings
    - Valve leak rate classifications
- Materials of Construction
  - Body, trim, seat, fasteners, packing, O-rings, gaskets etc.
  - Corrosion, galvanic corrosion, strength, erosion, wear, galling, and fracture considerations
  - Materials for high and low temperature services
  - Coatings, Hard surface, and plating. Materials for special services

DAY 1 PM: Module Description

- Quarter-turn valves: Butterfly, Ball, and Plug valves

I. Review of Quarter-Turn Valves
  - A. Butterfly valves
  - B. Ball valves
  - C. Plug valves

I. Review of Rising Stem Valves
  - A. Globe valves
  - B. Gate valves

II. Diaphragm Valves

III. High Temperature Services

IV. Design of Butterfly Valves
  - A. Valve Body
    1. Discussion of ASME B16.34 Standard
    2. Flanged construction, Lug/Wafer: ANSI, API, MSS, MILSPEC
    3. Flange surface finish
    4. Casting, Forging or Flame cut plate
    5. Establish body bore and seat diameters
    6. Calculate disc/pipe clearance
    7. Establishing minimum wall thickness
  - B. Valve Trim
    1. Calculate valve operating torque
    2. Establishing stem diameter
    3. Establish stuffing box dimensions
        - a. Chevron packing
        - b. Braided TFE packing
        - c. Laminated graphite

d. Live loaded packing design
4. Sizing packing gland bolting/thread engagement
5. Valve disc design
6. Stem-to-disc connection
7. O-ring sealing/gasket sealing

C. Valve seat
1. Establish through seat leakage
2. Criteria for soft seat design
3. Criteria for metal seat design
4. Fire-safe seat

D. Valve-actuator interface
1. Manual or automatic
2. Sizing mounting bolts based on ISO design
3. Mounting bracket design
4. Manual lever or actuator hand-wheel design

DAY 2 AM: Module Description

-------- Continuation of Butterfly Valves -------

E. Dry Link Butterfly Valve
1. Valve Operation
2. Sealing mechanisms

V. Design of Ball Valves

A. Valve body
1. Side entry, top entry, three piece design
2. End-to-end dimension
3. End connections
4. Bonnet and bolting design

B. Valve trim
1. Standard, full, or reduced port
2. Trim grounding

DAY 2 PM: Module Description

I. Rising Stem Valves (Globe Valve)

A. Valve body design
1. Establishing body bore
2. Establishing end-to-end dimensions
3. Establishing end connections
4. Minimum wall thickness

B. Valve trim design
1. Establishing disc lift
2. Flow over disc
3. Flow under disc
4. Stem diameter selection
5. Valve seat design
6. Compression spring calculations

C. Valve Diaphragm design (Diaphragm Valve)
1. Elastomer and reinforcement
2. Diaphragm strength and style

D. Manual over-ride design

II. Selection of Valve Operator (Actuator)

A. Hydrodynamic torque

    B. Lifting and closing forces
    C. Handwheel/lever design
    D. Electric operators
    E. Pneumatic operators
    F. Manual gear operators

III. Establishing C_v (Flow Coefficient) of Valve
    A. Experimental
    B. Estimating via interpolation

IV. Coatings and Platings
    A. Coatings on valve body
        1. Corrosion resistant coatings
        2. Abrasion resistant coatings
    B. Coatings on stem and disc
        1. Hard and soft chrome
        2. Electro-less Nickel Plating (ENP)
        3. Nickel-Boron
        4. Dry film lubrication
    C. Coatings on Fasteners
        1. Lock-tite
        2. Never-seize

V. Bill of Materials
    A. Format
    B. Things to include

VI. Drawing Notes
    A. General
    B. Marking, name plate information

VII. Valve Assembly and Testing
    A. Sequence of assembly
    B. Shell Test
        1. Hydrostatic
        2. Air under water
    C. Seat test
        1. Visual
        2. Pressure decay
    D. Torque test

VIII. Developing Prototype Procurement and Testing
    A. Which sizes to test
    B. First article testing
    C. Vendor selection
    D. Incorporating precious lessons

IX. Special Consideration for Unusual Applications
    A. Chlorine
    B. Steam
    C. Boiler blow down valves
    D. Oxygen
    E. Vacuum

X. Machining Practices and Manufacturing Processes
    A. Weldability of materials
    B. Heat treatment
    C. Brazing: furnace, stick
    D. Casting versus forging versus plate
    E. Sand versus allowances and their cost impact
    F. Surface finishes
    G. Domestic versus overseas production

XIV. Case Histories

A. Patent infringement: success and failure stories
B. Unsafe valve design: stem ejection
C. Reverse engineering

DAY 3 AM: Module Description

- Hydraulic Theory
  - Flow of fluids through pipes; liquids, steam and gases
  - Definition of C_v flow coefficient

- Criteria for Valve selection
  - Cavitation, Flashing, and Choked flow
  - Effect of pipe reducers and expanders on flow
  - Valve Flow characteristics
  - Sizing valves for optimum performance

- Introduction to Electric Actuators
  - Forces required by valve
  - Valve Design – its impact on actuator selection
  - Valve to Actuator Stem Connections
  - Actuator Gear Design
  - Quarter-Turn Electric Actuators, DOD-V-24657

DAY 3 PM: Module Description

- Electric Actuators - Continued
  - Multi-Turn Electric Actuators
  - Actuator Motor Design
  - Controls Options (Open/Close)
  - Controls Options (Modulating)
  - Smart Actuators
  - Fire Safety Issues

- Pneumatic & Hydraulic Actuators

7. COURSE INSTRUCTORS

Mr. Vinod Bhasin, *President of SigmaTech, a consulting engineering company, and President of Dry Link, Inc., a manufacturer of dry-disconnect couplings, has over 32 years of professional experience in the design, application, and manufacturing of piping, valves, and actuators for several companies including Hills McCanna Company, Rockwell International, and Westinghouse Electric Corporation. He served as Chief Engineer at Hills McCanna Company and Rockwell International. He is an alumnus of Illinois Institute of Technology (IIT), Chicago, Illinois. A registered PE, he holds BSME, MSME, and MSIE degrees. He has published numerous papers in Chemical Engineering, Chemical Processing, Chemical Processing International (UK), and the Journal of Naval Engineering related to piping, valves, and actuators. Mr. Bhasin has taught professional development courses on valves and actuators for the Instrument Society of America (ISA), and Navy's Life Cycle managers. He has also taught undergraduate courses in Solid Mechanics, and Machine Design at IIT. Mr. Bhasin is a member of ASME B16 committee and is currently chairing several valve and actuator technical committees on ships and marine technology under ASTM F25.*

Mr. James 'Ron' Whitmore, *has over 25 years of professional experience in the design, application, and manufacturing of valves and actuators for several companies including EIM Controls, RuLynn, Keystone Controls and Biffi, Inc. He has a B.S. Degree in Maritime Engineering from Texas A&M University. Mr. Whitmore's expertise is in the field of electric actuators. He has taught valve and actuator classes worldwide from basic applications for Valve distributors to advanced courses for Valve and Engineering Companies, and Navy and private shipyard personnel.*