Terra
Quantum

Enhancing Steel Production Efficiency with Hybrid Quantum Machine Learning
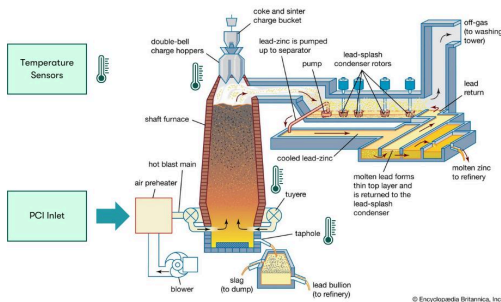
Optimizing Blast Furnace Operations Through Advanced Predictive Modelling

The Challenge

Steel is a vital resource empowering development across a wide range of industries including the energy transition. In a globalized world, the steel industry faces increasing pressure to improve efficiency and sustainability while maintaining product quality. At the core of this challenge lies the blast furnace - a highly complex system that's critical to steel production but notoriously difficult to optimize.

Key issues in blast furnace management include:

- **Temperature Control:** Maintaining optimal and stable temperatures is essential for product quality and operational safety. Current methods often result in fluctuations of up to ±50°C, which is far from ideal.

- **Resource Optimization:** Pulverized Coal Injection (PCI) is a vital process in modern blast furnaces. However, optimizing PCI rates to balance cost and effectiveness remains a significant challenge.

- **Environmental Impact:** With growing emphasis on reducing carbon footprints, every improvement in efficiency can contribute to lowering emissions.

The complexity of blast furnace optimization stems from several factors:

- **Delayed Feedback:** There's typically a 1-2 hour lag between operational changes (such as adjusting PCI rates) and observable effects on the system.

- **Limited Direct Measurement:** Due to the extreme conditions inside a blast furnace, most data comes from external sensors, providing only indirect insights into internal processes.

- **Multivariable Interactions:** Hundreds of variables interact in non-linear ways, making it difficult to model and predict system behavior accurately.

Traditional control methods, which rely heavily on operator expertise and reactive adjustments, often struggle to maintain optimal conditions consistently. The industry requires a more sophisticated, predictive approach to blast furnace management.

Terra Quantum's Solution

Terra Quantum addresses these challenges through a proprietary Steel Efficiency Optimizer, leveraging hybrid quantum machine learning to provide a comprehensive solution.

Key components of our solution include:

1. **Precise Temperature Prediction:** Utilizing our proprietary TQml platform, we've developed a model that forecasts furnace temperatures with significantly improved accuracy.

2. **PCI/RAR Optimization:** Our system determines optimal Pulverized Coal Injection rates and Reductant Ratios in real-time, balancing efficiency and cost-effectiveness.

3. **Internal Temperature Stabilization:** By continuously adjusting parameters based on prediction based optimization, our solution maintains more stable furnace conditions.

Central to our approach is the innovative Quantum Depth-Infused (QDI) layer, part of TQml. This component enhances our hybrid quantum-classical model's ability to explore complex feature spaces more efficiently than traditional neural networks, enabling our system to capture subtle patterns and relationships in the data that might be missed by conventional methods.

How It Works:

Our Hybrid Quantum Machine Learning system operates through a multi-step process:

1. **Data Processing:** We analyze over 1000 sensor inputs, using advanced feature selection techniques to identify the most relevant factors.

2. **Predictive Modeling**: Our TQml platform combines various layers to process data and forecast temperature changes and optimal PCI rates.

3. **Real-time Optimization:** We developed an advanced system that uses the sensor data and temperature prediction as inputs to continuously optimize input parameters to maintain ideal stable furnace conditions, adapting to changing circumstances.

Case Study: POSCO Holdings

POSCO Holdings, one of the world's largest steel producers, faced the ongoing challenge of optimizing their blast furnace operations. In an industry where efficiency and sustainability are paramount, POSCO sought innovative solutions to enhance their production processes. Terra Quantum partnered with POSCO to implement our Steel Efficiency Optimizer, aiming to improve temperature prediction and stabilization in their blast furnaces. The implementation of our solution demonstrated significant improvements:

- **Temperature Prediction:** Achieved ±7.5°C accuracy, a 42% improvement versus previous fluctuations.
- **Stabilization:** Potential to maintain temperature within ±1°C of the target 1510°C.
- **Resource Optimization:** Improved PCI rate optimization, leading to more efficient fuel use.

"POSCO Holdings is at the forefront of driving change in the steel industry. Through this collaboration, we are exploring the power of quantum computing to enhance the steel production, and to set new benchmarks for the industry, proving that economic growth and environmental responsibility can go hand in hand."

Senior Researcher from POSCO Holdings

Estimated Impact:

- **Cost Savings:** Potential for millions of dollars in annual savings through improved efficiency.
- **Quality Improvement:** More consistent steel quality due to better temperature control.
- **Environmental Benefit:** Reduced emissions from optimized fuel consumption.

Solution Performance Impact

- **Prediction Accuracy:** Substantial improvement in temperature prediction accuracy
- **Stabilization Potential:** Capability to significantly reduce temperature fluctuations
- **Model Efficiency:** Reduced model size and computational requirements compared to conventional AI approaches.

A core benefit of our Steel Efficiency Optimizer is that it delivers such performance enhancements using today's hardware, while positioning your business to leverage future advancements in quantum computing technology.

Benefits Beyond the Blast Furnace

While our solution focuses on blast furnace optimization, its impact extends further:

- **Energy Efficiency:** Reduced overall energy consumption in steel production.
- **Maintenance Optimization:** Better prediction of equipment wear, enabling proactive maintenance.
- **Scalability:** Methodology applicable to other complex industrial processes.

Why Choose Terra Quantum

- **Expertise:** Unique combination of world-class deep tech IP portfolio and steel industry experience.
- **Customization:** Our expert team can provide tailored solutions adaptable to specific operational needs.
- **Future-Ready:** Our hybrid approach delivers benefits today while preparing for future quantum hardware.
- **End-to-End Support:** From initial assessment, use-case development, to implementation and support.

Ready to boost your steel production efficiency?

Take the next step and Book a Demo.

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