

Argon gas purification and recycling

CHEMICALS

Background

In an integrated steel plant, ensuring the quality of finished product requires testing the chemical composition of input raw materials, intermediate products and the final steel at different stages of production to establish proper process control.

Optical Emission Spectrometry (OES) is one of the most versatile analytical methods for the chemical analysis of steels and cast-iron samples, capable of detecting multiple elements in a steel sample within just a few minutes. To ensure accurate analysis of nitrogen and carbon in steel samples, ultra-high-purity (UHP) argon gas (99.9990 – 99.9995 %) is essential. This allowable 5-10 ppm of impurity is in the form of hydrocarbon, nitrogen or other gases. Argon prevents contamination from air, particularly oxygen and nitrogen, which could alter the emission spectra and skew results. The argon must be extremely pure as even trace amounts of moisture or hydrocarbons can disrupt the plasma and render the analysis unusable. Since the analysis chamber is opened frequently to replace samples, and the gas naturally escapes during operation, argon must be constantly supplied to maintain the required inert environment.

Currently, argon gas cylinders (certified as <5 ppm N₂) are used alongside an 'argon gas purifier' equipped with 3 filters/cartridges (i. a hot titanium cartridge to absorb N₂ and O₂; ii. a copper cartridge to absorb hydrocarbons and carbon-based gases and, iii. a molecular sieve to absorb moisture). This setup enables approximately 3 months of uninterrupted chemical analysis of steel without requiring regeneration or maintenance of the molecular sieve. The other two cartridges need to be changed within 6 months to a year. Additionally, our facility is equipped with a pipeline supply of argon gas (industrial-grade, 99.9% with 1000 ppm impurity) which is not suitable for direct use in OES analysis due to its significantly lower purity.

What we're looking for

We are looking for a solution to enable the a) use of industrial pipeline argon gas for OES analysis of steel samples, ensuring the removal of impurities (including N₂) and moisture, with the potential for argon gas recycling and regeneration in the process of usage, and/or b) regeneration/ recycling of used argon gas (supplied to OES from cylinders) in the OES process.

Solutions of interest include:

- Filters, absorbents and purifiers
- Argon recovery and recycling mechanisms

Our must-have requirements are:

- Ensures filtering of ~1000 ppm impurity and moisture before entering the OES circuit
- Easy maintenance and reliable operation for at least 6 months
- Ready to implement or requiring minimal adjustments

Our nice-to-have's are:

- Scalable solutions
- Enables argon regeneration and reuse

What's out of scope:

- Replacement of existing setup
- Technologies that interfere with the operability and productivity of the existing equipment
- Solutions that impact test accuracy and argon flow/pressure inside the OES

Acceptable technology readiness levels (TRL): Levels 6-9

1. Basic principles observed
2. Concept development
3. Experimental proof of concept
4. Validated in lab conditions
5. Validated in relevant environment
6. Demonstrated in relevant environment
7. Regulatory approval
8. Product in production
9. Product in market

What we can offer you

Eligible partnership models:

- Sponsored research
- Supply/purchase

Benefits:

Sponsored Research

Tata Steel would fund the implementation, with the amount of funding to be discussed after the techno-commercial finalization of the proposal, subject to a tentative budget of up to \$100,000.

Expertise

Partner will be assigned a representative from Scientific Services at Tata Steel. They will assist the partner during the project as required.

Tools and Technologies

Partners will be allowed to do local customization of instruments. They can also access our lab facilities.

Data

After NDA is signed we can share required data.

Facilities and Services

Partner will be invited to concerned plant or facility for survey and on site understanding of the challenge (video call may also be explored). Required help will be given from Tata Steel to the selected partner.

Reviewers

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Area Manager Program Management

Please contact the University of South Florida Technology Transfer office representative for submission - Roisin McNally at rmcnally@usf.edu.