

Table 1 — TDE-Vacuum™ (VOD) Implementation Levels

TDE-Vacuum™ (VOD) can be deployed at three progressive implementation levels, depending on the customer’s objectives, available data and desired degree of plant integration.

Integration level:

● **Full live integration** ◐ **Partial / advisory integration** — **No live integration required**

Version	Main purpose	Typical use	Plant integration	Expected output
Offline Simulator	Process study and scenario evaluation	What-if analysis, deep decarburization studies, vacuum treatment assessment, chromium yield evaluation, training, benchmarking	— No live plant connection required	Simulated refining trends, thermal and metallurgical analysis, comparison of operating strategies
DSS / Advisory Mode	Decision support during VOD operation	Operator guidance, decarburization assessment, vacuum treatment review, temperature and chemistry adjustment support, deviation interpretation	◐ Historical, exported or semi-live plant data	Recommendations, warnings, process interpretation, support for operational decisions
Online Digital Twin	Real-time synchronized process representation	Live monitoring, predictive supervision, dynamic process tracking, digital twin deployment	● Integrated with live plant signals and automation architecture	Real-time tracking, predicted process evolution, dynamic advisory output, synchronized digital process view

Each level corresponds to a different operational scope, from offline engineering analysis to real-time synchronized process intelligence.