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ESTIMATION OF HEAD LOSS DUE TO FLOW INTRUSION WITH INNER RING SPIRAL WOUND GASKETS

Dale A Rice, P.E.
VSP Technologies, Inc.
Prince George, VA, USA

Jerry Waterland
VSP Technologies, Inc.
Prince George, VA, USA

David G. Chandler, Ph.D.
Syracuse University
Syracuse, NY, USA

ABSTRACT

The spiral wound gasket, developed after the turn of the 20th century, has been a popular gasket choice in the chemical, petrochemical, power and other industries. Since that time, metal gasket manufacturers have developed various designs for this popular type of gasket, using different metals and fillers in the windings. As a result, some subsequent spiral wound designs have included a metal inner ring inserted inboard of the windings, with the primary objective of preventing inward radial buckling of this gasket as well as to cover more of the flange face and minimize erosion between flange faces. However, the cost of fabricating the spiral wound increases in accordance with the metallurgy of the inner ring, as does the assembly bolt force required to fully compress this now captured spiral winding. Additionally, another recently identified drawback of the inner ring is the head loss due to the contraction of the flow area caused by the inner ring intrusion into the flow for certain nominal pipe sizes (NPS) and pipe schedules. For example, standard ASME B16.20 spiral wound gaskets with inner rings designed for ASME B16.5 Class 150 raised face flanges extend inside the flange and pipe wall to varying degrees for most Schedule 10 pipe between NPS ½" and 6". Such intrusions can impact the flow in the form of minor head loss resulting from intrusion of the inner ring. Flow equations for an orifice can be used to estimate head loss; such an empirical equation has been applied to estimate head loss associated with an inner ring style spiral wound gasket in various pipe schedules and NPSs. Total head loss for multiple flanges in a pipe network has also been calculated as the head losses from individual "inner ring orifices" are accumulated. Several scenarios were identified to indicate where spiral wound gaskets with an inner ring can not only lead to pipe network head loss but substantial hidden energy costs.

INTRODUCTION

The spiral wound gasket was introduced in 1912 [1], as a result of the need to address the severe temperatures and pressures acting on flanged connections in U.S. refinery operations. The fabrication of the spiral wound with metal strip and filler materials provided an effective seal under such conditions. Eventually metal gasket manufacturers developed various designs for spiral wound gaskets, using different metals and fillers in the windings. One common problem with spiral wound gaskets is the tendency in some circumstances for the windings to become loose because of gasket inward radial buckling and enter the piping and process fluid. To compensate for this potential liability, manufacturers inserted a metal inner ring inboard of windings to create an inner ring style gasket, compared to spiral wounds with no inner ring (Fig. 1). This feature has improved performance in reducing inward radial buckling potential but usually increases the cost, especially when the metallurgy, which is often matched to that in the winding, is an exotic or higher cost material such as Inconel®, Monel®, Hastelloy®, or titanium. In addition, the inner ring style typically requires a greater assembly stress / torque to seat than its counterpart without an inner ring [2]. Some manufacturers have developed a gasket style similar to the spiral wound gasket with no inner ring but with spaced gaps or