GIW® Minerals

GIW Industries Hydraulic Lab

Full-Scale Test Facility

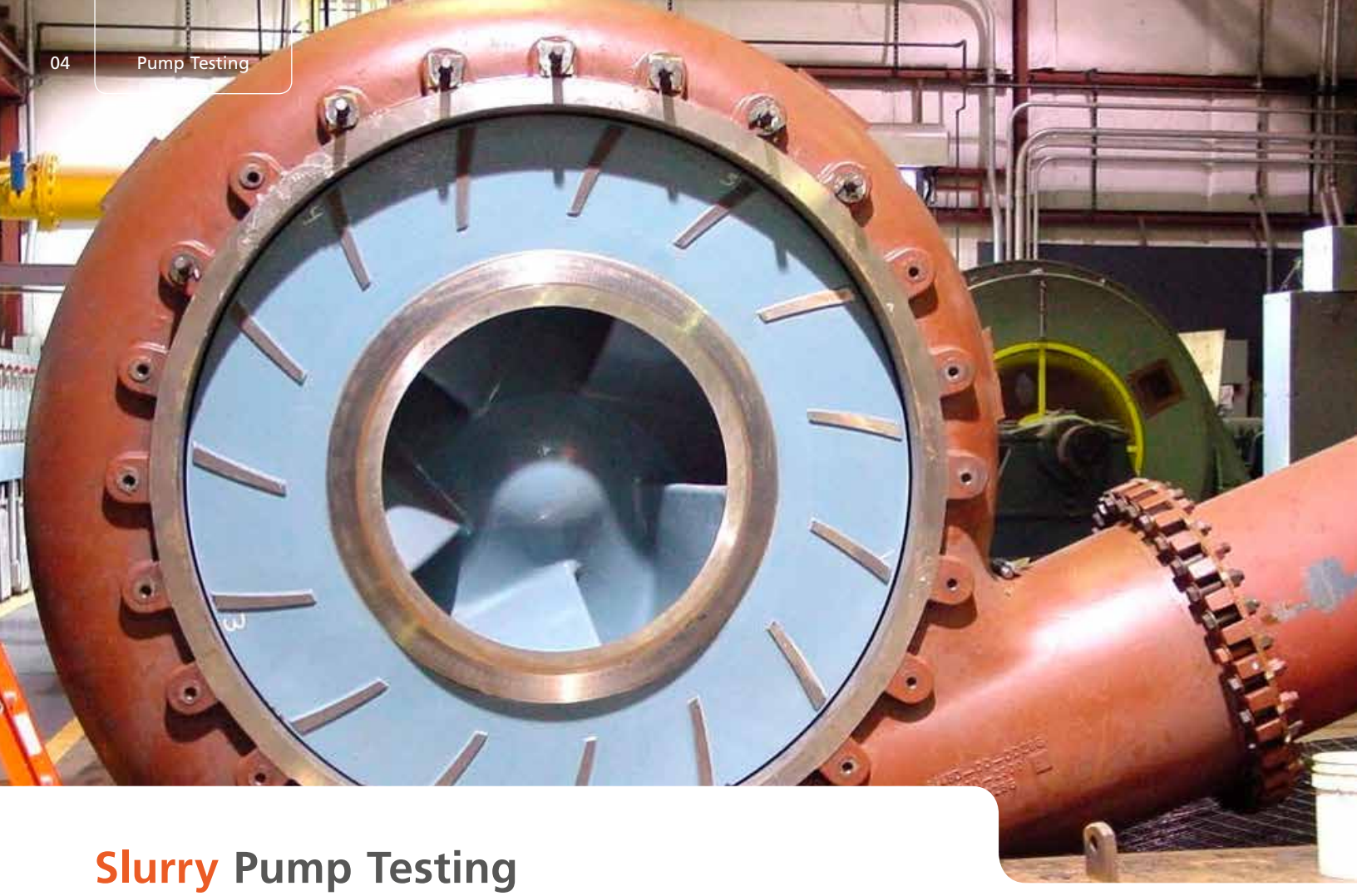
Hydraulic Lab Overview

GIW Industries, Inc. is the recognized leader in design, manufacturing, and application of heavy duty centrifugal slurry pumps. GIW's rich history in pump and pipeline testing began in 1956 with a facility focused on analyzing customer pumping problems and recommending solutions.

The Hydraulic lab in 1956.

The Hydraulic lab today.

Today, the GIW Hydraulic Lab performs pipeline tests on a wide variety of pumps and slurries. GIW is able to test every centrifugal slurry pump it manufactures, with impeller diameters up to 2800 mm (110 inch) in pipelines up to 1200 mm (48 inch). The Lab also has the capability to test slurries in a range of pipe sizes, measuring pump and pipeline solids effect, slurry rheology, solids bed formation, wear, and other important system design parameters.



Slurry Pump Testing

GIW Industries Inc. manufactures a wide range of severe duty slurry pumps which are employed throughout the world in the industrial minerals, hard rock mining, dredging, coal, aggregate, precious metals, and power industries. To bring pump products to market, GIW performs full-scale water performance testing of new designs. The resulting data is available in our SLYSEL pump selection and pipeline analysis software for sizing, system design and troubleshooting.

Some slurry pump users prefer the extra confidence which comes from witnessed performance testing of the actual pumps being purchased. GIW offers a variety of pump testing services for measuring and validating hydraulic and mechanical performance.

Types of Testing

- Pump Flow, Head and Efficiency
- NPSH Required
- Vibration and Sound Levels
- Mechanical Run
- Full Equipment String Test
- Pump Solids Effect on Slurries
- On-site or Remote Witnessing

Contract Slurry Testing

The GIW Hydraulic Lab contains a number of piping systems which can be custom configured for slurry tests. These range from 75 to 500 mm (3 to 20 inch) in diameter. Tests are carried out to determine pipeline friction gradients, slurry rheology, deposition velocities, pipeline wear, the effect of inclined, vertical and open channel flow, pipeline startup and shutdown, and other operational characteristics.

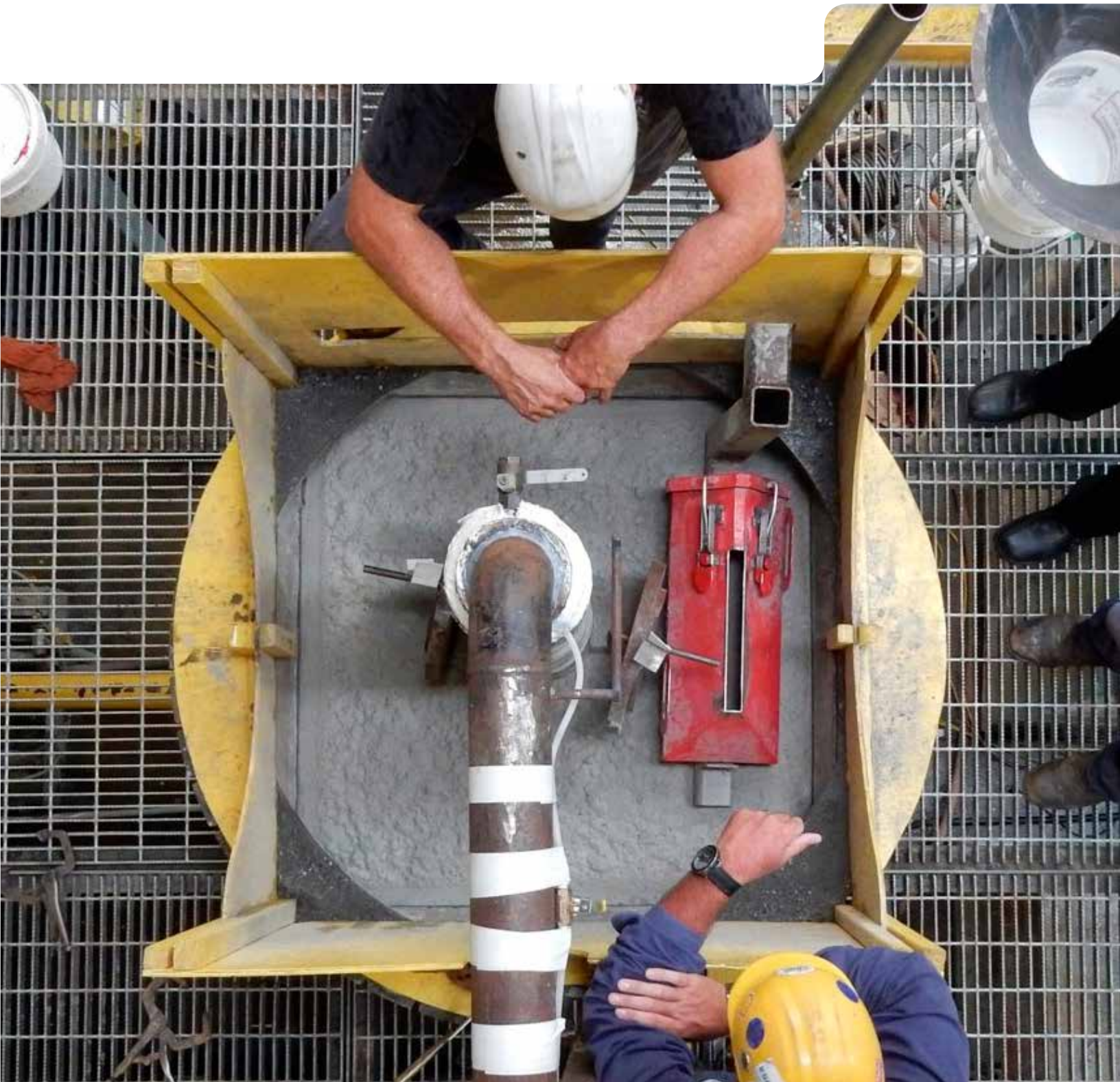
Specialty tests are designed to quantify or validate the performance of slurry handling equipment, such as distributors, cyclones, piping manifolds, liners and instrumentation. GIW Hydraulic Lab Engineers pride themselves on their ability to solve the most challenging slurry testing requirements and routinely deliver the highest quality data and analysis to satisfied customers.

Types of Testing

- Pipeline Friction
- Solids Deposition
- Slurry Rheology
- Particle Size Distribution
- Inclined and Vertical Flow
- Pipeline Wear Testing
- Flow Visualization
- Instrumentation Tests
- Equipment Validation

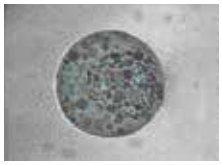
Slurries Pumped

- SAG & Ball Mill Discharge
- Flotation Tailings
- Slurry Froth
- Thickened Tailings
- Metal Concentrates
- Various Clays
- Shell and Gravel
- Coarse rock
- Mineral Sands
- Phosphate Matrix
- Taconite Pellets
- Oil Sand and Bitumen
- Alumina Red Mud
- Coal Products
- Fly Ash and Slag
- Fracking Proppant
- Salt in Brine



Materials Testing

The successful selection and application of various wear resistant materials requires a thorough understanding of erosive and corrosive wear. This ranges from qualitative comparisons, to detailed examinations of the interactions between materials and abrasive solids on a microscopic level. In the development of its own products, GIW conducts extensive materials testing. From cutting edge development on new materials, to the evaluation of parts returned from the field, our Materials Engineers explore all aspects of materials science related to slurry applications. As a service to our customers, GIW makes some of this test equipment and expertise available on a contract basis, with the most commonly requested tests noted on the facing page.



Coriolis Erosive Wear Testing

The best and most representative wear test on materials dealing with flowing slurries such as in slurry pumps and pipelines. This type of erosion testing is only available at a limited number of facilities in the world, and the GIW testing unit is perhaps the largest in scale and most sophisticated in design, performing both sliding and impact erosive wear tests. The major hydraulic and testing parameters are measured and monitored by a computerized system. The test system allows relatively flexible selection on solids particle size and flow rate/velocity.

Miller Wear Testing

ASTM G75-07 is used to determine the slurry abrasivity (Miller Number) and slurry abrasion response of materials (SAR Number). By using standard slurry and/or reference specimen, the relative material wear resistance and slurry abrasivity can be ranked. Based on Miller and SAR numbers, the best available materials can be determined, and the service life of wear components may be predicted.

Dry Sand Rubber Wheel Test

ASTM G65-04 (2010) is designed to rank the abrasion resistance of metallic materials exposed to dry scratching abrasion. A specimen is mounted vertically into the holder, providing a static load perpendicular to a rotating 9" rubber rimmed wheel. A nozzle feeds AFS 50/70 silica sand at a constant rate through a calibrated orifice between the specimen face and the rubber rimed wheel. After a certain number of wheel rotations a mass loss can be determined and converted to volume loss.

ASTM G105-02(2007) and ASTM B611-8(2005) Wet Abrasion Tests

These tests can be conducted by using different testing setups converted from an ASTM G65 machine with components such as slurry containment chamber and a smaller wheel. ASTM G105 wet sand rubber wheel test is used to rank metallic materials exposed to wet scratching abrasion. Three separate 7" rubber rimmed wheels (50, 60, & 70 Shore A) are used to produce mass loss values from the same sample to more accurately determine the mass and volume loss at 60 Shore A.

ASTM B611

This particular method is used to test the wet abrasive wear resistance of cemented carbide, tungsten carbide overlays or other hard particle reinforced metal matrix composite materials under high stress abrasive conditions. In this case a 6.65" steel wheel and a 30-mesh aluminum oxide grit slurry mixture are used. After a number of wheel revolutions the specimen mass loss is measured and the results reported as Abrasion Resistance (volume loss per revolution) or Wear Number value (relative density over mass loss).

The Taber Abraser or Rotary Platform Dual Head Test

A flat specimen is mounted to a vertical axis fixed speed rotating turntable. Two parallel free rotating Taber abrasive wheels with specified mass loads are lowered vertically onto the specimen surface (such as elastomers). As the turntable rotates, the abrasive wheels are driven in circular but opposite directions across the wear specimen. The number of cycles (or rotation of the turntable) and the Taber Abrader wheel type is dependent on the material being tested. This method employs a highly versatile test machine that is capable of providing wear resistance ranking between a wide variety of materials and covered by several ASTM test methods.

Training

GIW offers some excellent training courses for slurry system designers and slurry pump operators. These teach proven methods to maximize the performance and efficiency of your pumps and systems. Both courses offer a balance of classroom instruction coupled with hands on demonstrations in the GIW Hydraulic Lab.

Maintenance and Operation of Centrifugal Slurry Pumps

Reab Berry , 51-year GIW veteran, conducts a hands-on demonstration of the effects of water hammer.

Maintenance and Operation of Centrifugal Slurry Pumps offers a unique opportunity to gain insight into slurry pump maintenance and operation. Relevant classroom sessions combined with practical hands-on demonstrations allow participants to immediately apply what they are learning. Time will be spent each day on trouble-shooting and cost saving techniques as well as an emphasis on safety.

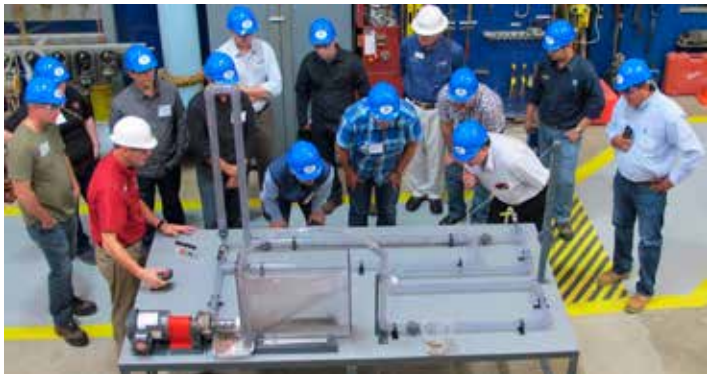
Hands-on sessions including wet end and mechanical maintenance will utilize full size pumps. Pipeline operational demonstrations are also included.

This course is intended for front line supervisors, team leads, reliability engineers, and personnel who are directly involved in the maintenance or operation of slurry pumping systems.

Topics include:

- Pipeline Friction
- Solids Deposition
- Slurry Rheology
- Particle Size Distribution
- Inclined and Vertical Flow
- Pipeline Wear Testing
- Flow Visualization
- Instrumentation Tests
- Equipment Validation

Transportation of Solids Using Centrifugal Pumps



Lab demonstrations include a miniature, see-thru slurry system and full sized pipeline tests of settling and non-settling slurries.

The theoretical and practical aspects of slurry transport, from design to operations, are covered by an international staff of experts. The format includes classroom lectures, problem solving sessions, demonstrations of slurry flow, and actual slurry tests in the GIW Hydraulic Lab. The week culminates in an extended "Total System Design" workshop, where participants practice the skills they have learned.

Course participants receive a printed copy of all presentations, a workbook with practice problems and solutions, and a copy of the supporting textbook "Slurry Transport Using Centrifugal Pumps" by Wilson, Addie, Sellgren and Clift.

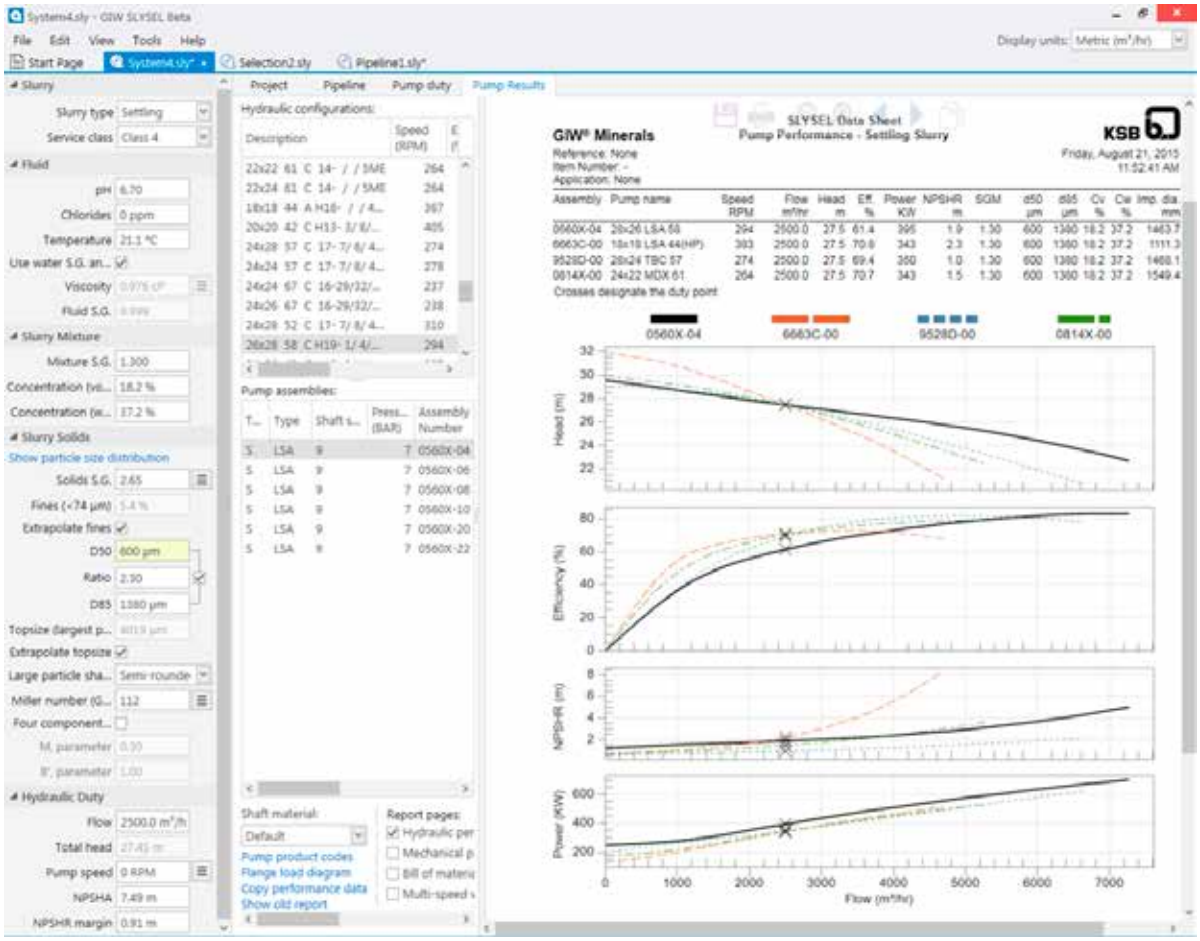
Optional activities include a tour of the GIW manufacturing facility and an evening receptions where participants can see slurry pumps first hand, test drive GIW's SLYSEL software for pump & pipeline calculations, and meet with the teaching staff in an informal setting.

The course is intended for university-educated engineers specializing in slurry system design and slurry pump application. Three continuing education units are awarded upon completion by our co-sponsor, Augusta University.

Other features include:

- Settling Slurries
- Non-Settling Slurries
- Pipeline Friction and Solids Deposition
- Pump Performance and Wear
- Pump – System Interactions
- Total Cost of Ownership

SLYSEL



The SLYSEL pump selection and pipeline analysis software has been developed in-house by GIW Engineers. Under continuous improvement for over 30 years, this program contains many of the most useful models for settling and non-settling slurry pipeline flow. It also contains pump performance data for many GIW pumps and has built-in guidelines for slurry pump selection based on more than 50 years of experience.

Capabilities and features include:

- GIW Four Component model for settling slurry pipe friction.
- Power law, Bingham plastic and Herschel Buckley models for non-settling slurries.
- Modelling tools for estimating particle size distribution.
- Pump selection tools, hydraulic and mechanical.
- Pump solids effect and wear analysis.
- Modelling of pump - system interactions.
- Pipeline modelling with multiple pumps.
- Data browser with integrated multi-speed pump curve viewer.
- Comprehensive plotting of pump and pipeline results.
- Intuitive and interactive user interface.

SLYSEL

Client List

1st Energy Generation Corporation
Agrico Chemical Co.
Alabama Power/ Southern Co.
ALCAN Inc.
ALCOA Inc.
Allen-Sherman-Hoff
ALPART (Jamaica)
Amax Chemical Corp.
Anglo American Clays Corp.
Argyle Diamonds
Army Corps. of Engineers
Ash Pump
Babcock & Wilcox
Ballast Nedam
Batu Hijau/ Fluor Daniel
Bechtel
Becker Minerals
BHP Minerals, Canada, Ltd.
Bougainville Copper
Bromwell Engineering
Canadian Natural Resources (CNRL)
Cargill Fertilizer, Inc.
Cleveland-Cliffs, Inc.
Cofeminas
Colt Engineering Corporation
Columbia Nitrogen Corp.
Contractors
Conversion Systems, Inc.
Crescent Technologies
Cyprus Bagdad
Dead Sea Works
DeCloedt Dredge
DEME
Diamonite Ceramics
DNR
Dredgemasters
Dredging International
DuPont
ECC International
Ellicott Machine Corp.
Ernest Henry Mine
Estech
Exxon Engineering
Fajardo/ Gauff Engr./ MARNR
Falconbridge, Ltd.
Florida Inst. of Phosphate Research
Fording Coal, Ltd.
Fort Hills
Freeport Indonesia
Geveke
Glencore
Great Lakes Dredge & Dock
Hagler Systems/ Manson Dredging
Ham Dredge Company
Hatch Associates Ltd.
Hibbing Tachonite
Hibernia Ballasting
Holnam Company
IHC
Iluka
IMC
INCO Ltd.
Indianapolis Power & Light Company
Intl. Minerals & Chem Corp.
J.M. Huber
Jersey Miniere Zinc
Jugotehna
Kaiser Aluminum
Kennecott
Kilborn SNC Lavolin/ INCO, Ltd.
Kinross
Krupp-Fordertechnik/ Hyundai Heavy Ind.
Krupp-Vosta/ Ballast Nedam Dredging
Krupp-Vosta/ Ham Dredging, Marine
KSB, Inc.
Leslie Salt Company
LKAB Sweden
Lockheed
Los Pelambres
MaAden
Massey Coal Services, Inc.
MET-CHEM Canada, Inc.
Mobile Pulley
Muskeg River Contractors
National Aluminum Co. (NALCO)
National Pump and Process
Naylor Pipe Company
NC Phosphate Corp.
Newmont Gold Company
Northgate Explor./ Kemess
NRC
NY State Electric & Gas
PCS Phosphate
Peabody Coal
Phelps Dodge Morenci
Phillips Driscopipe
Piping Spec. & FMC WY
Placer Dome, Inc.
PSI Gibson/ Babcock & Wilcox
Raytheon
Reserve Mining Company
Rhone-Poulenc Company
Riefill Corporation
Shell Development
Southern Company Services, Inc.
Suncor Energy, Inc.
Svedala Ind./ Homer City FGD Unit
Svedala Industries/ TEAS
Syncrude Canada Ltd.
Tarmac-Pensuco
Tennessee Valley Authority
Terra-Mar Consulting Engineers
Texasgulf
Thiele Kaolin Co.
U.S. Agri-Chemicals Corporation
U.S. Steel
Ultramar, Inc.
URS Greiner Woodward Clyde
Victaulic Company
Vosta LMG
Warren Pumps LLC
Waste Mgmt & Research Ctr Ilinois
Weeks Marine, Inc.
Wheelabrator/ City of Henderson
Worley-Parsons
Xtek Corporation
Zanen Verstoep

Published Work

Members of the GIW Hydraulic Lab and Engineering Department actively contribute to furthering the "state of the art" in slurry pump and system design through regular publications in conferences and technical journals. A few papers of special interest are listed below.

"Comprehensive Loop Testing of a Broadly Graded (4-component) Slurry". R. Visintainer, J. Furlan, G. McCall, A. Sellgren, and V. Matoušek. 20th International Conference on Hydrotransport. Melbourne, Australia, 2017.

"Experimental and Numerical Investigations of the Fluid Flow in a Hydrocyclone with an Air Core". R. Ke, C. Shingote, J. Kadambi, J. Furlan, and R. Visintainer. SME Conference. Denver, Colorado, 2017.

"Centrifugal Pump Performance When Handing Highly Non-Newtonian Clays and Tailings Slurries." J. Furlan, R. Visintainer, and A. Sellgren. Canadian Journal of Chemical Engineering 94, 2016.

"The Impact Wear Behavior of Large Rocks on Slurry Pump Materials and Equipment". R. Visintainer and D. Wolfe. Proceedings of the WEDA Dredging Summit and Expo. Houston, TX, 2015.

"Ultrasonic Measurements of Local Particle Velocity and Concentration Within the Casing of a Centrifugal Pump". J. Furlan, M. Garman, J. Kadambi, R. Visintainer, and K. Pagalthivarthi. ASME-JSME-KSME Joint Fluids Engr. Conference. Seoul, Korea, 2015.

"Finite Element Prediction of Multi-Size Particulate Flow Through Three-Dimensional Pump Casing". K. Pagalthivarthi, J. Furlan, and R. Visintainer. ASME-JSME-KSME Joint Fluids Engineering Conference. Seoul, Korea, 2015.

"Effect of Particle Size Distribution on Erosion Wear in Centrifugal Pump Casings". K. Pagalthivarthi, J. Furlan, and R. Visintainer, 13th International Liquid-Solids Flows Symposium. Lake Tahoe, Nevada, 2013.

"Development and Testing of a More Effective Froth Handling Pump". R. Visintainer, and L. Whitlock, 44th Annual Canadian Mineral Processors Operators Conference. Ottawa, Ontario, 2012.

"Simplified Approach to Effect of Concentration on Deposition Limit". K. Wilson, G. Addie, A. Sellgren, and R. Visintainer. 15th Intl. Conf. on Transport and Sedimentation of Solids Particles. Wroclaw, Poland, 2011.

"Erosion–Corrosion Performance of High-Cr Cast Iron alloys in Flowing Liquid–Solid Slurries". H. Tian, G. Addie, and R. Visintainer. Wear 267(11): 2039-2047, 2009.

"Prediction of Slurry Pump Component Wear and Cost". A. Sellgren, G. Addie, R. Visintainer and K. Pagalthivarthi. WEDA XXV – TAMU 37. New Orleans, LA, 2005.

"Determination of Wear Coefficients for Erosive Wear Prediction through Coriolis Wear Testing". H. Tian, G. Addie, and K. Pagalthivarthi. Wear 259(1-6): 160-170, 2005.

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