Solving the Myth About Recoverable Gasoline From Vapor Recovery Systems

A Technical Article

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PREFACE

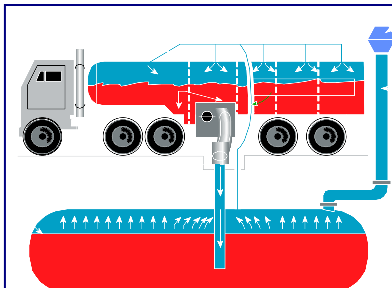
The purpose of this paper is to bring about much needed change in the design standards for hydrocarbon vapor emission systems in the bulk fuels terminal business. The change targeted is reduced capital spending and the application of advanced technology, both geared to the overall benefit of all terminal owners.

INTRODUCTION

The Clean Air Act of 1970 was preceded by an information gathering period intended to establish the actual conditions that exist in gasoline bulk loading terminals like the one pictured here. Gasoline marketers collected and analyzed random samples of tank truck vapors, and reported the findings to what would become the EPA. The result of years and testing and hundreds of samples are well documented in the Code of Federal Register (CFRs) for all to read, and the vapor control legislation that followed was based on this data.

It is generally accepted that the VOCs which form gasoline vapors reach equilibrium in air at about 60-65% by volume. However, test results of actual samples showed that actual HC concentrations range from a few percent to around 40%, depending on the several factors.

The key factor appeared to be the method used to manage vapors during offloading. When vapors from the receiving underground service station tank were allowed to escape to atmosphere, the HC concentration in the tank truck compartment was found to be low, often in the 3% to 10% range.



STAGE 1 VAPOR CONTROL

However, when the vapors from the receiving tank were directed into the tanker truck instead of being allowed to escape to atmosphere, the HC concentration in the tanker compartments was found to be in the 20-40% range, averaging about 30%. This difference prompted language in the Clean Air Act addressing the benefits of what is referred to as “Stage 1” vapor balancing.

DESIGN STANDARDS ESTABLSHED

In the 1970s various existing and a few new technologies were developed in an effort to capture hydrocarbon vapor from tanker truck compartments and to return that vapor to the liquid phase. The hydrocarbon vapor recovery industry was born. With no experience to draw from, this fledgling industry looked to the documentation in the

CFRs for design data, and the 30% HC concentration mentioned above quickly became a design standard that persists today. In the succeeding twenty years over 1000 vapor recovery systems were designed and manufactured and placed in service using this design standard as the basis for sizing each system.

The contributing issues to actual hydrocarbon concentration have been largely forgotten or overlooked. It is a rare occasion that samples are taken or tests conducted on the actual vapors to be recovered today in any terminal anywhere. In fact, many terminal owners and engineering firms now presume that the actual hydrocarbon concentration in tanker truck compartment vapors is likely to be closer to 40% on average due to the greater efficiency of all hoses and connections, allowing fewer leaks than existed in the early days of the original testing (now nearly fifty years ago!). So, some firms use the 40% HC concentration as the design standard for new or retrofit vapor recovery systems in contemporary applications today.

So, rightly or wrongly, the design standard for hydrocarbon concentration in 2007 used by most firms in inquiries for new or retrofit applications is either 30% or 40% hydrocarbons in the vapor phase of the recoverable vapors.

THE REALITY VERSUS THE MYTH

In the years since the 1970 original Clean Air Act was signed into law very little has been done by terminal owners or vapor control system suppliers to document the actual hydrocarbon concentration. However, in 2003 one firm decided to take a proactive approach to this question, and began to install vapor recovery systems with analytical instrumentation and computerized long-term recording capabilities. That firm is SYMEX Americas. In the years since 2003 this 21st century approach has shown that the 30-40% design HC concentration is a myth.

The impact of this is far-reaching in the industry, potentially reducing costs and adding stockholder value to all fuel terminal firms.

Since the 30-40% HC concentration design standard sets the size of ALL associated vapor control equipment, and since the size of the equipment is the basis for computing the purchase price of the equipment, any design data indicating lower concentrations could reduce the size and lower the purchase price (capital cost) of the equipment. It is clear that the result should be a significant improvement in profitability for every terminal owner and /or shareholder.

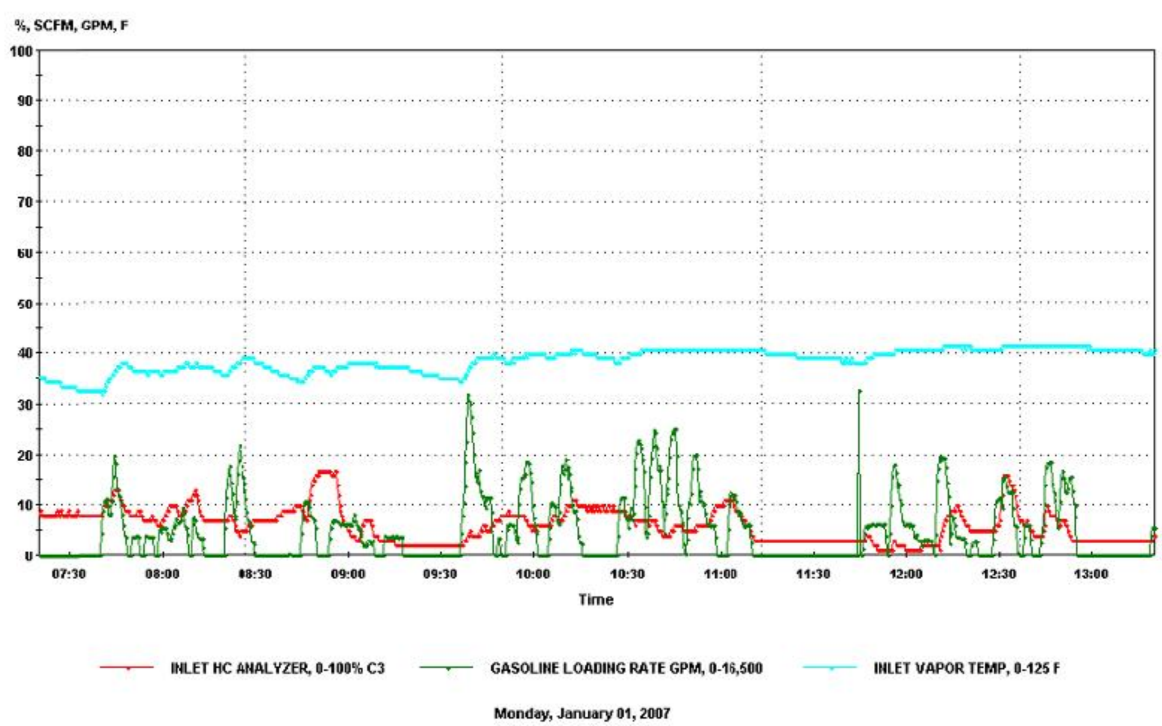
Again, the reality is that most firms have simply accepted the 30% or 40% HC value when creating design standards for equipment suppliers to bid on. And, furthering this reality, most vapor control equipment in service today has no means of measuring the actual concentration, even after nearly 40 years of supposed technology "evolution". One wonders why?

Perhaps the answer is that higher hydrocarbon concentrations translate to larger vapor recovery systems; systems commanding higher prices and greater profitability to the suppliers. Perhaps the answer is simply that the higher hydrocarbon concentrations specification allows the suppliers to oversize each system, thus avoiding any under-performance claims or warranty issues. Perhaps, the industry is okay with overspending in this environmentally sensitive area. Or, perhaps it is time to learn from the past four decades of experience, and to apply that knowledge to the future.

That approach has been adopted and has now applied in vapor control systems in the United States, China, and Hungary. The results are now several years old, consistent, and have been irrefutably documented in the computer memory of each system. The results clearly show two major trends:

1. When Stage 1 vapor control is used by all trucks delivering gasoline the vapor phase hydrocarbon concentration in the returning tank truck compartments ranges from 12% to 24%, and averages about 16%.
2. When Stage 1 vapor control is intermittently used by less than 10% of trucks delivering gasoline the vapor phase hydrocarbon concentration ranges from 3% to 24%, and averages only about 8%.

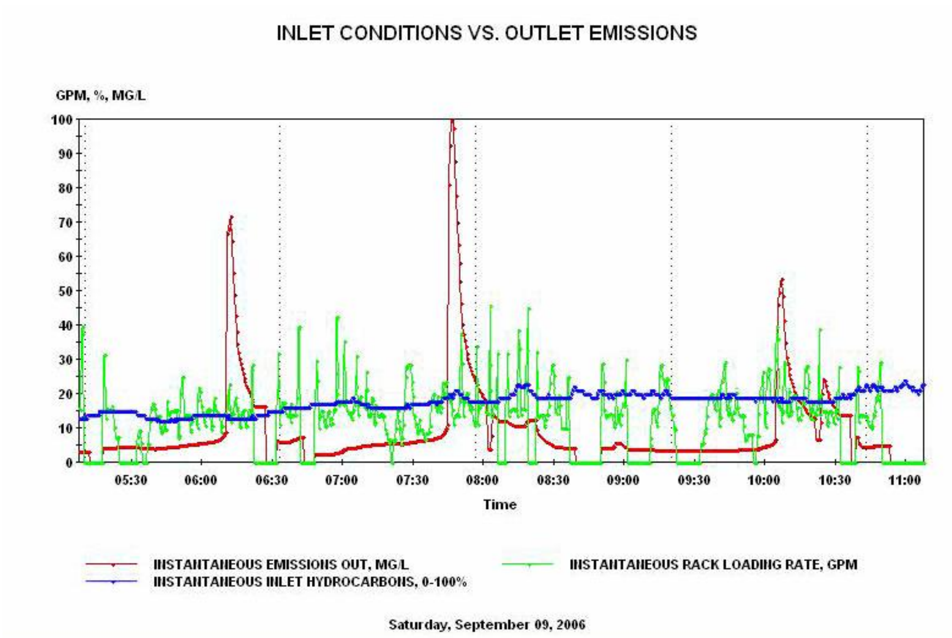
This can be seen in the typical graphs presented below. The first depicts the analytical results from a typical day in a terminal where <10% of the trucks practice Stage 1 vapor balancing/



Typical Hydrocarbon Concentration
With <10% of Trucks Practicing Stage 1 Vapor Balancing

The second depicts the analytical results from a typical day in a terminal where 100% of the trucks practice Stage 1 vapor balancing. The green line is the instantaneous loading rate (0-12,000 GPM) of the terminal while the blue line is the 0-100% hydrocarbon concentration of the vapors entering the vapor recovery system. The red line is the 0-35 mg/L output from the outlet hydrocarbon analyzer*.

*The momentary spikes in the red line show the typical normal condition when beds are switched. This is a major reason emissions permits are written around a six hour outlet concentration average.



Typical Hydrocarbon Concentration
When All Trucks Practice Stage 1 Vapor Balancing

In both of the above examples each terminal loads about 40% distillates and about 60% gasoline in a typical day. In both cases the entire vapor generated during the loading of any product (gasoline, diesel, distillate, etc.) is processed through the DRYVac™ vapor recovery system.

These examples are two excerpts of the over 2500 days worth of data these systems have monitored, collected, and recorded. The data is irrefutable; proving that the inlet hydrocarbon concentration varies terminal by terminal and varies dramatically depends on gasoline off-loading conditions. It also proves that even in 2007, when all loading and offloading conditions are as efficient as they have ever been, the average hydrocarbon concentration is at least 35% lower than the "standard" value currently in use. The 30-40% myth is solved, at last.

THE MYTH AND ECONOMICS

Since economics are the driver in most business decisions it pays to use correct and accurate data. In the case of vapor recovery systems, assuming inlet concentrations that are higher than reality produces skewed gasoline recovery economics. These calculations can appear to justify a decision to move forward when reality will show the fallacy of that decision. Since the future of a company and the careers of its employees are often weighed in the balance, it makes perfect sense to get it right up-front.

When the myth of high inlet hydrocarbon concentration is used to calculate the gasoline recovery rate of any vapor recovery system, the results are predictably high too; higher than reality will prove them to be. For instance, and chemical engineer calculate that a vapor with 30% hydrocarbon will allow for 1.64 gallons of recovery per 1000 gallons loaded. At 40% the recovery rate is 2.19 gallons/1000 gallons loaded. However, in the hundreds of vapor recovery systems operating at this writing the owner's measure and report gasoline recovery rates in the 0.4 to 0.7 gallons range per 1000 gallons loaded.

Given the above, it is easy to see the reason for this vast discrepancy. And, give the difference between the most optimistic prediction of 2.19 gallons per 1000 gallons loaded, and the lowest real recovery rate of 0.4 gallons/1000 gallons loaded, any economics based on the former will prove to be disastrous in reality.

CONCLUSION

The hydrocarbon concentration used to size, price, and purchase vapor control systems may be unnecessarily conservative. The actual inlet hydrocarbon concentration in any terminal may be considerably less than expected. Since this concentration data is used to set the size and price of new or retrofit systems, determining the actual concentration may result in significant capital and operating expense savings to the terminal owner. Therefore, it is the conclusion of this writer that the inlet HC concentration in each application should be measured and recorded during a typical week long (or longer) to determine the actual HC concentrations vs. time. That data should be used as the basis for sizing and pricing any new or retrofit equipment.

Where vapor recovery is concerned, applying real values rather than presumed, typical, or "mythical" values is the right way to make the best and proper use of the owner's capital.