## Contents

12 Rotodynamic centrifugal slurry pumps

12.1 Introduction

12.1.1 Scope

12.1.2 Purpose

12.1.3 Pump types and nomenclature

12.1.4 Definition of slurry

12.1.5 Definition of slurry pumps

12.1.6 Overhung impeller

12.1.7 Frame mounted

12.1.8 Cantilevered wet pit

12.1.9 Submersible

12.1.10 Lined type

12.1.11 Unlined type

12.1.12 Construction drawings

12.1.13 Part names

12.1.14 Letter dimensional designations

12.2 Definitions

12.2.1 Rate of flow (Q)

12.2.2 Speed (n)

12.2.3 Head (h) - general term

12.2.4 Condition points

12.2.5 Suction conditions

12.2.6 Power

12.2.7 Pump pressures

12.2.8 Mechanical seal terms

12.2.9 Slurry terminology

12.3 Design and application

12.3.1 Scope

12.3.2 Slurry services

12.3.3 Froth pumping

12.3.4 Wear in centrifugal slurry pumps

12.3.5 Hydraulic design and application considerations

12.3.6 Slurry system design

12.3.7 Wetted materials of construction

12.3.8 General arrangement details

12.3.9 Drive train arrangements

12.4 Installation, operation, and maintenance

12.4.1 Installation

12.4.2 Nozzle loads

12.4.3 Connecting piping

12.4.4 Commissioning

12.4.5 Start-up

12.4.6 Storage of elastomer linings

12.4.7 Impeller removal

12.4.8 Axial adjustment of the bearing housing

12.4.9 Piping system design

12.4.10 Possible operating problems

12.4.11 Spare parts stock

12.4.12 Maintenance procedures for maximum part life

12.4.13 Operational considerations
12.5 Intentionally left blank ................................................. 96
12.6 Testing ........................................................................ 96
  12.6.1 Scope .................................................................... 96
  12.6.2 Test conditions .......................................................... 97
  12.6.3 Manufacturer's testing ............................................. 97
  12.6.4 Field tests ................................................................ 97
  12.6.5 Wear tests ................................................................. 97
  12.6.6 Instrumentation. ........................................................ 98

Appendix A Equipment data sheets (informative) ......................... 99
Appendix B Nozzle loads tables (informative) .............................. 104
Appendix C Materials data (informative) ................................. 106
Appendix D Source material and references (informative) ............ 109
Appendix E Index (informative) ............................................... 113

Figures
  12.1.3 – Rotodynamic centrifugal slurry pump types .................... 2
  12.1.5 – Typical material types and discharge pressure for particle size ............................................................................. 3
  12.1.13a – Overhung impeller, separately coupled, single stage, frame mounted, metal-lined pump (OH0) .................................................. 5
  12.1.13b – Overhung impeller, separately coupled, single stage, frame mounted, elastomer-lined pump (OH0) .............................. 6
  12.1.13c – Overhung impeller, separately coupled, single stage, frame mounted, elastomer-lined pump, adjustable side-liners (OH0) .................................................................................. 7
  12.1.13d – Overhung impeller, separately coupled, single stage, frame mounted, end suction, vulcanized-elastomer-lined pump (OH0) .................................................. 8
  12.1.13e – Overhung impeller, separately coupled, single stage, frame mounted, end suction, metal, unlined casing pump (OH0) .................................................. 9
  12.1.13f – Overhung impeller, separately coupled, single stage, frame mounted, side inlet, metal, unlined casing pump (OH0) ......... 10
  12.1.13g – Overhung impeller, separately coupled, single stage, frame mounted, end suction, metal, tie bolt plate construction pump (OH0) .................................................. 11
  12.1.13h – Overhung, open impeller, separately coupled, single stage, foot mounted, metal, ASME B73.1 type pump (OH1) ........................................... 12
  12.1.13i – Overhung impeller, separately coupled, single stage, wet pit cantilever, elastomer-lined, single suction pump (VS5) ............ 13
  12.1.13j – Overhung impeller, separately coupled, single stage, wet pit cantilever, elastomer, vulcanized-lined, double suction pump (VS5) ........................................... 14
  12.1.13k – Overhung impeller, separately coupled, single stage, wet pit cantilever, unlined, metal, single suction pump (VS5) ............ 15
  12.1.13l – Overhung impeller, close coupled, single stage, submersible, elastomer-coated, single suction pump (OH8B) ............... 16
  12.1.13m – Overhung impeller, close coupled, single stage, submersible, elastomer-lined, single suction pump (OH8B) ............... 17
12.1.13n – Overhung impeller, close coupled, single stage, submersible, elastomer-lined, double suction pump (OH8B) ................................................................. 18
12.1.13o – Overhung impeller, close coupled, single stage, end suction, metal, submersible pump with agitator (OH8B) ............................................................... 19
12.1.13p – Overhung impeller, close coupled, single stage, submersible, metal, double suction pump (OH8B) ................................................................. 20
12.1.14a – Horizontal pump dimensions ................................................................. 28
12.1.14b – Direct drive pump and motor assembly dimensions ................................... 29
12.1.14c – Vertical pump dimensions ..................................................................... 30
12.2.3.4 – Datum elevations for various slurry pump designs ...................................... 34
12.3.2.1 – Solids transport rate .............................................................................. 46
12.3.2.2 – Nomograph for the relationship of concentration to specific gravity in aqueous slurries ................................................................. 47
12.3.2.3 – Schematic classification of slurries in industrial pipeline applications ......................................................................................................................... 48
12.3.2.4 – Nomograph for maximum velocity at limit of stationary deposition of solids. ......................................................................................................................... 49
12.3.2.5 – Effect of settling slurry on pump characteristics (schematic) ................................................................. 51
12.3.2.7 – Effect of average particle size and impeller diameter on $H_r$ and $R_h$ (For solids concentration by volume, $C_v = 15\%$ with solids $S_s = 2.65$ and a negligible amount of fine particles. Impeller diameters are given in millimeters and inches.) ................................................................. 52
12.3.3.2 – Application of empirical froth factor ........................................................ 56
12.3.3.3 – Approximate correlation between empirical froth factor (FF) and experimental froth volume factor (FVF) for froth pumps with increased inlet size ......................................................................................................................... 57
12.3.4.1a – Sliding wear coefficient $W_c$ for different resisting materials in a neutral pH media for different average-sized, silica based, abrading particles ......................................................................................................................... 59
12.3.4.1b – Erosion response for different impingement angles and materials ......................................................................................................................... 60
12.3.4.2a – Service class chart for slurry pump erosive wear ....................................... 62
12.3.4.2b – Miller number versus material abrasivity .................................................. 62
12.3.6 – Typical constant concentration slurry pipeline friction loss characteristics ......................................................................................................................... 65
12.3.8.2a – Typical lip seal and its components .......................................................... 69
12.3.8.2b – Typical labyrinth seal ............................................................................ 70
12.3.8.2c – Generic bearing isolator and its major components ..................................... 70
12.3.8.3.1a – “Flush-type” stuffing box with lantern ring in standard position .............. 72
12.3.8.3.1b – “Weep-type” stuffing box with lantern ring ................................................ 72
12.3.8.3.1c – Flow through flush .............................................................................. 73
12.3.8.3.6 – Centrifugal (dynamic) seal with “dry-type” packing ..................................... 75
12.3.8.3.7 – Multiple elements lip seal with internal flush ............................................ 76
12.3.8.3.8a – Flow rates required to create 4.6 m/s (15 ft/s) velocity past a bushing ........ 78
12.3.8.3.8b – Slurry pump shaft alignment and runout .................................................. 79
12.3.8.3.8c – Dual back-to-back pressurized seal arrangement for high pressure slurry applications ......................................................................................................................... 80
12.3.8.3.8d – Typical face-to-back dual pressurized seal arrangement for slurry applications ......................................................................................................................... 80