

Jinzhe Gong, Martin Lambert, Angus Simpson, and Aaron Zecchin

**Closure to "single-event leak detection in pipeline using first three resonant responses" by Jinzhe Gong, Martin F. Lambert, Angus R. Simpson, and Aaron C. Zecchin**

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1 **Closure to “Single-event leak detection in pipeline using first three resonant responses” by J. Gong, M.F.**  
2 **Lambert, A.R. Simpson, and A.C. Zecchin**  
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18 The authors would like to thank the discussers for the meaningful contribution. The experimental data  
19 presented by the discussers demonstrate that rigid orifice-like leaks with various shapes of the opening  
20 can induce similar reflections under a transient event. The authors agree that the theoretical orifice  
21 equation [Eq. (12) in the original paper] is applicable to the rigid shaped leaks as reported by the  
22 discussers. However, the discharge coefficients can vary for orifices with different shapes. For any  
23 specific orifice, the relationship between the head loss and the flow under transient events is complex,  
24 but the steady-state orifice equation can be used as a good first approximation of the characteristics  
25 (Washio et al. 1996).

26 The discussion of the orifice equation in the original paper was in the section ‘challenges in field  
27 applications’. Leaks in real pipeline systems can be much more complex than the leaks as simulated by  
28 rigid orifices in the laboratory. Leaks in field pipelines can be induced by longitudinal or circumferential  
29 cracks rather than a small hole on the pipe wall. The opening of a real leak can vary within a transient  
30 event due to the circumferential and longitudinal expansion of the pipe wall, rather than maintaining a  
31 constant shape. As a result, the authors believe that dealing with the complexities of leaks in the field  
32 can be a challenge as identified in the original paper.

33 Published literature has reported that the theoretical orifice equation [Eq. (12) in the original paper  
34 under discussion] is unable to accurately describe the behavior of some real leaks even under the steady  
35 state. The theoretical orifice equation is written as  $Q = cH^\alpha$ , where  $Q$  and  $H$  are the discharge  
36 through and the head across a leak,  $c$  is the leakage coefficient and  $\alpha$  is the leakage exponent.  
37 Greyvenstein and Van Zyl (2007) reported that in the field the leakage exponent was often considerably  
38 higher than the theoretical value of 0.5, as used for rigid orifice shapes. Experimental results for leaks  
39 with various shapes and different pipe materials were presented in their paper. An example is that a  
40 corrosion cluster in steel pipes can have a leakage exponent up to 1.90 – 2.30.

41 The leakage coefficient and exponent have no effects on the determination of the leak location using  
42 the proposed three-resonant-responses-based technique. Eq. (10) in the original paper describes the  
43 relationship between the location of a leak and the relative sizes of the first three resonant peaks, and  
44 this equation is independent from any other properties of the leak. To accurately locate a leak is  
45 considered to be more important than the accurate estimation of its size. As a result, despite the  
46 challenges imposed by the complexities of leaks in the field, the proposed new technique is useful and  
47 can contribute to leak detection in water transmission pipelines.

## 48 **References**

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