

Table of Contents

Introduction

Petroleum & Natural Gas
Workflow
Industrial Water Process
Workflow

**Oil and Gas Analytical
Technologies**

ICP-OES and OEA
Analyzers
Natural Gas Analyzers
IC, CIC, IC MS
Lab Data Management
Software

**Petroleum and Natural
Gas Process**

Upstream Sector
Midstream Sector
Downstream Sector

**Industrial Water
Processes**

HSS in Refinery Solutions
Cations and Amines in
Alkanolamine Scrubbing
Solutions
Trace Anions in Boiler &
Cooling Water

Resources



Oil and Gas Application Notebook

Complete workflow solutions:
Chromatography, Mass Spectrometry,
Molecular Spectroscopy,
lab data management software

Table of Contents

Introduction

Petroleum & Natural Gas Workflow
 Industrial Water Process Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA Analyzers
 Natural Gas Analyzers IC, CIC, IC MS
 Lab Data Management Software

Petroleum and Natural Gas Process

Upstream Sector
 Midstream Sector
 Downstream Sector

Industrial Water Processes

HSS in Refinery Solutions
 Cations and Amines in Alkanolamine Scrubbing Solutions
 Trace Anions in Boiler & Cooling Water

Resources

Oil and gas production. The global challenge.

Whether or not the oil and gas industry is in a boom or bust cycle, companies that succeed will be those that have learned to execute at a lower price point, by working with the supply chain in new ways. They will consider new technology that helps achieve higher product purity and improved production efficiencies.

Making informed decisions on selecting drill sites, crude oil testing, custody transfer, contaminant analysis, and product purity testing requires appropriately configured, accurate, dependable, and cost effective analytical instrumentation.

Thermo Fisher Scientific™ offers the most complete portfolio of analytical instrument workflow solutions in the industry. We deliver critical information about your upstream, midstream, and downstream production and industrial water preventative maintenance processes with a choice of available technologies and models that maximize instrument uptime.



Upstream

Midstream

Downstream

Exploration



Production



Custody Transfer



Storage



Wholesale Marketing



Refining



Distribution



Table of Contents

Introduction

Petroleum & Natural Gas Workflow

Industrial Water Process Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA

Analyzers

Natural Gas Analyzers

IC, CIC, IC MS

Lab Data Management

Software

Petroleum and Natural Gas Process

Upstream Sector

Midstream Sector

Downstream Sector

Industrial Water Processes

HSS in Refinery Solutions

Cations and Amines in Alkanolamine Scrubbing Solutions

Solutions

Trace Anions in Boiler & Cooling Water

Resources

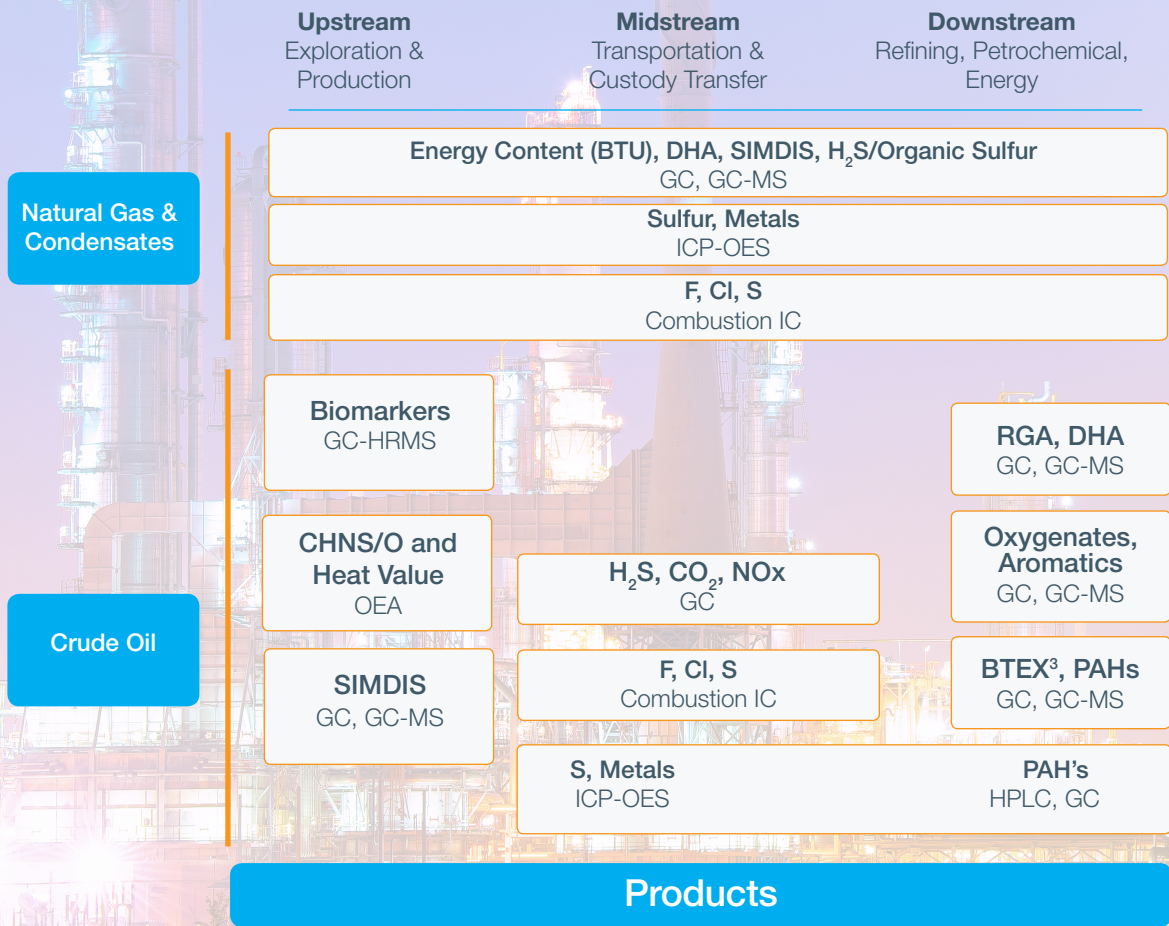
The oil & gas industry is driven by two workflows, one for petroleum and natural gas processes and one for industrial water processes.

The workflows can be described as a matrix that provides a choice of available products according to the process, matrices, application, and analytes of interest.

The petroleum and natural gas workflow includes matrices for natural gas, condensates, and crude oil. Both are segmented according to upstream, midstream, and downstream sectors. Analytical instrumentation includes GC, GC-MS, GC-HRAM, ICP-OES, HPLC, organic elemental analyzers (OEA), and combustion IC (CIC).

Feed stock testing

QA



Download the brochure

LIMS leverages all process steps

Table of Contents

Introduction

Petroleum & Natural Gas Workflow

Industrial Water Process Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA

Analyzers

Natural Gas Analyzers

IC, CIC, IC MS

Lab Data Management Software

Petroleum and Natural Gas Process

Upstream Sector

Midstream Sector

Downstream Sector

Industrial Water Processes

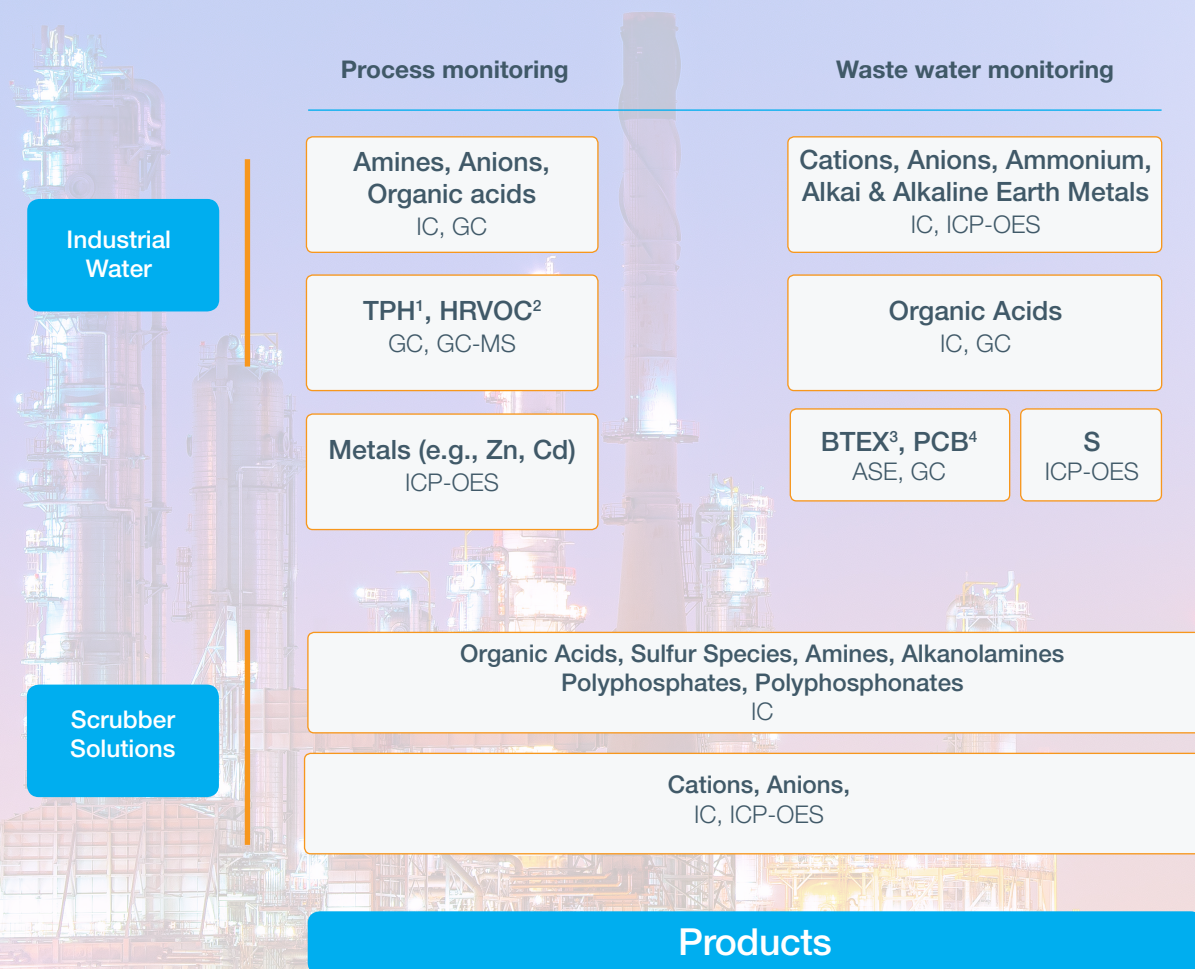
HSS in Refinery Solutions

Cations and Amines in Alkanolamine Scrubbing Solutions

Trace Anions in Boiler & Cooling Water

Resources

The industrial water processes workflow includes matrices for industrial water and scrubber solutions and is segmented according to process monitoring and waste water monitoring. Analytical instrumentation includes IC, ICP-OES, and GC, and GC-MS.



1. Total petroleum hydrocarbons
2. Reactive volatile organic compounds
3. Benzene, toluene, ethyl benzene, xylenes
4. Polychlorinated biphenyl

LIMS leverages all process steps

[Download the brochure](#)

Table of Contents

Introduction

- Petroleum & Natural Gas Workflow
- Industrial Water Process Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA Analyzers

- Natural Gas Analyzers IC, CIC, IC MS
- Lab Data Management Software

Petroleum and Natural Gas Process

- Upstream Sector
- Midstream Sector
- Downstream Sector

Industrial Water Processes

- HSS in Refinery Solutions
- Cations and Amines in Alkanolamine Scrubbing Solutions
- Trace Anions in Boiler & Cooling Water

Resources

Inductively coupled plasma analyzer

For ensuring consistent radial ICP-OES performance and accurate results with high matrix tolerance and stable operation

[Learn more](#)



Thermo Scientific™ iCAP™ 7000 Plus Series ICP-OES Analyzer

Organic elemental analyzer

For automated characterization of coal, crude, fuels, lubricants, and petrochemical products by determining nitrogen, carbon, hydrogen, sulfur, and oxygen

[Learn more](#)



Thermo Scientific™ FlashSmart™ Elemental Analyzer

Table of Contents

Introduction

Petroleum & Natural Gas Workflow

Industrial Water Process Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA

Analizers

Natural Gas Analyzers

IC, CIC, IC MS

Lab Data Management Software

Petroleum and Natural Gas Process

Upstream Sector

Midstream Sector

Downstream Sector

Industrial Water Processes

HSS in Refinery Solutions

Cations and Amines in Alkanolamine Scrubbing Solutions

Trace Anions in Boiler & Cooling Water

Resources

Natural gas and natural gas liquid analyzers

Specifically configured turnkey GC analyzers equipped with the appropriate injectors, detectors, and columns to meet the regulatory requirements for a wide range of GPA, ASTM, ISO, and DIN methods

[Learn more](#)



Thermo Scientific™ TRACE™ 1310 Natural Gas and Natural Gas Liquid Analyzers

Hydrocarbon processing

A complete suite of gas chromatography solutions from simple single channel gas chromatographs to highly configured multi-channel, multi-valve systems to meet the varied demands of the hydrocarbon processing industry - HPI

[Learn more](#)



Thermo Scientific™ TRACE™ 1310 Gas Chromatograph

Table of Contents

Introduction

- Petroleum & Natural Gas Workflow
- Industrial Water Process Workflow

Oil and Gas Analytical Technologies

- ICP-OES and OEA
- Analyzers
- Natural Gas Analyzers

IC, CIC, IC-MS

- Lab Data Management Software

Petroleum and Natural Gas Process

- Upstream Sector
- Midstream Sector
- Downstream Sector

Industrial Water Processes

- HSS in Refinery Solutions
- Cations and Amines in Alkanolamine Scrubbing Solutions
- Trace Anions in Boiler & Cooling Water

Resources

Ion Chromatography

For meeting your routine ion analysis demands with flexible detector configurations, automated consumables tracking, and the versatility to run under isocratic and gradient conditions

[Learn more](#)



Thermo Scientific™ Dionex™ Integrion™ HPIC™ system

Combustion Ion Chromatography

For achieving reliable, reproducible analysis of halides and sulfur in samples such as coal, crude oil, LPG, fuels, and lubricants

[Learn more](#)



Thermo Scientific™ Combustion Ion Chromatography (CIC) system

Ion Chromatography Mass Spectrometry (IC-MS)

Ensure analytical confidence and dramatically improve the detection capability of your Thermo Scientific Ion Chromatography (IC) system. IC with mass spectrometry (IC-MS) maximizes the ability to detect and quantify co-eluting analytes and confirm peak identity.

[Learn more](#)



Dionex Integrion HPIC System and Thermo Scientific™ ISQ™ EC Single Quadrupole Mass Spectrometer

Table of Contents

Introduction

- Petroleum & Natural Gas Workflow
- Industrial Water Process Workflow

Oil and Gas Analytical Technologies

- ICP-OES and OEA Analyzers
- Natural Gas Analyzers IC, CIC, IC MS

Lab Data Management Software

Petroleum and Natural Gas Process

- Upstream Sector
- Midstream Sector
- Downstream Sector

Industrial Water Processes

- HSS in Refinery Solutions
- Cations and Amines in Alkanolamine Scrubbing Solutions
- Trace Anions in Boiler & Cooling Water

Resources

Lab data management and analysis software

Integrated informatics, with connectivity between the LIMS and CDS, that enables real-time evaluation of results for process monitoring, ensuring that turnaround is timely and reducing the risk of lost quality or product

[Learn more](#)

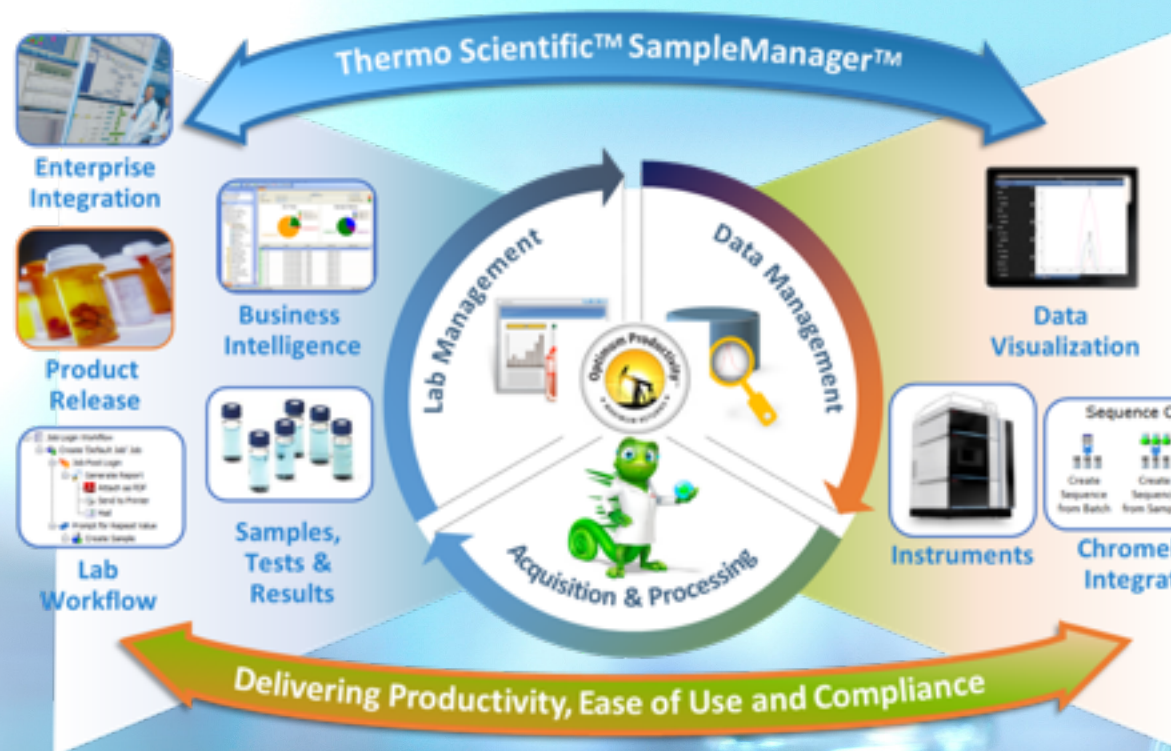


Table of Contents

Introduction
 Petroleum & Natural Gas Workflow
 Industrial Water Process Workflow

Oil and Gas Analytical Technologies
 ICP-OES and OEA
 Analyzers
 Natural Gas Analyzers
 IC, CIC, IC MS
 Lab Data Management Software

Petroleum and Natural Gas Process

Upstream Sector
 Midstream Sector
 Downstream Sector

Industrial Water Processes
 HSS in Refinery Solutions
 Cations and Amines in Alkanolamine Scrubbing Solutions
 Trace Anions in Boiler & Cooling Water

Resources



Petrochemical analysis can be challenging due to difficult matrices, a wide range of contaminants, and sensitivity requirements. We offer the broadest portfolio of laboratory analytical instrumentation in the industry that work together to enhance your analytical capabilities and streamline your upstream, midstream, and downstream processes.

- GC, GC-MS
- OEA
- CIC
- ICP-OES
- GC-HRMS

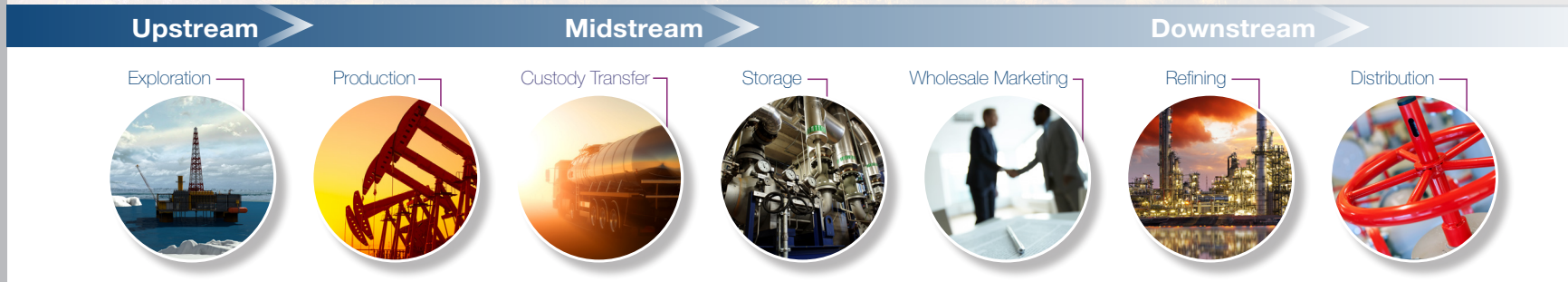


Table of Contents

Introduction

Petroleum & Natural Gas Workflow
 Industrial Water Process Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA

Analyzers
 Natural Gas Analyzers
 IC, CIC, IC MS
 Lab Data Management Software

Petroleum and Natural Gas Process

Upstream Sector

Nitrogen and Chloride

SIMDIS of Crude
 Midstream Sector
 Downstream Sector

Industrial Water Processes

HSS in Refinery Solutions
 Cations and Amines in Alkanolamine Scrubbing Solutions
 Trace Anions in Boiler & Cooling Water

Resources

Nitrogen in crude oil samples

Data obtained from the analysis of nitrogen in crude by ASTM D5291 fall within the statistical margin of error using Thermo Scientific™ FlashSmart™ Elemental Analyzer.

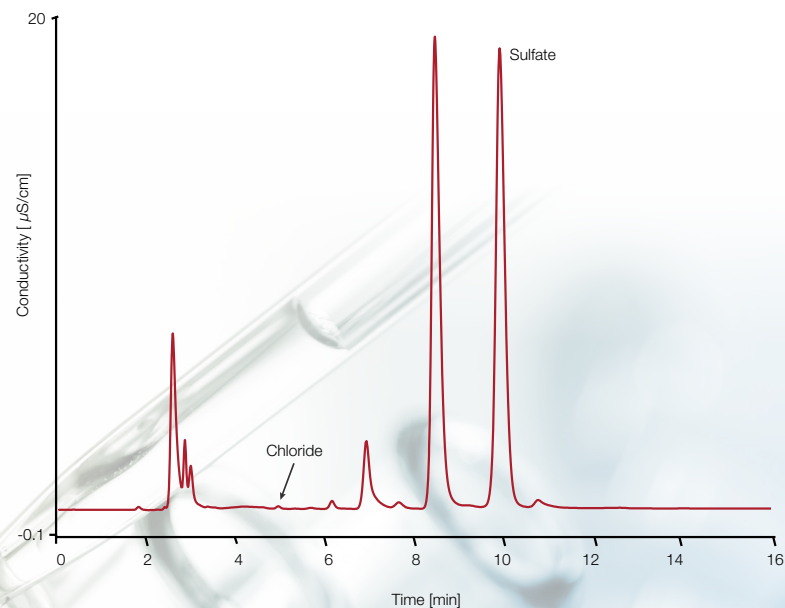
Sample*	Thermo Scientific	ASTM	ASTM
	N% value	Robust Mean N%	Reproducibility
1	0.675	0.6685	0.0604
2	0.700	0.7088	0.0471
3	0.576	0.5790	0.0604
4	0.760	0.7916	0.0634
5	0.522	0.5272	0.0518
6	0.774	0.7937	0.0460
7	0.608	0.6516	0.0601
8	0.707	0.7166	0.0363
9	0.791	0.7923	0.0723
10	0.786	0.7843	0.0740
11	0.716	0.7182	0.0515
12	0.788	0.7738	0.0596
13	0.643	0.6466	0.0537
14	0.687	0.7079	0.0712
15	0.784	0.7875	0.0607
16	0.929	0.9431	0.0618

Learn more

[*Characterization of lubricants and oils by the Thermo Scientific FlashSmart Elemental Analyzer](#)

Chloride and sulfur in crude oil

Results obtained using combustion IC (CIC), which replaces time-consuming manual combustion methods with automated sample preparation to improve data reproducibility and accuracy.



Learn more

[Combustion ion chromatography with a Dionex Integron HPIC System](#)



Table of Contents

Introduction

Petroleum & Natural Gas Workflow
 Industrial Water Process Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA Analyzers
 Natural Gas Analyzers IC, CIC, IC MS
 Lab Data Management Software

Petroleum and Natural Gas Process

Upstream Sector
 Nitrogen and Chloride

SIMDIS of Crude

Midstream Sector

Downstream Sector

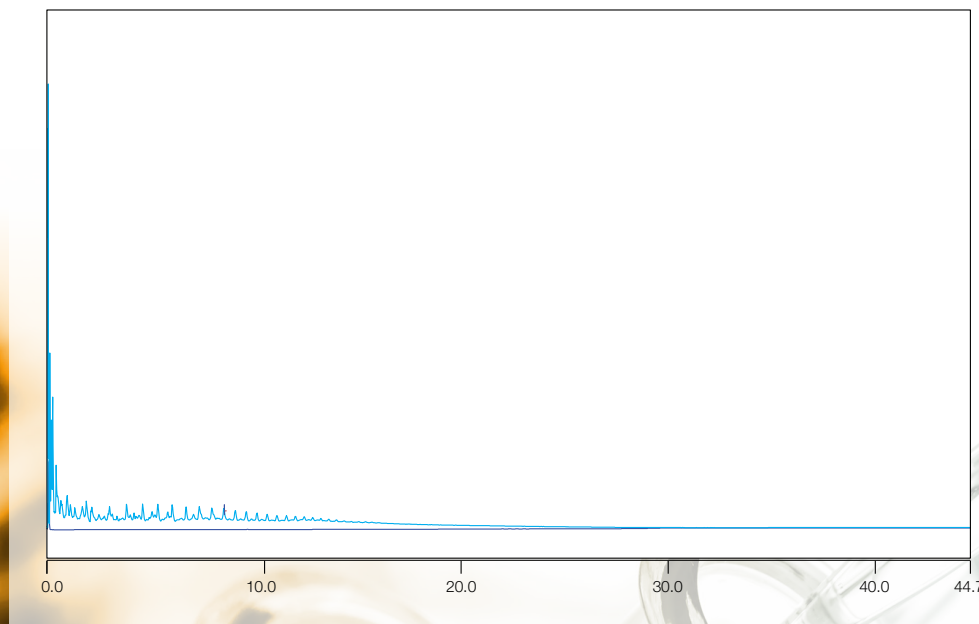
Industrial Water Processes

HSS in Refinery Solutions
 Cations and Amines in Alkanolamine Scrubbing Solutions
 Trace Anions in Boiler & Cooling Water

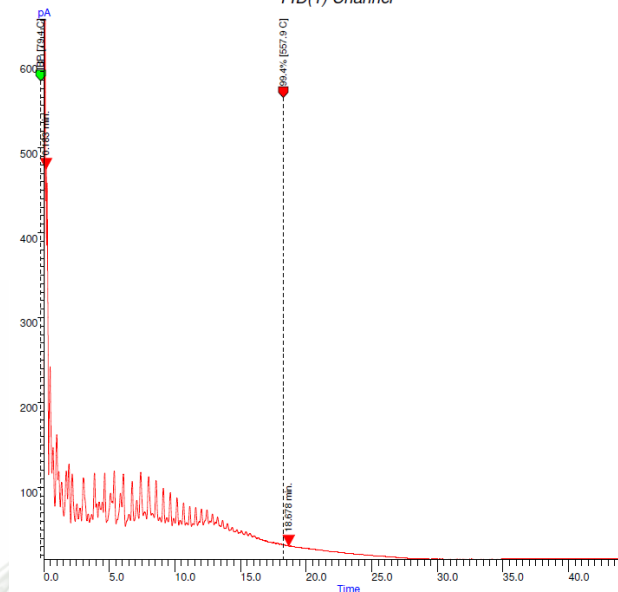
Resources

SIMDIS of crude oil

Results show the boiling point range distribution of petroleum fractions using a TRACE 1310 Gas Chromatograph. The chromatogram shows analysis of crude oil by ASTM D7169. The report at the right shows the percent of material at specific boiling points



Boiling Point Table (%Off)
 ASTM D7169
 FID(1) Channel



Recovery: 99.44 @1036.1F	Start Time: 0.183 min.	End Time: 18.678 min.
Analysis Area: 7.69980e+05	Start Signal: 475.025 pA	End Signal: 30.459 pA
Detector RF: 1.00000e+00	Sample Amt: 0.1000	Solvent Amt: 5.0000
R.Time Date: 1/26/2017	R.Factor Date: 1/26/2017	
Response Factor: 2.53271e-08		
R.Time File: C:\SimDis Data\07169 data\2017_Jan_16\Rt standard-2.cdf		
R.Factor File: C:\SimDis Data\07169 data\2017_Jan_16\RG0-3.cdf		
Blank File:		



Table of Contents

Introduction

Petroleum & Natural Gas
Workflow
Industrial Water Process
Workflow

**Oil and Gas Analytical
Technologies**

ICP-OES and OEA
Analyzers
Natural Gas Analyzers
IC, CIC, IC MS
Lab Data Management
Software

**Petroleum and Natural
Gas Process**

Upstream Sector
Midstream Sector
BTU of NGLs and NGs
Refinery Gas
Sulfur
Liquid Samples
Downstream Sector

**Industrial Water
Processes**

HSS in Refinery Solutions
Cations and Amines in
Alkanolamine Scrubbing
Solutions
Trace Anions in Boiler &
Cooling Water

Resources

The midstream process involves the transportation, storage, and custody transfer of crude and refined petroleum products. Pipelines and other transport systems are used to move crude oil from production sites to refineries and deliver the various refined products to downstream distributors.

NG, NGL Analyzer

Combustion IC

ICP-OES



Table of Contents

Introduction

Petroleum & Natural Gas Workflow
 Industrial Water Process Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA Analyzers
 Natural Gas Analyzers IC, CIC, IC MS
 Lab Data Management Software

Petroleum and Natural Gas Process

Upstream Sector
 Midstream Sector

BTU of NGLs and NGs

Refinery Gas
 Sulfur
 Liquid Samples
 Downstream Sector

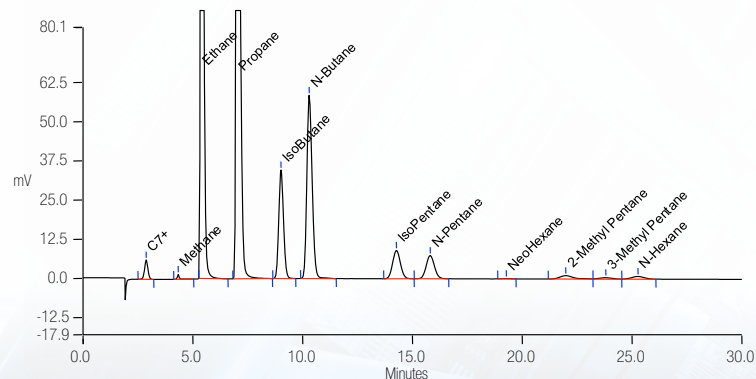
Industrial Water Processes

HSS in Refinery Solutions
 Cations and Amines in Alkanolamine Scrubbing Solutions
 Trace Anions in Boiler & Cooling Water

Resources

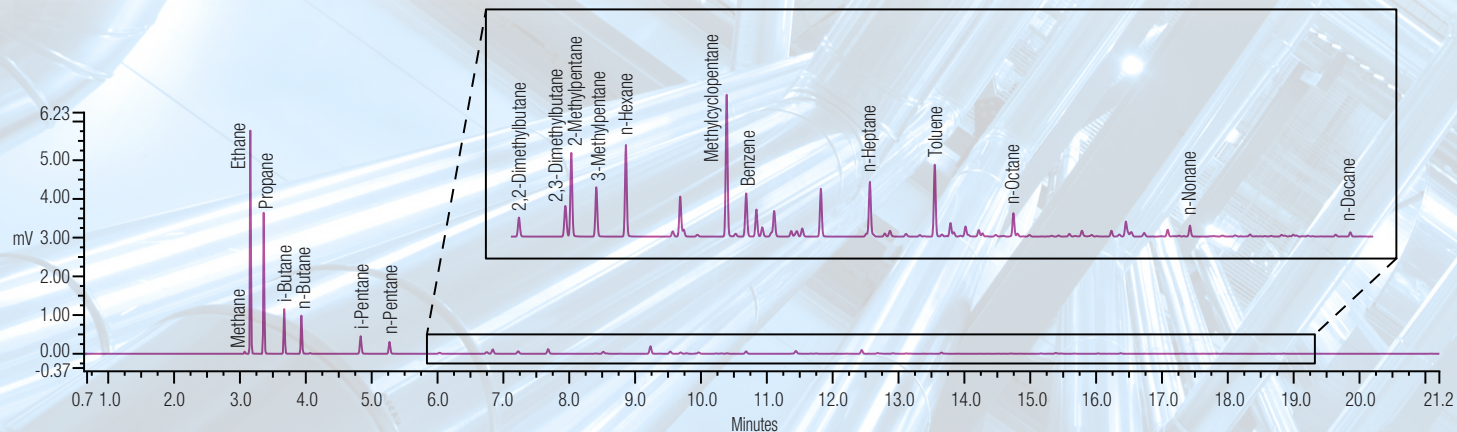
Determining BTU content of NGLs

Determination of the calorific value of natural gas liquids (NGL) by a TRACE 1300 Gas Chromatograph with thermal conductivity detection by GPA Method 2177.



Determining BTU Content of NGs

Determination of calorific value of natural gas (NG) by a TRACE 1300 Gas Chromatograph with FID Detection by GPA Method 2286.



Learn more

Natural Gas Analyzer for GPA 2177
 Natural Gas Analyzer for GPA 2186

Natural Gas Analyzer for GPA 2261
 Natural Gas Analyzer for GPA 2286



Table of Contents

Introduction

Petroleum & Natural Gas Workflow
 Industrial Water Process Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA

Analyzers
 Natural Gas Analyzers
 IC, CIC, IC MS
 Lab Data Management Software

Petroleum and Natural Gas Process

Upstream Sector
 Midstream Sector
 BTU of NGLs and NGs

Refinery Gas

Sulfur
 Liquid Samples
 Downstream Sector

Industrial Water Processes

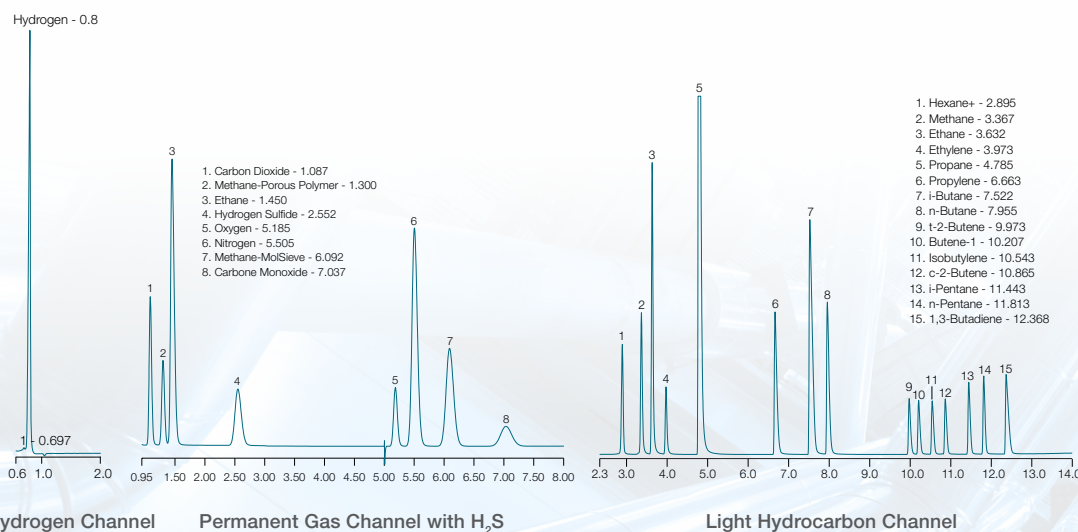
HSS in Refinery Solutions
 Cations and Amines in Alkanolamine Scrubbing Solutions
 Trace Anions in Boiler & Cooling Water

Resources

Refinery gas analysis

Three-channel systems provide a quantitative determination of hydrogen, permanent gases – CO₂, H₂S, and hydrocarbons C1-C8 in refinery process gases, LPG gases, and mixtures of propane and propene (excluding high-purity propene in the range of C1-C5) using a TRACE 1310 Gas Chromatograph.

Representative chromatograms



Learn more

[GC Analyzers for the Hydrocarbon Processing Industry](#)
[GC Analyzers Refinery Gas Analyzers](#)



Table of Contents

Introduction

Petroleum & Natural Gas
Workflow
Industrial Water Process
Workflow

**Oil and Gas Analytical
Technologies**

ICP-OES and OEA
Analyzers
Natural Gas Analyzers
IC, CIC, IC MS
Lab Data Management
Software

**Petroleum and Natural
Gas Process**

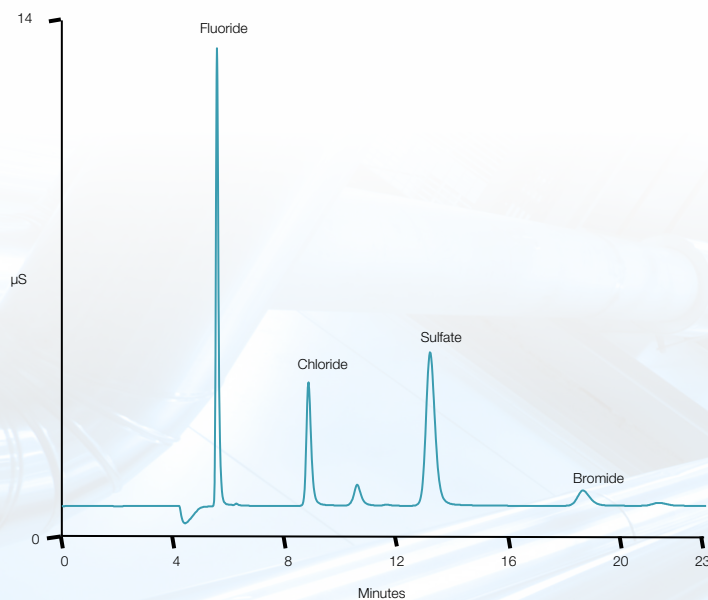
Upstream Sector
Midstream Sector
BTU of NGLs and NGs
Refinery Gas
Sulfur
Liquid Samples
Downstream Sector

**Industrial Water
Processes**

HSS in Refinery Solutions
Cations and Amines in
Alkanolamine Scrubbing
Solutions
Trace Anions in Boiler &
Cooling Water

Resources**Halogens and sulfur in LPG**

Results from the analysis of LPG using combustion IC (CIC) by ASTM 7994, automating sample preparation to improve data reproducibility and accuracy.



Learn more

Combustion ion chromatography with a
Dionex Integriion HPIC System



Table of Contents

Introduction

Petroleum & Natural Gas
Workflow
Industrial Water Process
Workflow

Oil and Gas Analytical
Technologies

ICP-OES and OEA

Analyzers

Natural Gas Analyzers

IC, CIC, IC MS

Lab Data Management

Software

Petroleum and Natural
Gas Process

Upstream Sector

Midstream Sector

BTU of NGLs and NGs

Refinery Gas

Sulfur

Liquid Samples

Downstream Sector

Industrial Water
Processes

HSS in Refinery Solutions

Cations and Amines in

Alkanolamine Scrubbing

Solutions

Trace Anions in Boiler &

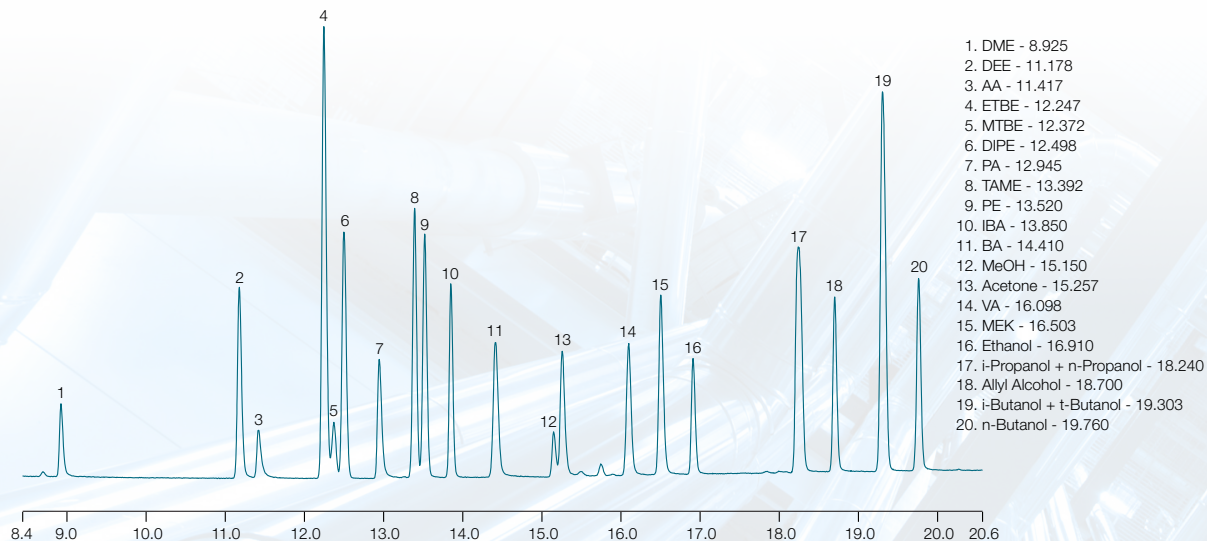
Cooling Water

Resources

GC analyzers for liquid samples

Liquid streams in a refinery process require analysis by gas chromatography. BTEX in gasoline, SIMDIS of crude oil and semi-finished products, DHA, and oxygenates are a few examples. ASTM D2/D3 provide numerous methods describing these analyses, like ASTM D7423 oxygenates in light hydrocarbons shown below

100 ppm standard 20 oxygenates in LPG



Learn more

GC Analyzers ASTM D7423 Analyzer

Table of Contents

Introduction

Petroleum & Natural Gas Workflow
Industrial Water Process Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA

Analyzers

Natural Gas Analyzers

IC, CIC, IC MS

Lab Data Management Software

Petroleum and Natural Gas Process

Upstream Sector

Midstream Sector

Downstream Sector

SIMDIS and Oxygenates

Lubricants

TEA in Naphtha

Aromatics in Gas

Organic acids

LIMS

Industrial Water Processes

HSS in Refinery Solutions

Cations and Amines in

Alkanolamine Scrubbing

Solutions

Trace Anions in Boiler &

Cooling Water

Resources

The downstream process refers to the refining of crude oil into petroleum products by distillation according to their boiling points. These products include the following;

Light distillates; LPG C3-C4, gasoline (C3-C12), naphtha (C6-14)

Middle distillates; kerosene, diesel (C9-C16), jet fuel (C9-C17)

Heavy distillates; lubricating oil (C20+)

GC, GC-MS

ICP-OES

IC

HPLC



Table of Contents

Introduction

Petroleum & Natural Gas Workflow
 Industrial Water Process Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA
 Analyzers
 Natural Gas Analyzers
 IC, CIC, IC MS
 Lab Data Management Software

Petroleum and Natural Gas Process

Upstream Sector
 Midstream Sector
 Downstream Sector

SIMDIS and Oxygenates

Lubricants
 TEA in Naphtha
 Aromatics in Gas
 Organic acids
 LIMS

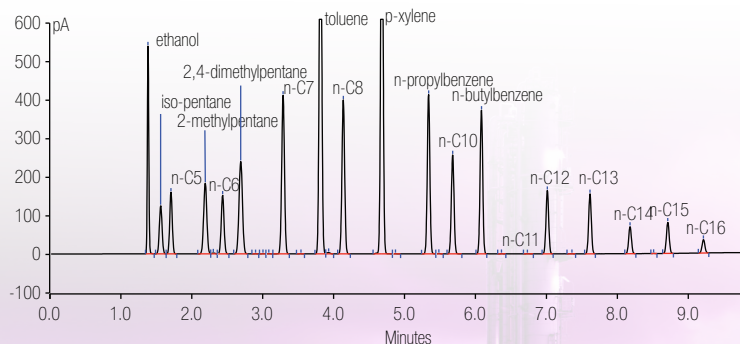
Industrial Water Processes

HSS in Refinery Solutions
 Cations and Amines in Alkanolamine Scrubbing Solutions
 Trace Anions in Boiler & Cooling Water

Resources

SIMDIS of gasoline with ethanol

SIMDIS is used to determine the boiling point range of refined product. The chromatogram shows the composition of gasoline with ethanol by ASTM D7096 simulated distillation with a TRACE 1310 Gas Chromatograph.



Learn more

[Reverse Flow Split/Splitless Injector: Simplification of ASTM D3606 and D4815 Methods](#)

Oxygenates in light HC samples

Analysis of corrosive oxygenates in LPG and other light hydrocarbons samples following ASTM D7423 using a TRACE 1310 Gas Chromatograph.

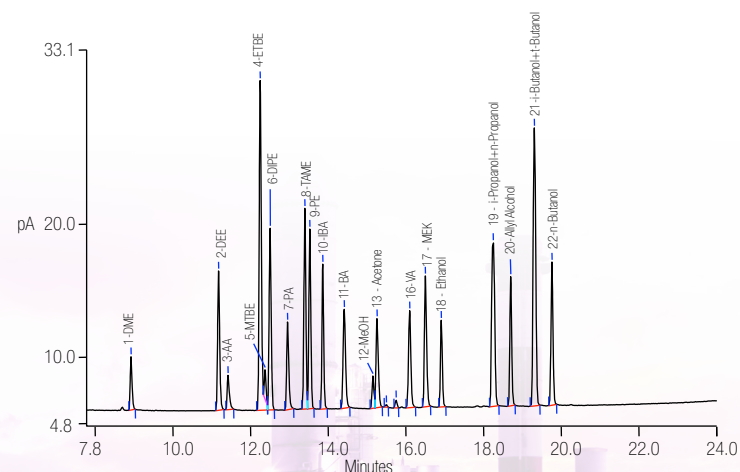


Table of Contents

Introduction

Petroleum & Natural Gas
Workflow
Industrial Water Process
Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA

Analyzers
Natural Gas Analyzers
IC, CIC
Lab Data Management
Software

Petroleum and Natural Gas Process

Upstream Sector
Midstream Sector
Downstream Sector
SIMDIS and Oxygenates
Lubricants
TEA in Naphtha
Aromatics in Gas
Organic acids
LIMS

Industrial Water Processes

HSS in Refinery Solutions
Cations and Amines in
Alkanolamine Scrubbing
Solutions
Trace Anions in Boiler &
Cooling Water

Resources**Nitrogen reproducibility of lubricants**

Results from the analysis of nitrogen show excellent reproducibility of lubricants with helium and argon gases by ASTM D5291 with the Thermo Scientific™ FLASH™ 2000 Organic Elemental Analyzer. There were no observable matrix effects when changing lubricant samples.

Sample Number	Helium Carrier Gas			Argon Carrier Gas		
	N%	Average N%	RSD %	N%	Average N%	RSD %
1	0.436	0.437	0.52	0.454	0.455	0.34
	0.440 0.436			0.455 0.457		
2	0.470	0.474	0.95	0.495	0.497	1.74
	0.479 0.473			0.489 0.506		
3	0.520	0.521	0.43	0.529	0.526	0.67
	0.524 0.520			0.522 0.526		
4	0.186	0.188	0.92	0.191	0.194	1.19
	0.189 0.189			0.195 0.195		
5	0.147	0.146	1.19	0.148	0.152	2.18
	0.147 0.144			0.148 0.153		
6	0.640	0.640	0.80	0.645	0.65	1.05
	0.635 0.645			0.648 0.658		



Table of Contents

Introduction

Petroleum & Natural Gas
Workflow
Industrial Water Process
Workflow

**Oil and Gas Analytical
Technologies**

ICP-OES and OEA

Analyzers
Natural Gas Analyzers
IC, CIC, IC MS
Lab Data Management
Software

**Petroleum and Natural
Gas Process**

Upstream Sector
Midstream Sector
Downstream Sector
SIMDIS and Oxygenates
Lubricants

TEA in Naphtha

Aromatics in Gas
Organic acids
LIMS

**Industrial Water
Processes**

HSS in Refinery Solutions
Cations and Amines in
Alkanolamine Scrubbing
Solutions
Trace Anions in Boiler &
Cooling Water

Resources**Trace element analysis in naphtha**

Results from the analysis of spiked naphtha are within acceptable limits of $\pm 5\%$ of the true values using Thermo Scientific™ iCAP™ 7600 ICP-OES. A cooled spray chamber reduces the volatility of the solvent, providing a more stable plasma for detecting trace elements at single digit ppb levels in complex matrices.

Element and Wavelength (nm)	Spike Concentration mg kg ⁻¹	Measured Spike Concentration mg kg ⁻¹	Spike Recovery %	RSD on Three Replicates of the Spike %	MDL µg kg ⁻¹
Ag 328.068	2.34	2.44	104	1.36	3.4
Al 396.152	2.34	2.46	105	1.20	7.9
As 189.042	2.37	2.39	101	0.25	7.4
B 208.893	2.34	2.44	104	0.58	13
Ba 455.403	2.34	2.40	103	0.86	0.2
Ca 393.366	2.34	2.44	104	0.33	0.1
Cd 228.802	2.34	2.37	101	0.28	0.6
Cr 267.716	2.34	2.34	100	0.57	1.0
Cu 324.754	2.34	2.44	104	1.15	1.3
Fe 259.940	2.34	2.34	100	0.35	1.9
Hg 184.950	2.36	2.38	101	0.44	2.7
Mg 279.553	2.34	2.39	102	0.22	0.04
Mn 257.610	2.34	2.34	100	0.38	0.3
Mo 202.030	2.34	2.35	100	0.19	2.7
Na 589.592	2.34	2.43	104	1.43	10
Ni 221.647	2.34	2.30	98	0.32	1.6
P 178.284	2.34	2.36	101	0.19	11
Pb 220.353	2.34	2.27	97	0.12	7.6
Si 212.412	2.34	2.39	102	0.46	8.0
Sn 189.989	2.34	2.27	97	0.92	8.1
Ti 334.941	2.34	2.37	101	0.40	0.4
V 309.311	2.34	2.37	101	0.39	1.0
Zn 213.856	2.34	2.35	100	0.01	0.4

Table of Contents

Introduction

Petroleum & Natural Gas
Workflow
Industrial Water Process
Workflow

**Oil and Gas Analytical
Technologies**

ICP-OES and OEA
Analyzers
Natural Gas Analyzers
IC, CIC, IC MS
Lab Data Management
Software

**Petroleum and Natural
Gas Process**

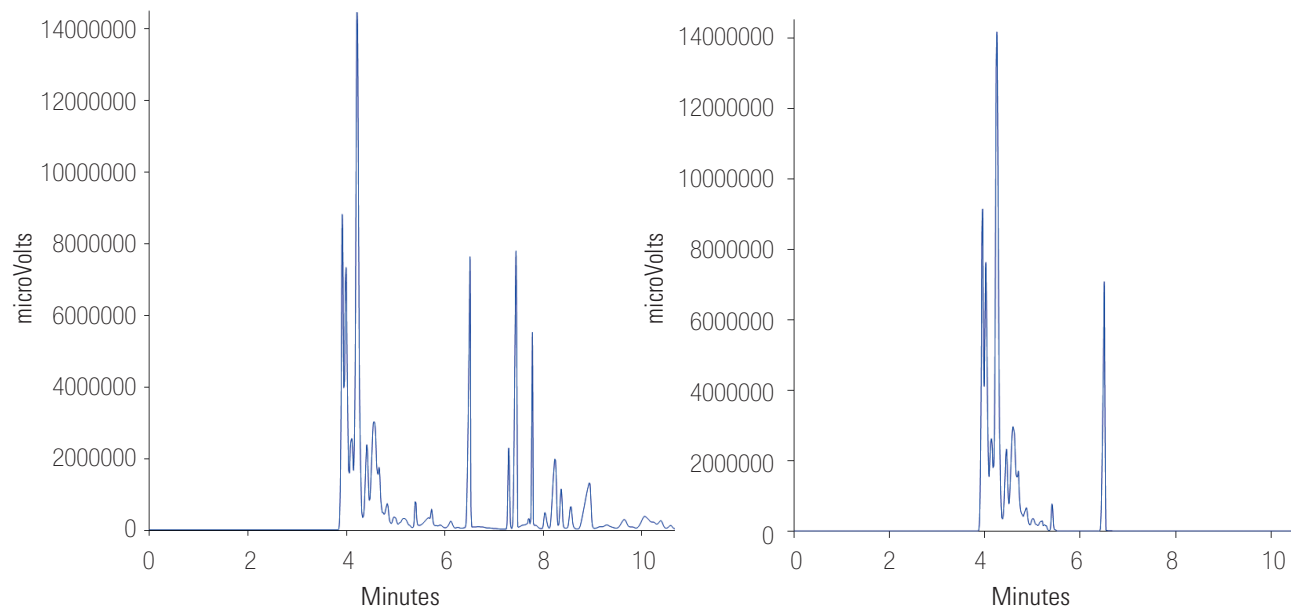
Upstream Sector
Midstream Sector
Downstream Sector
SIMDIS and Oxygenates
Lubricants
TEA in Naphtha
Aromatics in Gas
Organic acids
LIMS

**Industrial Water
Processes**

HSS in Refinery Solutions
Cations and Amines in
Alkanolamine Scrubbing
Solutions
Trace Anions in Boiler &
Cooling Water

Resources**Benzene and toluene in gasoline**

Analysis of aromatics (used to boost octane levels in gasoline) is shown with backflush (right) and without backflush (left) using a TRACE 1310 Gas Chromatograph. In the right chromatogram the heavier matrix components are eliminated, leaving the column and detector cleaner.



Learn more

[Simplification of the ASTM D3606 Method for the Determination for Benzene and Toluene in Gasoline](#)



Table of Contents

IntroductionPetroleum & Natural Gas
WorkflowIndustrial Water Process
Workflow**Oil and Gas Analytical
Technologies**

ICP-OES and OEA

Analyzers

Natural Gas Analyzers

IC, CIC, IC MS

Lab Data Management
Software**Petroleum and Natural
Gas Process**

Upstream Sector

Midstream Sector

Downstream Sector

SIMDIS and Oxygenates

Lubricants

TEA in Naphtha

Aromatics in Gas

Organic acids

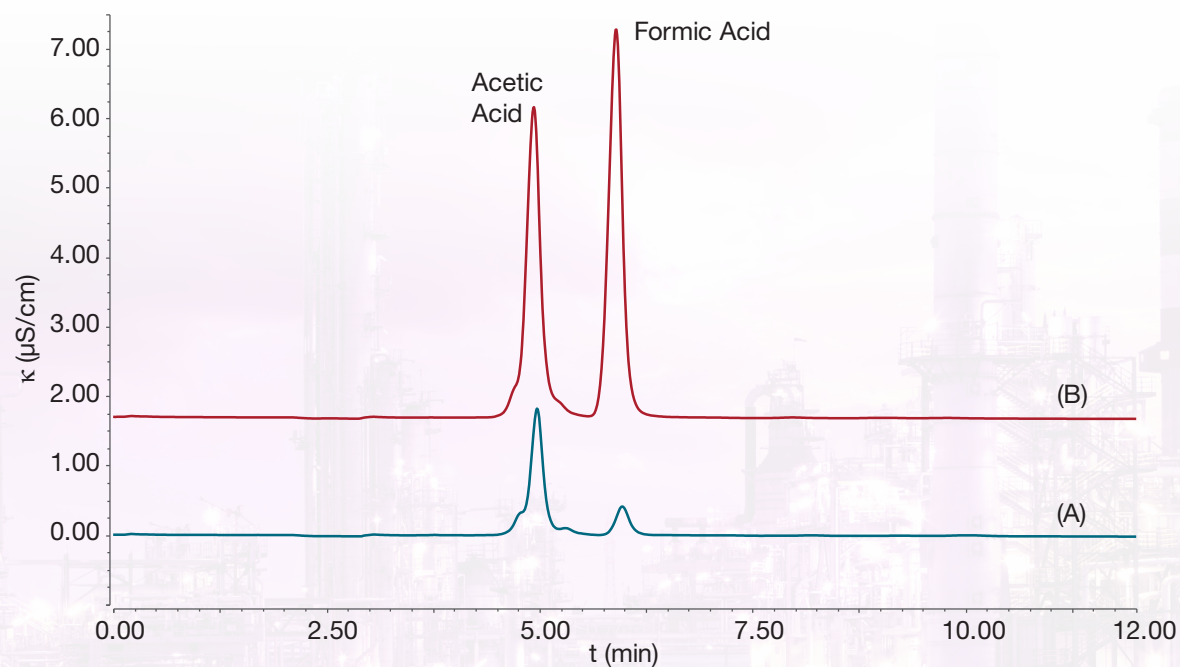
LIMS

**Industrial Water
Processes**

HSS in Refinery Solutions

Cations and Amines in
Alkanolamine Scrubbing
SolutionsTrace Anions in Boiler &
Cooling Water**Resources****Acetic acid and formic acid in diesel motor oil**

Results from a new IC method shows determination of acetic acid and formic acid in diesel containing 2% motor oil. (A) original sample (B) sample spiked with 10 mg/L of each organic acid (an offset of 20% was applied). Mixtures with up to 10% oil content, compatible with the Dionex Integriion HPIC system, showed no impact on the analytical performance, or method stability.



Learn more

[CAN 72204: Determination of Formic and Acetic Acids in Petroleum Products](#)

Table of Contents

Introduction

Petroleum & Natural Gas Workflow
 Industrial Water Process Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA Analyzers
 Natural Gas Analyzers IC, CIC, IC MS
 Lab Data Management Software

Petroleum and Natural Gas Process

Upstream Sector
 Midstream Sector
 Downstream Sector
 SIMDIS and Oxygenates
 Lubricants
 TEA in Naphtha
 Aromatics in Gas
 Organic acids
LIMS

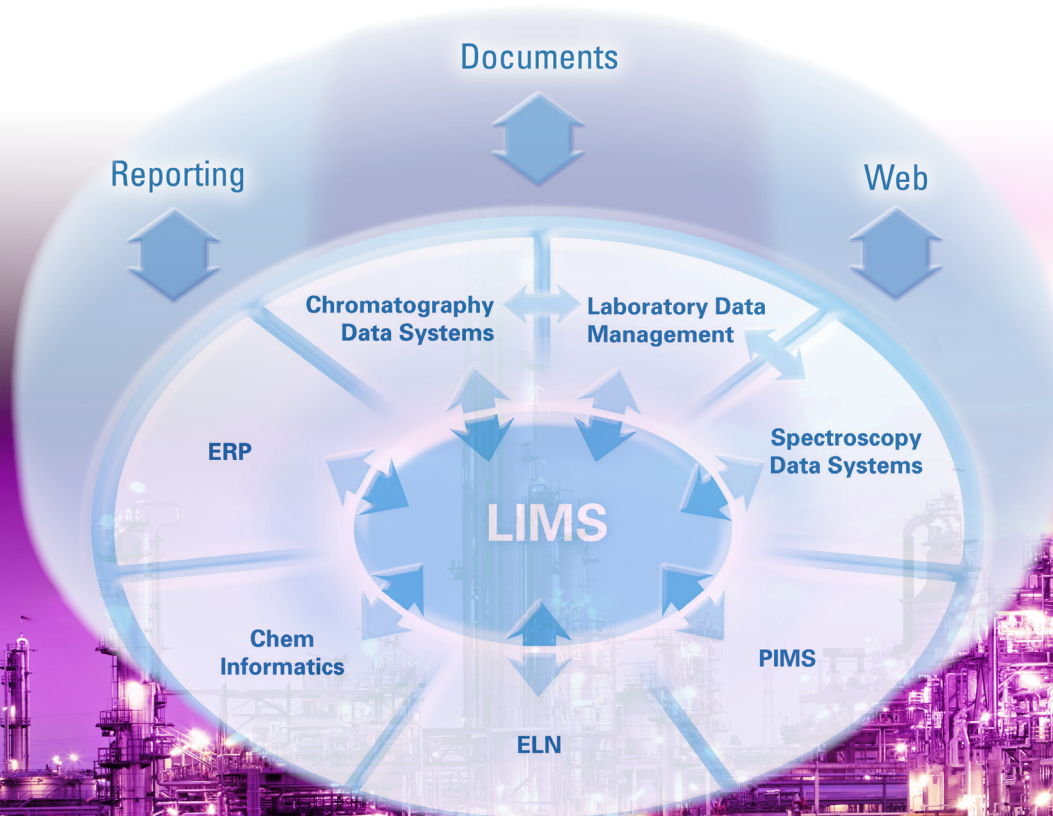
Industrial Water Processes

HSS in Refinery Solutions
 Cations and Amines in Alkanolamine Scrubbing Solutions
 Trace Anions in Boiler & Cooling Water

Resources

Lab data management, analysis, and reporting

LIMS can be integrated across the organization including lab instruments and applications as well as enterprise systems and systems



Learn more

[SampleManager LIMS Software Solutions](#)

[Implementation of Thermo Scientific SampleManager LIMS at Sinopec Guangzhou](#)

[The Real Benefits of Standardizing on a Single LIMS in the Gas and Petroleum Industry](#)

[Thermo Scientific Integrated Information Informatics Solutions for the Oil and Gas Industry](#)



Table of Contents

IntroductionPetroleum & Natural Gas
WorkflowIndustrial Water Process
Workflow**Oil and Gas Analytical
Technologies**

ICP-OES and OEA

Analyzers

Natural Gas Analyzers

IC, CIC, IC MS

Lab Data Management
Software**Petroleum and Natural
Gas Process**

Upstream Sector

Midstream Sector

Downstream Sector

**Industrial Water
Processes**

HSS in Refinery Solutions

Cations and Amines in
Alkanolamine Scrubbing
SolutionsTrace Anions in Boiler &
Cooling Water**Resources****Lab data management, analysis, and reporting**

Industrial water processes refer to preventative maintenance applications that keep a refinery operational. Alkaline scrubber solutions are used to neutralize corrosive acids such as H_2S formed during distillation that left untreated can damage equipment and release toxic gases into the air. Boiler and cooling water, used to control the distillation temperature, are treated with amines to neutralize acidic steam condensate.

IC

GC, GC-MS

ICP-OES



Table of Contents

Introduction

Petroleum & Natural Gas Workflow
 Industrial Water Process Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA Analyzers
 Natural Gas Analyzers
 IC, CIC, IC MS
 Lab Data Management Software

Petroleum and Natural Gas Process

Upstream Sector
 Midstream Sector
 Downstream Sector

Industrial Water Processes

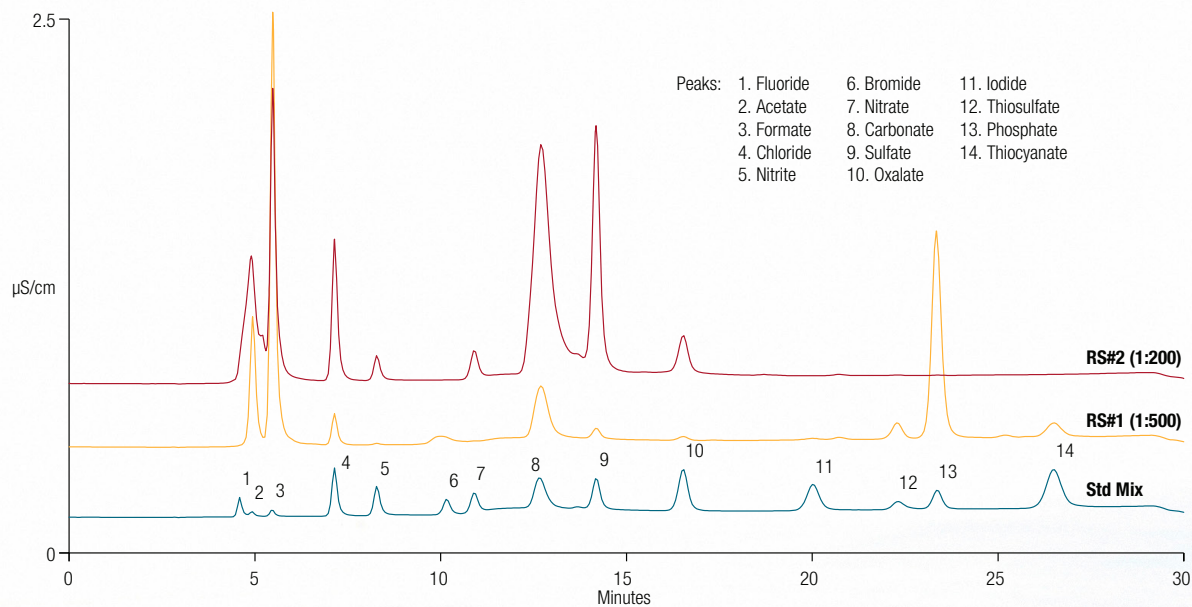
HSS in Refinery Solutions

Cations and Amines in Alkanolamine Scrubbing Solutions
 Trace Anions in Boiler & Cooling Water

Resources

Heat stable salts (HSS) in refinery solutions

Gradient separation of refinery samples. Results show resolution of corrosive anions, organic acids, thiosulfate, and thiocyanate using a Thermo Scientific™ Dionex™ IonPac™ AS25A column in less than 30 minutes.



Learn more

Fast separation of heat stable salts



Table of Contents

Introduction

Petroleum & Natural Gas Workflow
 Industrial Water Process Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA Analyzers
 Natural Gas Analyzers
 IC, CIC, IC MS
 Lab Data Management Software

Petroleum and Natural Gas Process

Upstream Sector
 Midstream Sector
 Downstream Sector

Industrial Water Processes

HSS in Refinery Solutions

Cations and Amines in Alkanolamine Scrubbing Solutions

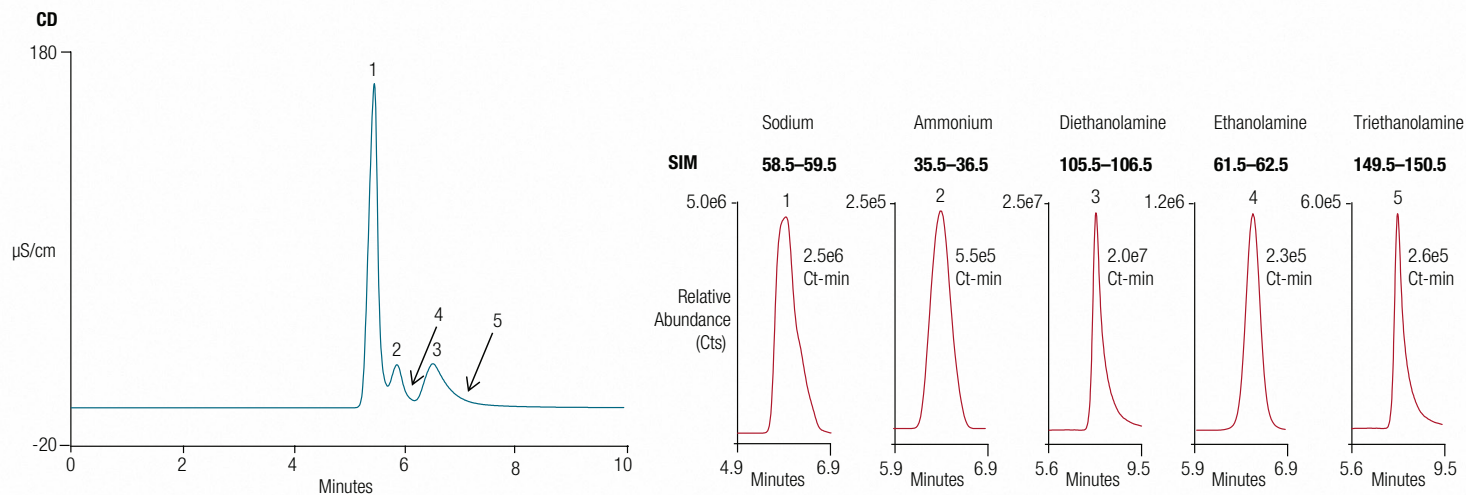
Trace Anions in Boiler & Cooling Water

Resources

Cations and amines in alkanolamine scrubbing solutions

Cations and amines in a scrubbing solution containing 100 mg/L sodium and ammonium were determined by Ion Chromatography with Mass Spectrometry (IC-MS). Coupling an MS detector to an IC system provides confirmatory information

and reduces the overall run time by fully resolving analytes (Selected Ion Monitoring, SIM) that are only partially resolved by conductivity detection (CD).



Learn more

Using ion chromatography with electrospray ionization mass spectrometry for the determination of cations and amines in alkanolamine scrubbing solutions



Table of Contents

Introduction

Petroleum & Natural Gas
Workflow
Industrial Water Process
Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA
Analyzers
Natural Gas Analyzers
IC, CIC, IC MS
Lab Data Management
Software

Petroleum and Natural Gas Process

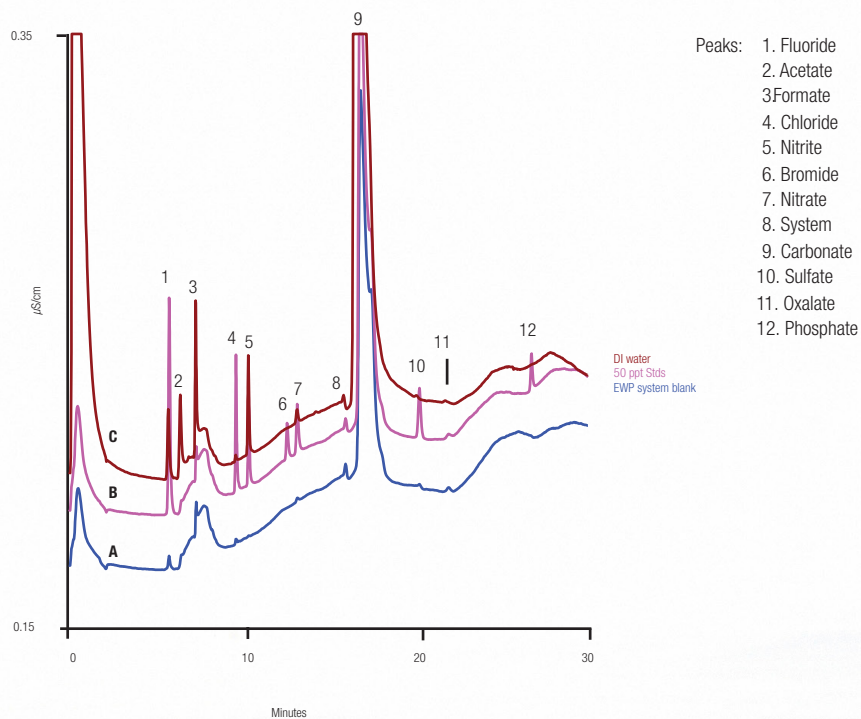
Upstream Sector
Midstream Sector
Downstream Sector

Industrial Water Processes

HSS in Refinery Solutions
Cations and Amines in
Alkanolamine Scrubbing
Solutions

Trace Anions in Boiler & Cooling Water**Resources****Trace anions in boiler & cooling water**

Anionic contaminants in boiler and cooling water can be determined at trace levels (ppt) by ion chromatography with suppressed conductivity detection using automated calibration and electrolytic water purification (EWP).



[Learn more](#)

[Configuring the Dionex Integrion HPIC system for trace anion determinations in ultrapure water](#)

Table of Contents

Introduction

Petroleum & Natural Gas

Workflow

Industrial Water Process

Workflow

Oil and Gas Analytical Technologies

ICP-OES and OEA

Analyzers

Natural Gas Analyzers

IC, CIC, IC MS

Lab Data Management

Software

Petroleum and Natural Gas Process

Upstream Sector

Midstream Sector

Downstream Sector

Industrial Water Processes

HSS in Refinery Solutions

Cations and Amines in Alkanolamine Scrubbing Solutions

Trace Anions in Boiler & Cooling Water

Resources

Additional Resources

Oil and gas products

www.thermofisher.com/oilandgastesting

Oil and gas onformation

www.thermofisher.com/oilandgasinfo

Oil and gas analyte blogs

<http://analyteguru.com/oil-gas>



Find out more at thermofisher.com

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