



Z ChemGear™ Chemical Mixing-Feeding Systems

Zeroday Enterprises, LLC &
Mainland Machinery Ltd
In Partnership

Zeroday Enterprises Background



- Zeroday Enterprises, LLC (www.ZerodayLLC.com)
 - Wilsonville, Oregon (Portland, OR area) headquarters
 - Founded 2001
- President, Bill Hancock:
 - Metallurgist, process engineer
 - 42 years mining process operating and research
 - International technical consultant, primarily flotation and solids-liquid separation
 - 13 years chemical technical sales/on-site process optimization service
 - Cytec (flocculants, flotation reagents)
 - Great Western Chemical (complete range of specialty and commodity chemical sales)
- Many years chemical applications experience, intimate knowledge what works and what does not work well
- Selling chemical mix-feed systems for > 13 years
- Design, fabrication our Z ChemGear™ packages since 2011



- Over his career Bill Hancock has worked for a range of companies including iron ore and uranium operations to technical chemical and equipment sales companies.
- Bill Hancock registered Zeroday March 2001 and is sole owner.
- Originally focused on mineral process and water treatment consulting
- Began selling primarily flocculants and coagulants, have sold commodities but not a focus, in the Pacific Northwestern USA and Alaska
- In mid 2000's began adding equipment and services to product line to support chemical sales: diaphragm pumps, peristaltic pumps, relabeled flocculant equipment from other manufactures
- Due to disappointment with quality and operational inconsistencies, Bill began designing and building his own systems focused on 'robust, highly consistent chemical systems that are built to last.
- Developed a strategy to be a "one stop shop" for chemical mixing and feeding systems.

Mainland Machinery Background

- Mainland Machinery Ltd (www.MainlandMachinery.com)
 - Abbotsford, BC Canada headquarters
 - Family-owned business established 1971
 - Consulting & Engineering / Custom Metal Fabrication / Field Services & Installation
- Focuses on heavy industrial equipment & bulk material handling systems
- Provides innovative designs for mining, energy, ports & terminals and industrial agriculture industries.
- 80-120 employees at two Abbotsford plants
 - Engineering team consists of ten designers & engineers using Inventor and Solidworks
 - Key Personnel for Z ChemGear
 - Paul Hiebert, President
 - Wes Dyck, Engineering Manager
 - Gary Chen, Sr. Mechanical Engineer
 - David Quon, CFO





We are a team-oriented steel fabrication company that is in tune with our customer's needs and dedicated to providing innovative solutions from design to fabrication and installation



Mainland Facilities



Facility #1

- 27,000 ft²
- Parts Preparation
- Fabrication
- Welding
- Assembly

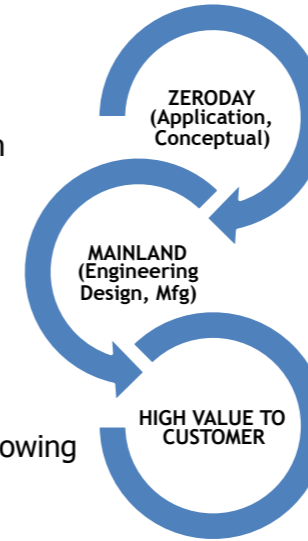


Facility #2

- 30,000 ft²
- Fabrication
- Welding
- Assembly

Zeroday-Mainland Partnership

- Zeroday – Mainland partnership
 - Maximizes cost competitiveness, system capabilities
 - Mainland brings top tier engineering, fabrication capabilities
 - Zeroday base designs, on-going chemical application expertise
- Business relationship
 - Mainland is exclusive global manufacturer
 - Mainland is global Z ChemGear distributor
 - Mainland manages all business aspects
 - Zeroday provides design & commercial support in growing the business
 - Zeroday independently sells systems
- Mainland has the ability to package Zeroday systems with other fabrications



6

- Zeroday chemical systems are supplied globally.
- In the mid 2010's, due to a very strong US dollar that put Zeroday at a competitive disadvantage, strong non-USA fabrication was needed
- After considering various options and strategies and discussions with several fabrication avenues, Zeroday and Mainland Machinery partnered on the chemical mix-feed systems business.
- Also develop and pursue other process systems opportunities
- For business coordination and management purposes, Mainland has assumed all aspects of the business including:
 - Commercial management
 - Global sales and sales support
 - Mechanical designs
 - Fabrication
 - Startup and on-going customer support services
- Zeroday's role in the partnership:
 - Provide overall design development guidance
 - Training on chemical characteristics and impacts on design considerations
 - Support overall sales efforts
 - Marketing strategies and efforts
 - Acts as an independent sales agent where Mainland does not have coverage
- Mainland leverages their efforts at customers by packaging chemical systems and regular fabrication, such as plate, structural, tanks, etc. and vice versa.

Z ChemGear Equipment Overview

- 'One stop shop' for chemical mix, feeding systems
- All chemicals, examples:
 - Flocculants
 - Xanthates, MBS
 - Copper, zinc, cobalt sulfate
 - All chemicals used in a process
- Highly capable systems
 - Integrated chemical mixing-feeding
 - Consistent and accurate
 - Provides optimum process performance
 - Robust operation
 - Long life, industrial duty
- Well designed to meet application and customer operational requirements



7

- An early and important Z ChemGear systems strategy is to offer a range of chemical systems.
- Allows Zeroday an ability to sell system(s) to a wide range of operations.
- Multi system sales possibilities.
- Opportunities:
 - New construction. This is a more challenging, although not impossible, market segment since Z ChemGear systems are robust, built for long life and EPCM's and even the mining companies who must approve equipment selection are sensitive to bid prices, working to meet capex budgets. While Z ChemGear systems are generally competitive price-wise for similar quality systems in the market, lower quality systems offered at lower prices. Very often customers upgrade/replace the systems they purchased in construction with more capable and durable systems.
 - Replacement at existing operations. Operations replace systems for several reasons:
 - Equipment past useful life (obsolescence).
 - Mill throughput changes, expansions require systems that match new chemical feeding requirements
 - Ore changes over time requiring new chemicals, different chemical feed volumes (higher and lower)
 - Installed equipment does not provide consistent operation
 - Replacement is a process optimization project
 - Z ChemGear systems are designed for consistent, optimal operations:
 - Robust, solidly industrial grade to provide excellent long-term performance.
 - Consistent and repeatable chemical concentrations
 - Accurate and steady dosing.
 - Minimal equipment breakdowns and easy to repair when required.
 - Built-in redundancies, alternative operation modes.
 - Effective and easy to use automatic mixing-feeding PLC software HMI (human-machine interface)
 - Connects to plant control systems so can monitor and control either remotely (control room) or by 'on floor' operators locally

Systems, Packages

- Design features:
 - Very small to very large units
 - Fully automatic
 - Over-under mix-day tank design
 - Integrated mixing & feed system
- Base designs, operating philosophy
- Systems customized for each application to maximize performance
- Many variables considered:
 - Dry, liquid product?
 - Volumetric feed rate
 - Chemical characteristics, dissolution rate
 - Mix concentration, dosing pump sizing
 - Consideration of specific layout needed



8

- Mainland Machinery is highly skilled and capable building small to the largest systems. They have done very large projects in past, although not chemical systems but are well within the Mainland's capabilities.
- With Zeroday's chemical and mixing-feeding expertise and Mainland's high mechanical design capabilities, there is no project out of our capabilities.
- Our basic designs have commonalities we have defined and identified make for effective chemical systems:
 - On small to medium sized systems, mix tank over-day tank under layout is used where an actuated valve opens to drain the mix tank into the day tank below. This minimizes mix-day tank transfer time which increases system capacity for the same sized tanks. And this is a less expensive mechanical design as large enough progressing cavity transfer pumps are expensive and require much more maintenance attention.
 - Depending on the specific chemical characteristics, dissolution rate and mix concentration, it is possible to use an over-under tank design for large kg/day feed dosages.
 - For slower dissolving flocculant 0.250.30% concentration solutions, the practical largest over-under design is the D750 (750 lb/day or 340 kg/day).
- Many factors are considered for a properly designed mixing-feeding system for each chemical and application types:
 - Consumption rate
 - Chemical use range
 - Number dosing points
 - Mixing-dosing concentration
 - Chemical hazards
 - Solution viscosity, density
 - Chemical packaging
 - Available footprint, height restrictions
- For liquid products, the system consists of dilution (if any required), product storage and pump stand with automatic monitoring and controls.
- Mainland offers design customization to meet application duty requirements.

Chemical Characteristics

- Water solubility
- Dissolution rate
- Density, product and solution
- Viscosity
- Corrosivity
- Flammability
- Explosivity
- Chemical packaging
- Health and safety
- Environmental
- Reactivity
- Chemical degradation
- Exothermic, endothermic reactions
- Dusting, gassing



9

- Key factors in design include whether the chemical is delivered as a dry or a liquid, use rate, dissolution rate (if dry product requires mixing) and target solution concentration.
- A myriad number of other chemical product factors must be taken into account and be built into the design; and provided in the above list.
- All of these product characteristics must be accounted in system designs and fabrication, as well as integration of hazardous condition mitigation processes.
- Materials of construction are crucial for systems that are robust, industrial duty and long-lasting while at same time provide consistent, repeatable performance.
- Ensuring proper designs for each chemical and application is a detailed complex process, particularly when there are hazard conditions.

Chemical Classifications

- Polymeric
 - Flocculants
 - Natural (starch, CMC, guar)
- Coagulants (dry DADMAC, organic liquids, inorganic – ACH, PAC, alum)
- Salts (CuSO_4 , ZnSO_4 , $\text{Fe}_2(\text{SO}_4)_3$)
- Bases (soda ash, NaOH)
- Sulfur based compounds (xanthate, MBS, NaS)
- Oxidizers (peroxide, perchlorate, HNO_3)
- Acids (sulfuric, hydrochloric, acetic)



10

- Are the chemicals delivered as dry, liquid or emulsion? The product form means quite different chemical system layout and requirements.
- The wide range of chemicals mines use can be sorted into generally broad categories of similar system designs:
 - **Polymers:** Included in category are synthetic flocculants and natural polymers. As dry powders, these products slowly dissolve, are made to 0.25-2.0% mix concentrations due to their high solution viscosities and proper powder wetting is via water wetting funnel-educator. Flocculant solution viscosities are an important factor in mixing and process application which is basically dependent on polymer chain length (molecular weight) and charge level (higher % charge gives increasing viscosity).
 - **Coagulants:** Included are organic (DADMAC, polyamine) and inorganics (ACH, PAC, ferric and aluminum salts). Generally all are liquids but there are dry powder DADMAC products available which must be mixed first with the dissolution fairly rapid due to there lower molecular weight vs. flocculants. To provide optimum process performance, due to their very high viscosities, the organic coagulants must be diluted to $\leq 20\%$ on a delivered basis before process dosing which can be achieved by teeing in water on the feed pump discharge line. Except for the dry DADMAC, coagulant systems are basically pumping skids from totes or storage tank.
 - **Salts:** These are inorganic compounds that generally readily dissolve so mix times are short and concentrations can be as high as 30%. Consequently chemical systems tend to be smaller. Other factors impacting salt system designs: solutions are acid, have higher solution specific gravity and prewetting is not required so just feed the dry salts directly into the mixing tank.
 - **Bases:** These products are corrosive and readily dissolve. Dry base chemicals tend to be exothermic or are severely exothermic which poses health and safety (HSE) issues and impacts system designs. NaOH rapidly heats to very high temperatures when beads are added to mixing water; from a practical standpoint can only make 10% maximum concentration without a heavy duty heat exchanger to maintain temperature $< 40\text{-}50$ deg C which generally means NaOH is purchased as 25 or 50% solutions.
 - **Sulfur based compounds:** These readily dissolve and are corrosive. Interesting characteristic of xanthates is these react to iron tanks and piping and passivate the surfaces so corrosion is generally not an issue so carbon steel materials are acceptable. Critically, these products evolve hazardous gases from HSE and flammability/explosivity standpoints as well as hazardous dust control significantly impacts system designs.
 - **Oxidizers:** Zeroday/Mainland have not built systems for these category of products. These are generally supplied in liquid form and dosing is via pumps, peristaltic pumps provide very good dosage control with minimal human exposure, although when tubing or hoses wear through. Materials of construction selection is critical.
 - **Acids:** These are always supplied as liquids so chemical systems consist of pumping skids and sometimes storage tanks and ancillary equipment such as filling piping. 98% sulfuric acid is not corrosive to steel but lower concentrations are highly corrosive. All acids have individual characteristics that must be taken into account in system designs.

Chemical Characteristics Drive Designs

- Equipment considerations
 - Layout, process flow
 - Mixer specification, power
 - Tank sizing
 - Piping diameters
 - Dust control
 - Off gas management
 - Electrical, controls and power
 - Pumps and sizing
- Application considerations
 - Footprint, dimensions
 - Dosage rates, solution concentration
 - Dosage points
 - Power availability
 - Feed water availability
 - Duty conditions



Coeur Silvertip – D300



12

- Coeur Silvertip mine located in northern British Columbia Canada.
- Fully automatic flocculant mixing-feeding system
- Technical description and features of the system delivered include:
 - Over-under tank design where the mixing tank is located above the day tank with ultrasonic monitoring of both tanks. When day tank level reaches low-level limit an automated solenoid valve opens to drain the mixed flocculant solution from the mix tank to day tank. When drained, the system automatically makes a new flocculant batch.
 - Hopper capacity is 220 lb (100 kg) with an integrated bag breaker for easy filling. The hopper cover seal is heavy-duty rubber gasket material for long life, soft closing. The oversized lid reduces finger-pinching possibility.
 - Dry polymer is augered from hopper into an oversized wetting funnel to minimize fish eyes and flocculant build up. A 1-inch eductor below the wetting funnel suctions the polymer-water slurry into the eductor, further dispersing & flash mixing the flocculant particles as the polymer particles flow into the eductor and high velocity motive water. Eductor water flow transfers the polymer to the mix tank.
 - Tanks and hopper made from heavy-duty 1/8"304 passivated stainless steel passivated to minimize corrosion and increase tank life.
 - The entire single skid mounted unit is an integrated 'plug-n-play', automatically controlled. Ready to run when delivered, installation is relatively simple and startup straightforward.
 - Standard 220-volt/1ph/60Hz NEMA 4 panel.
 - Control is by standard Automation Direct PLC and HMI using programmable logic to control the system.
 - Feed pump controls manual via the HMI or by plant DCS system (Wonderware) remote signal.
 - A specifically sized AFX Mixer Technologies mixer ensures good, low shear mixing and flocculant dissolution.
 - Three Seepex progressive cavity pumps provided with skid system, two operating with one standby. Butt-welded all stainless interconnected piping with 1" flanged POCs. The pump VFDs are included in the Zeroday control panel. Manual flow measure monitoring is through installed 2-liter graduated draw down cylinders dedicated to each pump.

Simplot Don Plant – D1500



- Simplot Don Plant is a large phos acid plant located in Pocatello, Idaho USA
- 1500 lb/day system for mixing a special flocculant at 0.8% concentration
- Mixer unit supplied for integration with existing day tank-feed pumps
- Technical description and features of the system delivered include:
 - Automatically mixes when solution is transferred to day tank. When drained, the system automatically makes a new flocculant batch.
 - Hopper capacity is 2000 lb (900 kg) supersack filling system.
 - Dry polymer is augered from hopper into an oversized wetting funnel to minimize fish eyes and flocculant build up. A 1-inch eductor below the wetting funnel suctions the polymer-water slurry into the eductor, further dispersing & flash mixing the flocculant particles as the polymer particles flow into the eductor and high velocity motive water. Eductor water flow transfers the polymer to the mix tank.
 - Tanks and hopper made from heavy-duty 1/8"304 passivated stainless steel passivated to minimize corrosion and increase tank life.
 - The entire single skid mounted unit is an integrated 'plug-n-play', automatically controlled. Ready to run when delivered, installation is relatively simple and startup straightforward.
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Barrick Pueblo Viejo - PAX System



14

- Pueblo Viejo is a very large gold producing mine located in the Dominican Republic
- System delivered December 2018
- Key system design criterion and elements include:
 - 2600 gallon mix tank, 3100 gallon day tank
 - Full stair and platform access to xanthate hopper, mix tank and day tank
 - Capable mixing 10-30% solutions
 - Mixer, pumps, piping and valves optimally designed for trouble free performance
 - Vented as one unit to control CS₂ emissions, CS₂ is a known neurological hazard, generated by constant xanthate solution breakdown
 - System captures fugitive xanthate dust when dumping
 - Collected vent gases scrubbed with carbon for enhanced CS₂ and organic safety
 - All motors NEMA 4x rated
 - Motorized supersack hoist for placement on bag breaker and dumping into hopper
 - Mix tank recirculation-solution transfer to day tank pump
 - Full tank level monitoring
 - Tanks and system components are highly accessible

Summary

- Zeroday has deep chemical product knowledge, process application experts
- Mainland are equipment design experts and a top tier fabricator
- Mainland manages the business, quotes and commercial aspects
- Together we provide industry leading, high value chemical systems that fully meet our customer needs
- Our endeavor is providing chemical systems that optimizes our customer's process performance

- Z ChemGear chemical systems are well designed and solidly built to provide robust, accurate and long service life.
- While we have a basic over-under tank design philosophy, our systems are modified to accommodate the characteristics of each chemical and application specific conditions.
- Zeroday and Mainland goals are to provide maximum customer value resulting from appropriate and consistent chemical use and stable process circuits resulting in greater profits.

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