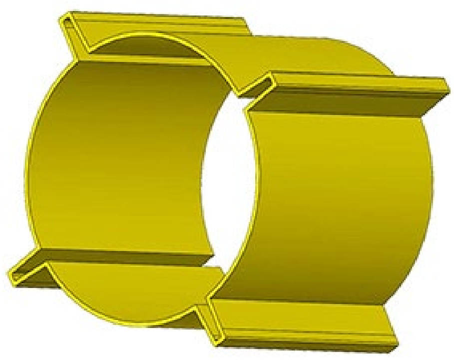
Hennings: Low-Cost VIV Assurance Devices

Henning Devices ("Hennings") are a new low-cost alternative to traditional VIV suppression devices such as helical strakes and fairings. While they are best suited for outside of the anti-fouling region, Hennings provide low drag and excellent VIV suppression at a much lower cost than helical strakes and fairings. Due to their low coverage density, Hennings are very fast to install.

Helical strakes and fairings are well proven VIV suppression devices that work well. Both provide very high VIV suppression effectiveness while fairings also produce very low drag. However completely covering every tubular with helical strakes, fairings, or a combination thereof, is very expensive and usually done to overcome modeling limitations. While it is common for a modeling program, such as SHEAR7, to indicate that sufficient VIV suppression can be obtained by covering only a relatively short length of the tubular, uncertainties in analysis often result in a decision to completely cover the tubular.

Long coverage lengths can significantly add to the overall tubular cost, especially when installation of the suppression devices is considered. If helical strakes are used, long coverage lengths can substantially add to the drag forces on the tubular and can potentially cause physical contact with adjacent tubulars or increased dynamic motions.

Hennings require only a small coverage density to be effective. While helical strakes and fairings usually have a coverage density of 80-100 percent, Hennings have been shown to be very effective at reducing VIV with a coverage density as low as 10 percent. Even if the tubular is fully covered with suppression, by utilizing Hennings over much of that length the overall quantity of suppression devices is greatly reduced thanks to the low coverage density of Hennings.



While various geometries of Hennings can be effective, the most effective geometry is a device that has four protruding "blades" or fins that are roughly 90 degrees apart. The Henning is free to rotate around the tubular which allows it to orient itself to an optimal position. A single thrust collar can be used for each Henning when properly designed.

Henning Devices are the result of a large number of tests on related devices and are the brainstorm of Dean Henning who, along with Li Lee, performed tests on several variations of Hennings. Tests on Hennings have been performed for various coverage densities[1]. Tests on a flexible cylinder experiencing first mode VIV at Reynolds Numbers up to about 250,000 were performed with Hennings spaced apart at various distances. Figures 1a and 1b show results for the tubular without Hennings (the “bare” tubular) and with Hennings spaced 3 pipe diameters (D) apart. Figure 2 is a photograph of the setup with Hennings at the 3D spacing.

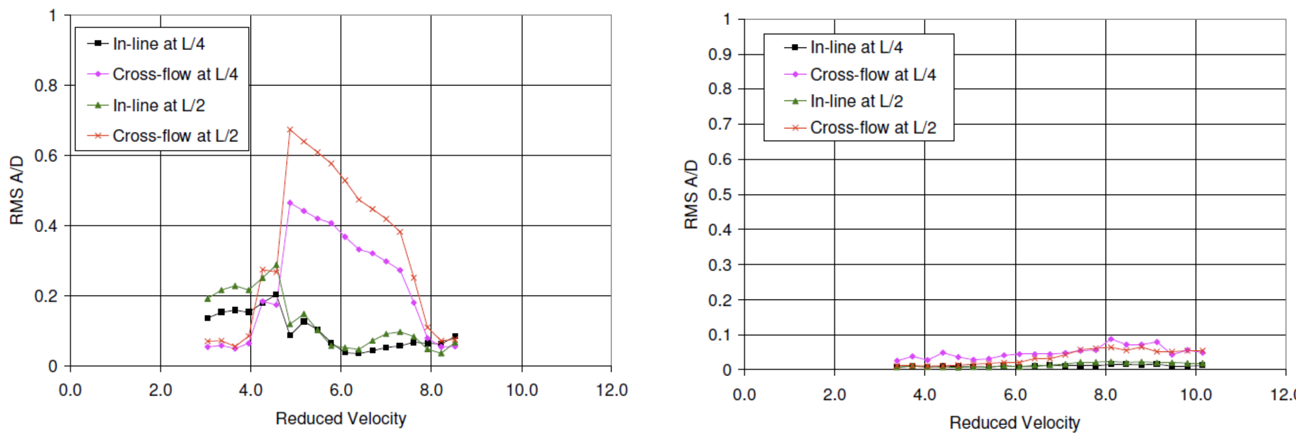


Figure 1: a) Bare Tubular; and b) Tubular with 3D spacing between Hennings

Figure 2: Henning Devices with 3D Spacing

These figures show that the Henning Devices had excellent VIV suppression.

These tests were repeated with distances between Hennings of 6D and 10D. The results are shown in Figures 3a and 3b.

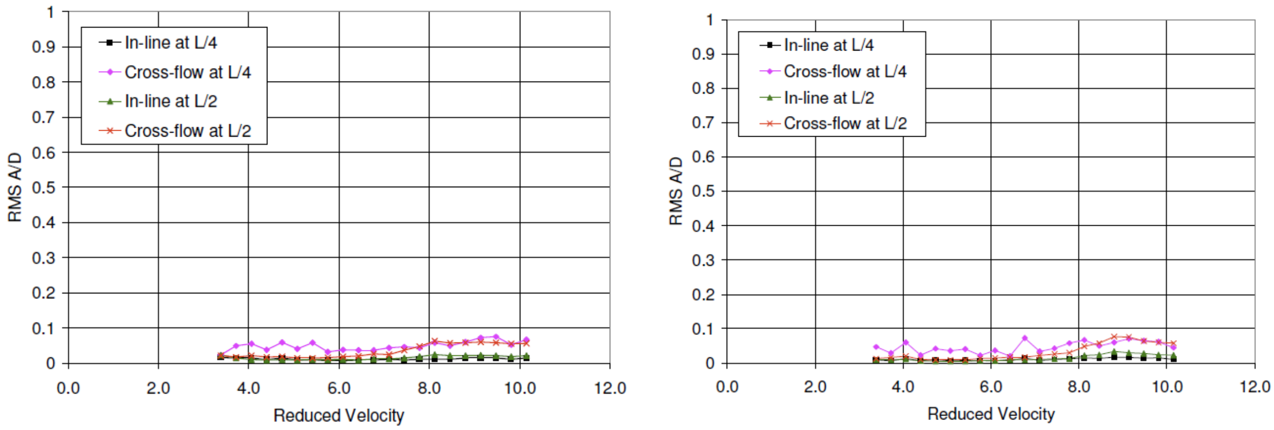


Figure 3: a) Hennings at a 6D Spacing; and b) Hennings at a 10D Spacing

Figures 3a and 3b shows how Hennings can be very effective even with very low coverage densities.

Hennings also allow for low drag. This is because the Henning reduces the VIV to a very low level so that the drag coefficient mimics that of a stationary tubular. Figure 4 plots the relative amplitude (with Hennings divided by the bare tubular) and drag coefficients for Hennings at various separation distances.

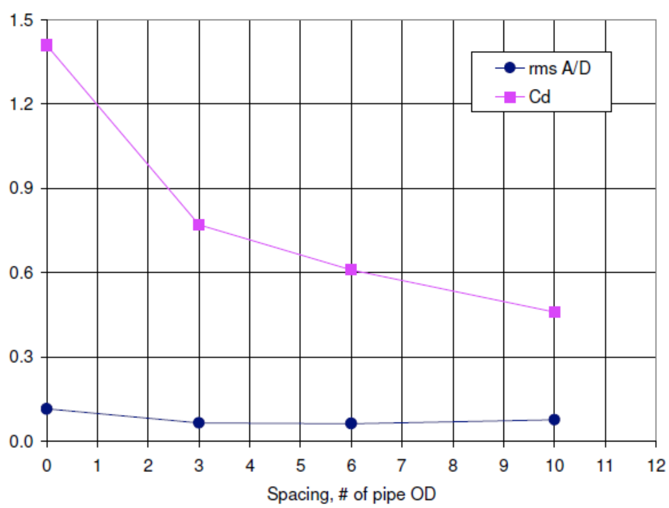


Figure 4: rms displacement ratio and Cd for Various Henning Separation Distances

Locally, the Hennings have higher drag due to their blades. However, as the density of Hennings decreases, the drag decreases since the pipe behaves asymptotically like a stationary bare tubular.

Computational Fluid Dynamics (CFD) was also used to model the Henning Device[2]. This study concluded that Hennings most likely gain their effectiveness by creating a highly three-dimensional flow pattern that disrupts correlation of vortex shedding along the tubular span. Figure 5 is a snapshot of the flowfield past a Henning Device at one time step during a CFD simulation of a single stationary Henning Device.

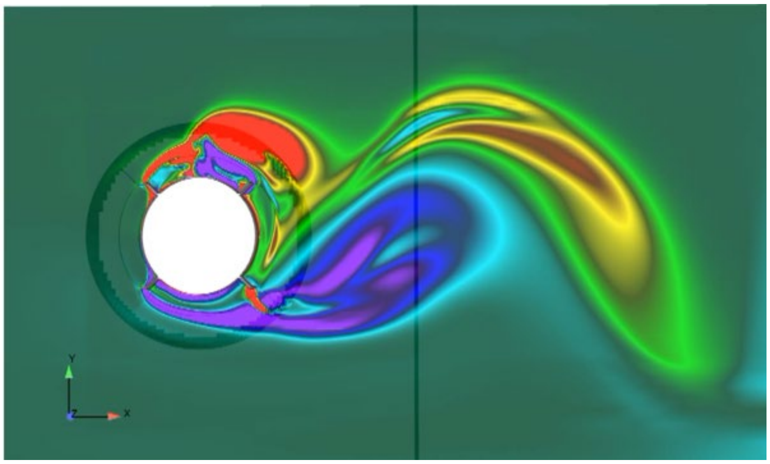


Figure 5: Flow Past a Single Henning Device at One Time-Step

Tests were also performed on Hennings with a moderately high degree of simulated marine growth and were less effective. Thus it is presently believed that Hennings should be used outside of the anti-fouling region.

Hennings are a patented technology that allow for substantial cost reductions for both the hardware as well as the installation costs[3]. These devices are especially attractive for adding to the coverage length of tubulars, such as risers and umbilicals, providing additional VIV assurance and the potential for significantly lower drag.

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[1] Lee, L., Allen, D. W., and Henning, D. L., (2009), Blade Henning Devices for VIV Suppression of Offshore Tubulars, Proceedings of the OMAE: 28th International Conference on Ocean, Offshore and Arctic Engineering, Honolulu.

[2] Pontaza, J. P. (2017), CFD of Henning Blade (Preliminary Results), Shell Global Solutions (US) Inc., private communication.

[3] Henning, D. L., Allen, D. W., and West, W. A. (2016), Apparatus for Suppressing Vortex-Induced Vibration of a Structure with Reduced Coverage, United States Patent 9,511,825.