Kelm Engineering, LLC

"Turning theory into practical solutions"

API 674 Pulsation Analysis Project Definition

The purpose of this document is to define how Kelm Engineering, LLC defines the project assumptions and modeling requirements for an acoustic pulsation analysis job using API 674[1]. The referenced standard has definitions regarding modeling methods and allowable values that must be used in the analysis. However, most of the requirements are optional and require clear definition.

Report Deliverables

Additional reports, additional report details, and further design work beyond what is outlined below will require additional project scope.

- Design approach 1 (D1):
  - Pump pulsation report
- Design Approach 1+ (D1+):
  - Pump performance review
  - Preliminary acoustic analysis
  - Final acoustic analysis
- Design approach 2 (D2):
  - Pump performance review
  - Preliminary acoustic analysis
  - Preliminary mechanical analysis
  - Final acoustic analysis
  - Final mechanical analysis
- Design approach 3 (D3):
  - Pump performance review
  - Preliminary acoustic analysis
  - Preliminary mechanical analysis
  - Final acoustic analysis
  - Final mechanical analysis

[1] API Standard 674: Positive Displacement Pumps – Reciprocating. 3rd Edition, Dec 2010.

Pump Pulsation Analysis Report (D1) – This report provides recommended pulsation control equipment based on provided information, as well as guidelines for pipe lengths to avoid and minimum distance in-between supports. This report documents compliance with API 674 Design Approach 1. This report is generally an information only report to document the acoustical characteristics for the pump and pulsation control equipment using empirical and proprietary analytical techniques. Client comments are limited to additional documentation details and/or grammatical modifications.

Pump Performance Review (D1+,D2,D3): This is an information only report to document clear scope definition for the remainder of the project. Client review is encouraged with changes/updates to be included in the subsequent analysis. This report includes the following:

- Fluid properties to be used in analysis
  - Temperature
  - Pressure
  - Viscosity
  - Bulk modulus
  - Speed of Sound

- Pump properties to be used in the analysis
  - Stroke Length
  - Bore
  - Clearance Volume
  - Crank Length
  - Pump Speed
  - Flow Rate

Preliminary Acoustical Analysis Report (D1+,D2,D3): This report provides details for selection of pulsation control hardware that complies with API 674 Design Approach 2 maximum pulsation limits. This report will not include highly detailed analysis results, but is intended to provide the necessary information to allow the client to select appropriate pulsation control equipment. Selections made during client review will be incorporated into the final acoustical design. This report includes the following:

- Recommendations for dampener volume and orifice pressure drop required to meet API 674 maximum pulsation limits. Recommended volumes and pressure drop will be within reasonable limits.
  - Suction - only options that will not cavitate the pump shall be presented
  - Discharge - only options that meet relief valve criteria shall be presented

Preliminary Mechanical Analysis Report (D2,D3): This report documents piping natural frequencies that are below the minimum natural frequency limit required by API 674. Recommendations for possible approaches to handling piping natural frequencies will be provided. Feedback from the client following review will be incorporated into the final analysis. Report deliverables include the following:

- Mechanical natural frequencies below first exciting frequency
- Recommendation of most viable design criteria
    - Options included in base Design Approach 2
        - Recommend supports to ensure a +/- 20% spacing of natural frequencies from exciting frequencies
        - Recommend supports to ensure lowest natural frequency is 20% above first exciting frequency
    - Options included in base Design Approach 3
        - Recommend supports based on forced response analysis using dynamic stress, support loads, and vibration displacement as design criteria

Final Acoustical Analysis Report (D1+,D2,D3): This report is generally an information only report to document the final acoustical characteristics for the pump, pulsation control equipment and piping network. Client comments are limited to additional documentation details and/or grammatical modifications. Report deliverables include:

- Appendix including pulsation amplitude vs frequency plots for all nodes post dampener
- Appendix including shaking force vs frequency plots for all nodes post dampener
- Figure in report detailing maximum pulsation vs frequency node
- Figure detailing cavitation margin
- Orifice details

Final Mechanical Analysis Report (D2,D3): This report is generally an information only report to document the final acoustical characteristics for the pump, pulsation control equipment and piping network. Client comments are limited to additional documentation details and/or grammatical modifications. Report deliverables include:

- Additional support recommendations