



Hydraulic System Design for Service Assurance

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The fluid power technology can never be considered fully mature until methods are available that, when used, will assure system reliability and longevity. Computerized methods have been introduced for achieving optimum system performance, but techniques for assuring component and system reliability and longevity are fragmented, even primitive or basically nonexistent. This book advances practical methods that will enable hydraulic systems to avoid common failures and prolong their useful service life.

1. Introduction

Service Reliability Perspective • An Approach to the Failure Dilemma • The General Contents • Why Computerize Service Assurance Aspects • Computerized Service Assurance Examples

2. Hydraulic Fluids

Status of Hydraulic Fluids • Composition of Hydraulic Fluids • Stability of Hydraulic Fluids • Physical Properties of Fluids • Viscosity • Bulk Modulus • Vapor Pressure (Volatility) and Aeration • Aeration and Foam • Specific Gravity/Density • Surface Tension • Hygroscopicity • Obliteration Stability • Flammability Characteristics • Chemical Properties of Fluids • Oxidation Stability • Thermal Stability • Hydrolytic Stability • Material Compatibility • Anti-Rust and Corrosion Stability • Antiwear Stability • Antiwear Assessment • Hydraulic Fluid Selection

3. Contamination Control and Filtration

Contamination Control Overview • Scope of Contamination • Particulate Contaminants • Water Contaminant • Contaminant Analysis • Cleanliness Level Descriptions • Wear Debris Analysis • Contaminant Ingression Control • Contamination Level Reference State • Component Contaminant Sensitivity • Fluid Filtration Mechanics • Filtration Structural Integrity • Particle Capture Assessment • Particle Capture Assessment • Filtration Models • Interpreting Filter Performance • Filter Performance Irregularities • Filter Location Options • Omega Rating Rationale

4. Hydraulic Reservoir and Fluid Conditioners

Scope of Fluid Conditioning • Reservoir Function and Design • The Conventional or JIC Hydraulic Reservoir • The Bootstrap Reservoir System • The Mobile Reservoir • The Critical Volume Reservoir (CVR) • CVR Design Considerations • Selecting and Assessing Hydraulic Reservoirs • Suction Line Hydraulics • Pump Filling Characteristics • Reservoir Pump Outlet Port Pressure • Pump Supercharging Options • Dehydration System • Deaeration or Degassing System

5. Heat in Hydraulic Systems

Heat Control • Heat Generation • Modes of Heat Transfer • The Overall Heat Transfer Coefficient • Thermal Steady State Analysis • Thermal Transient Analysis • Sizing of Heat Exchangers • Air Coolers • Pre-Heating Hydraulic Fluid

6. Leakage in Hydraulic Systems

Leakage • Leakage Causality • Effects of Leakage • Leakage Classification • External Leakage Assessment • Internal Leakage Assessment • Leakage Sources • Leakage Sources • External Leakage Sites • Static Seal Leakage Sites • Dynamic Seal Leakage Sites • Internal Leakage Sites • Leakage Summary

7. Tribological Wear

Scope of Tribological Wear • Abrasion Wear • Adhesion Wear • Surface Fatigue Wear • Delamination Wear • Fretting Wear • Erosion Wear • Cavitation Wear • Corrosion Wear • Hydrogen-induced Wear • Electrokinetic Wear • Radiation Wear

8. Motion Impediment

Overview of Motion Failures • Mechanical Lock • Mechanical Overload • Surface Lubrication • Thermal Lock • Thermal Shock • Hydraulic Lock • Adhesive Lock • Contaminant Lock • Static or Bridgement Jam • Shear or Coincidence Jam • Dynamic Jam or Silt Lock Seizure • Obliterant Choke • Viscous Lock • Flow Lock • Magnetic Lock • Bernoulli Spring Force • Port/Orifice Obstruction • Interstitial Closure By Obliteration

9. Structural Deficiencies and Design Mechanics

Introduction • Material Strength Considerations • Mechanical Static Loads • Material Fracture Loads • Stress Concentrations • Mechanical Dynamic Loads • Synergistic Effects of Loading Conditions • Material Damage Modes • Material Failure Factors • Failure of Basic Component Elements • Failure of System Interconnecting Elements

10. Condition Monitoring of Hydraulic Systems

Onset and Progression of Failure • Role of Condition Monitoring • Features of Condition Monitoring Systems • The Diagnostic System • Measurement Methods • Internal State Diagnostics • System Prognosis • Prescriptive Action • Weak Points of Systems • Fuzzy Logic Approach to Condition Monitoring

11. Hydraulic System Reliability

Reliability Concepts • Characterizing Reliability • Reliability Functions • Product Life Curve • Distribution Functions • The Mortality Model • Weibull Plot and Failure Analysis • Plotting on Weibull Probability Paper • Non-linear Weibull Plot • Reliability Quantification • Reliability Predictions • System Reliability Models • Component Hazard Data • A Deterministic Reliability Approach • Maintaining System Reliability • Designing for Reliability • Specific Reliability Design Factors

12. System Design Methodology

System Design Process • System Analysis Process • The Complete Design Process Steps • System Design Details • Virtual Laboratory Design Analysis