LOW ALLOY STEEL WITH A BENCHTOP WD-XRF

Low alloy steels, used in pipelines, automotive, aerospace, and structural engineering, owe their durability to corrosion-resistant high-strength low alloy compositions. With less than 10% alloying elements like C, Mn, Cr, Ni, Mo, V, and Si, precise elemental analysis is crucial for quality control and cost efficiency in steel production.

BENCHTOP WD-XRF: SUPERMINI200 (SM200)

A benchtop XRF spectrometer offers a fast, non-destructive solution for verifying composition, ensuring compliance with industry standards, and optimizing material properties. These instruments provide reliable analysis of key elements, such as Mn, Cr, and Mo, which influence mechanical strength and corrosion resistance. Their compact design makes them well-suited for production environments where speed and flexibility are essential.

STANDARDS AND CALIBRATION METHOD

The calibration for the low alloy steel analysis was established using certified standard reference materials from the Bureau of Analyzed Samples (BAS) and Japan Steel Standards (JSS) listed below.

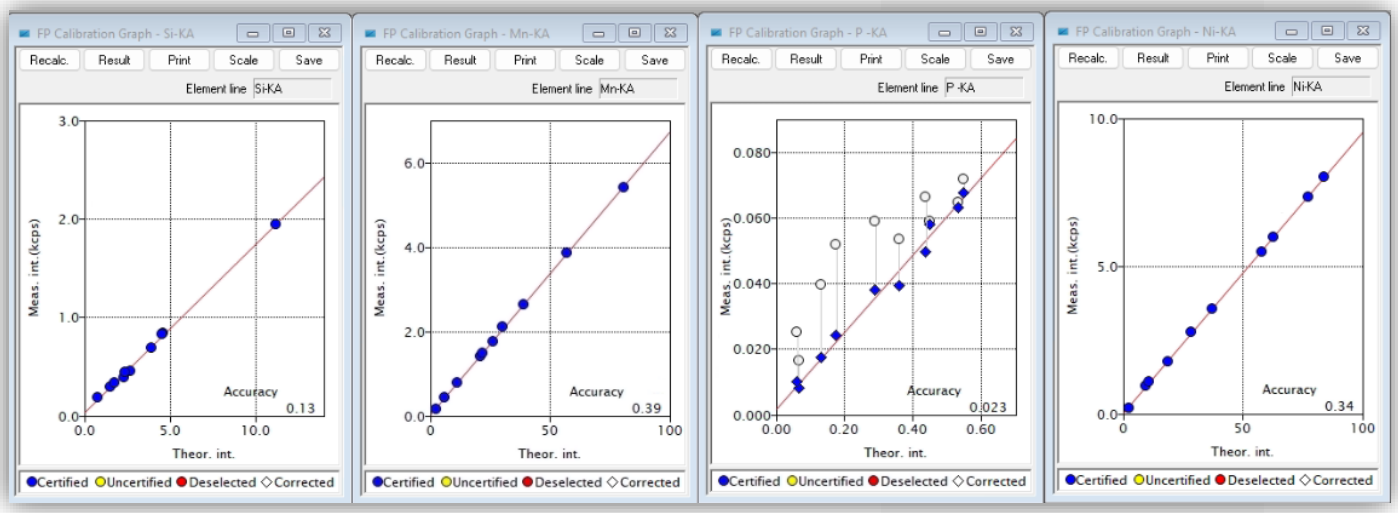
	Name	Note	C	Si	Mn	P	S	Ni	Cr	Mo	Cu	V	Al	Fe
			mass%	mass%	mass%	mass%	mass%	mass%	mass%	mass%	mass%	mass%	mass%	mass%
1	150-10		0.49	0.2	0.12	0.038	0.03	4.1	0.3	0.2	0.056	0.016	0.006	Balance
2	151-10		0.39	0.098	1.59	0.031	0.022	3.35	0.12	0.047	0.091	0.049	0.006	Balance
3	152-10		0.31	0.35	0.42	0.02	0.041	2	0.5	0.96	0.48	0.097	0.012	Balance
4	153-10		0.194	0.30	0.79	0.012	0.0087	1	1	1.25	0.3	0.21	0.011	Balance
5	154-10		0.11	0.60	1.15	0.0045	0.0045	0.52	1.98	0.37	0.20	0.30	0.009	Balance
6	155-10		0.043	0.51	0.23	0.0042	0.0052	0.12	3.08	0.69	0.39	0.40	0.007	Balance
7	SS406		0.23	0.31	0.61	0.009	0.049	1.52	2.10	1	0.28	0.017		Balance
8	SS407		0.47	0.59	0.047	0.03	0.01	0.59	2.95	0.78	0.57	0.18		Balance
9	SS408		0.285	0.23	0.51	0.037	0.028	4.45	0.102	0.09	0.66	0.031		Balance
10	SS409		0.082	1.46	0.44	0.025	0.021	3.06	0.94	0.65	0.048	0.09		Balance

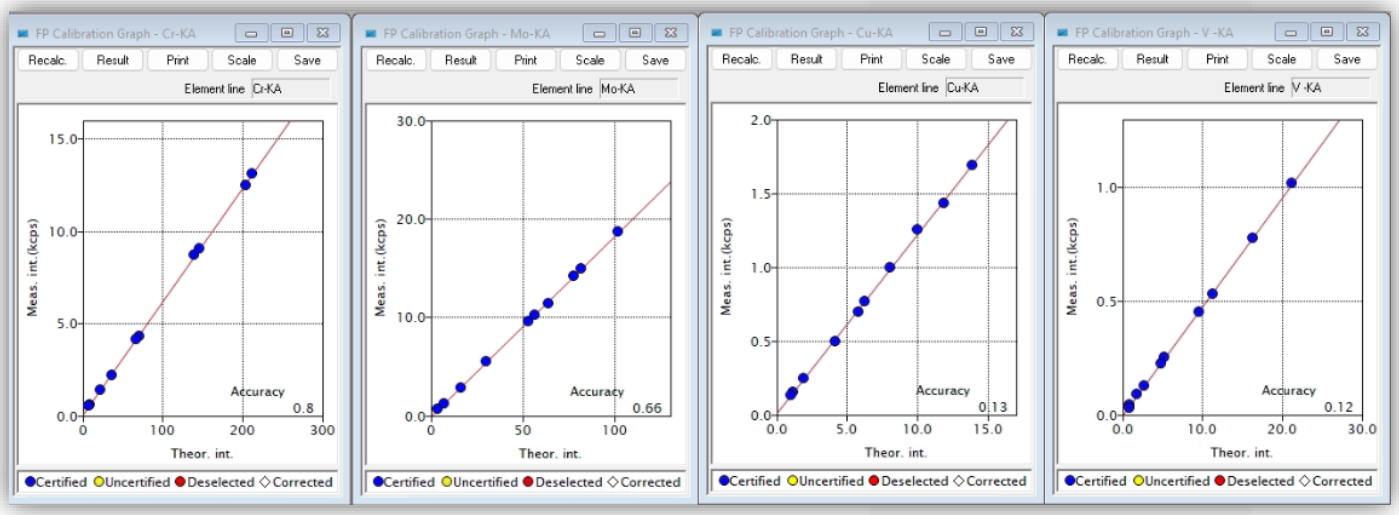
Measurements were conducted using the benchtop SM200, equipped with a 200W Pd target X-ray tube. The Kα line was analyzed for all elements, with a **total measurement time of 3 minutes**. For heavy elements from Cr to Mo, a LiF(200) analyzing crystal paired with a scintillation counter was used, while a PET crystal with a proportional counter handled the lighter elements—Si, P, S, and Al—ensuring precision of the measurement.

CALIBRATION CURVES

Representative calibration curves (shown below) illustrate the accuracy of the elemental analysis. Although low alloy steel is a consistent Fe matrix, the fundamental parameter method was applied to all calibrations to compensate for any matrix effects.

Overlapping corrections were implemented for P and S to address interference from Mo, ensuring precise quantification. The results demonstrate excellent accuracy across all measured elements.





REPRODUCIBILITY

To assess reproducibility, standards 407, 408, and 409 were analyzed in six (6) replicates using the calibrated method. Excellent relative standard deviation (%RSD) was achieved for all measured elements, confirming the high precision and stability of the SM200 system. This level of reproducibility ensures consistent results across multiple analyses, which is critical for quality control in steel production.

Sample ID	C* (mass%)	Si (mass%)	Mn (mass%)	P (mass%)	S (mass%)	Ni (mass%)	Cr (mass%)	Mo (mass%)	Cu (mass%)	V (mass%)	Al (mass%)
SS407-1	0.47	0.603	0.045	0.032	0.011	0.606	2.938	0.761	0.566	0.181	0.044
SS407-1	0.47	0.606	0.042	0.030	0.012	0.595	2.939	0.767	0.559	0.168	0.043
SS407-1	0.47	0.596	0.047	0.033	0.012	0.597	2.936	0.767	0.566	0.177	0.041
SS407-1	0.47	0.597	0.044	0.028	0.012	0.604	2.902	0.763	0.562	0.185	0.044
SS407-1	0.47	0.595	0.049	0.030	0.015	0.607	2.928	0.759	0.551	0.171	0.043
SS407-1	0.47	0.619	0.045	0.027	0.011	0.591	2.912	0.759	0.557	0.181	0.043
Mean	**0.47**	**0.603**	**0.045**	**0.030**	**0.012**	**0.600**	**2.926**	**0.763**	**0.560**	**0.177**	**0.043**
Nominal	**0.47**	**0.590**	**0.047**	**0.030**	**0.010**	**0.590**	**2.950**	**0.780**	**0.570**	**0.180**	**-**
%RSD	**0**	**1.51**	**5.34**	**7.60**	**12.10**	**1.10**	**0.53**	**0.48**	**1.03**	**3.68**	**2.55**

Sample ID	C* (mass%)	Si (mass%)	Mn (mass%)	P (mass%)	S (mass%)	Ni (mass%)	Cr (mass%)	Mo (mass%)	Cu (mass%)	V (mass%)	Al (mass%)
SS408-1	0.285	0.233	0.505	0.039	0.026	4.484	0.099	0.089	0.661	0.036	0.030
SS408-1	0.285	0.244	0.508	0.036	0.026	4.424	0.104	0.086	0.658	0.038	0.029
SS408-1	0.285	0.238	0.511	0.038	0.027	4.427	0.114	0.088	0.651	0.031	0.031
SS408-1	0.285	0.234	0.500	0.039	0.027	4.455	0.104	0.090	0.650	0.034	0.032
SS408-1	0.285	0.236	0.502	0.035	0.024	4.470	0.108	0.093	0.650	0.036	0.032
SS408-1	0.285	0.236	0.512	0.033	0.026	4.434	0.103	0.090	0.659	0.036	0.029
Mean	**0.285**	**0.237**	**0.506**	**0.037**	**0.026**	**4.449**	**0.105**	**0.089**	**0.655**	**0.035**	**0.031**
Nominal	**0.285**	**0.230**	**0.510**	**0.037**	**0.028**	**4.450**	**0.102**	**0.090**	**0.660**	**0.031**	**-**
%RSD	**0**	**1.66**	**0.96**	**6.61**	**4.21**	**0.55**	**4.87**	**2.62**	**0.77**	**6.83**	**4.52**

Sample ID	C* (mass%)	Si (mass%)	Mn (mass%)	P (mass%)	S (mass%)	Ni (mass%)	Cr (mass%)	Mo (mass%)	Cu (mass%)	V (mass%)	Al (mass%)
SS409-1	0.082	1.467	0.444	0.021	0.016	3.059	0.944	0.643	0.051	0.092	0.019
SS409-1	0.082	1.442	0.427	0.020	0.017	3.074	0.948	0.645	0.046	0.084	0.018
SS409-1	0.082	1.444	0.429	0.021	0.017	3.089	0.935	0.648	0.044	0.083	0.018
SS409-1	0.082	1.453	0.439	0.021	0.020	3.093	0.953	0.642	0.046	0.084	0.019
SS409-1	0.082	1.437	0.432	0.021	0.019	3.043	0.940	0.644	0.047	0.083	0.019
SS409-1	0.082	1.432	0.431	0.026	0.020	3.038	0.944	0.644	0.041	0.086	0.018
Mean	**0.082**	**1.446**	**0.434**	**0.022**	**0.018**	**3.066**	**0.944**	**0.644**	**0.046**	**0.085**	**0.019**
Nominal	**0.082**	**1.460**	**0.440**	**0.025**	**0.021**	**3.060**	**0.940**	**0.650**	**0.048**	**0.090**	**-**
%RSD	**0**	**0.87**	**1.50**	**9.97**	**9.48**	**0.76**	**0.66**	**0.32**	**7.23**	**4.04**	**2.96**

NOTE: *Carbon is an input value, Balance = Fe%

INSTRUMENTATION

SUPERMINI200

ELEMENTAL ANALYSIS TESTING SERVICES

VPrep Corp offers fast elemental analysis on a variety of materials by non-destructive direct wavelength-dispersive X-ray fluorescence (WD-XRF) for a wide elemental range. The Rigaku Supermini200 system is our choice for XRF analysis, offering precise elemental identification and quantification for materials such as cement, metal alloys, geological, plastics, pharmaceuticals, oils, and many more. We offer methods for full scans, semi-quantitative, and quantitative to cover all material types.

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