

# Enhanced Total Sulfur Analysis in fuels by TS 7000 to comply with ASTM D5453 method

This note describes the backgrounds, principle of operation and performance data of the Total Sulfur analysis in fuel samples carried out by the new TSHR Total Sulfur analyzer, model TS 7000.

## Introduction

The analysis of total sulfur in automotive fuels and related refinery products which is defined in ASTM D5453 method requires an easy to use, reliable and accurate lab analyzer from operator, laboratory and refinery operations perspective. The TSHR TS 7000 model, Total Sulfur analyzer, demonstrates an enhanced performance and fully compliance solution towards ASTM D5453 method.

Having minimum sample volumes but keep the same detection performance at low ppm level sulfur content within the scope of above ASTM method will have significant user advantages such as high productivity, less downtime and precise sulfur data.

This Note described the total sulfur performance data on the TSHR TS 7000 instrument, equipped with an auto injector (AI 7000 model) or with a liquids autosampler, HR 7000 series, to test the use of typical sample volumes and verify the calibration curves performance as per ASTM D5453 method. Also a set of CRM ultra-low sulfur diesel samples (ULSD) have been analyzed to show the correlation reference of these CRM samples when using the TS 7000.



Figure 1: TS 7000 with HR 7015 autosampler

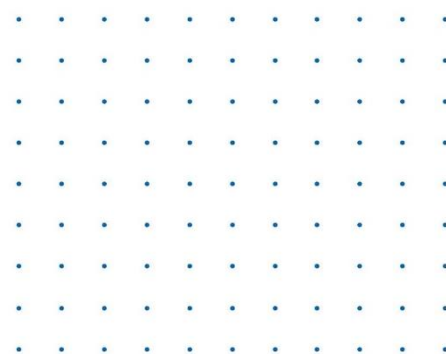
## Procedure

The ASTM D5453 method defined 3 calibration lines (Curves I, II and III) with the following concentrations and sample volumes:

Standard	Curve I	Curve II	Curve III
1	0,5	5	100
2	1,0	25	500
3	2,5	50	1000
4	5,0	100	
5	10,0		
Sample size	20 uL	10 uL	5 uL

Table 1: Calibration curves, points and sample volumes as per ASTM D5453 method

According above defined curves, a set of calibration standards have been analyzed with the respective concentrations and use the given sample sizes to analyze these as three replicates on the TSHR TS 7000 model total sulfur analyzer. The used system settings of the TS 7000 have been given in Table 2. The results obtained from these calibration standards are given in Table 3.



System	Setting
Inlet temperature	450 °C
Furnace I temperature	850 °C
Furnace II temperature	1050 °C
Carrier gas flow (Ar)	75 ml/min
Primary Oxygen (O <sub>2</sub> )	250 ml/min
Secondary Oxygen (O <sub>2</sub> )	100 ml/min
Sample volume	5 – 20 uL

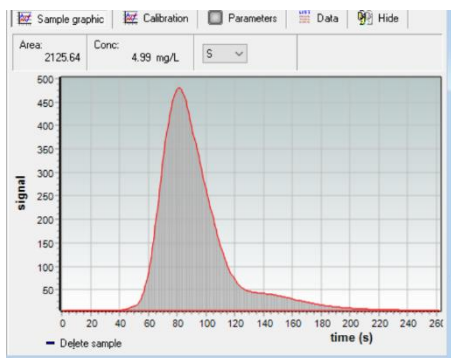
**Table 2: System settings of TS 7000**

## Results

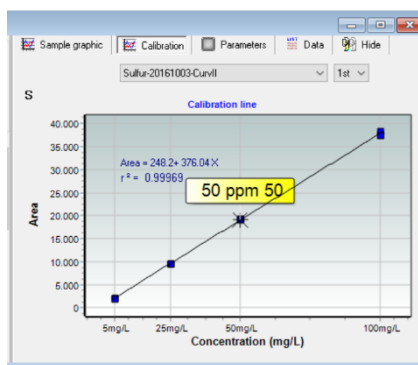
Results of Total Sulfur Calibration lines – ASTM D5453						
Standard	Curve I		Curve II		Curve III*	
	Mean (mg/L)	RSD %	Mean (mg/L)	RSD %	Mean (mg/L)	RSD %
1	0,51	2,0	4,78	0,9	104	0,7
2	0,94	1,9	25,0	0,5	492	1,3
3	2,40	1,5	50,5	0,8	1004	2,0
4	5,13	0,2	99,8	1,2		
5	9,97	0,7				
<b>R<sup>2</sup></b>	<b>0,9997</b>		<b>0,9997</b>		<b>0,9990</b>	

**Table 3: Total Sulfur data for the 3 calibration curves as per ASTM D5453**

*\*High range setting UV-F detector*



Sample graph of 5 ppm S with 10 uL injection volume



Calibration line 0 – 100 ppm

The results of curves I and II gives a good linearity and repeatability when using reduced sample volumes, as defined in ASTM D5453 method, on the TS 7000 instrument.

Curve III measure in high range setting of the UV-F detector shows also a good correlation and the use of only 5 uL sample volume gives a RSD below 2% for the 3 concentrations.

## Analysis of diesel samples

Name CRM	Den. (kg/L)	Ref. Value S (mg/kg)	Ref. Var S (mg/kg)	TSHR S (mg/kg)	TSHR Var S (mg/kg)	$\Delta$ TSHR Ref. S (mg/kg)
ASTM ULSD 1002	0,8521	7,66	0,56	7,55	0,13	-0,11
ASMT ULSD 1004	0,8515	7,63	0,47	7,55	0,03	-0,08
ASTM ULSD 1005	0,8364	4,75	0,38	4,64	0,20	-0,11
ASTM ULSD 1006	0,8365	4,72	0,38	4,62	0,14	-0,10
ASTM ULSD 1101	0,8617	8,31	0,48	7,84	0,07	-0,47

## Summary

Based on above experiments and test data we can conclude that the TSHR TS 7000 model in conjunction with the AI 7000 model auto injector and HR 7000 Liquids Autosampler series, is capable of handling low sample volumes as 5 up to 20 uL with precise sulfur data. This will result into short analysis times of less than 5 minutes and give customers productivity savings and low costs of operation. Also the sulfur content in diesel samples show a very good reproducibility and correlation with the reference data.

## Contact info

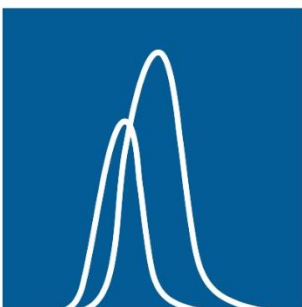
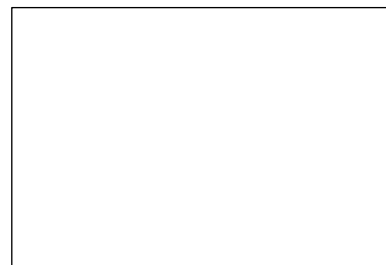
For service: [technicalsupport@tshrinternational.com](mailto:technicalsupport@tshrinternational.com)

For sales: [sales@tshrinternational.com](mailto:sales@tshrinternational.com)

For other: [info@tshrinternational.com](mailto:info@tshrinternational.com)

TSHR website: [www.tshrinternational.com](http://www.tshrinternational.com)

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