RECIPROCATING COMPRESSOR MOUNTING
COMMENTS ON THREE POINT SUPPORT
TECH TRANSFER, INC.
23-DEC-98

UNBALANCED FORCES

In reciprocating compressors, mechanical vibration is generated by unbalanced forces and moments that are produced by two masses: rotating and reciprocating. Rotating masses consist of crankpin, crankpin web, and 2/3 the connecting rod weight. These masses generate forces at one times running speed (1X RPM). Reciprocating masses consist of the pistons, piston rods, crossheads, crosshead pins, and 1/3 the connecting rod weights. These masses generate horizontal forces at 2X RPM.

Also, there are unbalanced forces created by the gas compression in the cylinders. These are composed of cylinder load couples and crosshead support forces. Piping shaking forces due to gas pulsation are always present and acoustical resonance may occur.

Equipment, piping and skid vibration can cause downtime due to failure of structural, piping and instrumentation components.

UNBALANCED ENERGY DISSIPATION

The unbalanced forces present in all reciprocating compressor installations must be correctly dissipated through proper energy paths to prevent vibration problems. These energy paths are created by equipment support, piping support, skid design and skid mounting. If any one of these energy paths is not complete, the energy dissipates locally as vibration.

SKID DESIGN

Two of the most critical aspects to ensure acceptable vibration levels for a reciprocating compressor installation are: (1) correct skid design and (2) proper skid mounting.

In general, the skid must be stiff enough to transmit unbalanced energy into a support foundation (or structure) and prevent structural excitation. This requires a four-runner design with full depth longitudinal and transverse beams. In addition, equipment pedestals, crosshead supports and discharge bottle (or outboard cylinder) supports must be relatively stiff. Concrete fill in various skid areas is highly recommended to help dissipate energy as it passes through the skid; however, this can also be accomplished with steel mass.

In most cases, it is not practical to design a skid that is infinitely stiff with enough mass to dissipate all the unbalanced compressor forces. A skid can approach this goal but it becomes very large, massive and expensive.

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SKID MOUNTING

In most installations, much of the skid stiffness is provided by the support structure. Critical support points are at the following locations: (1) motor or engine feet, (2) compressor feet, (3) scrubber support, (4) cooler support and (5) skid ends. The skid should be supported across all four transverse beams at these five locations. A trampoline effect can result from support of perimeter beams only. The skid should be supported along the two inner runners.

For offshore installations, it is critical that the skid and deck designs be coordinated to set up proper energy paths to dissipate unbalanced compressor forces. Major beams in the equipment support pedestals, the compressor skid, and platform deck should be aligned. Proper sizing and alignment will allow energy from the unbalanced forces to go through the skid structure, into the platform deck and major truss framing where it is dissipated. The compressor skid should be welded directly to the platform beams, or pads welded to the beams, at the locations mentioned above.

In addition, a dynamic analysis should be completed on the platform structure with all the other major skids and masses included. The platform deck with the compressor skid should be designed so that the natural frequency modes do not coincide with the frequency of the unbalanced forces. This prevents the unbalanced forces from exciting the deck and creating excessive vibration.

THREE POINT SUPPORT

Reciprocating compressors (less than 400 HP and speeds below 900 rpm) have been successfully designed to accommodate 3-point mounting with acceptable vibration levels. However, the skid designs are very large and suitable equipment and piping designs have been incorporated.

Based on field experience, three-point support of a typical reciprocating compressor skid above 400 HP will result in significant vibration problems. The following are major reasons:

- The unbalanced forces cause a rocking motion at the compressor frame. The entire skid will twist from side-to-side in the compressor area. In extreme cases, coupling alignment cannot be maintained.

- Unbalanced forces have high vertical components, which cause a trampoline effect in

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the skid and high vertical vibration.

- Three-point mounting does not offer sufficient energy paths to transmit unbalanced energy into the deck. The energy is dissipated throughout the skid, equipment and piping, which causes high vibration and fatigue problems. Damage to piping, valves and instrumentation will cause high maintenance and excessive down time.

- In order to prevent high piping stress and fatigue problems, the inner connecting piping to the skid must be very flexible. If the piping systems are very flexible, they will develop high vibration and fatigue problems due to normal pulsation and mechanical excitation. Flexible connections in pulsating services are not recommended because they fatigue in a short period of time. In one-way or another, significant piping vibration problems will occur.

- Three point mounts are difficult to design for offshore service. If they are designed as pin connections (such as ball joints), they will lock-up over a period of time in an offshore environment due to corrosion, lubrication breakdown and galling.

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