THE CARMAGEN Engineering, Inc. REPORT©
20th Anniversary

Partnering in Engineering Excellence

June 2006

CONTENTS

Editor
Lori Carucci

Text Editor
Pat Terry

Writers
Carmagen Engineering, Inc. Staff

The Carmagen Engineering Report© is published periodically by our staff and presents information and viewpoints on engineering topics relevant to the hydrocarbon processing industry. While the contents of The Carmagen Engineering Report© have been carefully reviewed, Carmagen Engineering, Inc. does not warrant it to be free of errors or omissions. Some back issues are available and may be requested while supplies last.

Corporate Office
4 West Main Street, Rockaway, NJ 07866
Tel: 973-627-4455 Fax: 973-627-3133

Website: www.carmagen.com

E-mail: carmagen@carmagen.com

Cost Management - Part 1

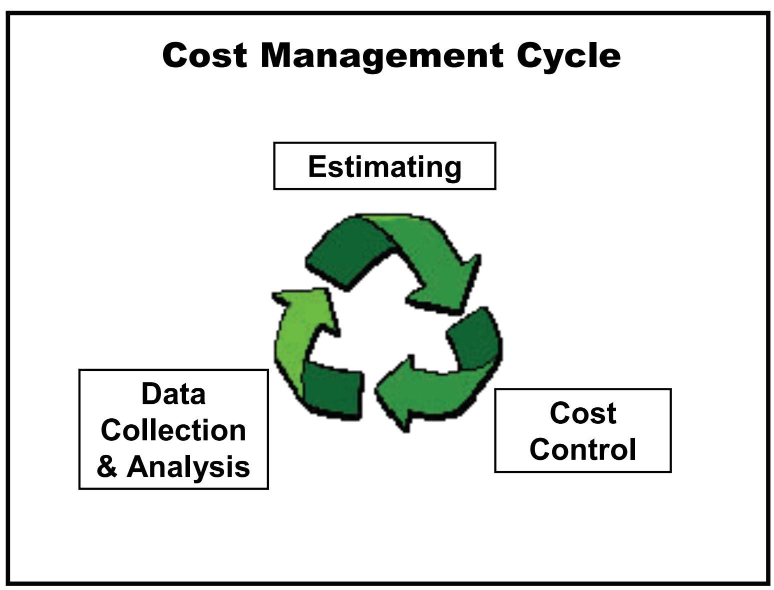
By Allen C. Hamilton, PMP, CCE

Note: This series of articles is extracted from a paper presented at the AACE Int'l. Association for the Advancement of Cost Engineering meeting in Washington, DC in June 2004. The full text can be obtained at *www.AACEI.org*.

Introduction

Cost management has increasingly become an important part of business. With the impact of globalization, companies had to recognize that a key part of business was efficiency. In this regard all types of projects can benefit from the appropriate application of cost management techniques, and not just in the biggest companies.

If the key steps of management are planning, implementing, and controlling, then the key steps of cost management are estimating, cost control, data collection, and analysis. Each is a parallel of the other in first establishing a plan or an estimate, then implementing that plan, controlling the activity, collecting data and analyzing the endeavor, and then making adjustments to the activity or adjustments to the information for the next cycle. The cost management cycle is illustrated below.



Continued on Page 2

Estimating

Cost estimating is the determination of quantities, and the prediction within a defined scope, the cost required for the equipment and construction of a facility (Ref. AACE International). People who are in project management understand that cost estimates are predictions of costs at a future date and are always subject to variability. Not understanding this variability is frequently why some projects fail to meet their stakeholder's objectives. Some key characteristics of a cost estimate are that it has an equal chance of under running or overrunning. In addition, the cost estimate should be objective in reflecting the scope of work and the estimate basis.

The estimate basis is one of the critical elements in determining the quality and accuracy of a cost estimate. The three parts of the estimate basis are the design basis, the planning basis, and the cost basis.

- The design basis is the technical content that drives the physical quantities and quality of the installation. The quality of the design basis is also instrumental in identifying the likelihood of changes expected on the project.
- The planning basis is the description of how the project will be managed and includes objectives, organization, communications, contracts, schedules, and quality.
- The cost basis is the description of the estimating methods, quantities, and unit costs. The cost basis also includes the sources and specification of the methods, quantities, and unit costs.

Estimate classification systems are used to identify the criteria that a given estimate must have in order to be classified in a certain group. Characteristics include standard references such as ANSI, project descriptions, level of project definition, end use of the estimate, estimating methods used, and level of effort to produce the estimate. The use of the classification system is usually linked to expected estimate accuracy. Greater use of resources and more detailed basis documents will usually produce more accurate estimates. In assessing estimate classification and accuracy, it is important to differentiate quantity, quality, and accurate estimate basis information.

Two important organizational elements are required to have an effective cost estimating system: work breakdown structures and code of accounts. The Work Breakdown Structure (WBS) is a grouping of project elements that organize and define the total work scope of the project (Ref. Project Management Institute). The WBS organizes the many project cost elements into controllable parts such as work packages. The WBS should be established prior to starting the estimate and be used through project closeout. The WBS is a hierarchal breakdown and should be in sufficient detail to define the scope but not burden the project team with excessive detail.

Codes of Accounts (COA) are systematic methods of identifying categories of costs incurred in the progress of a job for accounting purposes (Ref. AACE International). COA are important to cost management as the framework for cost control, cost accounting, and cost history. Project COA are most useful when they are derived from and related to the owner's accounting system. They should be flexible to specific project needs and be in enough detail to be manageable.

Of the many subjects in cost management, one that attracts a lot of discussion and attention is contingency. The success of many projects has depended on the assessment of how much contingency is added to a project estimate at a certain point in time. Many of these efforts have been unsuccessful as evidenced by the number of cost estimates that have overrun.

Contingency reflects a judgment by management to make an allowance to avoid project cost overruns within the parameters of risks assumed (Ref. AACE International's Certification Study Guide, 1996).

The assessment and decision on contingency should reflect the previous subjects related to the cost estimate such as the estimate basis and estimate classification. A particular point of misjudgment and confusion is the specific inclusions and exclusions of contingency. One generally accepted definition of contingency defines it as including the original scope of work, the original estimate basis, and the original schedule. Generally it excludes major scope changes, increases/ decreases in the facility capacity, weather extremes, facility location, and extraordinary events. Contingency can include any events that the stakeholders wish to include and have made appropriate allowances for.

Summary

This article introduced the subject of cost management on capital projects, identified its key steps, and discussed cost estimating. The next article in this series will discuss cost control.

Allen Hamilton has over 20 years experience in the management and control of projects, including cost estimating, cost and schedule control and contract management. Please contact Bruce McSkimming if you'd like more information on Carmagen's expertise in this area.

NIR Analyzer Precision Targets for Gasoline Blending Applications

By Ara Barsamian

ASTM provides the only internationally-recognized methodology to determine the precision of a measurement of hydrocarbon properties. It also provides the framework by which one evaluates the numerical performance of both laboratory and on-line analyzer precision.

The precision of an NIR analyzer depends on the design of the analyzer optics and signal processing electronics, and the comprehensiveness of the property prediction model in capturing the significant variability.

The precision is defined by ASTM in two ways: repeatability, which is indicative of short term stability, and reproducibility, which is indicative of comparative statistical stability.

- Repeatability ("r"): The difference between two test results, obtained by the same operator with the same analyzer under constant operating conditions on identical test samples within the same day would, in the long run, in the normal and correct operation of the test method, exceed "r" in only one case in 20.
- Reproducibility ("R"): The difference between two single and independent test results, obtained by different operators in different laboratories on identical test samples within the same day would, in the long run, in the normal and correct operation of the test method, exceed "R" in only one case in 20.

Practically, in order to meet the ASTM precision (either r or R), this means that out of 20 consecutive measurements, there can only be one value outside the ASTM precision number, thus creating a 95% confidence level.

Assuming that the NIR modeling is done following the "Extreme Recipes Envelope" technique, the expected NIR analyzer precision will meet or exceed the ASTM precision. The ASTM precision numbers were established by round-robin blind testing of samples by hundreds of laboratories. In all cases, in order to demonstrate that the NIR analyzer performance guarantees have been met, it is essential to "track" the performance using Statistical Quality Control charts, either in MS Excel, or preferably in the refinery LIMS system.

By using protofuels for comparative measurements with on-line analyzers, it is possible to improve the precision by a factor of approximately four (the analyzer measurement precision "inherits" the protofuel accuracy).

Ara Barsamian has over 31 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 Bruce McSkimming if you'd like more information on Carmagen's expertise in this area.

How FCCU Trickle Valves Affect Catalyst Losses - Part 1

By Donald F. Shaw and Richard E. Walter

High or abnormal catalyst losses from Fluid Catalytic Cracking Unit (FCCU) cyclone systems are sometimes attributed to plugged diplegs, often believed to be caused by one or more malfunctioning trickle valves. Units are sometimes shut down and catalyst unloaded to "clear" a plugged dipleg. Applied forces affect the opening and closing of a trickle valve for both positive and negative pressure cyclones. These forces are caused by the trickle valve design, weight of the flapper or counterweight, and catalyst level in the dipleg.

This article discusses catalyst losses in FCCUs and how trickle valves are used to minimize these. A subsequent article will describe the trickle valve designs commonly used in FCCUs, the pros and cons of each, the opening and closing forces exerted on these trickle valves, and measures that may be taken to improve their performance.

Background

The FCCU process includes the circulation of huge quantities of solids to convert feed stocks to desired products (e.g., vacuum gas oils to gasoline). Catalyst circulation rates can range from 10 to over 100 tons/minute between the reactor and the regenerator.

Cyclone systems typically consist of primary and secondary stage cyclones in both the reactor and regenerator to recover the solid catalyst from the reactor products and the regenerator flue gases. As more catalyst is collected with the cyclone systems, fewer processing problems occur in the product recovery circuit, and there will be lower solids emissions in the regenerator flue gas stream.

The role of the trickle valve has become increasingly more important as FCC technology has advanced from primarily bed cracking to Short Contact Time (SCT) Riser reactors, and environmental concerns have driven refiners to minimize catalyst losses. FCCUs initially did not use trickle valves on the cyclone diplegs. This worked fine once a bed level was established above the level of the dipleg discharges. The bed acts to seal the diplegs, and low catalyst losses can be achieved. However, high catalyst losses were observed during unit startups before a bed was established, or during upset situations where the bed levels were reduced below the level of the dipleg.

Adding a trickle valve to the end of the dipleg was successful in maintaining low catalyst losses during the unit startup phase before bed levels are established, and also during upset situations. The trickle valves also help maintain the dipleg seal when negative pressure reactor cyclones are utilized in SCT or other operations which discharge the catalyst into a dilute phase.

While overall experience with trickle valves has been good, now there was a mechanical device which adds to the possible list of reasons for increased catalyst losses from either the reactor or regenerator. In addition to the catalyst and other hardware, there is now the concern that the trickle valves could be directly involved in causing increased catalyst losses. While it is possible for trickle valves to cause high catalyst losses, a properly designed trickle valve should not be the primary cause.

Purpose of the Trickle Valve

The purpose of the trickle valve on the discharge end of the dipleg is similar to that of a check valve in a process line in that the trickle valve flapper prevents catalyst or gas flow up the dipleg. A cyclone will not work properly with gas flow up the dipleg. Upflow is prevented either by pressure differential, a mechanical device, or by massive down flow of solids. Figure 1 (see page 5) shows how a typical cyclone dipleg works. Cyclones can operate at a positive or negative pressure relative to the containment vessel. Also the diplegs can discharge into a bed or into a dilute phase. All these factors affect how the trickle valve functions and what it is expected to do.

The purpose of trickle valves that are inserted into the bed is primarily to minimize catalyst losses during start up and during other periods when the bed level is below the valve. Typically trickle valves that operate in the bed are provided with a shroud arrangement to prevent a gas bubble from entering the dipleg. Few problems are typically experienced with these trickle valves if they are immersed in a well-fluidized bed.

Continued on Page 5

Continued from Page 4

Positive pressure cyclones are not expected to experience flow up the diplegs except during start up or other low-rate periods. Typically the diplegs are inserted in a bed with positive pressure cyclones in an attempt to create a backpressure and to minimize gas flow down the dipleg. Except for certain coupled cyclone systems in reactors, cyclones in FCCUs typically operate at a negative pressure relative to the containment vessel.

Figure 1 shows a typical negative pressure cyclone system with pressure in the vessel, Pv, and pressure in the cyclone, Pc, with Pc less than Pv typically by the amount of the pressure drop through the cyclones. This differential pressure tends to push the flapper closed. To balance this closure force, a level of catalyst must build up in the dipleg and create a "hydrostatic" force to open the flapper. The weight of the flapper (or counterweights) creates an additional closure force that must also be overcome by the catalyst level.

Several trickle valve designs are widely used, each with advantages and disadvantages. The next article in this series will discuss these, along with measures that may be taken to improve their performance.

Donald Shaw has over 35 years experience as a mechanical engineer. His overall responsibilities included the design and development of equipment used in the petroleum refining industry; in particular pressure vessels, piping systems, valves, and tankage.

Richard Walter has over 35 years experience in FCCU process engineering. His expertise includes unit design, start-up, operations, troubleshooting, and optimization experience.

Please contact Bruce McSkimming if you'd like more information on Carmagen's expertise in this area.

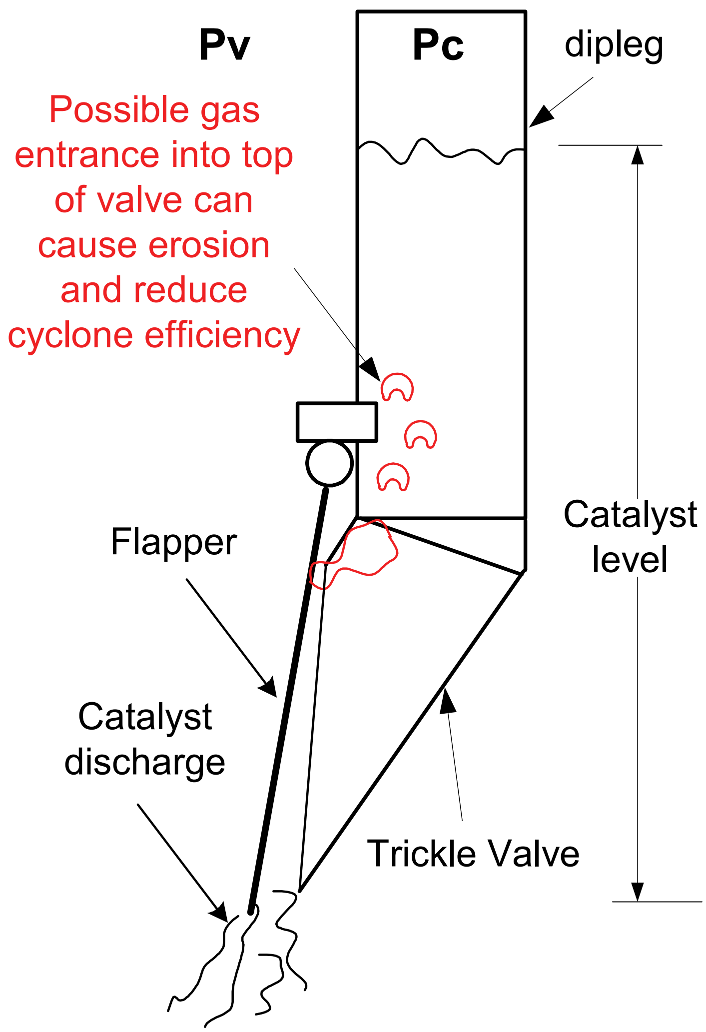


Figure 1

- Providing refractory consulting assistance for a Canadian refiner in support of turnaround planning activities.
- Continued to provide a US refiner full-time mechanical engineering assistance in performing Finite Element Analyses and general technical support.
- Continued to provide a US refiner extensive heat transfer support covering both heat exchangers and fired equipment.
- Continued to provide expert witness assistance to three US based clients.
- Assisting a US upstream company in the development of valve purchase specifications.
- Providing machinery inspection/test witnessing assistance to several US and European refiners.
- Providing refractory consulting assistance to a US client in reviewing the FCC external riser lines for three refineries.
- Continued to provide refractory review assistance to several US refiners.
- Updated technical and design practices for a US refiner.
- Continued to provide electrical engineering support to a US refiner.
- Provided metallurgical expert advice to a US client for fixed equipment repairs.
- Continued to provide project management services for a US refiner in multiple locations.
- Continued an inspection/maintenance improvement program for atmospheric storage tanks for a European refiner.
- Continued a turnaround improvement program for a European refiner.
- Provided a column inspection plan in a petrochemical plant for a Middle Eastern client.
- Provided an assessment of thermal NOx reduction to meet emissions targets for a US refiner.
- Provided an energy management assessment for a US refiner.
- Providing a reliability and maintenance audit for UK pharmaceutical client.
- Providing project management planning support to a US refiner for an upstream project.
- Provided metallurgical expert advice to a US chemicals client.
- Continued to provide process and mechanical engineering services for a US chemicals client.
- Provided a qualitative risk analysis of selected units for a US chemicals client.
- Continued to provide extensive process design services to a major technology developer/licensor.
- Performing follow-up review of vendors offering for vacuum unit overhead exchanger upgrade for European refinery.
- Performing pilot plant scale-up development for domestic refiner.
- Providing plot layout support for domestic and international refiners.
- Providing continuous support of a major Middle Eastern LNG project via engineering services at the contractor and the sub-contractor's offices in Europe.
- Provided consultation and vendor screening/ selection regarding modification options to meet H_2S emission requirements via vent gas caustic scrubbing, and execution liaison with selected vendor.
- Provided revamped vessel specification design support.
- Providing extended lube hydrotreating pilot plant support services.
- Continue to supply specialized, high-value added services to several novel process developments pursued by major technology companies.
- Provided LP planning support to a domestic refiner.
- Performed HPLC support for a domestic refiner.
- Performing preliminary flare network hydraulic analysis, including selected relief valves flare load development.

Continued on Page 7

- Continue relief system helpdesk support for a major refiner.
- Performing long-term coordination/support on-site at international refiner's facility during development of their strategic refinery reliability and improvement program.
- Performing strategic reliability initiatives for an international refiner, including the vacuum units, visbreaker, and two hydrocrackers and hydrotreaters and H_2 system.
- Performed preliminary process design, environmental support, and selected cost estimates for fluid coker coke transport and cooling system.
- Performing fluid coker on-site test run support and a high level debottlenecking study based upon the results of the performance test.
- Providing on-going fractionation specialist support to a major refiner.
- Providing on-going lubes consultation to a major refiner.
- Performing FCC PSV/safety evaluations for a domestic refiner.
- Supported hydrotreater startups in Canada and dewaxing unit startup in the Far East.
- Performing process heat transfer review and exchanger designs of novel AGHR assessment.
- Developed a new safety course for operations supervisors for a domestic refiner.
- Developed corporate safety standards for a domestic refiner.
- Developed LOPA standards for a domestic refiner.
- Performing fractionation tower tray installation inspection services for a domestic refiner.
- Preparing standardized process design notes for a client's licensed technology.
- Providing numerous construction site safety reviews for a major refiner at various refinery locations.
- Providing operating manual support for a major Middle Eastern LNG project via engineering services at the contractor's offices in Japan.
- Performing ASU vendor bid evaluation, Hazop and P&ID review support for a major refining and ethylene project in China.
- Consulting on FCC modification details for a major Gulf Coast refiner.
- Providing technical litigation support regarding a potential class action suit.
- Performing an Energy Management Study for a Crude Distillation unit for a major Gulf Coast refiner.
- Providing process design support in a major technology provider's offices regarding GTL and other related areas.
- Performed Hazop on FCC light ends fractionation, Minalk, and Merox units for foreign refiner.