Field Guide

SciAps

Residual Element Analysis for Hydrofluoric Alkylation Units

SciAps offers both XRF and LIBS based instruments. The Z-902 Carbon model is a portable handheld instrument utilizing Laser-induced Breakdown Spectroscopy (LIBS). The system combines a high-energy pulsed laser, Opti-Purge™ on-board argon purge, and multi-spectrometer design to achieve high-resolution data across a wide spectral range. These HH LIBS analyzers reliably and accurately verify materials for use in Hydrofluoric Alkylation Units (HF Alky). The Z-902 Carbon series can reliably and accurately measure C, Cr, Ni, Cu, and V as well as the other elements that are required for carbon equivalent calculation.

The SciAps X-550 is a highly portable, purpose-built instrument utilizing X-ray Fluorescence. The systems combine a 50 kV X-ray tube, a silicon drift detector, and compact geometry between the X-ray tube and detector to provide accurate and reliable analysis. XRF is a great option for measuring Cr, Ni, Cu, V, and Nb as well as P and S in low residual element material. The combination of the two technologies provides an optimal solution for testing per API 751 – Safe Operation of Hydrofluoric Acid Alkylation Units (HF Alky).

With the increasing demand for material traceability and compliance, the verification of material has become an essential component in reliability and safety programs. As material specifications become more stringent, the need to test these materials becomes increasingly critical. Standards for applications like the API RP-751 Safe Operations of HF Alkylation Process provides guidelines with proven industry practices for the safe operation of HF Alky units. RP-751 represents industry accepted engineering practices and outlines hazard management, operating procedures, personnel protection, materials of construction, inspection, and maintenance techniques.

Material chemistry in carbon steel plays a big role in components used HF Alky service. Low Residual Elements (RE) or HF compliant materials are components that meet the elemental low RE restrictions defined in RP-751. Components with a carbon content greater than 0.18% (C) in carbon steels and the combination of the residuals elements, Cr, Ni, and Cu exceeding 0.15% and Nb plus V exceeding 0.03% in HF Alkylation processes will likely experience an accelerated corrosion rate leading to a premature component failure and releasing HF Alky into the atmosphere. Accurately measuring these elements in carbon steel is critical for predicting accelerated corrosion of components in HF Alkylation process units.

SciAps understands the need to be able to verify critical chemistries in these components and has a solution to meet your verification needs. SciAps utilizes complementing technologies to accurately measure the restricted residual elements. Utilizing the Z-902 Carbon handheld LIBS and the X-550 Handheld XRF, you can confidently and accurately measure the Low RE restrictions in your HF Alky components. Below you will see the Low RE chemistry requirements for carbon steel material used in HF Alky service. Use this sheet as a quick reference guide to know and understand the elemental restrictions and formulas when analyzing HF Alky material in the field.

Quick Reference Field Guide for Analyzing HF Alky Material

HF Alkylation (API 751) residual elements:

Cu + Ni + Cr < 0.15% with C% >0.18%
Cu + Ni < 0.15% with C% <0.18%
Nb < 0.02%
V < 0.02%
Nb + V < 0.03%

ADDITIONAL SUPPLEMENTARY REQUIREMENTS

In addition, the following supplementary requirement is suitable for this application.

S54. Requirements for Carbon Steel Plate for Hydrofluoric Acid Alkylation Service

S54.1 Plates shall be provided in the normalized heat-treated condition.

S54.2 The maximum carbon equivalent shall be as follows:

Plate thickness less than or equal to 1 in. [25 mm]: CE maximum = 0.43

Plate thickness greater than 1 in. [25 mm]: CE maximum = 0.45

S54.3 Determine the carbon equivalent (CE) as follows:

$$CE = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$

S54.4 Vanadium and niobium maximum content based on heat analysis shall be:

Maximum vanadium = 0.02%

Maximum niobium = 0.02%

Maximum vanadium plus niobium = 0.03%

(Note: niobium = columbium)

S54.5 The maximum composition based on heat analysis of Ni + Cu shall be 0.15%.

S54.6 The minimum C content based on heat analysis shall be 0.18%. The maximum C content shall be as specified for the ordered grade.

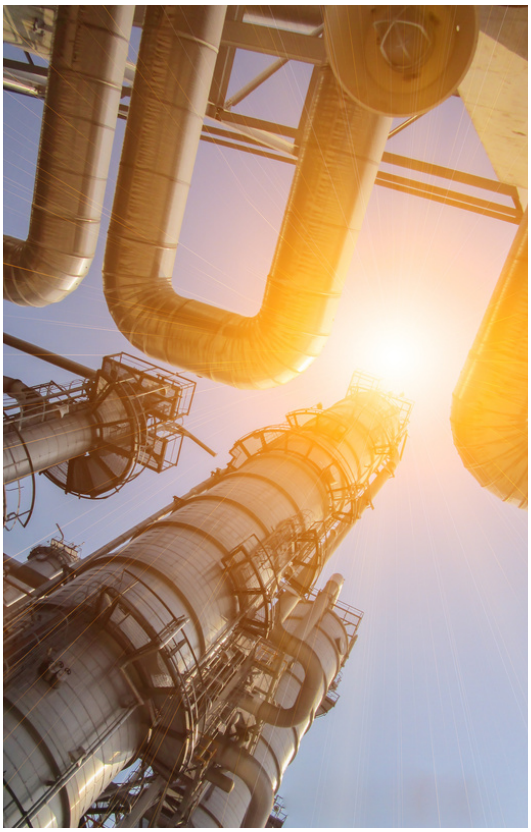
S54.7 Welding consumables for repair welds shall be of the low-hydrogen type. E60XX electrodes shall not be used and the resulting weld chemistry shall meet the same chemistry requirements as the base metal.

S54.8 In addition to the requirements for product marking in the specification, an "HF-N" stamp or marking shall be provided on each plate to identify that the plate complies with this supplementary requirement.

This chart summarizes the “Additional Supplementary Requirements”

CE	C	P	S	Ni+Cu[3]	Cr+Ni+Cu[4]	V	Nb	V+Nb
< 0.43[1]<0.45[2]	> 0.18%	<0.01%	<0.015%	< 0.15%	< 0.15%	< 0.02%	< 0.02%	< 0.03%

[1]Material thickness is < 1”
[2]Material thickness is > 1”
[3]Material thickness is < 1”
[4]When Carbon content is > 0.18



The Z-902 Carbon and X-550 have industry leading Limits of Detection (LOD) to be able to accurately measure those low RE elements needed to verify HF compliant components. The LOD are listed below for each technology.

Instrument LOD

Technique	C	Cr	Ni	Cu	V	Nb	P	S
LIBS Z-902 C	0.007%	0.015%	0.015%	0.01%	0.01%	0.02%	n/a	n/a
XRF X-550	n/a	0.003%	0.02%	0.002%	0.002%	0.001%	0.01%	0.015%

Carbon Equivalent (CE) is also a crucial part of the Supplementary Requirements (see note S54.2 above)

CE	Weldability
Up to 0.35	Excellent
0.36–0.40	Very good
0.41–0.45	Good
0.46–0.50	Fair
Over 0.50	Poor

Carbon Equivalency (IIW) most common:
CE = C + (Mn/6) + (Cr + Mo + V)/5 + (Cu + Ni)/15

Carbon Equivalent (AWS):
CE = C + (Mn + Si)/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15

Summary

With the demanding compliance restrictions for HF Alky material the SciAps Z-902 Carbon LIBS and X-550 can measure Low RE material while simultaneously determining CE in the field, helping you to identify potential rogue material or verify HF compliant material efficiently and accurately. By utilizing these two portable and incredibly fast technologies, you can be assured that you are meeting or exceeding the requirements in your reliability and safety program.

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