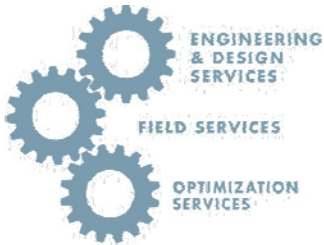


the BETA BULLETIN



MACHINERY ANALYSIS



In this Issue

We have packed this issue of the Beta Bulletin with timely information geared to your reciprocating and rotating equipment, including:

- The newly released (December, 2007) API 618 5th Edition and the significant implications for compressor owners and packagers.
- What is the real cost of a conservative design? See one example of the significant savings that can result from an optimized design approach.
- Spring Technical Training and Webinar availability.
- Our partnership with M2M Data Corp means more muscle for your remote monitoring program.

And there's plenty more, so, let's get started.

Ask the Expert

Send in your questions about machinery analysis and we'll answer them in future issues of the Beta Bulletin.

Q - Does the API 618 5th edition have a big impact on packagers of reciprocating compressors? On owners?

A - The short answer is yes. The impact can be significant, especially for larger, more critical units. API Standard 618 (the Standard) is used globally to define the pulsation and vibration design requirements for reciprocating compressors. The previous update was in 1995 (4th edition). In the years since then, the industry has identified many enhancements, which are included in the 5th edition.

To help our customers understand these important technical and commercial implications, Beta has created Application Notes that give an overview of the key changes (1a) and a summary of the implications of the Standard for packagers and owners (1b). The Standard addresses pulsation and vibration control (mechanical design), and engineering analysis of torsional vibration, dynamic skid design, piping system flexibility (thermal), and foundation design. The Standard is used throughout the industry and includes high speed machines. We have developed seminars on this topic and other aspects of pulsation/vibration designs. Please visit our web site, www.BetaMachinery.com, select Support > Application Notes, for free, downloadable pdfs of our Application Notes.



The API logo is reproduced courtesy of the American Petroleum Institute.

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Training

Join us for a one hour **Webinar** and discussion, "**An Overview of API 618 5th Edition**," offered on two different dates, Tuesday, May 13, 2008, and Thursday, June 12, 2008, at noon MST. If you are interested, but unable to make either of these, send me an email (mailto: jwalters@betamachinery.com) with your contact information and suggested alternate dates and times, and we'll do what we can to set up another time.

Classroom technical training for reciprocating and rotating equipment is scheduled for Calgary, May 15, 2008 and includes Pulsation/Vibration for Reciprocating Compressors and Torsional Vibration. For Houston and other locations, **on-site training** is available if you have six or more interested staff. Feel free to call or email me to discuss options.

As an introduction to pulsation/vibration in reciprocating compressors, we recommend watching our popular **video training tools**. To access, please visit our web site, www.BetaMachinery.com, and click on the main picture. *Coming April 10th* - the videos will also be available in Chinese.

The link below takes you to our web site, which gives course descriptions and more information about available training.

Schedule:

- Webinar, An Overview of API 618 5th Edition
Tuesday, May 13, 2008 noon MST
Thursday, June 12, 2008 noon MST
- Pulsation/Vibration for Reciprocating Compressors. Thursday, May 15, 2008
Calgary, Alberta, 9AM – 1PM
(lunch included)
- Torsional Vibration (Torque Talk)
Thursday, May 15, 2008
Calgary, Alberta, 1:30 – 3:30PM

Registration:

A registration form is included in this issue; plus registration forms and course information are on our web site, www.BetaMachinery.com. Select Training from the navigation bar at left, click on Register, or click on the course name for more information.



What is Your Conservative Design Really Costing You?

#3 in our Optimization series

The standard, or default, pulsation design approach can produce "over-designed" bottles and pulsation solutions that result in unnecessary costs. These days, pulsation analysis has the opportunity to reduce material and labour costs. In addition, it is now possible to examine total pressure drop throughout the compressor system and ensure the performance will meet the customer's requirements for capacity, efficiency, etc. This approach also provides a better understanding of the system performance - a key issue for managing capacity and operating costs.

This case study shows how an optimized compressor design resulted in a more cost effective compressor design. In fact, the optimized compressor design generated \$128,000 in reduced manufacturing costs. This return is more than six times the cost of the pulsation study.

Pulsation Bottle Optimization Generates Significant Savings

The project required two identical compressor packages – each one with 3500 HP, 3 stage, 6 throw, and operating between 700 and 1000 RPM. The pulsation solution for each unit required 6 bottles, most being acoustical filters that included baffles and choke tubes.

The standard (or default) approach to the acoustical design required large bottles, both in diameter and length. To accommodate the large diameter discharge bottles, the skid beams needed to be increased from the standard 24" beam to a 30" beam. The default approach to pulsation studies stops here.

The second approach involved optimizing the design of the bottles. As a result of using this approach, Beta Machinery Analysis (Beta) was able to reduce the material and manufacturing costs of the package. All bottles were re-designed to be smaller, which enabled a skid design using 24" beams.

An example of the difference in the bottle design for the 3rd stage discharge is shown in Figure 1 on the next page. Similar design changes were achieved in the other bottles. Both the standard design and optimized design resulted in acceptable pulsation and pressure drop.

...continued on page 3

The packager provided detailed costs for the different approaches, including labour, materials, and fabrication time. As shown in the chart below, the savings were over \$64,000 per unit, or \$128,000 considering both units. This represents approximately 6 times the return from the cost of the pulsation study.

There are significant costs savings associated with compressor bottle design optimization.

There are two critical requirements for efficient optimization. The software must:

1. Accurately calculate pulsation and acoustical forces at all operating conditions and at high frequencies; and
2. Determine dynamic pressure drop throughout the system.

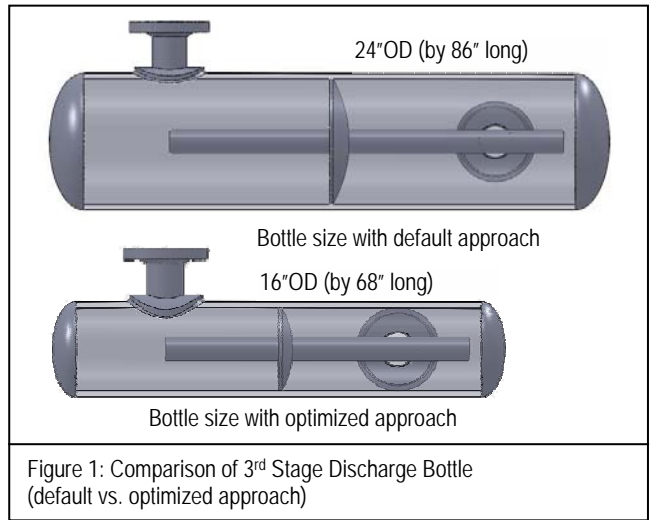


Figure 1: Comparison of 3rd Stage Discharge Bottle (default vs. optimized approach)

	Default Approach	Optimized Approach	Project Cost Savings with Optimized Design
Bottle Cost (labour and materials for 6 bottles)	\$58,100	\$39,450	\$18,650
Skid Costs (labour and materials)	\$113,000 (30" beam)	\$92,500 (24" beam)	\$20,500
Manufacturing Time (cycle time in engineering/shop)	Engineering & fabrication delays	Less time in shop	\$25,000 (conservative estimate)
Savings per unit			\$64,150 (one unit)
Total savings, 2 units			\$128,300 (two units)
Over 6X return with optimized design approach			

Through innovative software development, Beta introduced a Time Domain (TD) pulsation analysis solver in the early 2000s. The TD solver ensures accurate simulation of the pressure pulsations and the dynamic pressure, which is necessary for optimization efforts. As discussed below, the same level of analysis and confidence in the design is not possible with the older Frequency Domain (FD) solver.

Note that most other pulsation consultants only have FD solvers, and, therefore, cannot accurately measure dynamic pressure drop.

Limitations with Frequency Domain (FD) Solvers

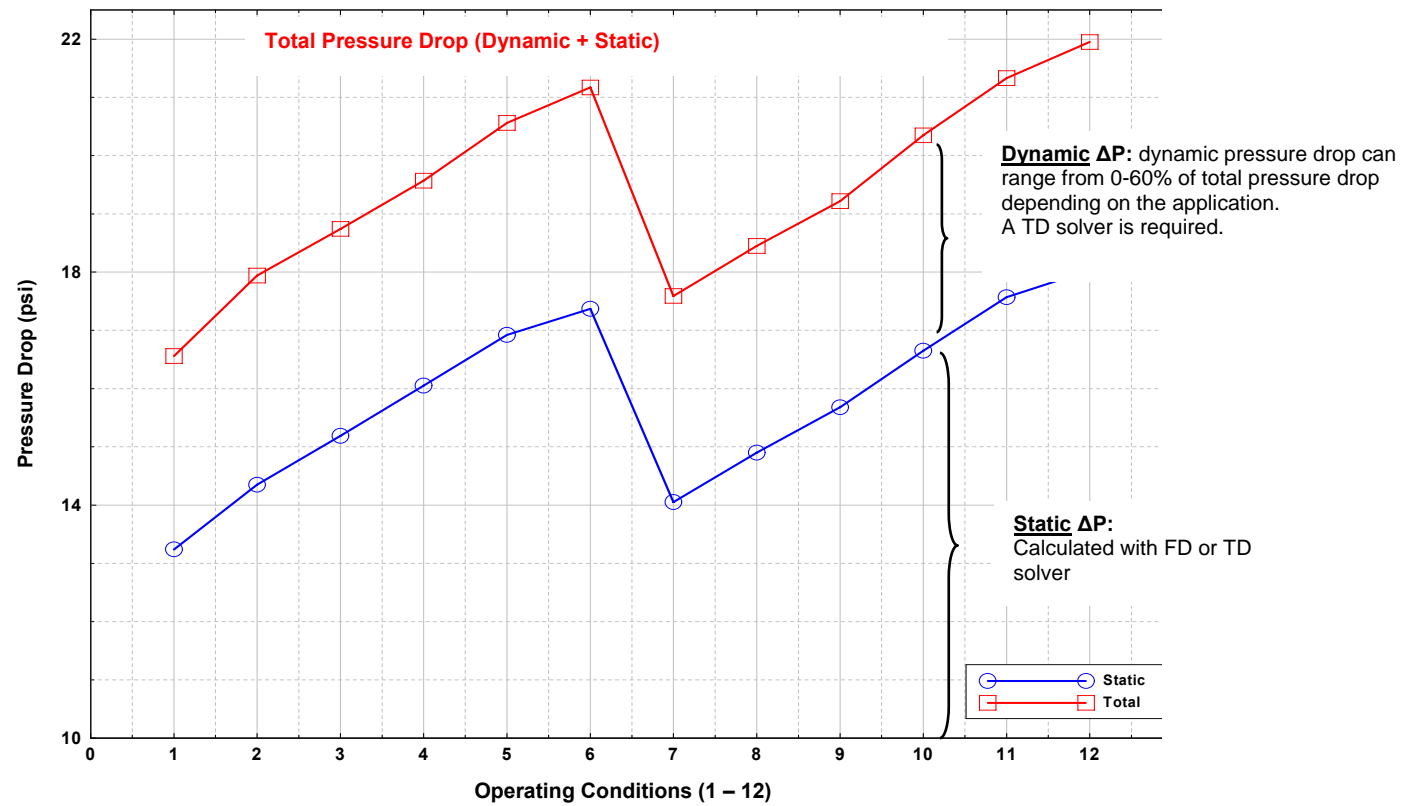
Past software limitations created technical challenges for the consultant. The software used a **Frequency Domain (FD)** based solver to calculate pulsations, unbalanced acoustical forces, and static pressure drop. Accuracy can be a problem with the FD solver, especially for high pressure applications, high clearance slow speed compressors, and pulsations at high frequencies. As a result, the pulsation control solution may be over-designed.

Another drawback with the FD solver is that it cannot accurately calculate dynamic pressure drop through the compressor system. This is important, since total pressure drop (static + dynamic pressure drop) is required to assess the package's total performance and losses in the vessels, bottles, coolers, and the rest of the piping systems. Figure 2, on the next page, illustrates static and dynamic pressure drop in a discharge system. Dynamic pressure drop can represent a significant portion of the total pressure drop in the system. The accuracy and limitations of the older FD simulation software can result in hidden costs such as:

- larger pulsation bottles,
- more expensive piping and skid design to accommodate larger bottles,
- the inability to assess total pressure drop and its impact on the required compressor performance, and
- higher total pressure drop, which reduces capacity and can lead to higher operating costs (higher fuel gas requirements).

...continued on page 4

Figure 2: Pressure Drop in the Final Discharge System



“Time Domain” Solvers Enable an Optimized Pulsation Control Solution

Time Domain (TD) solvers were first introduced by Beta in 1998 and upgraded in the early 2000s. Compared to Frequency Domain solvers, Time Domain solvers include the nonlinearity of pressure pulsations as well as an accurate model of the compressor cylinder operation.¹ The TD solver includes the effects of the cylinder clearance volume, cylinder valve resistance, and cylinder valve events, when calculating the system’s pressure pulsations. Therefore, the TD solver is more accurate. The TD solver calculates the alternating and mean pressure throughout the system which provides dynamic and static pressure drop. One drawback to TD solvers in the past was the increased computation time. Today’s powerful computers and optimized solvers mean that TD simulations are run quickly, so Beta uses TD solvers for all pulsation studies.

TD simulation enables owners and packagers to optimize their compressor designs, resulting in a more cost effective design. The approach also provides a better understanding of the system performance – a **key issue** for managing capacity and operating costs.

Summary

The standard, or default, pulsation design approach can produce “over-designed” bottles and pulsation solutions that result in unnecessary costs.

An optimized compressor package design can provide the following benefits:

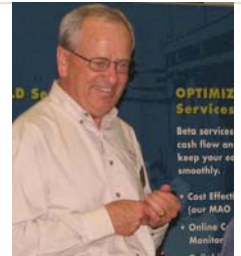
- practical pulsation solution,
- assist the packager in minimizing bottle and skid related costs,
- ability to accurately assess system performance, avoid surprises when the actual capacity is less than required,
- identify improvements to reduce total pressure drop (lower operating costs or higher throughput), and
- better information for the operators, including accurate system performance at every operating condition.

In the case presented, the default solution had significant hidden, or unnecessary, costs. The optimized approach generated a significant return on investment.

To improve the accuracy and financial return from your pulsation/vibration design studies, ensure that your supplier quotes an optimized pulsation solution and uses a Time Domain solver for the analysis. The older Frequency Domain solvers are not as accurate and do not provide the same level of confidence in the final design.

¹ For a more in-depth explanation of acoustical analysis, time domain vs. frequency domain simulations, and other case studies illustrating optimized design solutions, visit www.BetaMachinery.com.

Bryan Long on Asset Management



Asset Management – the 2008 viewpoint from Beta

The Beta companies have been involved with the development and application of predictive maintenance tools and technologies for over 30 years. First-of-type systems (DATA-TRAP and RECIP-TRAP) were developed and successfully commercialized by Beta personnel.

While engaged in these activities, it became increasingly evident that there was a gap between the technical activities of operating companies and their business objectives and activities.

To illustrate, we would ask both the technical people and the management personnel whether there was significant "waste" in their systems and, if so, how much. Almost everyone felt that there was significant waste in the forms of lost opportunity and unnecessary costs. A few grabbed a number like "two percent". But most readily acknowledged that they did not know how much, because it was not being measured.

This remains the usual situation today because:

- the business functions (accounting) cannot measure the "waste" at the machine level. Even when accounting can identify excessive costs or lost opportunity at an aggregate level, it is history and cannot be recovered; and
- the technical functions (reliability programs, predictive maintenance, ...) tend to operate in silos and do not, for the most part, develop the needed measures, especially higher level financial measures.

So, we were proclaiming the need for extending the condition and performance monitoring activities to bridge the gap. We applied the term "strategic machinery assessment (SMA)". Admittedly, the message was self-serving as we were offering products and services that at least made some effort to meet this need. This positioning served us well with a few customers. And, I believe, it served the customers well, too.

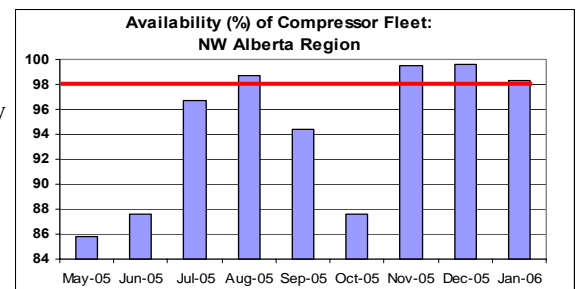
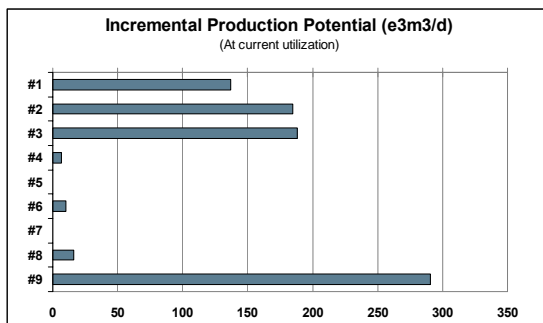
So, we arrive in 2008 (actually late in 2007); I encountered a most interesting article titled, "Asset Management - Chart Your Course Before You Begin Your Journey," in the October, 2007 issue of Uptime magazine. The article, written by John Woodhouse, describes a new European standard called PAS-55. In essence, PAS-55 is a modern and larger scope version of our old SMA concept. It's a good article and well worth reading for anyone involved in machinery operation or maintenance.

A few key points from the article are:

- Woodhouse states that all British electricity and gas distributors must be "PAS-55 by 2008". So it's not just a nice concept; it's a real process for managing physical assets.
- The article illustrates how performance and condition monitoring connects the physical asset processes with the business plan.
- Direct quote: "...there is an awakening to the need for business focus in place of technical or operational jargon..."
- Second part of the quote: "...there is an awakening to the need for ... bottom-up cost/risk/performance evaluation of individual activities (not just top-down budget setting of the past)."

Do we feel vindicated? Sure. And we continue to address this need within the services offered by Beta. For example, information generated by Beta's MAO (Monitor/Analyze/Optimize) service was key to achieving increased availability of a compressor fleet. Each 2% increase in availability represents about \$500,000 per year in increased cash flow.

Another valuable MAO measure directly related to business objectives is the additional production potential of each of the units in the fleet, as shown in the graph, below.




This information is important to operations and optimization personnel to ensure maximum economic performance.

Dr. Bryan Long is Director of Business Services at Beta Machinery Analysis

Beta News

New Machinery Diagnostic & Optimization Service

 M2M Data Corporation (M2M) and Beta Machinery Analysis (Beta) have partnered to develop a breakthrough new multi-tiered machinery diagnostic and optimization service that improves compressor value and lowers total life cost. The name of this service is Intelligent Machinery Service, or iMA™.

M2M remotely monitors over 8000 compressor and machine assets around the globe. Under the new iMA service, Beta will provide analysis and monitoring on the compressor, engine, and motor. We track the condition and performance data and give timely and practical feedback and recommendations to the owner.

This partnership is important as it represents the most cost effective real-time monitoring, analysis, predictive maintenance, and optimization solution available. Benefits include increased throughput, optimized performance, lower cost of maintenance, and emissions monitoring, to name a few. For more information about how this service can help your organization, see our web site www.BetaMachinery.com, and from the navigation bar, select Services > Monitor, Analyze, Optimize > intelligent Machinery Analysis.

Humour

You might be an engineer if:

- You have no life - and you can PROVE it mathematically.
- You've actually used every single function on your graphing calculator.
- You consider ANY non-engineering course "easy".
- You enjoyed trigonometry in high school.
- You can quote lines, or whole scenes, from Monty Python.

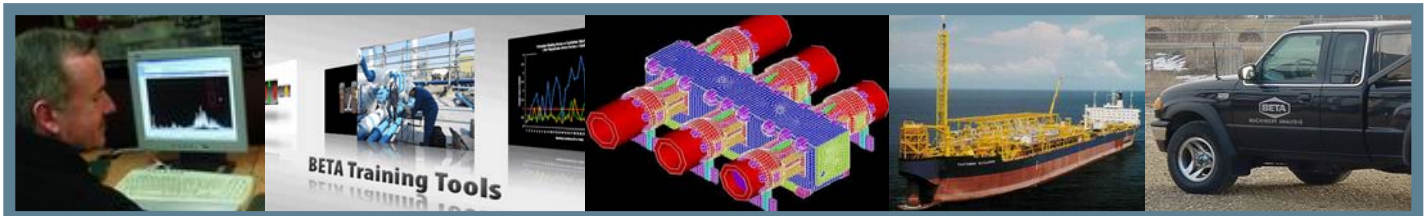
Trade Shows and Conferences

We've seen some of you at trade shows and conferences already this year and we hope to see you at these upcoming events:

Sep 8-11, **TurboMachinery Symposium**, Houston, TX. Booth #860. Technical papers TBA.

Oct 6-8, **GMC**, Albuquerque, NM. Booth 602. Technical papers TBA.

Oct 27-29, **EFRC**, Dusseldorf, Germany. Booth and technical papers TBA.



Do you have comments or questions about any of this material? Do you have topics you'd like to see covered in the Beta Bulletin? If so, send an email to: jwalters@betamachinery.com.

Sincerely,
Jackie Walters
Beta Machinery Analysis



2008 Technical Course Registration



1. Provide Personal Information *(please print clearly)*

Mr. / Ms. _____
 Last Name First Name Middle Initial

Job Title / Position _____

Organization _____

Address _____
 Dept, Street, P.O. Box, etc.

City Province Postal Code

Contact _____
 Phone Fax Email

2. Choose Course *(location for classroom training is the BETA Office: 300, 1615 10th Avenue SW, Calgary, AB T3C 0J7)*

A. An Overview of API 618 5th Edition A GoToMeeting Webinar and Discussion. Details provided to registrants.

- Tuesday, May 13, Noon MST Registration No Charge
- Thursday, June 12, Noon MST Registration No Charge

B. Pulsation/Vibration for Reciprocating Compressors (lunch is included with this course)

- Thursday, May 15, 9AM-1 PM Registration \$150CAD PDH 4

C. Torque Talk (Torsional Analysis)

- Thursday, May 15, 1:30 – 3:30 PM Registration \$100CAD PDH 2

3. Payment to Accompany Registration Form – *(Please add GST)*

Note: **Multi-employee discount** of 20% applies if more than one person attends from your company and payment is made with one cheque or credit card.

Cheque payable to Beta Machinery Analysis:

(mail to Course Registration, Beta Machinery Analysis, 300, 1615 10th Ave. S.W., Calgary, AB T3C 0J7 CANADA)

Credit Card (VISA or MC) _____ Exp. Date ____ / ____ (mm/yy)

Name on card (please print) _____ Signature _____

My signature acknowledges that I am authorized to use this credit card.

How did you hear about the course _____

Name as you want it on your certificate (classroom training) _____

4. Fax completed registration form to 403-245-3257

Cancellation Policy: Cancellations received more than 14 days ahead of the course are fully refundable. After that, at the sole discretion of Beta Machinery Analysis, registration fee may be applied as credit toward a future course. **Substitutions** can be made at any time with at least one day's notice. Beta Machinery Analysis reserves the right to cancel at any time with liability to registration fee only. In this case, every attempt will be made to give as much notice as possible.

For more information, call 1-800-561-2382, email jwalters@BetaMachinery.com,
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