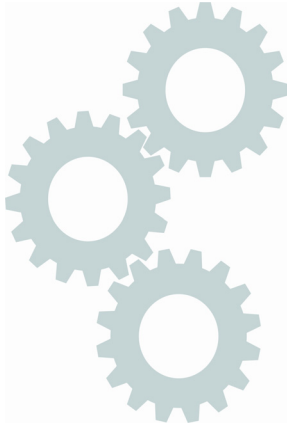


# the BETA BULLETIN



MACHINERY ANALYSIS



## Training

Our next classroom technical training for reciprocating and rotating equipment at Beta in Calgary and Houston is coming up in October. Registrations are now open. To find the schedule on our web site, [www.BetaMachinery.com](http://www.BetaMachinery.com), select Training and then click on Schedule. You can access course descriptions and registration forms from the schedule.

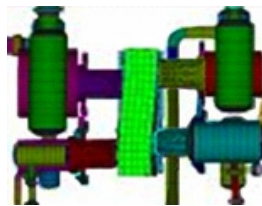
A training video explaining vibration issues in reciprocating compressor packages is coming up soon on our website.

## Ask the Expert

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

**Q - Is it important to consider the compressor frame in a mechanical model? I thought the frame is rigid and doesn't contribute to vibration in the piping system.**

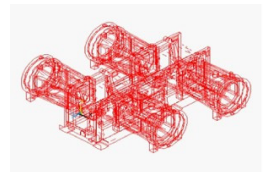
A - This illustration of the top view of a reciprocating compressor finite element model, shows the dynamic flexibility inherent in the frame.



A common assumption is that the compressor frame is rigid and has no movement, so it can be ignored in the mechanical model (i.e., API 618 M5 and M6 studies). In reality the compressor frame is NOT rigid, so dynamic flexibility of the compressor frame could be considered when designing the compressor skid, vessels and piping.

Recognizing this, Beta developed super-element models for many compressor frames. Super-element modeling is a proven technique for simplifying the simulation of complex systems and significantly reducing the analysis time. The super element modeling technique, when done correctly, can accurately represent the dynamics of the compressor frame. In a recent project where there were high frequency vibrations, modeling with the frame was within 1.0% of the measured field MNFs.

Beta recommends including the compressor frame in mechanical FEA studies when mechanical reliability is critical to the owner and the most accurate predictions are needed. This feature is an option to our Beta Design Study. **Beta's Application Note 5** on our web site more information about the super-element model.



- Kelly Eberle, Principal Engineer, Beta Machinery Analysis

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# Tech Tip

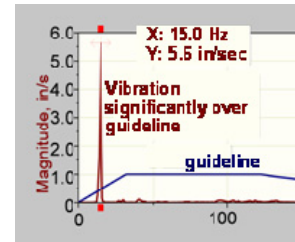
## To minimize resonance in scrubbers

During field troubleshooting assignments we often find scrubbers with vibration problems. The vibration problems can be limited to the scrubber or they can cause extreme vibration of the piping and other components connected to the scrubber, such as instrumentation. The chart below illustrates high vibration on a scrubber at 15 Hz (1 times run speed for 900 rpm compressor).

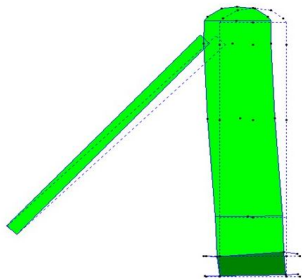
Excessive vibration leads to premature wear or failure of components that can compromise the safety of the installation and can result in a gas release. Fixing a scrubber vibration problem in the field is often expensive and can result in unplanned production downtime. To avoid this, there are some rules of thumb. Scrubbers should be designed so their MNF is above 2.4 times compressor speed. Several variables affecting the scrubber MNF are:

- Overall height
- Outer diameter
- Weight
- Stiffness of the scrubber base and skid underneath the scrubber

Beta can provide recommended scrubber designs (e.g., height vs. diameter ratio) to avoid resonance and to have MNFs greater than 2.4 times run speed. This service is included as part of our pulsation/mechanical design services.



Other important recommendations include:



- The scrubber skirt and scrubber shell should be approximately the same thickness
- The scrubber skirt must connect directly to the skid beams (either by welding or bolting). Baseplates should be avoided, if possible, as they tend to decrease the stiffness of the scrubber base.
- Four beams should be arranged in a box shape underneath the scrubber skirt, spaced approximately 90% of the outer diameter of the scrubber skirt, to ensure the skirt crosses the beam web at 8 locations.
- The skid below the scrubber should be grouted down to concrete, or at least two piles should be attached to the skid beams underneath the scrubber.

Refer to **Beta's Application Note 3** on our website for more information on scrubber designs to avoid resonance.

*Chris Harper, Principal Engineer, Beta Machinery Analysis*

## Some Thoughts on Offshore Applications

### #2 in our Optimization series



Last issue we gave an overview of different meanings people give the word "optimization". This time, let's look at the first meaning, **design optimization**, as it relates to **offshore applications**.

A growing number of reciprocating compressors are being used on Floating Production Storage and Offloading vessels (FPSOs). These compressors are significant sources of vibratory forces and can cause high vibrations of the compressors and FPSO module, resulting in costly and premature machine failures...as well as safety concerns to operators in work areas. Owners and engineering companies often require a dynamic analysis of the production structure when high horsepower reciprocating compressors are employed to mitigate these issues.

Based on our experience with over 60 offshore reciprocating projects, we discuss **new analysis techniques** to calculate the amplitude and location of high vibrations on the module deck and to optimize the topside module design. We'll look at an example that reviews an integrated design approach, combining the topside module structural model with the mechanical model of the compressor packages. We'll give a summary of the recommended specifications for performing dynamic analysis studies, and examples from recent projects – including a large FPSO project where three compressor packages were mounted on the topside module. To download the complete article from our website, [www.BetaMachinery.com](http://www.BetaMachinery.com), select Support and click on articles.

## Humour



An engineer was crossing a road one day, when a frog called out to him and said, "If you kiss me, I'll turn into a beautiful princess." The engineer bent over picked up the frog and put it in his pocket.

The frog spoke up again and said, "If you kiss me and turn me back into a beautiful princess, I will stay with you for one week." The engineer took the frog out of his pocket, smiled at it and returned it to the pocket.

The frog then cried out, "If you kiss me and turn me back into a Princess, I'll stay with you for one week and do ANYTHING you want." Again the engineer took the frog out, smiled at it and put it back into his pocket.

Finally, the frog asked, "What is the matter? I've told you I'm a beautiful princess and that I'll stay with you for one week and do anything you want. Why won't you kiss me?" The engineer said, "Look, I'm an engineer. I don't have time for a girlfriend, but a talking frog, now that's cool."

## Trade Shows and Conferences

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

- **Sept 10-13, TurboMachinery Symposium**, Houston TX. Stop by our booth #132 as we focus on optimization and what it means to you. Our Chief Engineer, Brian Howes, is one of the leaders for the discussion group for reciprocating compressors.
- **Oct 1-3, GMC**, Dallas, TX. Come and visit us at booth #702 and on October 2, at 2:15 p.m., plan to sit in on the technical paper, Integrating Compressor Performance with the Effects of Pressure Pulsations Across a Unit's Entire Operating Map, co-authored by one of Beta's Principle Engineers, Kelly Eberle.

## Beta News

### Offshore compressor projects

In the past few years, Beta has been awarded many **offshore projects**. Due to our technical leadership, we continue to grow in this field. Kelly and Chris share their thoughts on offshore structural dynamic analysis in a paper presented to the EFRC in March. Excerpts from this paper were also featured in the March and April issues of CompressorTechTwo magazine. See the article on Page 2, or visit our website for a free download of the complete paper. This, and all our technical papers can be found on our web site.

**Beta celebrates 40 years** in the industry; 1967 – 2007. Thank you to our excellent staff and valuable customers for helping us "**keep it running smoothly.**"

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](mailto:jwalters@betamachinery.com).

Sincerely,  
Jackie Walters  
Beta Machinery Analysis

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Thank you for your feedback.



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