

# The real time analysis of the Extrel<sup>®</sup> MAX300<sup>™</sup>-IG process mass spectrometer enables the Vacuum Oxygen Decarburization process to be optimized for efficiency and product quality.



Vacuum Oxygen Decarburization (VOD) is one of several steel manufacturing processes that benefit from the accuracy and speed provided by the Extrel MAX300-IG process mass spectrometer. The VOD batch process ensures the quality of stainless steel by calculating and controlling the amount of carbon that remains in the product. During the VOD process, oxygen is blown directly onto the surface of the liquid steel converting any carbon into carbon monoxide and carbon dioxide. Using the MAX300's fast and precise analysis data, the control system is able to quickly calculate the rate of decarburization and the end point of the VOD process.

## Typical Analysis Information

Figure 1 displays analysis concentration data from the exhaust stream of a typical VOD batch process. The MAX300 analyzes the full exhaust stream composition in less than 3 seconds and the graph clearly indicates the rapid change in the component concentrations during each stage of the VOD process.

**1. Evacuation and Initial Blow:** During this first phase, the liquid metal is agitated by blowing argon through the liquid steel. The concentration of nitrogen decreases during this phase while argon, carbon monoxide and carbon dioxide increase. The temperature is then increased and oxygen is introduced.

**2. Main Blow:** During the main blow phase, the oxygen flow is maximized to enable the carbon in the steel to be converted into carbon monoxide and carbon dioxide. The rate of conversion is constant and will be indicated by a stable carbon monoxide plus carbon dioxide concentration ( $\text{CO} + \text{CO}_2$ ).

**3. Final Blow:** During this stage, the oxygen flow is decreased and the vacuum is increased. This results in a decreasing carbon conversion rate as indicated by the decreasing carbon monoxide plus carbon dioxide concentration ( $\text{CO} + \text{CO}_2$ ).

**4. Degassing:** During the final stage, the oxygen flow is terminated and the vacuum is increased. This allows dissolved gases such as nitrogen, argon and hydrogen to be removed from the liquid steel.

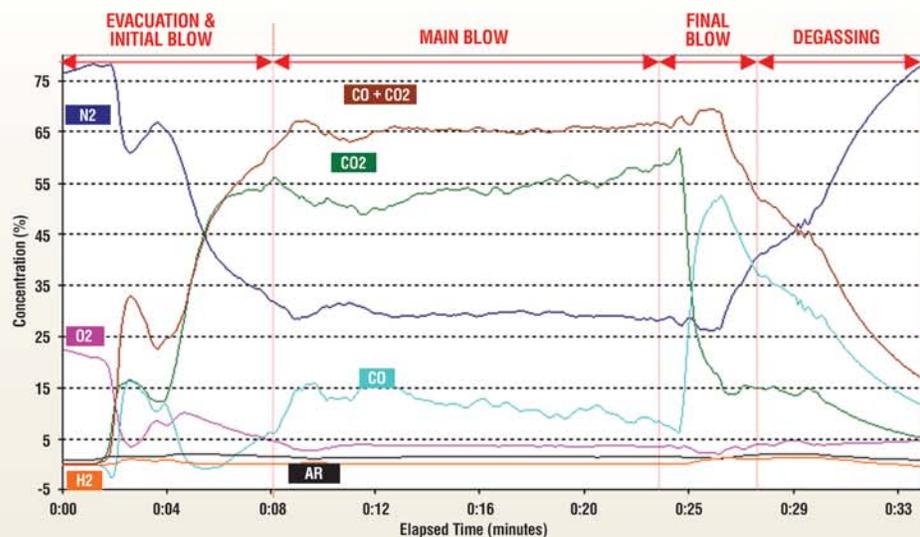


Figure 1: VOD Profile from Mass Spectrometer Analysis

# STEEL VOD

One of the benefits of the MAX300-IG is that it analyzes gases in real time; the 7 components in the exhaust stream can be analyzed in less than 3 seconds. As Figure 1 indicates, this real time analysis enables the plant control system to quickly identify the end of each VOD stage. A typical VOD exhaust stream composition is displayed in Table 1 at right.

Since the remaining carbon content in the steel product is calculated based on the amount of carbon monoxide and carbon dioxide measured in the exhaust, an accurate stream analysis is required to insure product quality. The Extrel MAX300-IG process mass spectrometer does not sacrifice analysis accuracy in order to obtain fast results. The standard deviation (STD ppm) data listed in Table 1 was generated from an analysis of a certified calibration standard at laboratory conditions. The cylinder components were at concentration levels typically found in a VOD process. As you can see, the expected standard

deviation of carbon dioxide at 27.30% is 54 parts per million (ppm) while carbon monoxide, at a concentration of 19.98%, will have an expected standard deviation of 124 ppm. This level of measurement accuracy enables the plant control system to consistently achieve high levels of product quality through accurate carbon calculations.

Component	Est. Conc	Analysis Mass	STD (ppm)
Nitrogen	35.40%	14	70
Carbon Dioxide	27.30%	44	54
Carbon Monoxide	19.98%	28	124
Argon	10.00%	40	18
Helium	3.31%	4	36
Oxygen	2.99%	32	9
Hydrogen	0.99%	2	18

Table 1: Typical VOD Stream Composition

## Key Application Facts

- Typical analysis time is less than 3 seconds for a full VOD stream analysis.
- The Extrel MAX300-IG utilizes the next generation design for the inlet, ionizer and filament assembly. This extends the life of the filaments, increases time between service and decreases maintenance downtime.
- The Extrel MAX300-IG's optional differentially pumped inlet enables rapid and consistent sampling from process streams with different pressures such as VOD analysis.
- The Extrel MAX300 supports a variety of industry standard communications including ethernet, Bi-directional MODBUS, MODBUS TCP/IP, OPC and analog communication protocols.



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