CASE STUDY REPORT
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AUTOMATIC GAS COUPLING

AUTOMATIC GAS COUPLING FOR SAFER MELT SHOP OPERATIONS

CUSTOMER CASE STUDIES

FROM EXPOSURE TO AUTONOMY

Manual gas coupling is replaced by a hands-off process, removing operators from the hazard zone and eliminating routine risk.

99% FIRST-TIME SUCCESS

A self-aligning system engineered for the harsh reality of the melt shop, absorbing crane variability without slowing down production.

PRECISION AT THE PUSH OF A CRANE

Automated media links turn a manual bottleneck into a stabilized, high-speed operation that reduces cycle times and secures stirring quality.

FOREWORD

In the modern metallurgical landscape, operational excellence is no longer defined solely by throughput or chemical precision. As global safety standards evolve and the competition for skilled labor intensifies, the industry is reaching a critical inflection point: the traditional acceptance of manual "touchpoints" in hazardous zones is becoming a liability to both safety and process stability.

For decades, the manual coupling of gas hoses was viewed as an unavoidable reality of melt shop operations — a "simple" task performed under extreme conditions. Today, we recognize that this task represents a significant source of risk and an unnecessary point of variability in the production chain.

The transition to qouplerG represents a fundamental shift in how a modern melt shop manages its most critical assets. It is not merely a story of replacing a hose with a mechanical coupling; it is a blueprint for removing the human operator from the hazard zone entirely. By automating the link between the ladle and the station, we are closing the gap between manual intervention and autonomous reliability.

The philosophy behind the projects detailed in this white paper is simple: safety through elimination, not just mitigation. By integrating self-aligning mechanical logic with robust metal-to-metal sealing, we have built an architecture where the connection is a seamless, hands-off result of the process itself.

This document outlines the journey from a fragmented, manual coupling model to a synchronized, automated environment. It serves as a testament to what is possible when a melt shop stops viewing safety as a technical burden and starts seeing it as the foundation for operational stability and long-term cost leadership.

The future of the melt shop is not about protecting the operator from the process; it is about designing a process where the operator no longer needs to be at risk.

Lukas Katzianka
Mechanical Engineer of qoncept engineering GmbH

PIONEERING TECHNOLOGIES

MAKING INTELLIGENT PRODUCTION A REALITY

Software and engineering solutions that increase process efficiency, optimize raw material use, and increase operator safety in steelmaking.

GLOBAL FOOTPRINT

15+	5	60+	19	40+	9
Software Projects	Countries Software	Equipment Projects	Countries Equipment	Consulting Projects	Countries Consulting

PRODUCT PORTFOLIO

SOFTWARE & HARDWARE

qontrol MAPS
Raw material management & charge optimization

qontrol L2
Level 2 automation & digital twins

qontrol MES
Manufacturing execution system

qontrol LMS
Ladle management system

qurve AI
Operator terminals & camera systems

EQUIPMENT & DEVICES

qouplerG
Automatic gas coupling system

qouplerM
Patented multi-media coupler

qouplerD
Automatic slide gate coupling, globally unique

Bins & Silos
Complete industrial silo systems

Engineering Services
Custom mechanical design & revamps

CONSULTING & STUDIES

Metallurgical Process Consulting
Measurable improvements in melt shop operations

Digitalization & Software Strategy
Feasibility studies and transformation roadmaps

COMPANY HISTORY

2018 — FOUNDATION

Founded in Leoben, Austria, by metallurgists with strong industrial backgrounds.

Establishment of the internal software architecture creating the scalable foundation for modular qontrol integration.

2020 — MARKET READINESS – qouplerM & FIRST PRODUCT DEPLOYMENT

qouplerM, an automatic multimedia coupler, reached market readiness and was patented.

Implementation of the first productive scrap tracking system, marking the transition to operational digital steel production.

2022 — PATENT AND FULL STEELMAKING INTEGRATION

Patent granted for the automatic slide gate coupling system qouplerD. This expanded the portfolio into automated slide gate actuation and signal integration.

Implementation of the first productive steel plan management system (Level 2) on full scope.

2024 — NORTH AMERICAN EXPANSION & PLATFORM SCALING

Establishment of qoncept Americas Inc. to support North American customers.

Functional specialization of the qontrol platform with dedicated modules for heat optimization, ladle tracking, and advanced scrap yard management.

TODAY — 100+ PROJECTS WORLDWIDE

Active operations across Europe, the Americas, and Asia.

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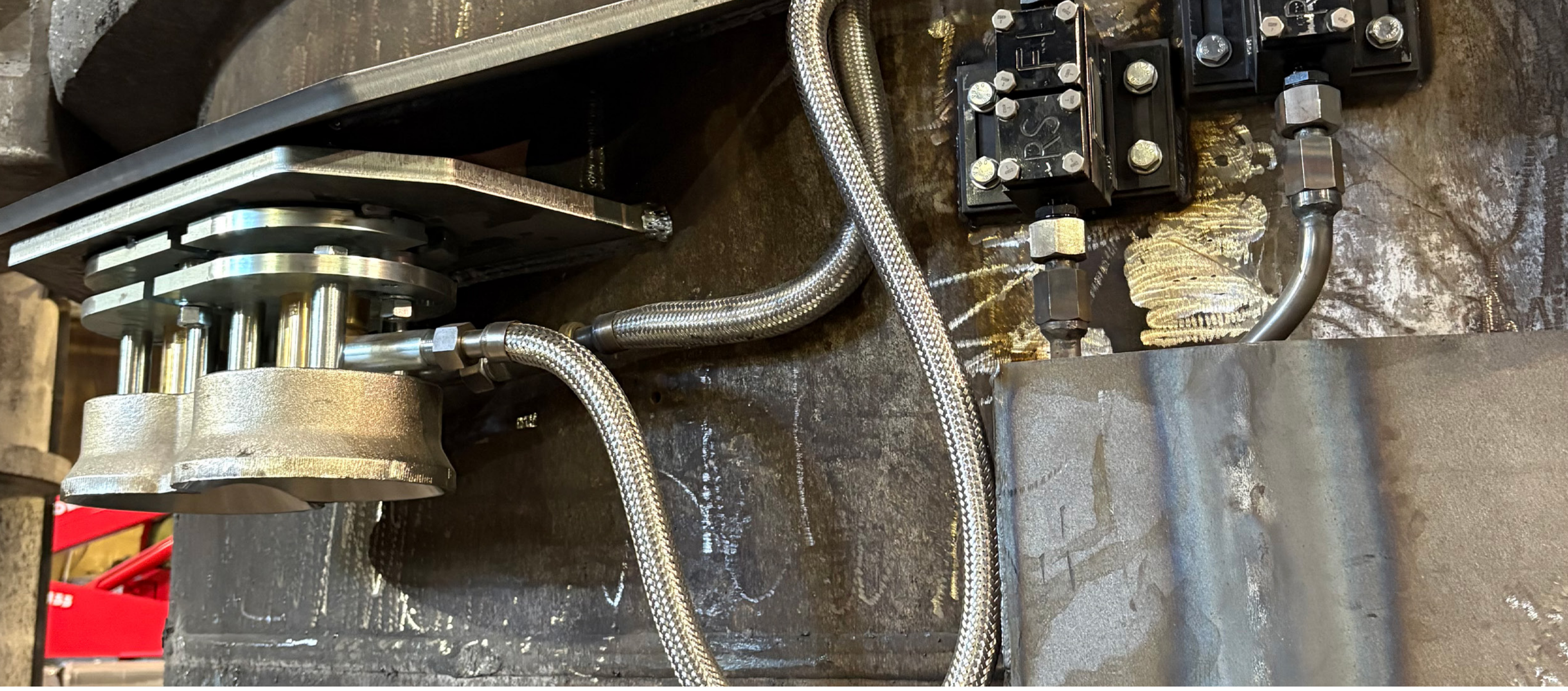


01 CUSTOMER CONTEXT

Steelmaking is carried out in an environment where operators routinely work close to liquid steel, radiant heat, dust, and overhead crane movement. The ladle is the vessel that links every stage of secondary metallurgy and continuous casting, and to perform its role each ladle must be connected at multiple stations to a stirring gas supply feeding the porous plugs at the bottom of the vessel. In conventional melt shops this connection is made manually: an operator approaches the ladle after crane placement and couples a hose to the ladle inlet, often with several tons of molten steel only meters away. At some sites this maneuver is repeated up to ten times per hour across the different stations of the melt shop, each event a discrete exposure to thermal and mechanical hazards and a source of variability in gas flow and stirring behavior that depends on the individual operator, the condition of the hose, and the cleanliness of the connection point.

The team of qoncept has worked in automatic media coupling for ladles and metallurgical vessels since 1997 and has developed the qoupler product family to address this situation. Within that family, qouplerG is the dedicated automatic gas coupling system, installed in melt shops in Europe, North and South America, and Asia, across EAF shops, ladle furnaces, vacuum degassing stations, and continuous and ingot casting operations. This white paper focuses on qouplerG specifically, summarizes its technical concept, reviews two recent installation cases, and draws together the practical learnings from those projects.

Image 1: Manual Hose Coupling at a Ladle – the Operating Situation that qouplerG Replaces.

02 INITIAL PROBLEM

Before the introduction of an automatic coupling system, the typical plant situation can be described along three dimensions. The first is operator exposure: manual coupling requires personnel to physically approach a vessel that may contain up to 350 tons of liquid steel (depending of exact meltshop configuration) at temperatures above 1,500 °C (2,732 °F), handling a gas hose and a connection fitting close to hot surfaces and in an area subject to slag splashes and overhead crane traffic. Personal protective equipment mitigates but does not eliminate this exposure, and the procedure repeats at every station the ladle passes through, resulting in hundreds of individual safety-relevant events per week.

The second dimension is process variability. Manual hose connections are inherently inconsistent – the position of the hose, the torque on the fitting, the condition of the sealing surface, and accumulated dust at the ladle inlet all affect how cleanly gas is delivered to the porous plug. The third is cycle time. Manual coupling at various stations throughout the meltshop may require coupling operations to executed in a very short period of time to ensure process stability. The central issue is not one specific hazard but the repetition of a hazardous manual procedure across every ladle, every station, and every heat – removing the procedure itself, rather than merely improving the protective equipment around it, is the more durable solution.

> Manual coupling forces personnel to physically approach vessels at temperatures above 1,500 °C (2,732 °F), resulting in hundreds of individual safety-relevant events per week.

03 DECISION BASIS

When a plant evaluates automatic ladle gas coupling, the decision basis is rarely a single criterion. Safety is the driver, but the investment must also pass practical tests of reliability, integration effort, and compatibility with existing equipment. Four considerations consistently shape the decision. First, the system must tolerate real melt shop conditions – ladles are not placed on their support saddles with laboratory precision; dust accumulates, refractory dimensions drift, and crane placement varies. A system that requires precise alignment will either fail to couple reliably or will demand additional crane handling that defeats the purpose of automation. Second, the coupling must be tight and repeatable, not merely approximate: metal-to-metal sealing with defined compression, rather than elastomer seals that degrade under heat and dust, is a clear requirement.

Third, the system must be implementable in an existing plant without forcing a redesign of the ladle, the cars, or the treatment stations. It must be compact, must weld onto the ladle shell in a position that does not interfere with lifting or tilting, and must mount on the station without creating new collision risks. Fourth, it must cover the full fleet – a coupling that works at one station and not another forces operators to maintain two procedures in parallel and erodes the safety benefit. qouplerG was designed against exactly these criteria: it accepts placement variability through a spring-loaded male section and a centering pin on the coupling interface, it seals metal-to-metal under controlled compression, it retrofits onto existing ladles and stations through welded brackets and customized mounting frames, and it is available in G1, G2, and G3 configurations covering one, two, or three gas lines within a single coupling event. These properties are summarized in the technical data below.

PARAMETER	SPECIFICATION
Number of ports	1 for gas coupling (qouplerG1) 2 for gas coupling (qouplerG2) 3 for gas coupling (qouplerG3)
Media	Technical gases Ar/N_2
Max. pressure	25 bar
Max. Flow Rate	0 – 2 500 l/min (0 – 90 cfpm)
Max. ambient temperature	Max. 450 °C (850 °F), 600 °C (1110 °F) on special request
Sealing compound	Metal / Metal
Flexibility	± 65 mm (2.5 ") in X-, Y- and Z-axis

04 SOLUTION APPROACH

qouplerG couples the stirring gas supply to the porous plug automatically, as a direct consequence of placing the ladle on its station. The system consists of two parts: a female section welded onto the ladle shell that remains with the ladle through its full operating cycle, and a male section mounted on the station – a ladle car, a ladle stand, a VD/VOD tank, or a casting turret – and connected to the plant gas supply through flexible hoses. When the crane lowers the ladle onto its saddle, the two sections are pressed together; gas flows as soon as the sealing surfaces meet, and no operator action is required. Alignment is handled progressively: a centering pin on the male section engages first and guides the female section into final position as the ladle descends, with additional guiding features closing out the remaining offset. In practice, qouplerG accepts approximately ± 65 mm of offset on each axis and can accommodate ladle tilt of several degrees – values that correspond to real variability in melt shop operations.

The coupling force is generated by a package of flexible springs housed in the male section. When the female is pressed down, the springs compress to generate the metal-to-metal sealing force and hold the connection tight for the duration of the heat. No latch, holding pin, or hydraulic lock is required, which is important for safety: when the ladle is lifted off the station, the coupling separates immediately and cannot obstruct an emergency lift. For sites where the available crane stroke is not sufficient to compress the spring package through the ladle descent alone – for example, on a continuous caster turret where clearances are tight – the male section can be mounted on a pneumatic or hydraulic manipulator that extends it into the coupling position after the ladle has been placed; the coupling principle is unchanged, and the manipulator is controlled by the plant PLC and moves only when ladle-in-position permissives are satisfied. The system supports up to three independent gas lines through a single coupling event, available as G1, G2, and G3 variants; the coupling principle, the tolerance envelope, and the sealing method are identical across all three.

Image 2: qouplerG Overview Picture Showing Male and Female Coupling Parts.

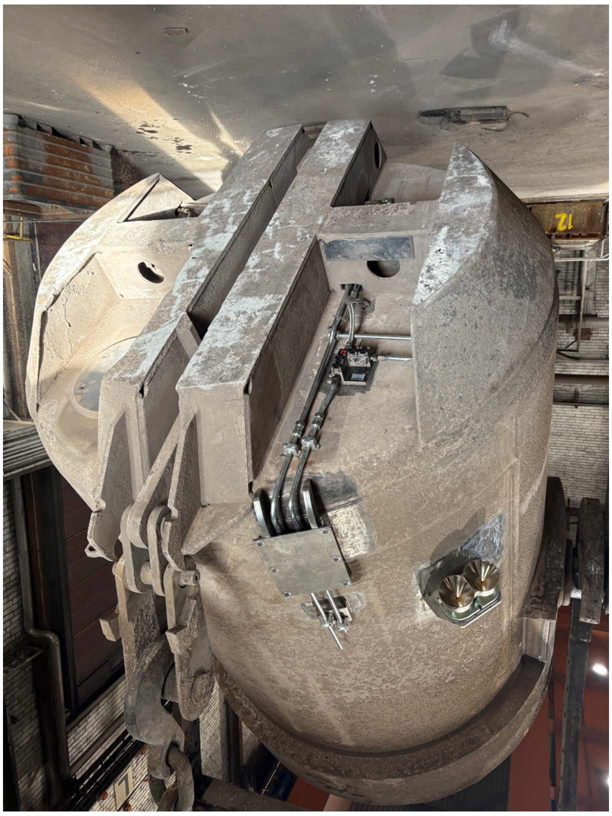


Image 3: Newly Installed Feeding Lines for a Two-Porous-Plug Application.

Image 4: Installation of qouplerG on Ladle Car.

05 IMPLEMENTATION

Each qouplerG installation begins with an engineering study. The study establishes where the female section can be welded onto the ladle shell, where the male section can be mounted on each station, and whether the available clearances permit direct compression of the spring package or require an actuator. It considers every operational state of the ladle – lifting, transport, placement on each station, tilting, teeming – and verifies on 3D models derived from plant drawings, validated on-site, that the coupling hardware does not collide with existing structures in any state. After the study is accepted, welding brackets, protection plates, and alignment templates are supplied by qoncept so that the installation position is reproduced consistently across the ladle fleet and across each station. A typical first-installation sequence equips one ladle and one station, commissions the pair through cold tests, and only then rolls out the remaining units. Two recent installations, described below under generic references Customer A and Customer B, illustrate how the same qouplerG concept adapts to different plant configurations.

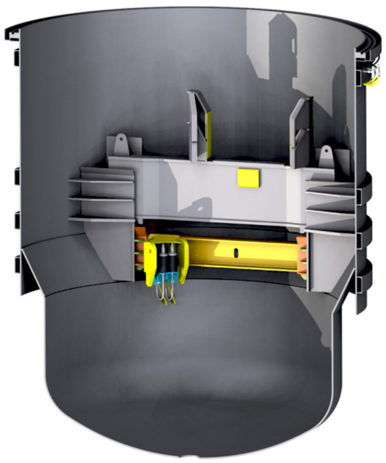


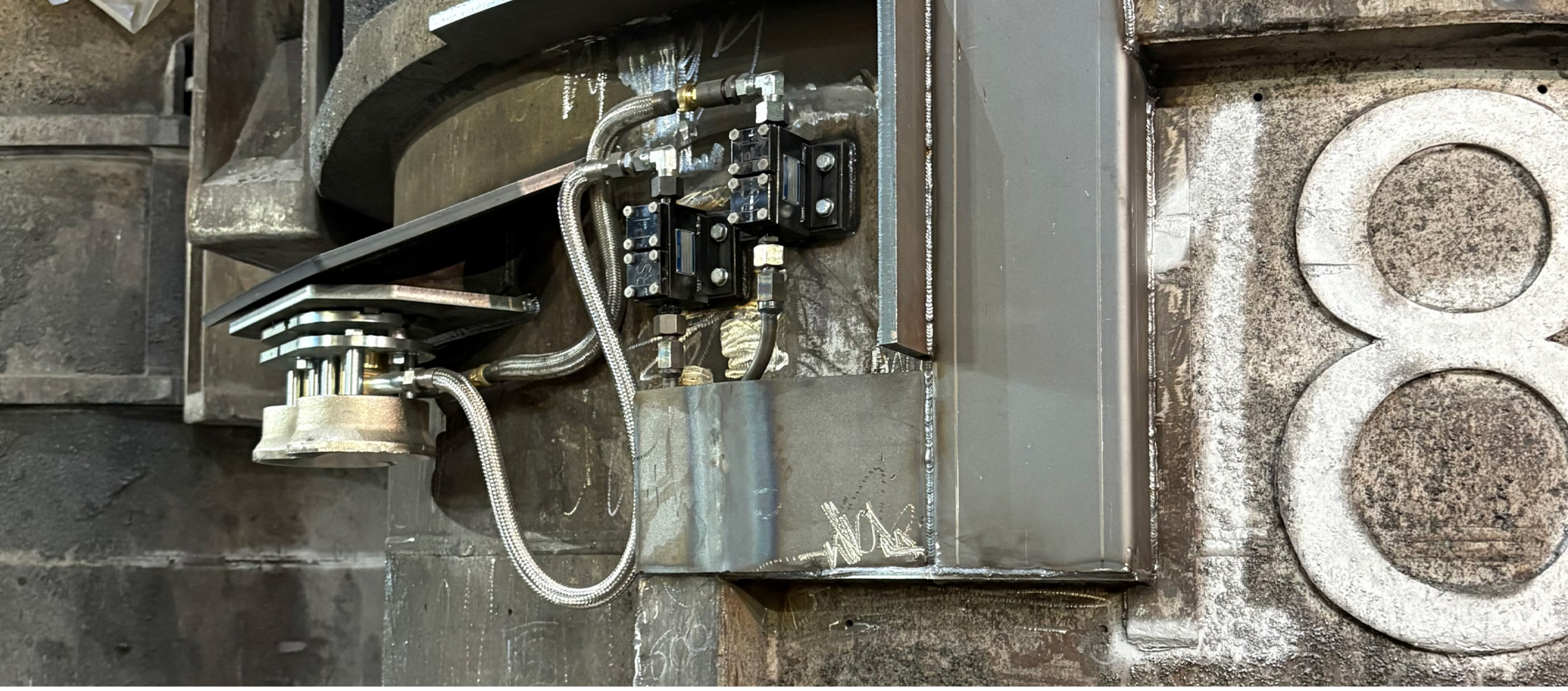
Image 5: Detailed 3D Planning for Integration into a VD Tank

> By using 3D models and on-site validation, the installation ensures that coupling hardware does not collide with existing structures during any stage of the ladle's operating cycle.

5.1 CUSTOMER A

Customer A operates a melt shop with an EAF, a ladle furnace, and a VD station. The project addressed the LF ladle transfer cars and the VD tank, using a qouplerG1 single-port configuration matched to ladles with a single porous plug line. On the ladle, a welded bracket carries the female section and a high-temperature check valve; existing manual quick-couplings were retained as a fallback. On each station, the male section is mounted in a fixed position and connected to the gas supply through flexible metal hose. Coupling is achieved purely by compression of the spring package as the ladle is lowered by the overhead crane – the crane stroke at this site is sufficient and no actuator is required. The engineering study focused on the exact weld position of the female, to avoid interference with existing lifting lugs and refractory-handling features, and on the male-section mounting position on the LF transfer car and at the VD tank. Custom welding brackets were manufactured on the basis of the study and installed using standardized templates, so that every ladle in the fleet is equipped identically.

Through a fixed-position mount and high-temperature check valves, the qouplerG1 provides a robust, automatic gas connection while retaining manual couplings as a secure back up line.



5.2 CUSTOMER B

Customer B operates a melt shop with an EAF tapping car and a ladle furnace turret, with ladles equipped with two porous plugs. A qouplerG2 dual-port configuration was selected so that both plug lines couple automatically in a single engagement. On the ladle, a welded plate carries the female section together with the BEDA non-return valves and corresponding welding nipples; a dedicated protection plate shields the check valves from accidental mechanical contact during ladle handling. On the EAF tapping car, the male section is mounted within a supporting frame that also carries bump stops, an X-guide to confirm lateral ladle position, and a splash protection plate; the motion study for this station assumed a distinct ladle inclination based on site observation, with the operating rule that any visible tilt beyond this value should lead the crane operator to re-seat the ladle before coupling. On the LF turret, a vertical configuration is used: the male section engages the ladle once the turret has rotated into its LF position, in a sequence coordinated with the plant PLC.

Image 6: qouplerG2 "Female" on the Ladle (Top) and on Ladle Car (Bottom)

Image 7: qouplerG on the Same Ladle and Ladle Car Shortly Before Mating.

06 RESULTS

Results from qouplerG installations are consistent across different plants, station types, and configurations. The first and most important effect is the elimination of manual coupling at the ladle under normal operation: operators are no longer required to approach the ladle to connect a hose, and the associated exposure to liquid steel, radiant heat, and crane traffic is removed. Manual intervention may still occur during commissioning, operator training, or fault recovery, but routine operation is automatic and hands-off – an outcome met at every installation site. The second effect is improved coupling consistency. The metal-to-metal sealing interface, combined with the controlled compression force from the spring package, removes the main sources of variability present in manual hose connections. The automatic coupling system achieved a successful-coupling rate of more than 99% across the installed stations, without requiring special maintenance interventions.

The third effect is diagnostic visibility. On installations integrated with the plant PLC, redundant sensors in the coupling plugs confirm the connection and the HMI in the control room shows coupling status in real time; faults and wear indicators are logged automatically, which supports planned maintenance rather than reactive response.

Across the recent installations reviewed in this paper, qouplerG consistently delivered three outcomes: manual ladle-side coupling was eliminated in normal operation, coupling success rates exceeded 99%, and ladle-change cycle time at the caster was reduced by up to one minute relative to the manual procedure.

07 LEARNINGS & OUTLOOK

Three learnings apply to any melt shop considering this type of project. First, success is as much a function of the engineering study as of the hardware. qouplerG is a mature product, but installation in any specific plant is a site-specific engineering exercise: weld position on the ladle, male-section mounting on each station, collision envelope against cranes and existing structures, and the choice between direct compression and an actuator are all decided during the study. Plants that invest in a thorough study with 3D motion analysis and an engineering site visit reach stable operation more quickly. Second, there is clear value in covering the full ladle route – a partial rollout delivers part of the safety benefit and almost none of the procedural simplification, while plants that roll qouplerG out across the tapping position, the ladle furnace, the VD/VOD tank, and the casting position are able to retire the manual procedure entirely.

Third, automatic coupling is not only a safety technology but also a productivity technology. The cycle-time reductions, the improved repeatability of stirring, and the diagnostic visibility from sensor feedback each contribute operational value in their own right, and the combined safety-and-productivity argument is easier to justify internally than either alone. The multi-media variant qouplerM extends the same coupling principle to hydraulics and electrical signals and represents the natural next step beyond gas-only automation; that extension is outside the scope of this paper. For the gas application specifically, qouplerG remains the reference solution, validated across more than twenty installations worldwide in the last few years.

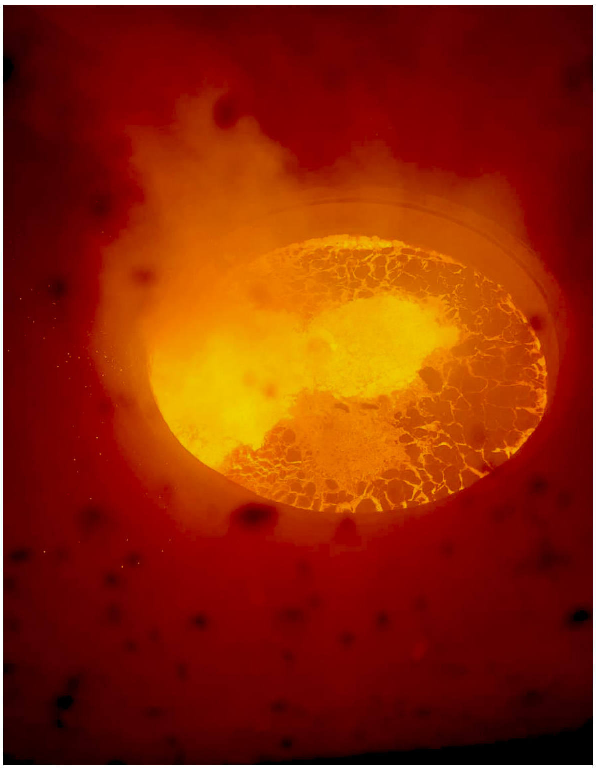


Image 8: Successful Initial Purging with the qouplerG System

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