CHEMICAL CLEANING

White paper on Heavy Industrial Chemical Cleaning in Place

VIKING CIP

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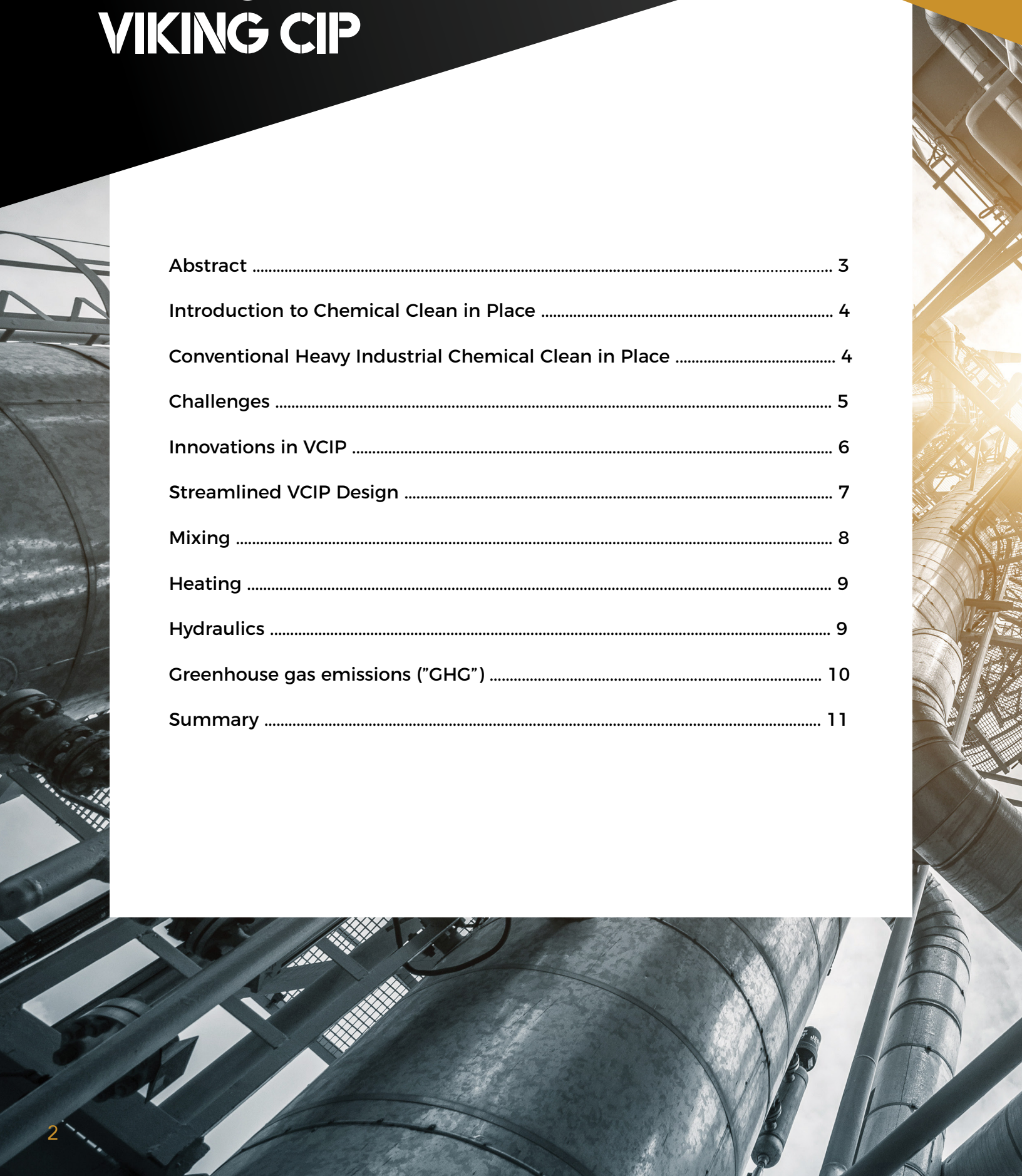


Heavy industrial Mobile chemical clean in place ("HIMCIP") is an industry that has seen little innovation over the last 40 years. It is an industry afflicted by significant safety risks and technology challenges that impact the effectiveness of clean events and can lead to ineffective facility performance. Today's petrochemical and oil producing facility owners are facing increased scrutiny by investors to reduce environmental and social impacts of their operations and showcase their actions towards a sustainable future. Canada's leading energy producers are committing to deliver economic prosperity that is balanced with social well being and responsible resource development. In Alberta, large greenhouse gas ("GHG") emitters have sustainability goals to reduce GHG emissions and operate in a way that minimizes harm to the health and safety of its employees, contractors, and public stakeholders.

Current practices of conventional HIMCIP involve imbalanced chemical mixing methodologies, utilize open flame heating, and operate inefficient diesel fueled gear driven pumps. Although these conventional practices may be accepted today; they do not address any key ESG challenges that have been systemic in the HIMCIP industry.

Advances in technology and the refined application process of Viking CIP ("VCIP") have made significant improvements to safety, system efficiency, and technology advancements in HIMCIP that improve the environmental and safety performance of clean events. This paper provides an overview of the enhanced HIMCIP designed by Viking CIP Ltd. compared with conventional HIMCIP practices used across North America today. VCIP's innovative technology and superior application process contributes to overall sustainability performance by helping Clients to achieve environment, social and governance targets while benefiting from improved safety, cost savings and optimized equipment performance.

This white paper has been written to protect the IP of Viking CIP Ltd. by limiting the information on science and engineering outlined in this document. More information and details require a non-disclosure agreement.

"There is nothing so useless as doing efficiently that which should not be done at all."

- Peter Drucker

Introduction to Chemical Clean in Place

HIMCIP is the process of using chemicals at specific temperatures to clean interior surfaces of pressure vessels and similar without disassembly. HIMCIP has a wide array of applications in various settings, ranging from food/beverage to petrochemical industries. HIMCIP is used when debris builds up in pressure vessels causing bottlenecks in production capabilities of the facility, which can result in damage to components and lead to costly shutdowns for repairs and component replacements.

The lack of innovation in HIMCIP means there is little available research and data on the effectiveness of conventional practices in industrial environments. To date, most advancements in HIMCIP are attributed to individual service providers adjusting their methods to meet site needs or a change in chemistry. Few HIMCIP providers have approached HIMCIP through an innovative lens looking to eliminate safety risks, improve clean results and streamline practices to better meet Clients needs.

Conventional Heavy Industrial Chemical Clean in Place

Conventional HIMCIP providers require significant time to mobilize and integrate into a site. HIMCIP process begins with site integration, when the mobile HIMCIP unit is set up onsite, it typically involves various ancillary site equipment set up and manpower to coordinate and move chemicals, shower units, and other equipment into place.

Chemical introduction to a system is conventionally done via a floor hopper connected by chemical transfer hoses. The hopper is a component in the main circulation system. The conventional equipment has a mobile heating unit with an oval-shaped mixing tank, and an open flame heater. The open flame coil heater is a component in the main circulation system. The oval tank recirculates 100% of what enters the tank.

"The vast majority of Heat Exchangers run at less than 90% efficiency for more than 90% of their operational lifetime, because of process conditions and contamination and thus need of cleaning."

Challenges

The HIMCIP industry is hampered by safety hazards that, when combined with significant technological inefficiencies and habitual cleaning application procedures, erode the operational benefits derived from HIMCIP. These challenges have direct impacts on the overall effectiveness of CIP events and can lead to ineffective facility performance.

The primary technological and procedural challenges of conventional HIMCIP are:

Mobilization/demobilization - current practices require a significant amount of rig up time and manpower for setting up and removing clean in place ("CIP") and ancillary equipment.

Explosion – an open flame diesel powered fluid heating system is an ignition source and poses a significant safety issue in facility environments (i.e., lower explosive limit ("LEL") environments and similar).

Spills - current design poses risk of chemical spills due to lack of solid containment for chemical mixing (ground hopper) and major equipment components: mix tank, pump and valves.

Greenhouse gas emissions - current designs have two large emission sources, the use of highway tractor diesel motors to power pumps, and, the diesel fluid heating flame both contribute to GHG emissions during each cleaning event.

Hydraulics - current designs have inconsistent flow rates due to PTO pump systems (i.e., pump driven by combustion engine).

Chemical Heating - in current designs, the diesel flame high temperatures in direct contact with the steel fluid coil, result in disruption of the cleaning chemical (i.e., degradation and evaporation).

Mixing Tank - in current designs, the mixing tank is an oval shape, leading to a ratio of 100% of the fluid gets recirculated.

Chemical Mixing - in current setups, the chemical is introduced via a hopper connected by chemical transfer hoses, the chemical reaction occurs in the hose which causes hoses to blow out to surge in pressure and temperature.

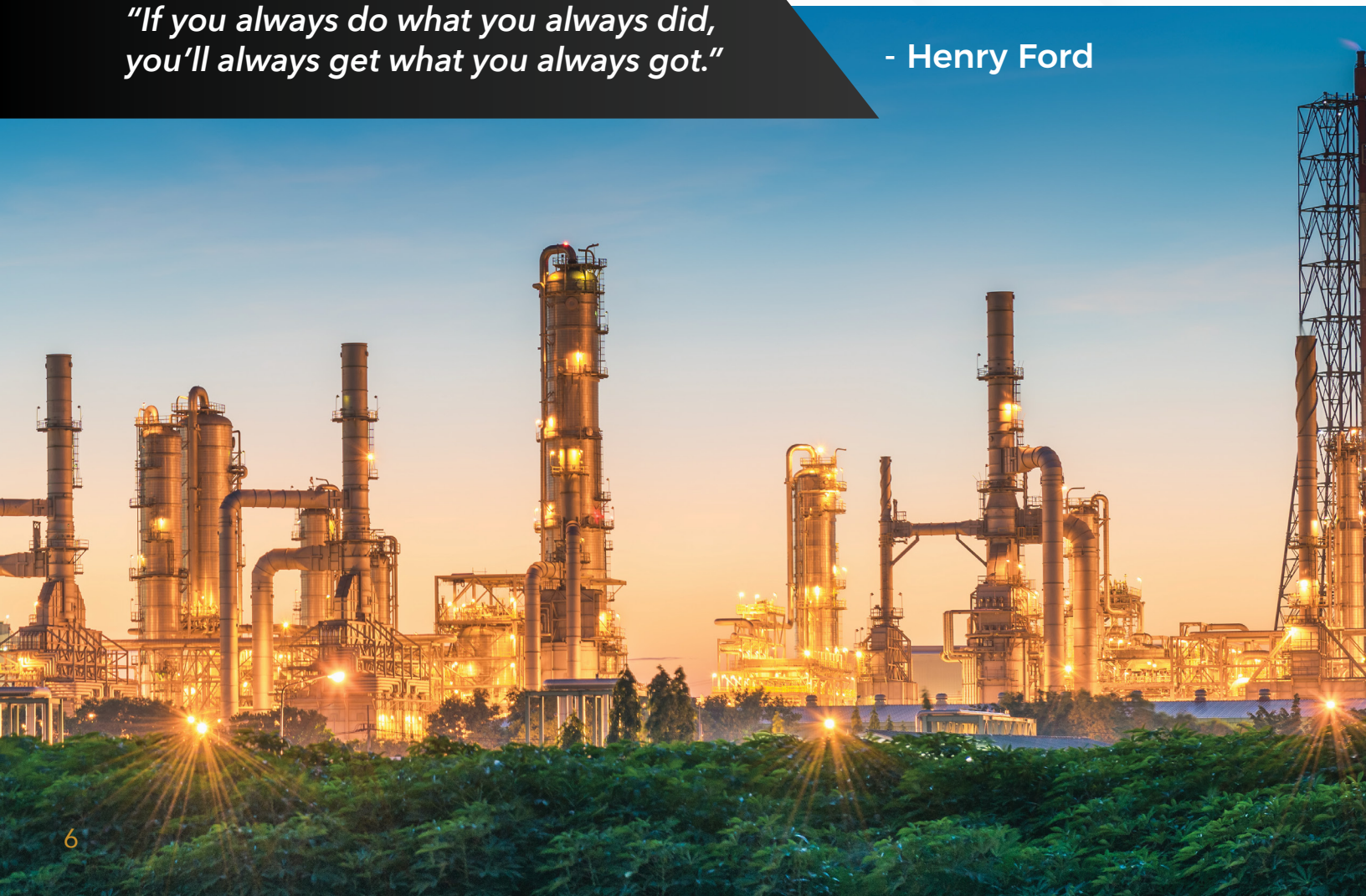
Innovations in CIP

Exceptional CIP is improving on the design of CIP technology and re-envisioning HIMCIP units. Viking CIP presents an innovative approach “VCIP” to HIMCIP that provides safer fluid heating, reduces risk in chemical mixing, and allows for more chemical contact time. The VCIP new system results in dramatic operational improvements to the performance of pressure vessel systems across the mining and mineral, oil and gas, chemical, HVAC and power industries.

Providing the right chemical mixing for the application, utilizing higher efficiency electric pumps, and changing the way HIMCIP is done is the next step to provide VCIP Clients with solutions that are aligned with corporate sustainability objectives.

“If you always do what you always did, you’ll always get what you always got.”

- Henry Ford



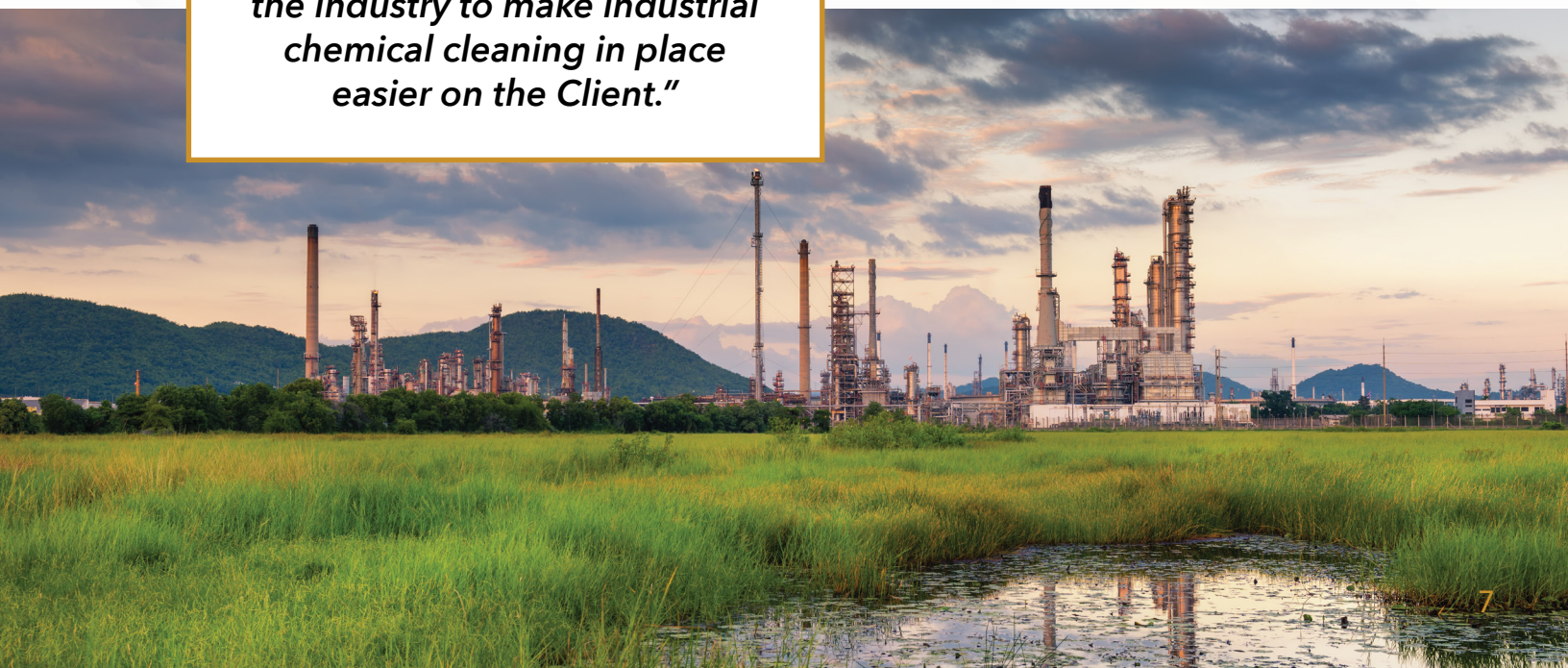
Streamlined VCIP Design

Primary process for chemical introduction is conventionally done via a ground level hopper between transfer hoses, part of the main circulation circuit. This type of loading bears considerable safety risks as the chemical and make up water reaction occur in the hose, leading to hose blow-outs. Furthermore, human error and the design of the hopper can lead to overflow. Inconsistent flow rates and overheating are primary concerns for a clean's effectiveness, while open flames on site cause additional fire and explosion risk.

Mobilization and demobilization is simplified with VCIP's 'plug and play' modular cleaning units, which are designed to make repairs and component replacements faster with built-in flexibility to plug into a site's shore power or water sources. The VCIP units have integrated safety showers with eye wash stations.

In HIMCIP applications, the size of the mixing tank or onboard recirculating tank matters. Inadequate volumes result in inefficient cleans and or in profuse chemical waste. VCIP has in turn designed MiniCIP for pressure vessel volumes <1m3, MediumCIP for pressure vessel volumes of <2m3 and LargeCIP for pressure vessels with 2m3 and up. The purpose of these designs is to deviate from one-size-fits-all, and, to ensure less spent solution (i.e., custom for project).

"VCIP vision is to revolutionize the industry to make industrial chemical cleaning in place easier on the Client."



Mixing

The VCIP mixing of the chemical occurs in its own separate closed loop with its own hopper, transfer pump and mixing tank. The chemical mixing is separate from the main circulation loop.

The purpose of these methods is to ensure that:

- The chemical reaction is contained. When adding the chemical, the reaction occurs in the process pipe and mixing tank.
- The mounted above-ground-level hopper is part of the piping system over a containment area and not on the ground. This reduces the risk of spills.
- There are no hose blowouts from expanding reactions in a chemical transfer hose. The hopper is connected on both sides by hoses and part of the main circulation system.

Furthermore, the shape of the VCIP mixing tank is uniquely designed to allow for heavier materials to be deposited during circulation, preventing the debris from recirculating throughout the system. The conventional method is 100% of what flows into the oval tank flows out of the oval tank.

"Efficiency is doing things right; effectiveness is doing the right things."

- Peter Drucker

Heating

Heating via open flame and coil presents several risks. Because of the elevated flame temperatures and thus elevated coil temperatures, chemical degradation and outbreaks of vapor occur. The exposure increases with lowered flow rate through the coil, exacerbated by the element of human error. Cooked scale build-up in the coils causes the continuous plugging of the coils. Furthermore, certain chemicals have low boiling points and a low flow rate through the heating coil inevitably leads to the formation of gas pockets following the evaporation of the fluid, requiring more chemical for chemical balance and a successful clean.

VCIP utilizes submerged explosion proof electrical super duplex heaters in the mixing tank which have a regulated thermostat. A set desired temperature can be achieved safely without posing the risk of chemical evaporation and degradation. In an open flame environment, if an abnormal operating condition unfolded using current heating practices, the open flame could provoke ignition with LEL conditions.

Similar to the mixing, heating is separate from the main circulation loop. The heating is integrated in the mix tank, making the mix tank the heart of the circulation system and not a component of the conventional circulation system.

"VCIP's class 1 division 2 design leads to electric chemical heating which requires no hot permit, avoids degradation of chemicals and vapor releases."

Hydraulics

In conventional systems, a power take-off drive shaft is used to drive the pump for large volumes of flow. This creates a host of variables and most importantly, non-continuous flow as the tractor motor RPMs will fluctuate based on the head, pipe layout, solid obstructions, foulant build structure, and vapor pockets.

VCIP uses electrically driven pumps. Continuous uninterrupted drive shaft RPMs create a more consistent flow and system pressure, which allows for greater entrainment of heavy particles. In certain pressure vessel layouts and technologies such as in spiral heat exchangers or manifolds, the constant flow delivery is critical.

Greenhouse Gas Emissions

Heavy GHG emitters across North America are looking for operational solutions to help meet sustainability targets for environment, social and governance ("ESG"). Increasingly, the investment world is looking to corporate ESG reports as a key metric that determines a company's long-term investment value. The way a company addresses its ESG plays a key role in financial investment in Alberta's oil and gas industry. Advances in processes like HIMCIP and other services contribute to ESG targets and success in achieving corporate sustainability targets.

VCIP helps its Clients by aligning its process and technological improvements with Client's Sustainability commitments related to reducing GHG emissions and improving safety conditions of HIMCIP events.

VCIP reduces greenhouse gas emissions by half through:

- Utilization of electricity (shore power) eliminates the need for diesel tractor highway motors to power pumps.
- Integration of heating coil in the mixing tank eliminates the need for open flame heating onsite.

These improvements to HIMCIP combine for a GHG emissions savings of 100%. When powered by a low-emission diesel generator, VCIP can decrease GHG by 46%.

	Conventional Tractor Diesel Motor	Conventional Diesel Coil Heater	VCIP (Shore Power)	VCIP (Tier 4 Diesel Generator)
Diesel Consumption	11 USG/hr	2 USG/hr	0 USG/hr	6 USG/hr
C02 Emissions	244 lbs/hr	44 lbs/hr	0 lbs/hr	133 lbs/hr
Total Emission Reductions			100%	~46%

VCIP improves safety conditions for onsite employees by:

- Elimination of open flame heating sources
- Integration hopper feed system for chemical loading
- Sound attenuation design of mobile units

"VCIP disrupts the industry norm by providing industrial facility operators the option that results in improved system efficiencies, reduces time of clean events and improves the safety of cleaning activities."

Summary

Today's petrochemical industry faces increased scrutiny by investors to reduce the environmental and social impacts of their operations and showcase their commitments towards a sustainable future. Canada's leading energy producers have made significant commitments to deliver on economic prosperity balanced with social well-being and responsible resource development. In Alberta, energy companies have sustainability goals to reduce GHG emissions and to minimize harm to the health and safety of its employees, contractors and public stakeholders.

The simple but significant innovations that VCIP has made to the mixing, heating, hydraulics, and design of HIMCIP is revolutionizing the industry.

VCIP has reduced the risk of explosions, hose blowouts and chemical spills by redesigning the modular HIMCIP unit and eliminating the use of open flame heating. Using shore power and electric pumps cuts the GHG emissions by more than half, resulting in a better clean. Integrated safety showers and chemical feed system, flameless heating coils and separate mixing tank reduces site mobilization needs, saving time and money. The future of CIP is safer, more economical, and environmentally responsible with Viking's innovative approach.

"VCIP will provide results that go beyond the standard clean expectations."

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