APPLICATION NOTE

Using Hydrogen as Carrier Gas:
Fast Detailed Hydrocarbon Analysis (DHA) analog to ASTM D6730

- **Lower Cost of Operation**
- **Cuts Analysis time by ± 1 Hour**
- **Compares to ASTM Methods**

Keywords:
DHA, Carrier, Hydrogen

INTRODUCTION

In todays labs chromatographers are more and more likely to choose hydrogen as a carrier gas. This decision is driven by increasing helium prices and supply shortage issues.
Helium prices on average are approximately 4 times that of Hydrogen, and with the price for helium expected to increase with an estimated 10-15% year over year, the benefits are easy to see. An average lab employing 5 to 10 GC systems can save as much as several thousands of dollars per year in operating cost just by changing carrier gas to Hydrogen.
This application note describes the safe use of Hydrogen as carrier gas, and discusses its analytical speed benefits.

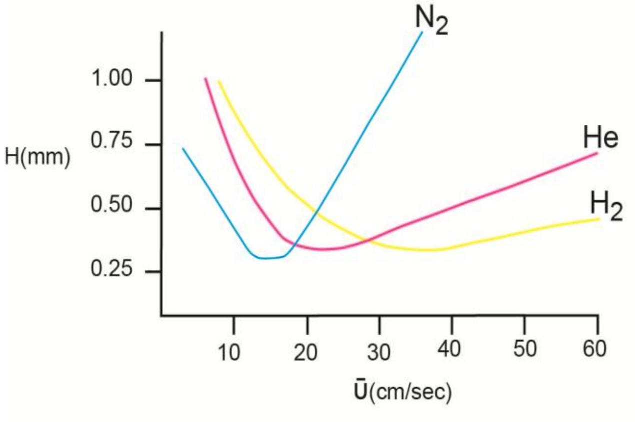

Figure 1: Van Deemter Curve for Different Carrier Gases

HYDROGEN AS SUPERIOR CARRIER

Hydrogen is an extremely useful carrier gas for GC and provides significant benefits compared to the use of helium. The major benefit of hydrogen is the fact that it can lead to a dramatic reduction of the time required for any given separation.
The Golay theory for open tubular columns predicts that optimum gas velocity is proportional to diffusivity. Hydrogen has a higher diffusivity than helium, thus its optimum linear velocity is higher, and can be used at a higher flow rate without adversely affecting efficiency.
The Height Equivalent to Theoretical Plate (HETP) is maintained over a wider range of linear velocities for Hydrogen (see Figure 1).

SYSTEM DESCRIPTION

Any basic DHA systems is equipped with S/SL injector, FID, silicone capillary column and usually an automated injection device.
Using the unique Combi inlet, any AC DHA analyzer may be configured for running two applications in one system:

- a DHA Front End application for light end analysis in crude oil
- one of the following standard ASTM test methods: D6729, D6730, D6733
- or even our own AC Fast DHA method.

The AC DHA Front End and Combi solutions are available on the 7890 Series GC only.
For the Front End application the AC pre-fractionator is added to backflush the heavy part of the sample. The AC Combi systems combine a pre-fractionating injector and a split/splitless injector. The S/SL injector is dedicated to samples in the naphtha and gasoline range whereas crude oil samples are injected on the pre-fractionating injector.

RESULTS & COMPARISON

Use of Hydrogen Carrier lowers runtime with up to 1 hour, depending on method, as can be seen in Figure 3. Note that the chromatograms appear very similar, and may almost be overlaid.
Table 2 compares runtimes for both carrier gases across different DHA methods

Method	Helium	Hydrogen
ASTM D6729	140 min	90 min
ASTM D6730	173 min	110 min
ASTM D6733	137 min	90 min
DHA FE	137 min	90 min

Table1: Compared Analysis time per Method

Some critical-pair separations are mentioned in ASTM D6730.
Separation of the following pairs is compared for Hydrogen and hydrogen carriers:

1. 1-methylcyclopentene / Benzene
2. 2,3,3-trimethylpentane / Toluene
3. 1,4-dimethylbenzene / 2,3-Dimethylheptane
4. 1-Methylnaphthalene / n-Tridecane.

Resolution	Helium	Hydrogen	δ
Pair 1	3.6	3.5	-0.1
Pair 2	2.8	2.8	0.0
Pair 3	2.0	1.7	-0.3
Pair 4	3.7	3.8	0.1

Figure 2 compares separation efficiency graphically demonstrating results with Hydrogen are equal to those with Helium carrier. They are conform pair separation requirements for ASTM methods.

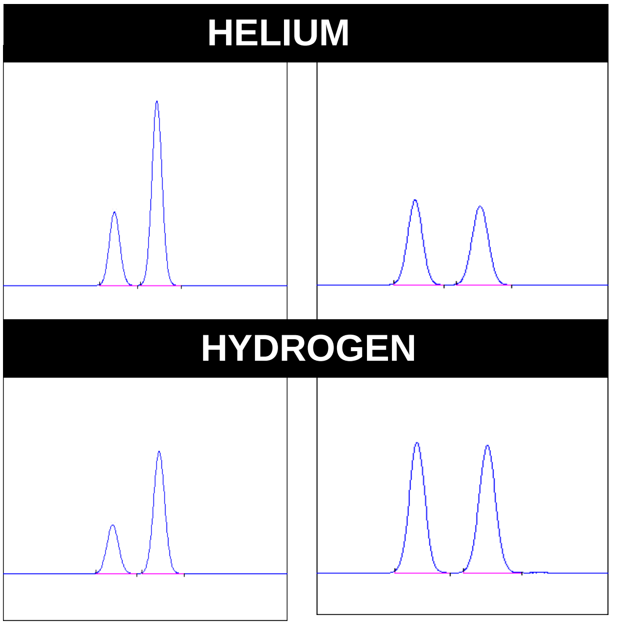

Figure 2: Critical Pair Separations for 1-methyl cyclopentene / Benzene *(left figure) and* 1-Methyl naphthalene / n-Tridecane *(right figure) for Helium (upper trace) and Hydrogen carrier (lower trace). Data on Hydrogenchannel rescaled for comparison.*

SAFETY CONCERNS

If your laboratory now uses or plans to use hydrogen as fuel or carrier gas, you should always review company, state or national laws and policies, make use of safety equipment and procedures related to hydrogen.
All AC DHA systems are employed with electronic pressure controls and these automated systems will detect potentially unsafe fault situations that could result in leakage, and will shut off carrier gas flow to avoid any potentially unsafe situation.

CONCLUSION

Data demonstrates that Hydrogen can be used as alternative to Helium. Without any compromise to data quality, this will lower cost of operation, decrease time to result and increase sample throughput.

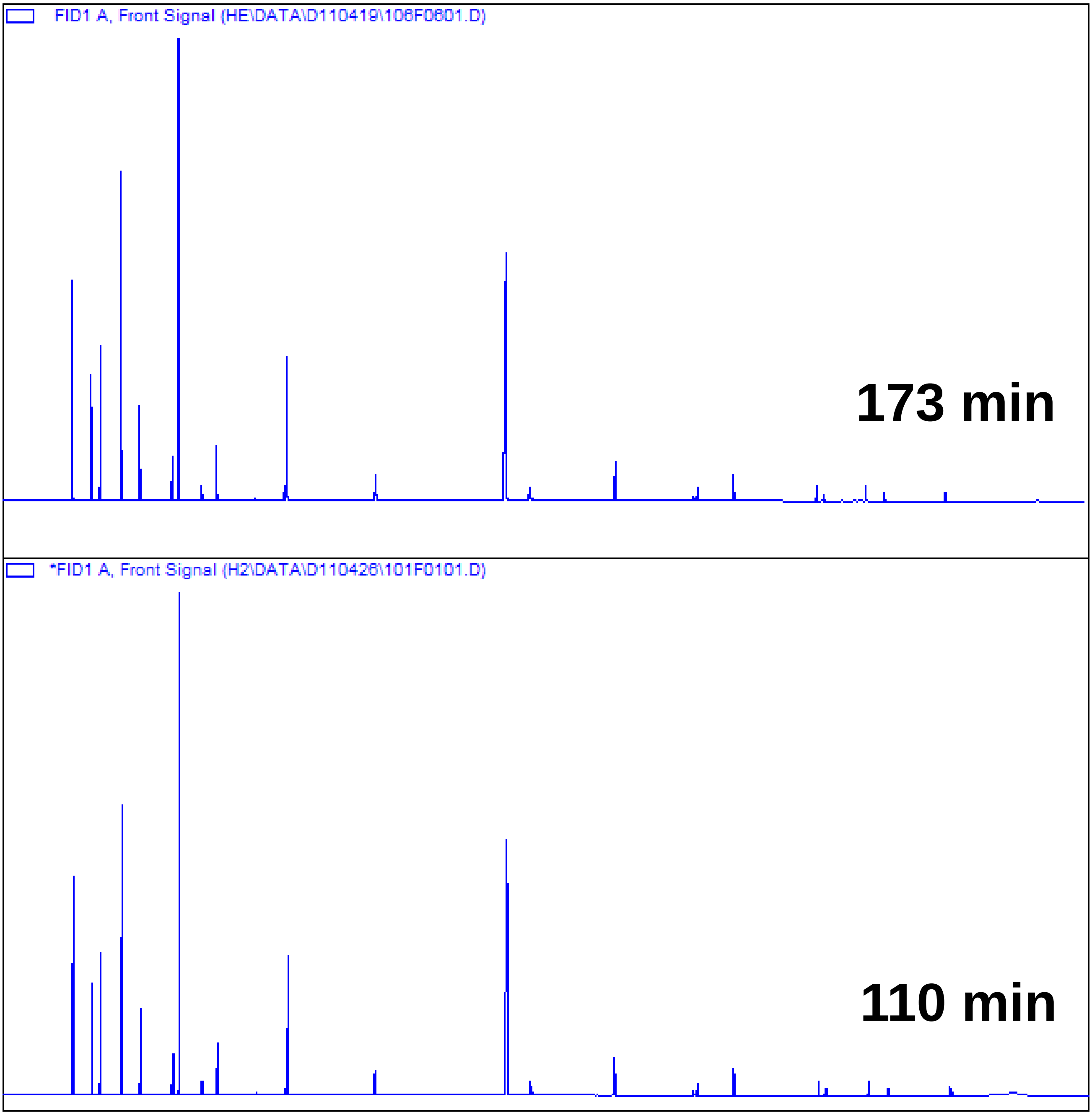

Figure 3: Compared Chromatograms for DHA ASTM D6730. Upper Trace is the application on Helium Carrier taking >170 minutes, lower trace is on Hydrogen carrier , runtime is 110 minutes.

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