PIONEER

- Short Construction Period
- Fast Regulation
- Low Power Consumption

Optimal Solution to Oxygen Supply in EAF Steelmaking

Vacuum Pressure Swing Adsorption(VPSA) Oxygen Generation

Industry Background

The current total steelmaking capacity of over 200 electric furnace steel mills in China is about 120 million tons. The development of short-process EAF steelmaking has drawn great attention since its production capacity increased greatly. The short process of scrap-based EAF steelmaking has significant advantages of energy saving and sustainability, compared with the long process of blast furnace-converter steelmaking.

After years of development, the EAF steelmaking technology has made huge progress. The application of a large amount of oxygen can help to accelerate decarburization, whilst the heat released in the oxidation reaction can be fully utilized to achieve energy saving and consumption reduction. The technologies of aerobic burner, oxygen-blowing accelerated melting and decarburization in molten pool, oxygen lance and secondary combustion are all enhanced oxygen utilization technologies, combination of which can improve the effect of mixing in the molten pool, promote the metallurgical reaction, reduce the power consumption and increase the productivity.

Excellent Performance

At present, there are more than 100 electric arc furnaces in the world equipped with VPSA oxygen generators, which are widely applied over the world. The long-term practice shows that VPSA oxygen units can meet the requirements of EAF steelmaking. Since 2018, PKU PIONEER has successively undertaken several VPSA oxygen unit projects for Luzhou Yixin Iron & Steel Co., Ltd., Zunyi Changling Special Steel Co., Ltd. and Chizhou Guihang Metal Products Co., Ltd., etc. For instance,

Luzhou Yixin, with four electric arc furnaces, among which the maximum capacity reaches 700,000 tons, has applied VPSA oxygen unit (5,700Nm³/h, 93%) designed by PKU PIONEER to supply oxygen gaseous instead of previous liquid oxygen which became less cost-effective due to price uprise. The new equipment provided satisfactory performance since the first production commencement in November 2018 with its oxygen production and purity having reached the design indicators. After that, the steel products are transported downstream for steel bar production.

> The power consumption of the project is 0.55 kWh/m³ (for 100% pure oxygen production with the oxygen pressure of 1.5MPa), therefore, the unit oxygen production cost is calculated to be $0.05/m³ (based on the tariff of Luzhou as $0.09/kWh), while the unit liquid oxygen cost is $0.21/m³ (based on local liquid oxygen price of about $147.8/ton, 700m³ of gaseous oxygen per ton of liquid oxygen). With the assumed annual operating duration of 8,400 hours, an annual cost saving of $7.24 million may be achieved.
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> According to the feedback from Luzhou Yixin, its EAF smelting cycle remains unchanged and the downstream production has not been affected after the supply of liquid oxygen is replaced by that of VPSA oxygen.

How to Select the Oxygen Supply Mode?

To meet the requirements of capacity expansion and transformation of EAF steelmaking, steel works need to build new oxygen generation stations or to be equipped with more supporting oxygen generators. In recent years, China has made outstanding achievements in R&D and technology improvement of oxygen generation processes. The cryogenic air separation process is no longer the only way for industrial oxygen generation, but rather, it has been replaced by various solutions combined with competitive VPSA oxygen generation technology and liquid oxygen gasification, etc., which can not only adapt to the complex working conditions of oxygen supply for steelmaking, but also significantly improve the economic benefits. The characteristics comparison between VPSA oxygen generation and conventional cryogenic oxygen generation technology is shown as follows:

Item	VPSA Oxygen Generation	Cryogenic Oxygen Generation
Construction Period	Small Footprint; Simple Installation; Short Installation Period of 6-7 Months	Complex Equipment with Many Components; Large Footprint and Professional Installation Team Required; Long Installation Period of 10-12 Months
Automation	High Degree of Automation; Unattended Operation Possible; 2 People/Shift Required Generally	Dependent on the Scale; More People for Larger Scale; About 8-10 People/Shift Required Generally
Turndown Ratio	Easy to Regulate, with Range of 50%-100%	Complicated Regulation with Range of 80%-110%
Operator	Ordinary Staff with Simple Training	Professional Training and Occupational Qualification Certificate Required
Operational Control	Start at Any Time, with Startup Duration of 0.5h	Need to Run Continuously, with Startup Duration of over 36h
Oxygen Purity	Conventional Purity of 80%-93%; Only Oxygen Available	Purity up to 99.6%; Oxygen, Nitrogen, Argon Available
Energy Consumption	Low Unit Energy Consumption; Lower Electricity Cost	High Unit Energy Consumption; Higher Electricity Cost
Working Condition Adaptability	Intermittent Oxygen Supply Dependent on Actual Working Conditions, Solving the Contradiction Between Supply and Demand of Oxygen Generation and EAF Steelmaking	Continuous and Uninterrupted Oxygen Supply with Frequent Release of Oxygen, Resulting in Energy Waste

Comparative Conclusions of Three Oxygen Supply Modes

1

VPSA oxygen system can be put into production within a short period of time with recognizable advantage of bringing substantial profits to steelmakers as early as possible. Liquid oxygen gasification can be an alternative for emergency or standby oxygen supply, but it is not suitable for long-term medium and large-scale oxygen supply.

2

The unit comprehensive cost of VPSA oxygen plant is $0.04-0.07/Nm³ only, much lower than that of cryogenic air separator and liquid oxygen gasification technology. Many steel mills have already replaced liquid oxygen with VPSA oxygen system to meet their long-term oxygen demands.

3

The three oxygen supply modes have their own characteristics. For short-process steelmaking with the oxygen supply gap of 1,000-15,000Nm³/h, VPSA oxygen unit is the preferred solution in terms of the economic benefits.