APPLICATION NOTE NO. 21120607

SOLVING CARBON EQUIVALENCE WITH HANDHELD LIBS

It is critically important to ensure the right grade of steel is being used for an application. However, being dependent on the grade alone can be a risk, as there can be significant variation even within a grade. Problems with weld integrity can occur due to variances in the exact composition. Variances in metal alloy grades happen because of secondary production of metal alloys from recycled materials produced in an electric furnace. Secondary production introduces residual elements to the process. These residual elements typically include vanadium (V), manganese (Mn), chromium (Cr), molybdenum (Mo), copper (Cu), and nickel (Ni). This means precise measurements of the exact composition of each individual piece is necessary to determine how the component will behave.

Increasing the carbon (C) content increases hardness and strength while improving hardenability. However, carbon also increases brittleness and reduces weldability. This means controlling carbon content is crucial, as more C can sometimes compromise the metal.

This is where the “carbon equivalent” (CE) concept comes in handy. CE allows you to predict the hardness of the heat-affected zone. Based on the calculated CE, you can determine the correct welding procedure required to join the two carbon steels, including choosing the correct welding media (welding wire) and heat treatment (pre-heat and post heat). Determining CE allows you to try to eliminate sulfide stress cracking (SSC) and hydrogen stress cracking (HSC). All of this becomes even more crucial for piping that has highly corrosive materials, like hydrogen sulfide, flowing through it.

The Rigaku KT-500 handheld LIBS analyzer provides high performance metal alloy analysis to determine CE content.

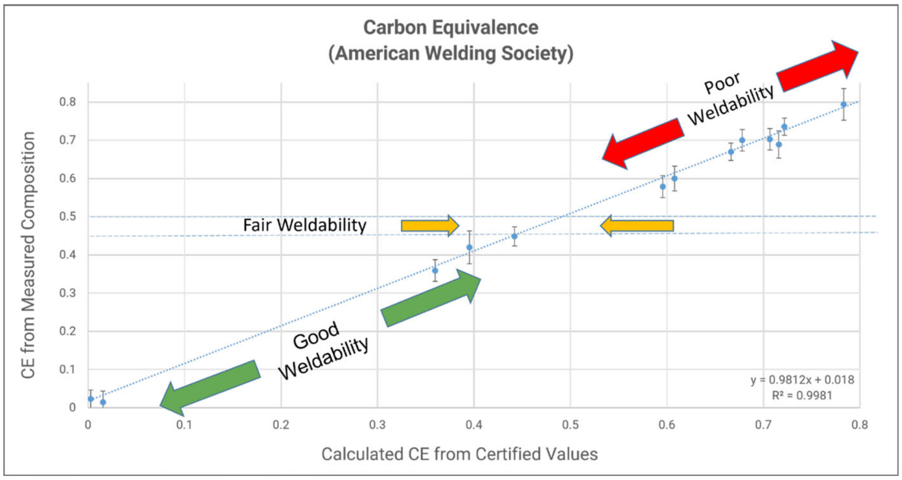

Figure 1

The graph in Figure 1 shows CE values for carbon steel reference alloys containing a wide range of concentrations of carbon and residual elements. Values below 0.4 are considered good. While values over 0.5 are considered poor for weldability. This calculation is from the American Welding Society (AWS) - one of the few more common equations for carbon equivalence.

Rigaku®

SOLVING CE WITH HANDHELD LIBS

Incumbent technology, such as handheld X-ray fluorescence (XRF), provided a viable, though only partial, solution a decade ago for analyzing CE. Handheld XRF provides excellent analysis of key residual elements like vanadium, manganese, molybdenum and other heavier Z elements, but never provided carbon, which is the key to the CE equation. Handheld LIBS arrived a few years ago and provided carbon, but did not necessarily provide the analysis needed for the residual elements. This void left an opportunity for a product and technology that could provide the complete solution for CE.

RIGAKU KT-500 HANDHELD LIBS METAL ANALYZER FOR CE TESTING

Featuring the first carbon-capable high-resolution echelle spectrometer, known as HiRES Technology™, the Rigaku KT-500 analyzer represents the next advancement in handheld LIBS. Its carbon capability, along with accurate alloy analysis, makes the KT-500 the analyzer for analysis of carbon and residual elements to determine CE content and your needed welding procedures.

METHOD AND RESULTS

Element chemistry and CE result is displayed for the user, along with a quick and easy determinant as to the welding procedure needed. The elemental anatomy for American Welding Society (AWS) Equation for CE using a KT-500 follows in the figure below.

An average of five measurements and 1 standard deviation on an AISI 1018 carbon steel sample preformed with the Rigaku KT-500 LIBS analyzer.

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