Vibration Forced Vibration	Forced Vibration of Tank due to Pipe Pressure Pulsations of Reciprocating Compressor	Plant

Object Machine

Reaction tank wherein gas circulates by a reciprocating compressor (Fig.1)

Observed Phenomena

In a batch-operated reaction tank, the tank and its frame experienced large vibrations when operation started.

Cause Estimation

An agitator was installed in the reaction tank. During operation, a reciprocating compressor was applied to circulate gas. Thus, the following three factors are considered:

1) Whirling motion of agitator
2) Excitation of inner fluid caused by agitator blades
3) Excitation of inner fluid caused by pulsations of gas circulating in the reciprocating compressor

Analysis and Data Processing

Based on the assumed reasons, measurements were made of the pipe internal pressure pulsations at the points indicated in Fig.1, as well as of vibrations at the reaction tank main body and the frame, when the gas circulation flowrate was at 50% of the rated flow rate. Vibrations in the vertical direction were remarkable, which holds true for all the vibration measuring points. The maximum vibration amplitude was 481μm peak-to-peak, with its dominant frequency being 7.5Hz (Fig.2). The agitator has six blades and the rated speed of 110rpm. If the estimated cause was whirling motion of the agitator, vibrations in the horizontal direction should be prominent at 110rpm (1.83Hz), but if excitation of inner fluid caused by agitator blades was the cause, then the prominent vibration component should have the blade passing frequency (1.83 x 6=11Hz). However, the measurements do not agree with the above blade passing frequency. As the measurements of pipe internal pressure pulsations in Fig.3 show that a 7.5Hz component is dominant. This corresponds to the primary component of pipe internal pressure pulsations of ordinary reciprocating compressors (rotating speed of 445rpm), which agrees with the frequency of vibrations. The circulation gas blows out of a sparger located at the reaction tank bottom, and pulsations of the gas are not controlled to an adequately low level, thus blowing out regularly and intermittently. It is thus considered that the reaction tank is forced to vibrate in the vertical direction.

Based on this assumed reason, a trial was made to decrease the vibrations of the reaction tank by lowering the pipe internal pulsations. The gate valve located at the discharge snapper outlet of the reciprocating compressor was temporarily narrowed to allow measurement. As a consequence, steady pipe internal pressure pulsations due to the reciprocal compressor were sufficiently reduced, together with the amplitude decreased to about 1/2 (Figs.4, 5). However, these vibrations exhibit a form of free vibration due to random gas blowout, and the inadequate rigidity of the frame (beam) of the reaction tank was also suggested.

Countermeasures and Results

As a permanent measures, an orifice for reducing the pulsations was installed at the discharge snapper outlet of the reciprocating compressor. For this purpose, a pulsation analysis was conducted in advance to verify an adequate pulsation reduction effect. At the same time, the beam was also reinforced. These countermeasures taken have reduced the vibrations to a sufficiently low level.

Lesson

Keep in mind that reciprocal fluid machines, no matter how small and general-purpose ones, may be a source of vibrations. It is thus necessary always to control pipe internal pressure pulsations adequately.

References

Nothing in particular.

Keywords

Drum, agitator, reciprocating compressor, pulsation, sloshing, forced vibration

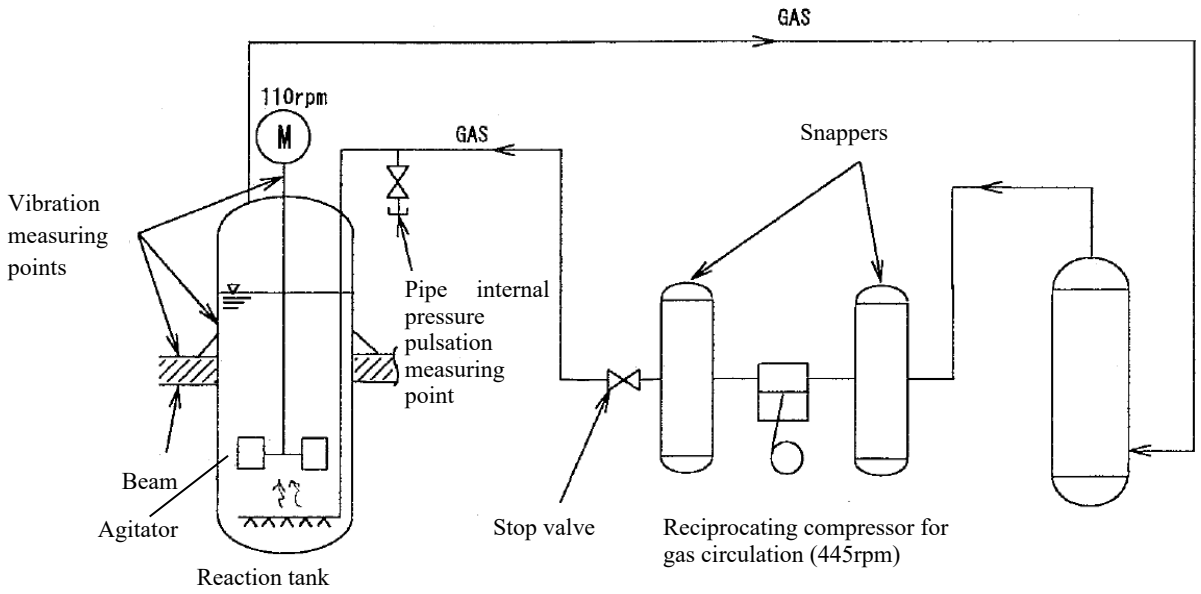

Fig.1 General process flow/vibration measuring points

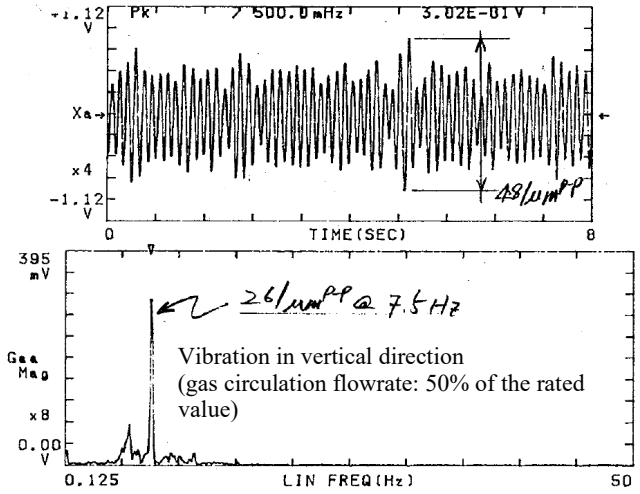

Fig.2

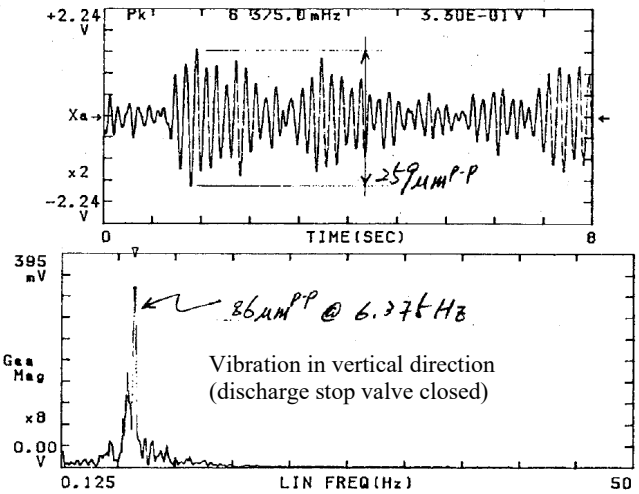

Fig.4

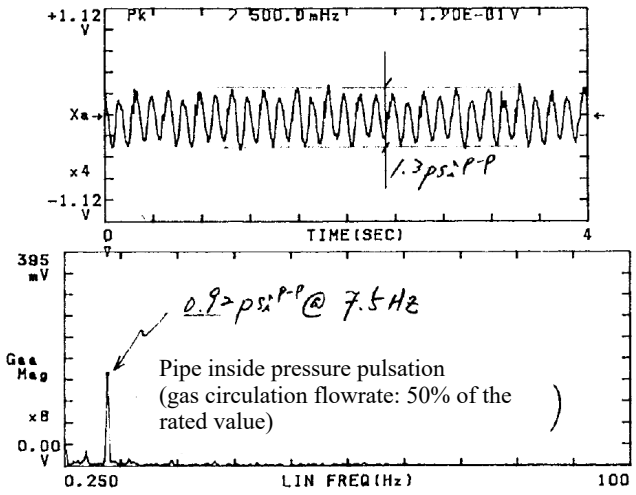

Fig.3

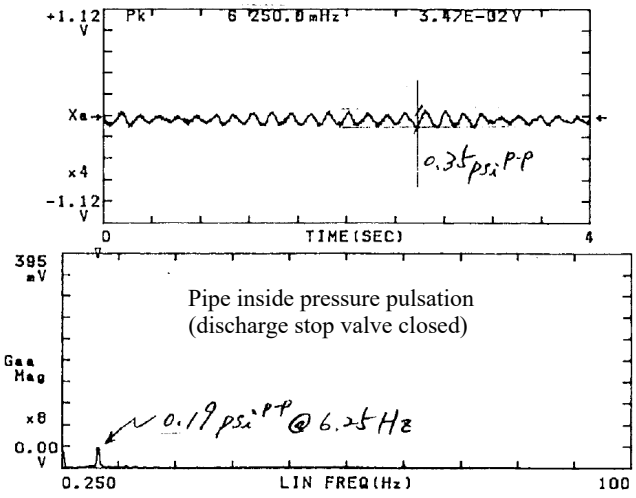

Fig.5