

THE

CARMAGEN
Engineering, Inc.

REPORT

Partnering in Engineering Excellence

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2008 – A Great Year for Holidays

By Preston Bemis

Everyone is concerned about the prevailing cost of energy. Gasoline and diesel fuel consumer prices are at historic highs. Many people are downsizing their cars and some are avoiding travel completely. But perhaps 2008 is a good year to take that long-delayed vacation.

There are many indications that petroleum supplies will become even tighter next year. One research group⁽¹⁾ found that refinery maintenance will increase several-fold in 2009. Turnarounds have been postponed due to the tight labor market and the recent trend in strong profit margins in the industry. This year, 257 process units are scheduled for maintenance downtime, with 1282 units planned next year. Coupled with industry multi-billion dollar budgets to execute a large number of refining improvement, expansion, upgrading and clean fuels projects, the available work force appears inadequate. Downtime is likely to be extended; in fact, Marathon Oil⁽²⁾ “sees refining downtime lingering longer”, with US refining capacity utilization running at 82.4% in April, well below the 90% + achievable in the past.

The rest of the world is also worried about supply. Setting aside dislocations caused by civil unrest, war, or territorial disputes, the Wall Street Journal reports a net export decline, saying “fresh data from the U.S. Department of Energy show the amount of petroleum products shipped by the world’s top oil exporters fell 2.5% last year, despite a 57% increase in prices, a trend that appears to be holding true this year as well.”⁽³⁾

The Journal also says that last year, the Middle East’s six largest petroleum exporters – Saudi Arabia, United Arab Emirates, Iran, Kuwait, Iraq and Qatar – curbed their output by 544,000 barrels a day. At the same time, their domestic demand increased by 318,000 barrels a day, leading to a loss in net exports of 862,000 barrels a day.

OK – Enough ‘Facts’

The US will continue to be heavily dependent on oil as we all recognize; increasing our use of coal for power production appears to have run into environmental, cost, and political barriers. And NIMBY reigns supreme when nuclear plants are discussed – although recent permitting activity may indicate changing public and governmental attitudes. We don’t want LNG terminals on our shoreline either, and windmills don’t seem sturdy enough for Katrina-force winds. Biofuels might hold promise

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someday if we don't first starve ourselves, our livestock, and our water supplies trying to get there. And there is also that annoying competition from developing nations for their fair share of the world's dwindling oil supplies.

Much of the refining construction activity in the USA is building new conversion or desulfurization units, and several projects are increasing crude throughput. No new refineries have been built since the Garyville, LA refinery was commissioned in 1976, in part because of government red tape and environmentalists. High construction costs as compared with Asia or the Mid-East, and poor margins would not make a new refinery particularly profitable. Our refining facilities are getting older, but with improved maintenance and technology have become very reliable and safe. However, there comes a time when the inspection reports cannot be ignored and process units must be repaired.

So What?

Energy costs next year are likely to be much higher than those today, so take your holiday now. The USA enjoys relatively cheap gasoline and diesel. In Europe, we are paying as much as \$9.50 per gallon of gasoline – although about 68% of that is government tax. In the USA, the politically correct tax is a bargain at \$0.48, or about 12% of the cost of a gallon. No wonder why our transportation infrastructure isn't the best in the world! My old 1999 Audi diesel gets 38 mpg average driving in England – a similar engine power new Dodge Caliber driven from Columbus, OH to Atlanta, GA recently gave me 28 mpg on the highway. My 1995 Mercury with lots of V-8 horsepower gets 24 mpg on such a trip. Madison Avenue (and Detroit) should be ashamed.

Considering expected longer duration refinery outages, lower import finished product supply availability, and the continuing increase in energy demand, oil prices will continue to rise. You might see gasoline pump prices above \$6 per gallon next year, even if the US government doesn't get smart by raising the tax (political suicide, thus highly unlikely). Transportation costs will climb, with offsetting consumer price increases in all sectors.

As Martha Stewart might say, 'It is a good thing that China is manufacturing most of our household products using cheap labor and coal-based electricity, otherwise we wouldn't have the energy to do it ourselves.'

These are just some of my thoughts – debate, disagreement, and provocative outright name calling accepted. I have many more ideas and thoughts on our energy situation. There are also certainly many ways that Carmagen Engineering can help refineries improve their reliability and profitability. Let me know if you are interested.

References:

- (1) Industrial Info Resources, as reported in Hydrocarbon Processing, March 2008, page 21 (www.industrialinfo.com)
- (2) Hydrocarbon Processing, May 2008, page 7
- (3) Wall Street Journal, as reported by Finfacts Ireland, February 2008 (http://finfacts.ie/irishfinancenews/article_1012573.shtml)

Preston Bemis has over 30 years of international experience in all aspects of refining activities including refinery management (process, technical, operations), project management, energy management, oil-loss, reliability and maintenance, and turnaround coordination. Please contact Vince Carucci if you'd like more information on Carmagen's expertise in these areas.

Lightning Protection for Instrumentation

By Dan Bolland

The pictures below show a “fried” thermocouple input card and a GE Mk V system on a critical refinery GTG that took a lightning hit. Thermocouples are a common route for lightning currents to enter DCS or other control systems. The author has been involved in five GE Mk V lightning strike investigations. New installations now incorporate surge arrestors on the more sensitive circuits, as well as a better understanding of the need for bonding between the MkV control system and the GTG frame.



Multiple separate grounding systems are a common feature in lightning damage scenarios. Often there is a DCS ground, a safety ground, a lightning ground, and sometimes a computer ground. The correct answer is to have an integrated grounding scheme. Two overseas refineries modified their systems by integrating safety and DCS grounds and installing bonding between the control house and the plant. Since making these changes, there has been no lightning damage even during high storm activity. The picture on the left below shows separate instrument & safety grounds. On the right, some simple bonding is the best practice where safety and instrument grounds are bonded at one point.



Vendors of DCS and field instrumentation are often of little help when it comes to good lightning protection practice. DCS vendors want their own ‘clean earth’ and field instrument suppliers will sell instruments with surge arrestors already fitted. Separate earthing systems lead to voltage differences during a lightning strike situation. At a large Louisiana refinery, DCS lightning damage occurred only on circuits where the latest installed field transmitters had ‘free’ surge arrestors fitted. You have to know what you are doing with surge arrestors as they often cause lightning currents to be injected into the circuit. The transmitter may be OK, but the DCS at the other end is zapped.

Dan Bolland is an Instrumentation & Control Systems (I&CS) specialist. His experience includes being a Facilitator of ExxonMobil refining instrument networks in Europe, Asia Pacific, and the Americas. Dan was a subject matter expert for ExxonMobil's instrumentation codes and standards. He was a Company-recognized expert on lightning protection for instrumentation. Dan's work activities have encompassed project engineering QC activities, pre-commissioning, FAT/SAT's, start-ups, and production of design documents across the full range of I&CS activities on refinery and chemical projects worldwide. Please contact Vince Carucci if you'd like more information on Carmagen's expertise in these areas.

2008 Survey of Blending On-Line NIR Analyzers

By Ara Barsamian

The purpose of the survey was to determine the usage of NIR-type on-line blending analyzers, and what it takes to have a successful installation. The reason for using an NIR type analyzer is that it replaces 6 to 8 conventional analyzers with correspondingly lower capital investment, lower maintenance costs, and overall much higher reliability and fast response.

The results of the survey can be used to determine if the NIR type of online blending analyzer is for you, what parameters it can measure, how fast, modeling requirements, lessons learned, etc.

We requested information from approximately 400 refineries world-wide (out of a total of ~700), and received 41 replies. This was a bit disappointing considering that there are approximately 500 NIR analyzers used in refining as of July 2007, out of which 215 are used in gasoline and diesel blending (Table 1). This tells us that many NIR owners are not entirely satisfied with their performance; we can surmise the reasons why later, when we look to the survey data.

Table 1—Overall NIR vs. Conventional Statistics (2007)

Total NIR's in Refining	489
NIR's in Gasoline Blending	180
NIR's in Diesel Blending	35

The 41 responders are quite aggressive in their use of on-line analyzers, NIR in particular, for blend control, optimization, and product release. They have taken the time to understand how they work and how to install and support them properly; as a result, they are happy with their choice, and would use NIR analyzers again.

Table 2—Survey Overall NIR vs. Conventional Statistics

Percent respondents using NIR	59%
Percent using conventional online analyzers	22%
Percent releasing on on-line analyzers	80%
Percent having Release Waivers-Total	41%
Percent having Release Waivers-NIR only	15%
Percent NIR Meeting ASTM Precision	34%

The summary of survey results are in Table 3. Basically, the 59% using NIR blending analyzers are pretty happy with them: they meet or exceed ASTM precision, measure a wide range of properties very fast (2 minutes on the average), are used both for gasoline and diesel blending, are robust, reliable, and low maintenance, and some use them also for blend component property measurements.

The biggest user complaint was with property prediction modeling: the fact that many NIR analyzer vendors do not provide process property measurements performance guarantees (i.e., that it meets or exceeds ASTM precision), and that in general, the vendor modeling support is unsatisfactory because the vendors themselves understand poorly how to model the blending process.

When the modeling is done right, one does not need to adjust it every couple of months; once or twice a year is sufficient, if warranted by the number of outliers. Before plunging into modeling, one requires examining blend component variability, rundown segregation strategy, and the blend recipe "space," all detailed in excruciating detail in ASTM E1655 NIR modeling practice ... but very few read it and follow it.

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Table 3—2008 Survey In-Line Blending Analyzer Statistics *

Total No. of Respondent Sites	41	
Release by Online Analyzer (1)		
* by NIR or Raman analyzers	24	
* by Conventional analyzers (e.g., knock engines)	9	
* by Lab tests “finalizing” a tank	8	
Waiver for In-line Release	17	
Waiver for In-line Release by NIR only	6	
Frequency of NIR readings, minutes	2	average
NIR Calibration Modeling Basis		
* by Grade and Season	10	
* Global Model	7	
Model Updating Frequency—6 mos. Avg.	9	out of 16
Use Wash & Validation	11	
Use Protofuels	4	
Typical Problems		
* Clogged filters	10	
* Film on optical parts	7	
* Low flow	7	
Meets ASTM Precision	14	
Measure Blend Components	4	
Uses NIR on Diesel	5	
Would Use NIR again	18	out of 29
Most Complaints		
* Need vendor turn-key responsibility	8	
* Need extensive modeling support	8	

(1) Not all respondents answers all questions, so they do not add up to 100%

A minor complaint is with filters clogging and film deposition on optical parts; again, the successful installations use a properly designed sample conditioning system and automatic wash and validation either daily or twice a day (as recommended in ASTM D6122).

Properties Measured by NIR Blending Analyzers

Table 4 shows the gasoline properties measured by an NIR analyzer; Table 5 shows the Diesel properties measured by NIR.

Table 4—Gasoline Properties Measured by NIR

RON	E200F
MON	E300F
RVP	Aromatics
T10	Olefines
T50	Benzene
T90	Oxygenates/Oxygen/Ethers
FBP	Ethanol
E70C	Density
E100C	Acidity
E150C	

Table 5—Diesel Properties Measured by NIR

Cetane number	T10
Cetane index	T50
Viscosity @ 40C	T90
Flash Point	FBP
Cloud Point	Acidity
CFPP	Density
Pour Point	

Overall, the use of NIR analyzer technology was used more aggressively and successfully in the EU, where newer refineries or recent modernization promoted the use of NIRs. In the USA, the use of NIR, although numerically larger, was less robust because of the tendency to “do-it-yourself” cheaply without understanding the subtleties of modeling. Currently, a number of US refineries are in the process of upgrading models through extended support agreements with NIR vendors to provide chemometric specialists assistance.

In conclusion, the major factors for success are:

- Proper modeling of gasoline (or diesel) properties [1], [2]
- Frequent (once a day) automatic wash and validation [3]

Success is defined as meeting or exceeding ASTM PRM test method precision for 90% of the time, and not requiring model update more frequently than once every six months during the normal course of refinery operation.

We plan to update the survey in 2009; please feel free to suggest additional survey questions that should be included.

I would like to thank all survey respondents for their support in providing the information.

[1] "How to Develop NIR Property Models That Work," Barsamian, A., Carmagen Newsletter, Nov. 2005

[2] ASTM E1655, Standard Practice for Infrared Multivariate Quantitative Analysis

[3] ASTM D6122, Standard Practice for Validation of the Performance of Multivariate Process Infrared Spectrophotometers

Ara Barsamian has over 30 years of experience in blending (crude, mogas, distillate, fuel oil, lubes), oil movements & storage (OM&S), crude handling logistics, refinery tank farm sizing studies, refinery supply chain management, NIR analyzers, and master plan/automation benefits studies for major process plants and hydrocarbon storage facilities. Please contact Jerry Lacatena if you'd like more information on Carmagen's expertise in this area.





HIGHLIGHTS

Training

- Providing global manufacturing training course development support for a major refiner.
- Conducted LOPA course for a domestic refiner.
- Presented one-day, introductory level training courses covering piping design and maintenance and heat exchanger design. Also presented a two-day instrumentation and control systems course. These courses are part of an ongoing program in which our refining client has engaged Carmagen to present courses that the client has already developed themselves.
- Presented our four-day, heat exchanger advanced reliability course for a refining client in the US. The course was attended by representatives from several of their refineries and was very well received.
- Presented our five-day Risk Based Inspection (RBI) course, plus a one-day client-specific workshop, at a refinery located in the Caribbean region.
- Presented a three-day onshore crane safety course for a US refining client.

Heat Transfer Equipment

- Completed ENCON scoping of overseas refinery to identify areas for further plant energy optimization and heat recovery. Initiated the next phase of refinery-wide heat recovery study in greater detail, plus instituted heat recovery optimization helpdesk.
- Conducted a finite element heat transfer analysis of a complicated equipment item being used as part of a new biofuels facility currently being designed. The objectives were to determine the local temperatures and temperature gradients in critical sections of the equipment in order to assist in materials selection and mechanical design.
- Reviewed the operations and the performance of the fired heaters installed at a refinery in Europe during a one-week onsite visit. This resulted in several recommendations for improving their efficiencies for enhanced fuel savings, many of which can be accomplished with little or no capital investment.
- Continued to provide continuous, onsite fired equipment and heat exchanger design and troubleshooting support at the engineering office of a major oil company.

Process, Operations, & Safety

- Performing strategic reliability initiatives for an international refiner, including a hydrocracker catalyst evaluation and reactor loading plan to maintain conversion, increase run length, and also produce a 10 ppm sulfur diesel plus assessment of unit performance.
- Providing continuous, onsite process design support in a major technology provider's offices.
- Providing on-going technical process development, design, and heat transfer support in expanding role to a major domestic client for "first-of-kind" process development for ethanol production.
- Performing PIMS modeling and refinery planning support.
- Providing ongoing technical mogas blending consultation to seven domestic refineries regarding optimization, equipment and controls assessment, and certification.
- Completed revamp studies for Northeast refiner's multiple trains of crude and vacuum unit fractionation and profitability improvement. Follow-up continuing.
- Providing extended onsite process engineering support to West Coast Refiner's expansion program, including support in contractor's office to assist in program execution work.
- Completed scoping review of overseas client's wastewater treatment facilities.
- Providing on-going, multi-unit HAZOP support to a domestic refiner's overall safety program.
- Providing pilot plant and brainstorming support to domestic refiner's process research entity.
- Providing long-term onsite process support to a refinery in the Mid-West to augment client's resources to address miscellaneous small projects, troubleshooting, and staff mentoring.
- Completed hydrogen plant/management scoping support to a refinery in the Mid-West.
- Supporting Saudi Arabian refiner's long range safety/HAZOP program.
- Performed onsite process support for overseas refiner changing FCC operations from full combustion to partial burn regenerator mode.

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Process, Operations, & Safety (cont'd)

- Prepared Process Specification cost estimate and HAZOP for Central American refiner implementing upgrade in diesel dehazing provisions.
- Conducted hydrogen plant management scoping study for refinery in Italy. Several projects were recommended that could provide operating savings of 3.3 Mt/y with minimum investment.
- Performing hydrogen plant and amine unit scoping studies, and providing technical consultation on a coker unit for a South American refiner.
- Conducting site visit to provide technical consultation on a new sulfuric acid alkylation plant in India.
- Conducting review of delayed coker incident, which damaged fractionator trays, and selected delayed coker operating procedures. This unit has had several similar incidents in a relatively short time frame.
- Providing R&D guidance for our client's prototype biodiesel technology, which includes defining a Pre-Gate 1 economic model relevant for decision making.

Reliability & Maintenance

- Completed the first phase of a significant program to review and improve the Reliability Centered Maintenance (RCM) program for a major European refiner. The overall objective is to increase the effectiveness of their current program to improve their overall ranking with respect to their competition. This will be done by recommending changes to their current procedures, providing new procedures where needed, and identifying local obstacles to effective implementation of a world-class RCM program and recommending ways to overcome these.
- Began a major program to improve the inspection practices and procedures for a major European refiner. Among the areas to be addressed are cost effective inspection planning, inspection practices and procedures, RBI, and organization and training. Detailed inspection planning and procedures documents have been prepared.
- Conducted a turnaround planning review during a one-week onsite visit to a major refiner located in Europe. This visit was part of a continuing program to assist this company improve their overall turnaround organization and procedures with the goals of reducing T/A time and cost while achieving desired plant reliability. Another review visit is planned later this year.

Materials, Refractory, & Corrosion

- Provided materials selection recommendations for biofuels projects being undertaken by two different clients.
- Reviewed and commented on the pipeline coating document of a major integrated oil company. Recommended that consideration be given to replacing this relatively large document with a short tutorial/guidance document, and just maintain individual engineering specifications for specific coating systems.

Project Management

- Continued to provide significant project management and cost engineering consulting support for multiple clients in the US and overseas.

Miscellaneous

- Providing process plot layout support for domestic and international refiners.
- Performing Cold Eyes Reviews of an international pharmaceutical company's global engineering alarm management and inert gas blanket systems standards.
- Completed reviews of plans for several critical lifts for refining clients. These reviews focused on identifying potential concerns regarding safety, scheduling, and cost.
- Continued to provide materials, and process engineering litigation consulting support for multiple major cases.

